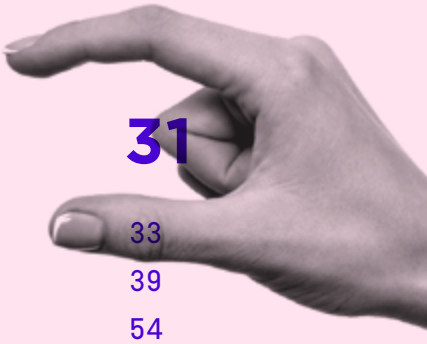
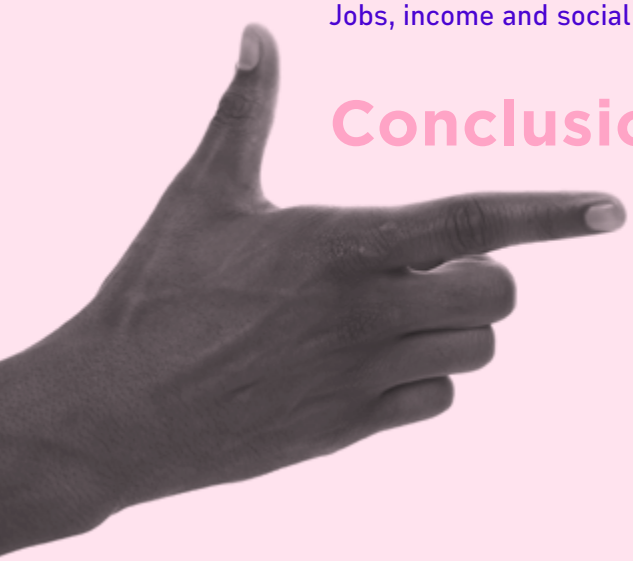
social services for digital citizens

Opportunities for Latin America & the Caribbean

IDB

CONTENTS





4IR

Fourth Industrial Revolution

The future is already here

There are at least 3 differences between this revolution and the previous ones

We are in the midst of the Fourth Industrial Revolution (4IR), which will affect governments, businesses and economies in substantial and unanticipated ways. Today's digital and automation technologies—driven by the exponential growth of smartphones, fast-paced technological innovations, and the constant stream of big data—are utterly transforming individual lives and societies. The Latin America and the Caribbean (LAC) region has seen substantial change in the past two decades regarding digital services, including increased internet usage and growing mobile penetration. However, around 300 million people still lack internet access, and important issues related to affordability, infrastructure, and demand remain.[1]

We should not underestimate the change ahead of us, as there are at least three differences between this revolution and the previous ones. The first of these differences is **speed**. Previous industrial revolutions took decades to occur, but the 4IR is rapidly unfolding. The second is that the 4IR is powered by a wide range of **new breakthroughs** not only in the digital realm (such as Artificial Intelligence-AI) but also in the physical realm (new materials), as well as the biological realm (bioengineering). Novel technologies and the interaction between them will offer fresh ways to create and consume, transform how we deliver and access public services, and enable new ways to communicate and govern. The third difference is that this revolution is not about a single product or service innovation— it is about innovating entire **systems**. Take, for example, the ride-sharing platform Uber. It is not producing new cars but rather an entirely new transportation system. It is creating the shared economy of tomorrow. With these changes, the transformation morphs from purely an economic one to a social one as well.

Disruption is the new normal and the digital transformation can spur innovation growth across many activities, transform public services, and improve well-being as information, knowledge and data become widely available. Once limited to futuristic visions of society, technologies such as automation and AI are becoming part of everyday life. Digital innovation is revolutionizing health, education, transport, and other public systems, contributing to our well-being and to the preservation of our planet. The 4IR transforms how we interact with one another, and broadly speaking, with society, changing the nature and structure of organizations and the profile of jobs, raising important issues around privacy, security, individualism,

1 OECD, Active with Latin America and the Caribbean, 2017, at http://www.oecd.org/global-relations/Active-with-Latin-America-and-the-Caribbean.pdf.

and skills, among others. Governments need to be forward-looking to seize these opportunities.[2]

4IR emerging technologies can help governments reduce costs while maintaining or even improving services. Rapid advances in technology are changing governance structures in fundamental ways, making them potentially more rational, effective, collaborative, transparent, and democratic. Whether participating in problem-solving or getting real-time feedback on the impact of a program, everyone now has levels of access once available only to major stakeholders and large organizations. Technology now reaches people who might never have thought of themselves as catalysts for change. Gaining access to these new technologies does not require substantial investments in software, platforms, apps, or systems; low-cost technologies can all increase government's efficiency and effectiveness. By increasing access and lowering barriers to entry and innovation, technology is enabling the democratization of governments. Although technology is a powerful force for change, this change does not take place easily or at the same rate throughout society. Poverty is a multifaceted phenomenon, which often entails one or more of these realities: a lack of income (joblessness), a lack of preparedness (education), and a dependency on government services (welfare). The emerging technologies of the 4IR, if implemented adequately, can address all three.[3]

The digital transformation requires that governments do some forward planning. Firstly, it is about equipping people with the necessary skills as well as an ability to upskill and reskill quickly. Secondly, governments need to prepare transition policies. There are going to be winners but also losers. This means building support plans that cushion the transition.[4]

2 Andy Wyckoff, 2017, Re-booting Government As A Bridge To The Digital Age, at http://www.oecd.org/internet/re-booting-government-as-a-bridge-to-the-digital-age.htm.

3 William D. Eggers, Laura Baker, Audrey Vaughn, 2013, Public Sector, disrupted: How Disruptive Innovation Can Help Government Achieve More For Less, at https://www2.deloitte.com/insights/us/en/topics/innovation/public-sector-disrupted.html.

4 Ibid.

Successfully navigating the digital transformation may be less about technology policy and more about distributional policy. How do we ensure that there are opportunities available to all? How do the winners lend a helping hand to the losers and those struggling? If today's leaders can make decisions that allow a promising and inclusive digitalized future to emerge, then everyone will benefit.[5]

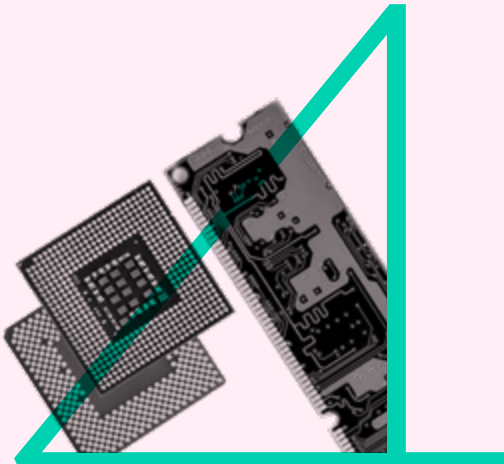
Innovative governments have realized that a citizen should not have to know the internal workings of complex bureaucracies to obtain the services they require. They have begun to change the way in which they do business by providing more holistic solutions that optimize services, according to the needs of their citizens, continuously improving services in response to feedback. Several trends have been observed in this area:

Governments are embracing user-centered design principles from the tech industry to innovate services.

Digital government efforts and the growth of data are leading to holistic and personalized services.

Governments are using transparency to build trust in these service innovations.

Governments are using systems thinking approaches to transform government at a at a systems level.[6]



5 Andy Wyckoff, 2017, Re-booting Government As A Bridge To The Digital Age, at http://www.oecd.org/internet/re-booting-government-as-a-bridge-to-the-digital-age.htm.

6 OECD, 2017, Embracing Innovation in Government Global Trends 2017, at https://www.oecd.org/gov/innovative-government/embracing-innovation-in-government.pdf.

Key building blocks of the fourth industrial revolution

Each decade has seen a new form of technological revolution

Reflecting on the past four decades of digital transformation, each decade has seen a new form of technological revolution: "personal computers" in the 1980s, the Internet in the 1990s, mobile computing and smartphones in the 2000s, and the Internet of Things (IoT) in the current decade. Basic computing and networking technologies continue to improve over time through, for example, continued miniaturization of devices, increased processing power and storage capacity at declining cost, and availability of higher speed on fixed and wireless networks. However, future potential economic and social benefits increasingly depend on more recent technologies that, in turn, rely on these existing and more mature fundamental building blocks, including the IoT, cloud computing, big data analytics, AI and blockchain. This set of technologies forms an ecosystem in which each technology both exploits and fosters the development of the others. Cloud computing is based on always-on everywhere-available and high-speed Internet connectivity and is essential to big data analytics, which relies on cheap and massive processing power and storage capacity. The power of big data depends on sophisticated algorithms that, in turn, form the basis of AI. To comprehend their – virtual or physical – environment and take appropriate decisions, machines such as robots and drones rely on AI that often uses big data to identify patterns. The characteristics of each of these technologies create a specific set of opportunities and challenges and, as such, can be considered separately. However, it is increasingly necessary to also analyze them within the broader context of the societal ecosystem without which they could not thrive, and to which they contribute.[7]

All these exciting developments are quickly permeating LAC and other emerging economies. This development is reflected in the Harvard Business Review Digital Evolution Index 2017. According to this Index, Mexico, Colombia, Brazil, and Bolivia are considered "break out" countries that are rapidly evolving to widespread digitally-driven innovation, and

7 OECD Digital Economy Outlook 2017, at http://www.oecd.org/internet/oecd-digital-economy-outlook-2017-9789264276284-en.htm.

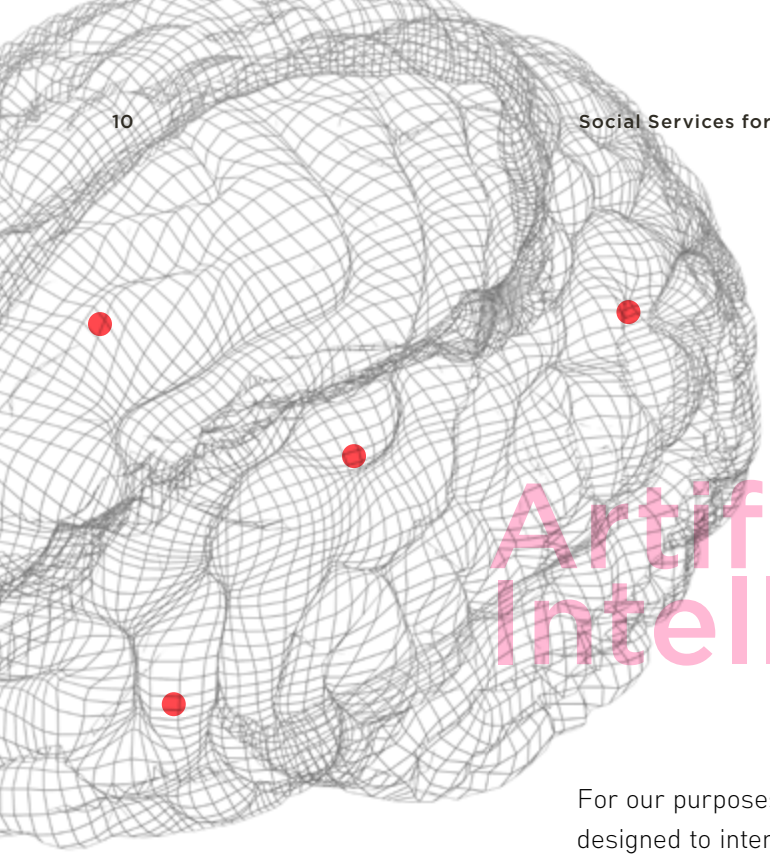
Chile is almost a top tier “stand out” country, with high digitization and innovation scores.[8]

Not every emerging technology will alter the social landscape, but some truly do have the potential to disrupt the status quo, change the way people live and work, and rearrange value pools. It is therefore critical that policy leaders understand which technologies will matter to them and prepare accordingly. This paper focuses on the following key building blocks of the 4IR in order to examine their impact on the social services sector in LAC: Artificial Intelligence, Blockchain, Internet of Things and Cloud Computing, Big Data, Virtual and Augmented Reality.

This document also touches upon other emerging technologies, such as:

- **3D Printing**
- **Advanced Robotics**
- **Mobile Internet**
- **Social Networking**

8 Claudio Muruzábal, 2018, For Latin America to thrive in the digital era, it must first teach minds, then the machines, at https://www.weforum.org/agenda/2018/03/here-s-how-latin-america-can-thrive-in-the-digital-era.



Artificial Intelligence (AI)

For our purposes, we define AI as computer systems that have been designed to interact with the world through capabilities (for example, visual perception and speech recognition) and intelligent behaviors (for example, assessing available information and then taking the most sensible action to achieve a stated goal) that we would think of as essentially human. These computer systems use a number of different algorithms and decision-making capabilities, as well as vast amounts of data, to provide a solution or response to a request.

AI is all too frequently used as a shorthand for software that merely does what humans used to do. However, replacing human activity is precisely what new technologies accomplish. What is novel about AI is that it is not simply replacing human activities external to human bodies; it is also replacing human decision-making inside human minds. This should not obscure the fact that AI itself is not one technology, or even one singular development. It is a bundle of technologies whose mode of decision-making is often not understood even by AI developers.

AI can help us in many ways: it can perform hard, dangerous or tedious work for us; help us save lives and cope with disasters; entertain us; and make our daily life more comfortable. AI scientists are currently building on new approaches in machine learning, computer modelling, and probability statistics to improve financial decision-making and are using decision theory and neuroscience to drive the development of more effective medical diagnostics. The real potential of AI includes not only the development of intelligent machines and learning robots, but also how these systems influence our social and even biological habits, leading to new forms of organization, perception and interaction. AI will extend and therefore change our minds.[9]

9 Rose Luckin, Wayne Holmes, Mark Griffiths, Laurie B. Forcier, 2016, Intelligence Unleashed; An argument for AI in Education, at https://www.pearson.com/content/dam/corporate/global/pearson-dot-com/files/innovation/Intelligence-Unleashed-Publication.pdf.

The ability of AI tools to automate processes depends on Five key considerations

Public agencies are leveraging AI tools to become smarter, more efficient, and more responsive. While AI has the potential to transform decision-making processes, these tools are often promoted as a one-size-fits-all policy solution. The ability of AI tools to automate these processes depends upon five key considerations:

1. It is important to understand the nature of the problem we are seeking to solve using AI tools. For example, not all policy decisions hinge on prediction; some policy problems require causal inferences, i.e., understanding the underlying mechanisms. Understanding the difference between the causation and prediction policy problem is a critical first step for developing AI tools.

2. Once the problem has been identified, it is important to consider the types of data available for addressing the problem. This has historically been a problem in government where data is fragmented, not normalized and widely disbursed. Building powerful AI tools that aid decision-making (or make decisions outright) depends on the availability of large volumes of data. Feeding quality data that draws from multiple sources is an essential ingredient for developing these AI tools.[10]

3. These AI tools need large volumes of training data. Consider the case of AI tools predicting crimes. To build these tools for monitoring and predicting occurrences of crime, the developer has to teach these tools to classify criminal versus non-criminal activities. Algorithms need sufficient training data to develop their predictive capacities before they can be deployed with confidence. In addition, the outcome dataset should be a representative sample that captures various nuances of the population set. From a policy perspective, this is a critical concern because of the digital divide: how many people have access to internet or smartphones to avail these services?

Policymakers have long grappled with the issue of designing electronic services that cater to the needs of all citizens. If the goal is improving customer services and including marginalized populations in decision-making, public agencies must examine the demographics of people using AI enabled public services.

10 Jon Kleinberg, Jens Ludwig, Sendhil Mullainathan and Ziad Obermeyer, 2015, American Economic Review: Papers and Proceedings 105(5):491-495, at https://www.cs.cornell.edu/home/kleinber/aer15-prediction.pdf.

4

It is critical to evaluate the quality of data that is integrated across databases. The AI tools' decision power depends upon the quality of data fed into these systems. AI tools that support decisions are only as good as the quality of data.[11]

5

Finally, as we increasingly leverage AI tools for sorting, recommending, and making decisions, we have to pay attention to protecting these tools from hackers. Coordinated initiatives across public agencies are a good first step towards protecting data from hackers, particularly as AI tools become a critical component for public service delivery. Public agencies also need to think about designing systems and data flow processes that have inbuilt privacy elements and are bias-free.[12]

✳ Use of chatbots in delivery of public services

Chatbots are computer programs that leverage machine learning and AI to complete tasks while mimicking human conversation.[13]

Public agencies are developing their own chatbots to transform their service delivery. Agencies are reducing employees' workload and response times by delegating mundane and routine tasks to chatbots, saving human labor for more technical and nuanced tasks. By leveraging AI to help with the routine requests, IT personnel can focus on complex issues that require human assistance.[14] Public agencies use chatbots to connect with citizens and engage diverse stakeholders in addressing social challenges. Cities in the U.S. are utilizing text-based services to aid citizens and government employees. Elsewhere, public agencies are using chatbots to help clients complete transactions. Chatbots can improve service delivery and help

11 Christopher Matthews, 2013, How Does One Fake Tweet Cause A Stock Market Crash?, at http://business.time.com/2013/04/24/how-does-one-fake-tweet-cause-a-stock-market-crash.

12 Kevin C. Desouza, Rashmi Krishnamurthy, and Gregory S. Dawson, 2017, Learning From Public Sector Experimentation With Artificial Intelligence, at https://www.brookings.edu/blog/techtank/2017/06/23/learning-from-public-sector-experimentation-with-artificial-intelligence; Eyragon Eidan, 2016, Keeping Bias Out Of Data (And Other Key Considerations), at http://www.govtech.com/Keeping-Bias-Out-of-Big-Data-And-Other-Key-Considerations.html.

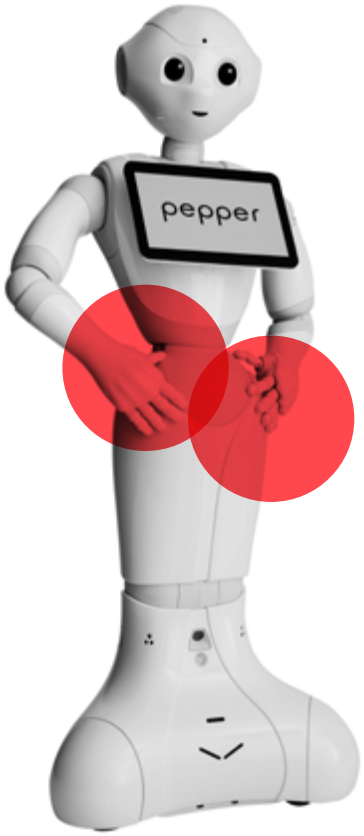
13 Jack Karsten and Darell M. West, 2016, Streamlining Government Services With Bots, at https://www.brookings.edu/blog/techtank/2016/06/07/streamlining-government-services-with-bots.

14 Jack Karsten and Darell M. West, 2016, Streamlining Government Services With Bots, at https://www.brookings.edu/blog/techtank/2016/06/07/streamlining-government-services-with-bots; Justine Brown, 2016, Chatbots Debut In North Carolina, Allow IT Personnel To Focus On Strategic Tasks, at http://www.govtech.com/computing/Chatbots-Debut-in-North-Carolina-Allow-IT-Personnel-to-Focus-on-Strategic-Tasks.html.

government better respond to citizens' needs.[15] Public agencies also deploy chatbots to receive instant feedback and understand citizens' perspectives about issues through surveys and gathering information in real-time.[16] The Government of Buenos Aires has a very successful example[17].

Open-source AI initiatives

Increasingly, organizations are sharing their AI tools as open software. The open-sourcing of AI tools is likely to spur rapid innovation in this area in which people are continually updating and learning from each other. AI tools can be utilized not only for automation or recommendation, but also as a strategic asset that can monitor information systems within and across public agencies.[18]



Emotion AI

An emerging trend in AI is to get computers to detect how we feel and to respond accordingly. They might even help us develop more compassion for one another. Technology that humanizes AI will be especially in demand as humanity comes to terms with the arrival of intelligent machines in our daily lives. With AI expected to create as many new jobs as it will destroy, public and government stakeholders, health care practitioners and education providers have an immense opportunity to be the first in their industries to capitalize on this technology. And as Emotion AI plays a progressively greater role in society, utilizing emotion-infused technologies will be more important than ever.[19]

15 Jack Karsten and Darell M. West, 2016, Streamlining Government Services With Bots, at https://www.brookings.edu/blog/techtank/2016/06/07/streamlining-government-services-with-bots/; Jessica Farrelly, 2016, Are Virtual Assistants The Future Of Public Sector Customer Service?, at https://www.criterionconferences.com/blog/government/virtual-assistants-future-public-sector-customer-service.

16 Alex Tilson, 2015, The Road To A More Connected Gwinnett County, at http://blog.textizen.com/gwinnett-20151027.

17 https://aivo.co/en/clients/government/case-study-buenos-aires-city-government/

18 Kevin C. Desouza and Rashmi Krishnamurthy, 2017, Learning From Public Sector Experimentation With Artificial Intelligence, at https://www.brookings.edu/blog/techtank/2017/06/23/learning-from-public-sector-experimentation-with-artificial-intelligence.

19 Madhumita Murgia, 2016, Affective Computing: How "Emotional Machines" Are About To Take Over Our Lives, at http://www.telegraph.co.uk/technology/2016/01/21/affective-computing-how-emotional-machines-are-about-to-take-ove.

We are surrounded by hyper-connected smart devices that are autonomous, conversational, and relational, but they are completely devoid of any ability to tell how annoyed or happy or depressed we are.

We are surrounded by hyper-connected smart devices that are autonomous, conversational, and relational, but they are completely devoid of any ability to tell how annoyed or happy or depressed we are. What if, instead, these technologies—smart speakers, autonomous vehicles, television sets, connected refrigerators, mobile phones—were aware of our emotions? What if they sensed nonverbal behavior in real time? Mood-aware technologies would make personalized recommendations and encourage people to do things differently, better, or faster.

Today, an emerging category of AI—artificial emotional intelligence, or emotion AI—is focused on developing algorithms that can identify not only basic human emotions such as happiness, sadness, and anger but also more complex cognitive states such as fatigue, attention, interest, confusion, distraction, and more. The field is progressing so fast that it is expected that the technologies that surround us will become emotion-aware in the next five years. They will read and respond to human cognitive and emotional states, just the way humans do. Emotion AI will be ingrained in the technologies we use every day, running in the background, making our tech interactions more personalized, relevant, authentic, and interactive.

Emotion AI has several potential benefits, such as serving as a companion or helping to perform certain tasks. It will also be used as a support to delivering social services, such as education, health, etc. For instance, in online learning environments, it is often hard to tell whether a student is struggling. By the time test scores are lagging, it's often too late—the student has already quit. But what if intelligent learning systems could provide a personalized learning experience? For example, researchers have used facial analysis to spot struggling students in computer tutoring sessions. The AI was trained to recognize different levels of engagement and frustration, so that the system could know when the students were finding the work too easy or too difficult. This technology could be useful to improve the learning experience in online platforms.[20] Another illustrative example are AI enabled devices through which we could track our mental state, sending alerts to a doctor if we chose to share this data. Researchers are looking into emotion AI for the early diagnosis of disorders such as Parkinson's and coronary artery disease, as well as suicide prevention and autism support.

There is a lot of evidence that we already treat our devices, especially conversational interfaces, the way we treat each other. However, we know

20 Will Knight, 2013, Facial Analysis Software Spots Struggling Students, at https://www.technologyreview.com/s/516606/facial-analysis-software-spots-struggling-students.

that younger generations are losing some ability to empathize because they grow up with digital interfaces in which emotion, the main dimension of what makes us human, is missing. Emotion AI just might bring us closer together.[21]

The notion of whether an AI could ever experience emotions remains controversial. Even if it could, there may certainly be emotions it could never experience, making it difficult to ever truly understand them. [22]

* AI ethics

As the use of AI enabled services becomes ubiquitous, regulators need to think about developing rules to manage security and privacy concerns associated with the use of these new tools.

The use of AI in provision of social sector services will give rise to new ethical and liability concerns. What happens if artificially intelligent chatbots learn harmful behaviors from their interactions with people? Developers of AI cannot predict every scenario in how these tools will learn and evolve as they interact with users. Furthermore, AI-based systems are outpacing the laws and regulations governing their development and use. As public agencies increasingly adopt AI solutions, they need to think critically about the issue of liability when the systems act unexpectedly. Building chatbots that are ethical will become an important issue, and public agencies should think creatively about the rules and regulations governing their use.[23]

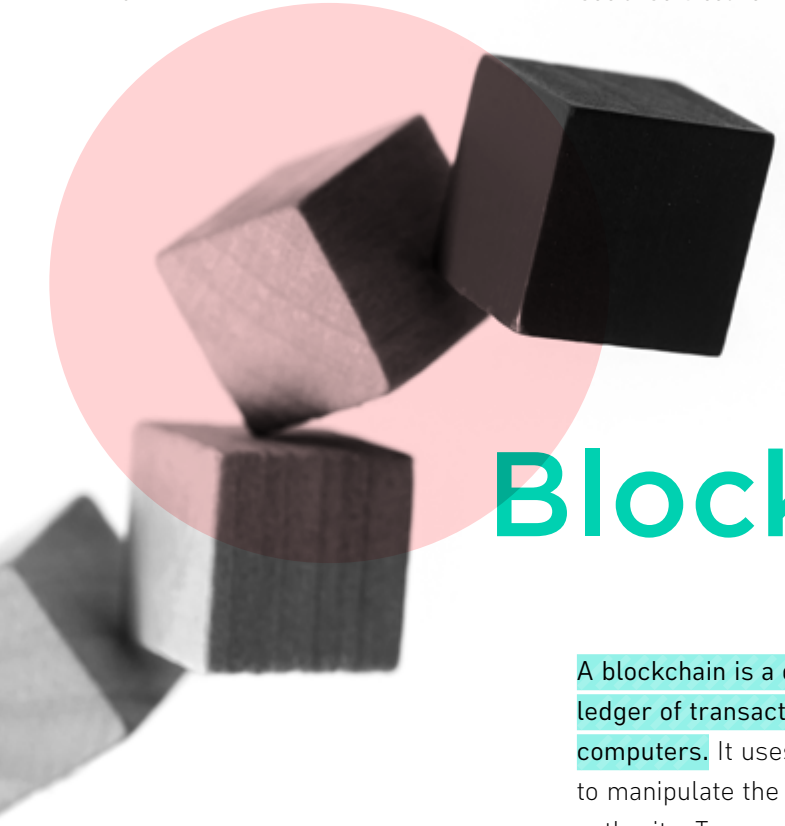
As the use of AI enabled services becomes ubiquitous, regulators need to think about developing rules to manage security and privacy concerns associated with the use of these new tools. Hackers and scammers could use chatbots to gather valuable personal information by contacting organizations and posing as clients. Similarly, they could design bots to target unsuspecting users. The issues of security and privacy will become more complicated as chatbots carry out more tasks and transactions.[24]

21 Rana el Kalioby, 2017, We Need Computers With Empathy, at https://www.technologyreview.com/s/609071/we-need-computers-with-empathy/; Danny Stern, 2018, These Industries Can Benefit From Emotion AI Now, at https://sternspeakers.com/news/industries-can-benefit-emotion-ai-right-now/?utm_campaign=Insights&utm_medium=email&_hsenc=p2ANqtz-8ex59Y_CSayNZy_cYv4Obwk6fKD-9xjLM9G5JvTlUX3SauTeeMpQwFSMDBFjrZy5N08kTftctr10Ljgcx55-K9l2YxcQ&_hsmi=59787862&utm_content=59787860&utm_source=hs_email&hsCtaTracking=1a13a6c8-f118-4b4d-80db-6fc4a256ec59%7C2a584351-2a52-448a-8c2a-4a2f54d403c5; Kevin C. Desouza and Rashmi Kirshnamurthy, 2017, Learning From Public Sector Experimentation With Artificial Intelligence, at https://www.brookings.edu/blog/techtank/2017/06/23/learning-from-public-sector-experimentation-with-artificial-intelligence.

22 WEF, 2017, With leaps and bounds in technology, will AI ever be able to understand emotion?, at https://www.weforum.org/agenda/2017/01/with-leaps-and-bounds-in-technology-will-ai-ever-be-able-tounderstand-emotion.

23 Alan Boyle, 2016, Microsoft's Chatbot Gone Bad, Tay, Makes MIT's Annual List Of Biggest Technology Fails, at https://www.geekwire.com/2016/microsoft-chatbot-tay-mit-technology-fails.

24 Kevin C. Desouza and Rashmi Krishnamurthy, 2017, Chatbots Move Public Sector Towards Artificial Intelligence, at https://www.brookings.edu/blog/techtank/2017/06/02/chatbots-move-public-sector-towards-artificial-intelligence.



Blockchain

A blockchain is a data structure that makes it possible to create a digital ledger of transactions and share it among a distributed network of computers. It uses cryptography to allow each participant on the network to manipulate the ledger in a secure way without the need for a central authority. Transactions are contained in blocks that are linked together through a series of hash pointers. Any tampering of a block can be detected since the hash pointer to it would no longer be valid. As a ledger system it is very open. In addition to the source code being openly available, a key feature of blockchains is that, in principle, every user has their own copy of the entire blockchain.

The blockchain is widely associated with Bitcoin, the first digital currency, invented by the pseudonymous "Satoshi Nakomoto" in 2008, but the technology has come a long way since then. New platforms offer sophisticated "smart contracts" that allow anything of value to be exchanged securely between multiple parties. Big financial institutions have recognized the disruption that blockchain applications will bring to their traditional ways of doing business and are investing heavily in "permissioned" systems that they can control.

✳ How does it work, exactly?

Imagine we have a bit of important information that we would like to store on the web, such as a birth or healthcare record. We may choose to store it in one of many blockchain networks to keep the data safe. To do that, we need to communicate to the network, in the form of a transaction, the information we want to store and wait until this transaction is collected in a block. A block is a just a chunk of information in the form of pieces of data called transactions, that is identified with a block number and hashed when validated. To be archived (become a permanent record), the data must be

What makes blockchain so special is that it cuts the middleman.

linked to the "blockchain" in a global network of millions of computers. The blockchain is the futuristic version of the old-fashioned paper ledger that businesses once used to keep track of their transactions.

Once the block is linked to the chain, everyone in the network gets an updated copy. So, if one computer gets shut down, it is not a problem. The millions of others in the network have a copy of the blockchain, and our record is safe. Our data, once on the blockchain, becomes what is known as "pseudo-anonymous," which means people can see that a transaction was made but will not see any specifics.

This is what makes blockchain so special: it cuts out the middleman. There are already lots of places where information can be stored online. Our bank keeps track of our financial transactions. Facebook is a compendium of what our friends are doing. In each of these cases, there is someone who owns and manages all that information, which could present problems. First of all, that middleman is holding our data and in theory could do whatever he wants with the information. Some middlemen are not willing to serve everybody. Poor people might not have enough money to open a bank account. And there is another problem: the middleman could also be hacked.

Once our data are part of the blockchain, it is difficult to change or remove them. In public networks, generally a group of special users in the network, called miners, help keep it honest by verifying the transactions. In private and federated networks, the administrators of the network are responsible for providing the system with a finite number of miner nodes for hashing blocks. If blocks were not mined -that is basically the process of validating and hashing them-, the blockchain won't be secure.[25]

✳ Smart contracts

Smart contracts are small computer programs stored on a blockchain, which will perform a transaction under specified conditions. A smart contract can be used as a script that simplistically states "transfer X to Y if Z occurs." Unlike a regular contract, in which after reaching an agreement, parties must execute the contract for it to take place, a smart contract is self-executing; i.e. once the instructions are written to a blockchain, the transaction will take place automatically when the

25 NPR podcast, Blockchain Looks To Change How To Do Business Online (2016), at http://www.npr.org/2016/05/09/477382547/blockchain-looks-to-change-how-to-do-business-online.

appropriate conditions are detected, with no further actions required by the parties to the transaction or other third parties.

The promise represented by smart contracts is that after digital records become verifiable, a whole new ecosystem of technical automation will start to evolve to produce a new social fabric that enables civic efficiencies, personal mobility, and institutional transformation. Within this context, smart contracts represent an automated view of the future.[26]

A game changer

Blockchain is secure, difficult to alter, and open to everyone

The nature of blockchain technology—secure, difficult to alter, and open to both the rich and the poor—is the reason why it could be a game changer for people living in low-income countries or fragile states at risk of economic collapse, corruption or conflict.

For instance, imagine a small farmer in Haiti. He dutifully registered his land, which his family depends on for food and income, with the government. The paper copy of his registration was then filed in a storeroom, but the earthquake in 2010 destroyed all the municipal buildings where deeds were stored. Now he does not have proof that he is a landowner. Or let us say the record of his registration is a digital file on a government database. It could be tampered with or erased, or maybe the database uses technology that is outdated or unsearchable. But if he filed his land deed in a blockchain, perhaps he could avert those problems. Mainly because he will not rely on a physical asset and because his ownership could be proved by other nodes in the blockchain.

Blockchain has other potential benefits. For instance, Sony Global Education adapted blockchain to file academic records, showing its promise in the education space—an area the World Bank has been watching.[27] Other industries that are bound for disruption include media, logistics, healthcare, and finance.[28]

26 JRC, European Commission (2017) Blockchain in Education, http://publications.jrc.ec.europa.eu/repository/bitstream/JRC108255/jrc108255_blockchain_in_education%281%29.pdf.

27 Malaka Gharib, 2017, Blockchain Could be a Force for Good. But First You Have to Understand it, at https://www.npr.org/sections/goatsandsoda/2017/01/11/503159694/blockchain-could-be-a-force-for-good-but-first-you-have-to-understand-it.

28 David Wither, 2018, 7 Predictions for Blockchain Technology in 2018, at https://www.influencive.com/7-predictions-blockchain-technology-2018.

✳ A challenge to implement it in low-income countries...

People in resource-strapped, low-income countries are in a poor position to adopt the technology.[29] Right now, if people want to use a blockchain-powered platform, they need a computer or smartphone and an internet connection. Many people in the developing world do not have these things. The challenge is how to make blockchain function on a mobile phone.[30]

Another key question is not whether blockchain systems will be used, but rather how they will be used. Bitcoin was born in the midst of disillusionment with the financial institutions that had betrayed the trust of their clients; the purpose of blockchain was to do away with the need for banks. Not surprisingly, financial institutions are investing heavily to stop this from happening and to tame the technology for their own purposes.[31] Will new and sophisticated platforms be used to widen access to education, allowing students to define and assemble their own mix of qualifications across a range of courses of their choice, from different institutions?[32]

The point of an open blockchain is to give a person secure and dependable control of their assets, whether money, an educational qualification, a work of art or anything else of value. This should reduce or remove inappropriate controls by intermediary organizations. As blockchain applications widen beyond digital currencies, enabling an increasing range of transactions, these new benefits are expected to support one another.[33]

29 Brett Scott, 2013, The Heretic's Guide to Global Finance: Hacking the Future of Money, at https://www.amazon.com/Heretics-Guide-Global-Finance-Hacking/dp/0745333508.

30 Malaka Gharib, 2017, Blockchain Could Be A Force For Good. But First You Have To Understand It, at https://www.npr.org/sections/goatsandsoda/2017/01/11/503159694/blockchain-could-be-a-force-for-good-but-first-you-have-to-understand-it.

31 There is also a concern with dealing with illegal activity and money laundering

32 Martin Hall, 2016, The Blockchain Revolution: Will Universities Use It Or Abuse It?, at https://www.timeshighereducation.com/blog/blockchain-revolution-will-universities-use-it-or-abuse-it.

33 Ibid.

Internet of Things (IoT)

The IoT represents the next step towards the digitalization of our society and economy, in which objects and people are interconnected through communication networks and report about their status and/or the surrounding environment.[34]

The IoT is an increasingly important aspect of life in and outside of the workplace, and analytics will naturally develop and evolve to handle the massive amounts of data generated by the growth of the IoT. The IoT is the concept of basically connecting any device with an on/off switch to the internet (and/or to each other). As things connected to the internet evolve, they will also become more intelligent, thereby providing more useful information. Rather than just report raw data, connected things will soon send higher-level information back to machines, computers, and people for further evaluation and quicker decision-making.

In the public sector, government agencies are being tasked to keep pace with expanding customer service requirements emanating from the connected economy.

In the public sector, government agencies are being tasked to keep pace with expanding customer service requirements emanating from the connected economy. New citizen engagement strategies involving technology, policy, programs and intra/inter-agency collaboration are required to address the avalanche of needs and fixes associated with interoperability and the IOT of smart government.

34 Internet of Things (Unit E.4), 2013, The Internet of Things, at https://ec.europa.eu/digital-single-market/en/policies/internet-things.

Big Data

Data has become a key asset for the economy and our societies, similar to the classic categories of human and financial resources. Whether it is geographical information, statistics, weather data, research data, transport data, energy consumption data, or health data, the need to make sense of "big data" is leading to innovations in technology, development of new tools, and new skills.

Big data refers to large amounts of data produced very quickly by a high number of diverse sources. Data can either be created by people or generated by machines, such as sensors gathering climate information, satellite imagery, digital pictures and videos, purchase transaction records, GPS signals, etc. It covers many sectors, from healthcare to transportation and energy.[35]

The current state of technology enables the world to grapple with some 2.5 quintillion bytes every day. Google processes 3.5 billion requests per day. Amazon has some 1.4 million servers spread across the world.[36] The constantly increasing availability of open data and data from social media, combined with the global multiplication of sensors linked to mobile phones, smart cities, the IoT, CCTV cameras, drones and satellites is generating previously inconceivable volumes of data on the physical and social environment. For instance, in just three years, the number of SIM-connected IoT devices in Organization for Economic Co-operation and Development (OECD) countries grew from 72 million to 124 million.[37]

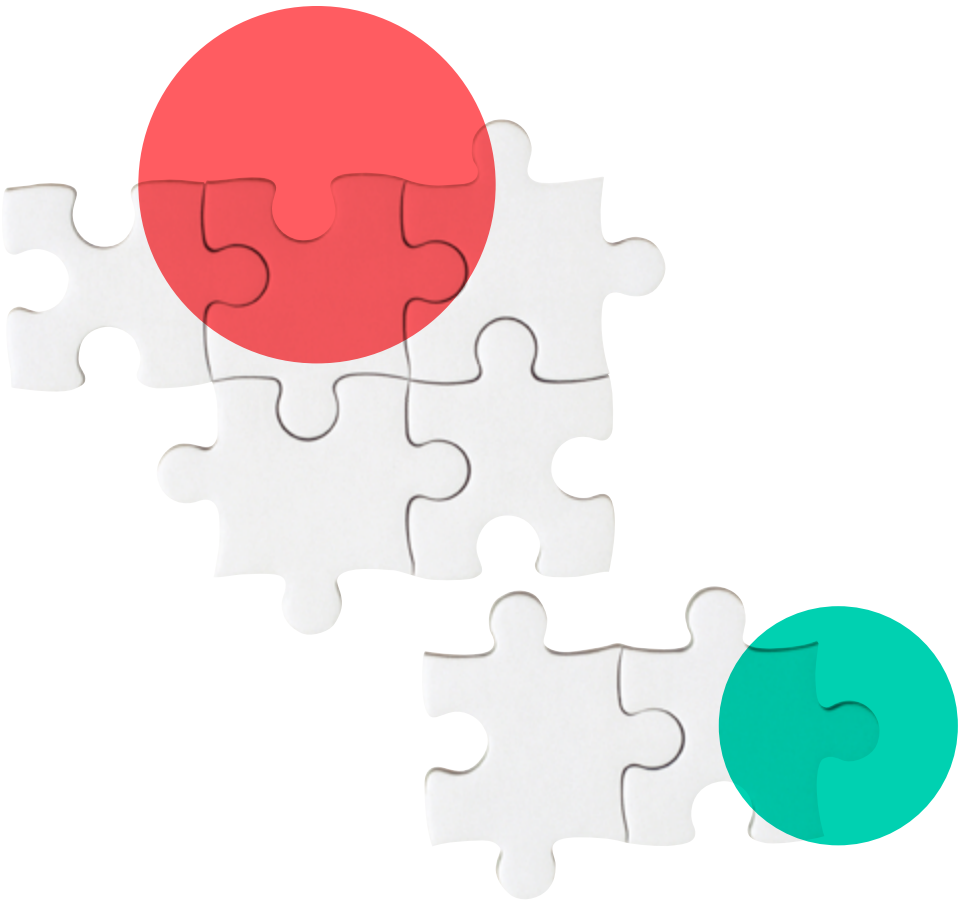
35 DG Connect, 2014, Big Data, at https://ec.europa.eu/digital-single-market/en/policies/big-data.

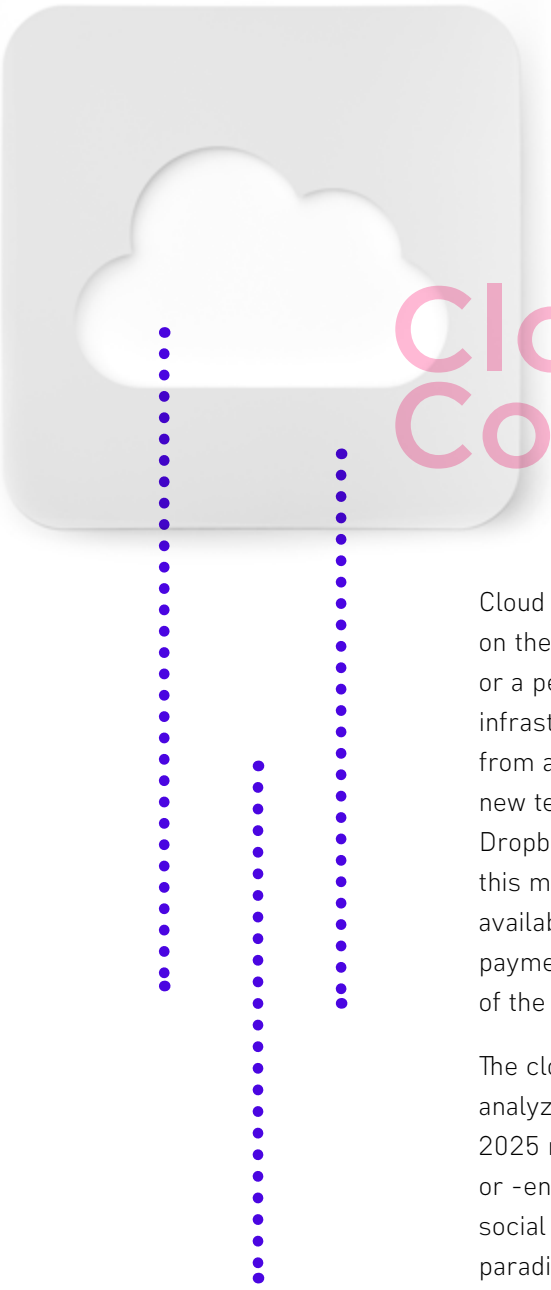
36 UNESCO, 2017, The Data Revolution in Education, at http://uis.unesco.org/sites/default/files/documents/the-data-revolution-in-education-2017-en.pdf.

37 OECD, 2017, Embracing Innovation in Government Global Trends, https://www.oecd.org/gov/innovative-government/embracing-innovation-in-government.pdf.

Innovative governments are taking advantage of big data from these machine sensors to develop new approaches to understanding and predicting trends affecting societies. These machine-generated data are being combined with citizen-produced data and government data to support early warning and indicator systems and to gather new insights for strategic policy-making. Big data sets can now be harnessed to better predict which programs help certain people at a given time and to quickly assess whether programs are having the desired effect.

If implemented adequately, big-data analytics promises something closer to an unbiased, ideology-free evaluation of the effectiveness of provision of public services in the social sector. We could come closer to the vision of a meritocratic, technocratic society that politicians at state and local levels have begun to embrace.





Cloud Computing

Cloud computing is the practice of using a network of remote servers hosted on the internet to store, manage, and process data, rather than a local server or a personal computer. It refers to an on-demand, self-service internet infrastructure that enables the user to access computing resources anytime from anywhere. It is a new model of delivering computing resources, not a new technology.[38] Examples of commonly used cloud applications include Dropbox and Google Docs. However, compared with conventional computing, this model provides three new advantages: massive computing resources available on demand, elimination of an up-front commitment by users, and payment for use on a short-term basis as needed.[39] Cloud computing is one of the building blocks of the 4IR.

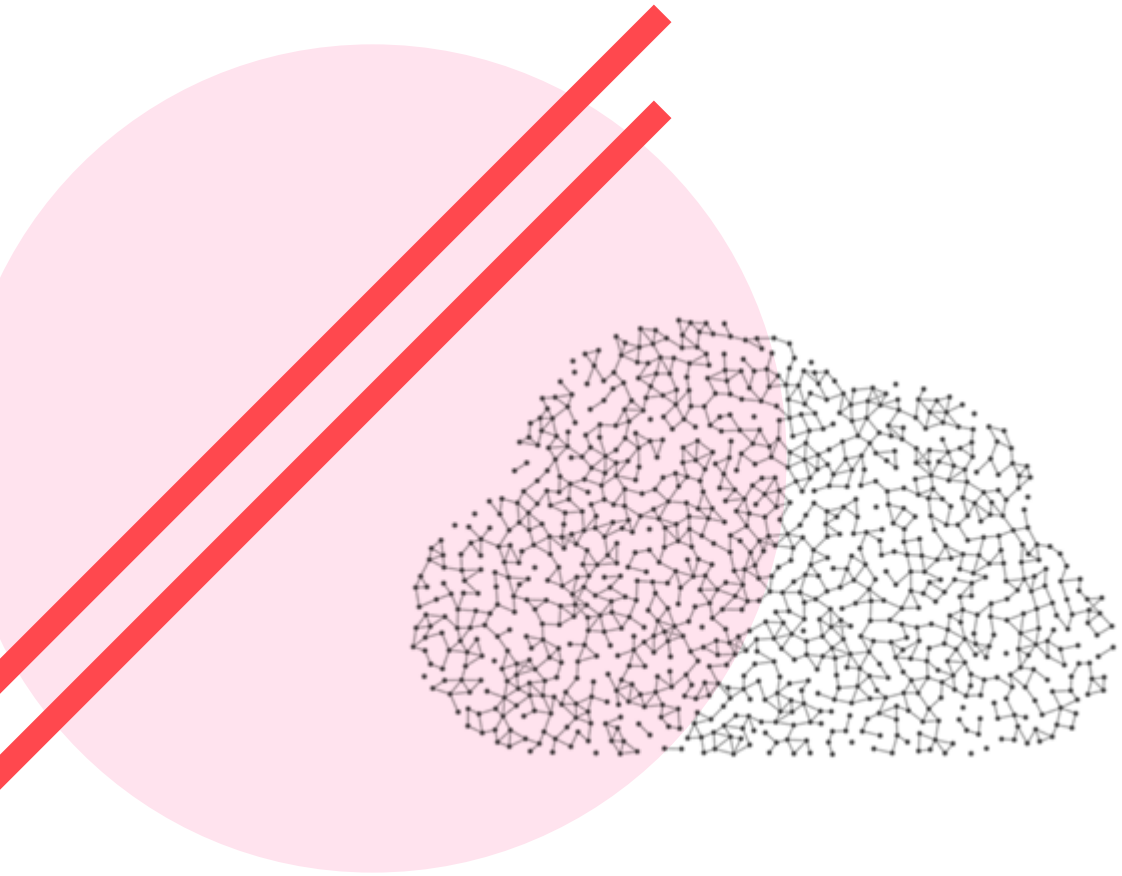
The cloud enables some of the most highly impactful technologies we analyze in this paper: mobile internet and the IoT. By some accounts, by 2025 most IT and web applications and services could be cloud-delivered or -enabled. Cloud computing holds great potential in the democratization of social services' delivery. As the cloud setup becomes a dominant computing paradigm, it could have wide-ranging implications for policymakers. Network capacity is a critical enabler for cloud computing, especially wireless networks for consumers using the mobile internet. Cloud technology is deployed through massive data centers that require high-capacity bandwidth. Thus, developing countries, LAC included, will have to deal with potential setbacks, such as infrastructure and internet access, in order to fully benefit from cloud computing.[40]

38 Mell P, Grance T. The NIST definition of cloud computing. Commun ACM. 2010;53(6):50.

39 Alex Mu-Hsing Kuo, 2011, Opportunities and Challenges of Cloud Computing to Improve Health Care Services, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3222190.

40 McKinsey Global Institute (2013) Disruptive technologies: Advances that will transform life, business, and the global economy, at https://www.mckinsey.com/~/media/McKinsey/Business%20Functions/McKinsey%20Digital/Our%20Insights/Disruptive%20technologies/MGI_Disruptive_technologies_Full_report_May2013.ashx.

LAC governments have started to use cloud computing as a way of generating benefits for the community. For instance, Peru's government used the cloud to increase citizen engagement by providing an app that located the nearest polling station for voters. The result was a nearly 60 percent reduction in voter absenteeism in 2016 compared to the 2011 presidential elections. The government of Antigua and Barbuda created a Citizen's Portal that increased citizen engagement and provision of services online to include the renewal of driver's licenses, applications for entry visas, and access to land and company registries. This has proven to be a cost-effective strategy.[41]



41 IDB (2017), Integration and Trade Journal: Volume 21: No. 42: August, 2017: Robot-lución: The future of work in Latin American Integration 4.0 at https://publications.iadb.org/handle/11319/8487.

Virtual Reality (VR) & Augmented Reality (AR)

Virtual Reality (VR) offers an entirely new experience by transporting the user to an immersive digital environment where the user is able to interact with the digitized construction. A decent VR system will allow navigation and manipulation of objects using a device commonly known as a flystick. There are also trackers and markers to keep track of user movement in the virtual environment (VE). In an ergonomics related project, markers are attached to strategic parts of the human body so that the VR system can keep track of the user's posture while he is performing a task.

VR has been in use for quite some time, but, lately, it has gained momentum due to advances in the technology and, most importantly, a steep drop in price for VR equipment. Although all these applications are meant for the gaming industry, real world application can also benefit from this advancement.

Unlike virtual reality, which transports the user, usually via a headset, into a fully virtual world, augmented reality (AR) applications present an illusion of layers of graphic information superimposed on some portion of the worker's field of view. Most AR systems currently deployed are tablet- or smartphone-based, although some are now moving aggressively in the direction of head-mounted displays (HMDs) that allow the worker to access AR data continuously, without interrupting a task, on a tablet display. According to Goldman Sachs' estimates, almost half of the AR industry's revenue will be generated in the enterprise and public sectors, with healthcare and engineering as the most promising areas of use (refer to Figure 1 below).[42]

42 Heather Bellini, 2016, Virtual And Augmented Reality: The Next Big Computing Platform?, at http://www.goldmansachs.com/our-thinking/pages/virtual-and-augmented-reality-report.html, Felix Ritcher, 2016, The Diverse Potential Of VR And AR Applications, at https://www.statista.com/chart/4602/virtual-and-augmented-reality-software-revenue.

Figure 1.
The Diverse Potential of VR and AR Applications. Predicted market size of VR/AR software for different use cases in 2025.

Source: Felix Ritcher, 2016, The Diverse Potential Of VR And AR Applications, at https://www.statista.com/chart/4602/virtual-and-augmented-reality-software-revenue/

A myriad of uses for AR exist in the broad public sector, and as with any new technological innovation, its potential is limited only by the creativity and ingenuity of its users.

A myriad of uses for AR exist in the broad public sector, and as with any new technological innovation, its potential is limited only by the creativity and ingenuity of its users. The following potential use cases, some of which are already being planned or in the proof of concept stage, provide a cursory overview of the possibilities.

AR could be used to provide government services, allowing for forms and applications to be accessed, viewed and completed through a variety of AR devices—smartphones, smart glasses, in-office displays and readers—with a full range of accessibility aids (sound, language translations, visual and graphic instructions, etc.). AR could be used for the creation and usage of policy, legal, regulatory documents and frameworks that can interact with citizens and officials via AR-enabled devices. AR could be used to give citizens and businesses the possibility to "see" what planned public-works projects—highways, water and energy facilities, public parks, new transit lines and stations, etc. —would actually look like and even interact with the augmented project.

AR could enable inspectors of all kinds—health, building and public safety, environmental quality, etc. —to instantaneously interact with data and information related to a facility, an agricultural area, a neighborhood or district. Communities interested in encouraging healthy and sustainable living for their citizens could connect healthy amenities—parks, recreation facilities, farmers markets and urban farms, community health festivals—to healthy activities such as walking and biking, wayfinding and getting-around resources that offer "healthy" options, or options with the lightest carbon footprint. Imagine a host of environmental quality (air, water, ground, etc.) detectors and AR combined with environmental sensors to allow environmental officials and citizens to make real-time decisions on movement, activity and official response.[43]

43 Ibid.

Other emerging technologies

✳ 3D Printing

Additive manufacturing, also known as three-dimensional (3D) printing technology, promises to revolutionize manufacturing. The process of 3D printing stacks multiple layers of two-dimensional printing on top of one another. It is a disruptive technology and a major driving force in many areas including bioengineering and medicine.[44] The main economic advantages of 3D printing are that it substantially reduces the cost of manufacturing, and virtually eliminates the cost of distribution. Medical applications for 3D printing are rapidly expanding and are expected to revolutionize healthcare.[45] The technology of 3D bioprinting, which synergistically combines synthetic biology's building blocks with the 3D printer's mechanics to form functional living tissues and organs, provides much more than mere economic implications—it promises medical breakthroughs on an unprecedented scale. It is likely that this technology will gain prominence in the coming years and have a far-reaching impact on our daily lives.[46]

44 Phoebe H. Li, 2014, 3D Bioprinting Technologies: Patents, Innovation and Access, 6 Law, Innov. and Tech. 282-304.

45 C. Lee Ventola, 2014, Medical Applications for 3D Printing: Current and Projected Uses, 39 P&T 704-711.

46 Roots Analysis, 3D Bioprinting Market, 2014-2030, at http://www.rootsanalysis.com/reports/ view_ document/3d-bioprinting-market-2014-2030/55.html.

✳ Advanced Robotics

70%

of young people believe that robots will be able to do many of their jobs within 10 years.

Increasingly capable robots or robotic tools, with enhanced "senses,"" dexterity, and intelligence—can take on tasks once thought too delicate or uneconomical to automate. These technologies can also generate significant societal benefits, including robotic surgical systems that make procedures less invasive, as well as robotic prosthetics and "exoskeletons" that restore functions of amputees and the elderly.

A recent IDB report highlights the fact that over 70 percent of young people believe that robots will be able to do many of their jobs within 10 years. In addition, 32 percent of Latin Americans look positively on the spread of robots to care for the elderly and the sick, among other potential applications. Nevertheless, levels of technological awareness vary by social class and level of education.[47]

✳ Mobile Internet

7

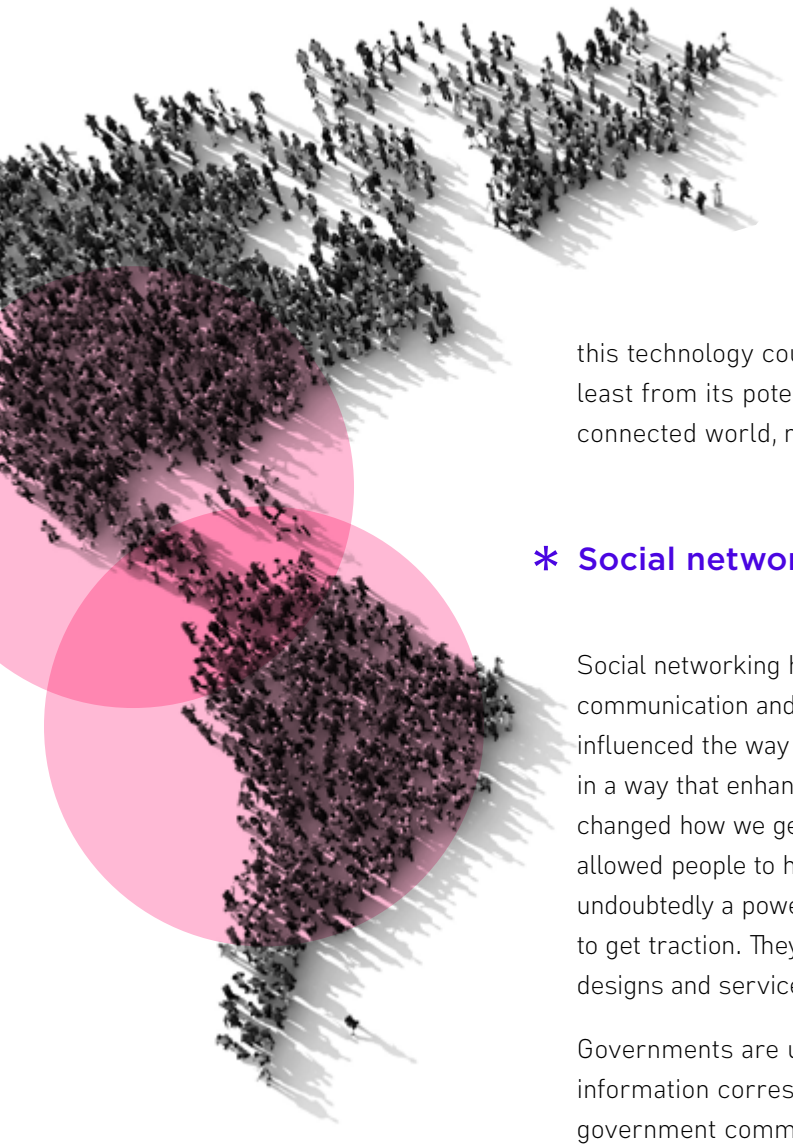
billion people
have access to mobile phone.

A 2013 UN study estimated that out of the world's estimated seven billion people, six billion have access to mobile phones. Far fewer—only 4.5 billion people—have access to working toilets.[48]

The use of mobile internet technology is already prevalent, with more than 1.1 billion people currently using smartphones and tablets. Equipped with internet-enabled mobile computing devices and apps for almost any task, people increasingly go about their daily routines using new ways to understand, perceive, and interact with the world. In a remarkably short time, mobile internet capability has become a feature in the lives of millions of people, who have developed a stronger attachment to their smartphones and tablets than to any previous computer technology. However, the full potential of the mobile internet is yet to be realized; over the coming decade,

47 IDB, 2017, Integration and Trade Journal: Volume 21: No. 42: August, 2017: Robot-lución: The future of work in Latin American Integration 4.0, at https://publications.iadb.org/handle/11319/8487.

48 Wang, 2013, More People Have Cell Phones Than Toilets, U.N. Study Shows, at http://newsfeed.time.com/2013/03/25/more-people-have-cell-phones-than-toilets-u-n-study-shows.



this technology could fuel significant transformation and disruption, not least from its potential to bring two to three billion more people into the connected world, mostly from developing economies.[49]

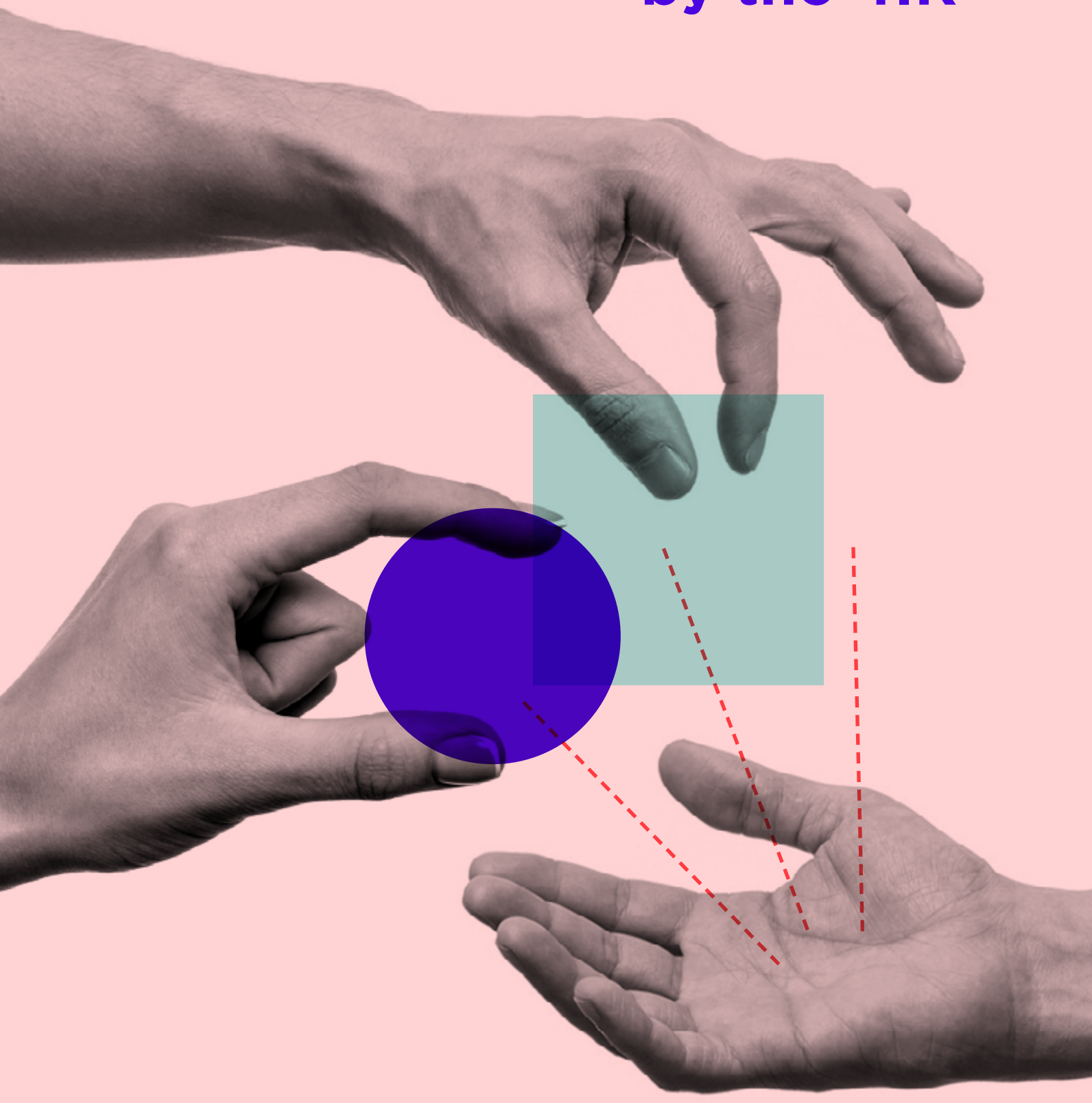
Social networking

Social networking has changed the access and rate at which people access communication and how they collaborate. It has spurred new ideas and influenced the way we think about democracy. It has democratized information in a way that enhances education and new ideas. Twitter, as an example, has changed how we get news. Social networking is a powerful tool that has allowed people to have a voice and connect globally. Social networks are undoubtedly a powerful tool to both spur innovative ideas and influence them to get traction. They allow us to aggregate opinions, get feedback for service designs and service reviews, and have new channels of democracy.

Governments are using social media to reach specific groups with information corresponding to their needs, meaning better citizen-government communication, and social media is also helping disadvantaged groups connect and co-operate.

49 McKinsey Global Institute (2013) Disruptive technologies: Advances that will transform life, business, and the global economy, at https://www.mckinsey.com/~/media/McKinsey/Business%20Functions/McKinsey%20Digital/Our%20Insights/Disruptive%20technologies/MGI_Disruptive_technologies_Full_report_May2013.ashx.

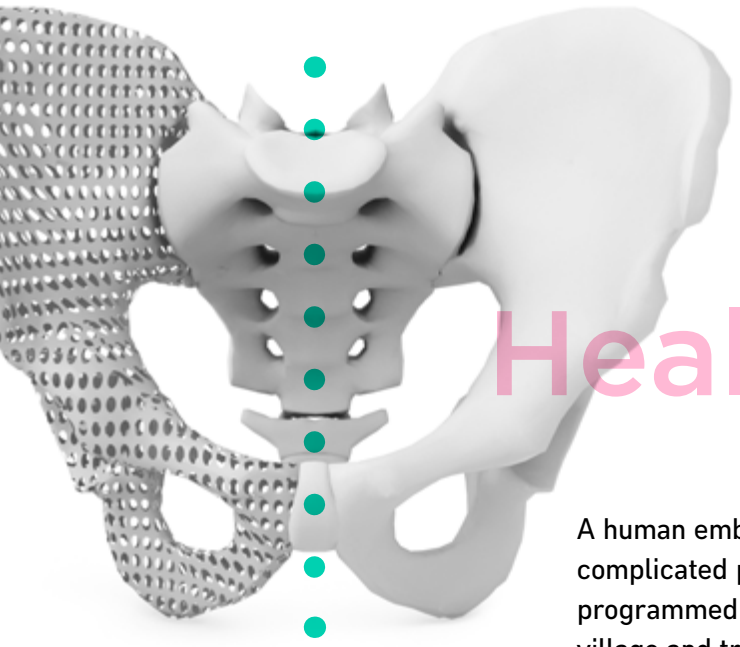
Main social sectors affected by the 4IR



4IR is about more than just technology-driven change; it is an opportunity to help everyone, including leaders, policy-makers and people from all income groups and nations, to harness converging technologies in order **to create an inclusive, human-centered future**. The real opportunity is to look beyond technology and find ways **to give the greatest number of people the ability to positively impact their families**, organizations and communities.[50]

Section 3 of this paper looks at different social sectors (healthcare, education, gender and diversity, and skills, social protection and jobs) and how these are impacted by the disruptive technologies of the 4IR.

50 UNIDO, 2017, Industry 4.0 Opportunities Behind the Challenge Background Paper, at https://www.unido.org/sites/default/files/files/2017-11/UNIDO%20Background%20Paper%20on%20Industry%204.0_27112017.pdf.



Healthcare

A human embryo's DNA is edited to cure a disease. Surgeons practice complicated procedures on models created by 3D printers. A pre-programmed drone collects blood samples from residents of a rural village and travels back to the capital. These awe-inspiring scenarios have all recently unfolded in what is undoubtedly a golden era of innovation in healthcare.[51]

The 4IR opens up the possibility for emergence of new care options in the healthcare industry, such as e-health delivery systems through portals, remote consultations, electronic personal health records, surgical robots and wearable devices to deliver on-demand non-emergency medical treatments to patients. Identifying patterns in huge data sets of genetic information and medical records, looking for mutations and linkages in diseases, and personalizing the treatment and process protocols for a patient will play a key role in increasing the efficacy of treatment to address chronic disease. Digital technologies such as 4G/5G mobile communication, AI, or supercomputing offer new opportunities to transform the way we receive and provide healthcare services. Health data and advanced data analytics can help accelerate scientific research, personalized medicine, early diagnosis of diseases and more effective treatments at lower cost. For instance, virtual patient visits can cut costs by one-fourth.[52]

A truly digital healthcare industry would revolutionize diagnosis and treatment, with a shift in focus to prevention and management. With the introduction and seamless coordination of digital apps and connected devices, the healthcare industry could be transformed to a system that is proactively

51 Pam Belluck, 2017, In Breakthrough, Scientists Edit a Dangerous Mutation From Genes in Human Embryos, at https://www.nytimes.com/2017/08/02/science/gene-editing-human-embryos.html; Dan Mangan, 2015, New Brain Surgery Innovation Practice on a 3D Model, at https://www.cnbc.com/2015/11/23/new-brain-surgery-innovation-practice-on-a-3-d-model.html; Stony Brook University, 2016, Drones Improve Healthcare Deliveries in Madagascar, at http://sb.cc.stonybrook.edu/news/general/2016_08_05_DronesInMadagascar.php.

52 European Commission, 2014, Transformation of Health and Care in the Digital Single Market, at https://ec.europa.eu/digital-single-market/en/policies/ehealth.

centered on the patient and driven by data. This will shift the focus of responsibility to citizens for managing their own health and well-being.

With citizens who are empowered to manage their own care, valuable resources in the health system would be freed up. Intelligent systems would allow lower-skilled workers to carry out more routine monitoring and virtual consultations. Highly skilled and highly paid healthcare professionals would be able to focus their efforts on more complex and higher-value cases. Data-driven clinical decision support and personalized treatment plans would have higher success rates, cutting down on waste. Digital healthcare has the potential to bring about not just small improvements in efficiency, but a steep change in the productivity of the healthcare industry along with a significant impact on health outcomes.[53]

✳ AI and healthcare

In the doctor's office, AI is already helping dermatologists distinguish cancerous growths from harmless spots,[54] diagnosing rare genetic conditions using facial recognition algorithms,[55] and lending an assist in the reading of X-rays and other medical images.[56] Soon, it will be detecting signs of diabetes-related eye disease. In addition to image classification, AI can also mine text data. That kind of technology undergirds a crowdsourcing platform that gives any primary care doctor access to the expertise of specialists from all over the world, which is extremely important for developing countries that face shortages of highly skilled medical personnel.[57] After the patient receives his diagnosis, he can now take home an AI-equipped robot to help him comply with the treatment plan.[58]

53 WEF, 2016, Digital Transformation of Industries Healthcare Industry, http://reports.weforum.org/digital-transformation/wp-content/blogs.dir/94/mp/files/pages/files/dti-healthcare-industry-white-paper.pdf

54 Megan Molteni, 2017, If You Look at X-rays or Moles for a Living, AI is coming for your job, at https://www.wired.com/2017/01/look-x-rays-moles-living-ai-coming-job.

55 Megan Molteni, 2017, Thanks to AI, Computers Can Now See Your Health Problems, at https://www.wired.com/2017/01/computers-can-tell-glance-youve-got-genetic-disorders.

56 Klint Finley, 2015, Robot Radiologists Will Soon Analyze Your X-rays, at https://www.wired.com/2015/10/robot-radiologists-are-going-to-start-analyzing-x-rays.

57 Megan Molteni, 2017, Want a Diagnosis Tomorrow, Not Next Year? Turn to AI, at https://www.wired.com/story/ai-that-will-crowdsource-your-next-diagnosis.

58 Tom Simonite, 2017, Google's AI Eye Doctor Gets Ready to go to Work in India, at https://www.wired.com/2017/06/googles-ai-eye-doctor-gets-ready-go-work-india.

Our phones now tell us how to sleep better, eat healthier, and exercise more. AI can pick up patterns in the way we talk and text, to detect the first signs of depression and suicide risk. Amiable chatbots trained on cognitive behavioral therapy concepts are now helping people who lack the time or resources for counseling. This approach takes advantage of the fact that people open up better to machines than other humans—the algorithms do not judge. AI is smartening up other devices too. Deep neural software is making it easier to tune things like hearing aids and ultrasound machines. It is making artificial hands better at gripping (but not breaking) things.[59]

AI allows us to develop new and innovative solutions to many complex problems developing countries are being faced with. For example, it is common knowledge that a malaria test traditionally requires a well-trained medical professional who analyzes blood samples under a microscope. In Uganda, an experiment showed that real-time, high-accuracy malaria diagnoses are possible with machines running on low-powered devices such as Android phones.[60]

✳ Blockchain and healthcare

Blockchain shows great potential in disrupting the traditional healthcare system (see Figure 2). For instance, blockchain platforms can support the entire lifecycle of a patient's electronic medical record (EMR). Blockchain can also be used to introduce anti-tampering capabilities in the manufacturing phase to ensure pharmaceuticals are genuine.[61] Blockchain, coupled with AI and IoT, may also provide a secure and easily authenticated platform for the integration of data from wearables such as fitness trackers and devices using mobile apps. A single patient can generate authenticated and secure health data from multiple devices. By monitoring and accessing their daily health data, individually-tailored health and exercise plans can be created for patients and continually adjusted as results are interpreted. The transparency and accountability inherent to blockchain will assure the security of data and reduce the associated risks.[62]

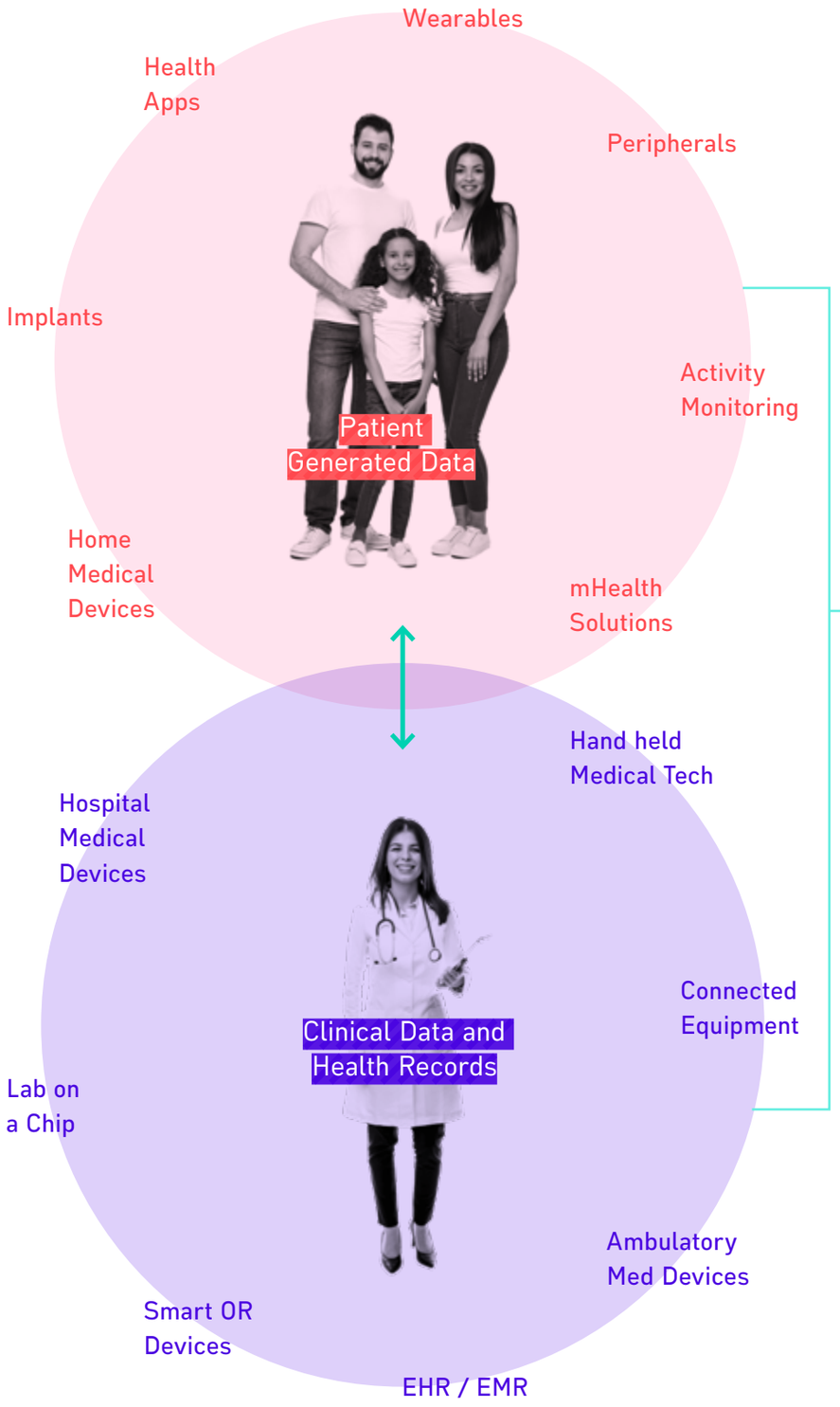
59 Megan Molteni, 2017, Health Care is Hemorrhaging Data. AI is Here to Help, at https://www.wired.com/story/health-care-is-hemorrhaging-data-ai-is-here-to-help.

60 Leebong Lee, 2017, The Rise of Artificial Intelligence: What Does it Mean for Development, at http://blogs.worldbank.org/ic4d/rise-artificial-intelligence-what-does-it-mean-development.

61 IBM Blockchain Unleashed, 2017, Blockchain is Goodyou're your Health, and Your Business, at https://www.ibm.com/blogs/blockchain/2017/12/blockchain-good-health-business.

62 Ibid.

Figure 2.
Blockchain Technology – promising use cases for healthcare industry.



Stores different types of health data (e.g., images, genomics, and lab reports).

Consists structured and unstructured data

Information is encrypted and digitally signed

Data lakes

Encryption & Digital Sign →

Indexing ↑

→ Decryption & Authenticate Digital Sign →

Blockchain

Consists of a complete indexed history, patient's unique identifier, and an encrypted link to health record.

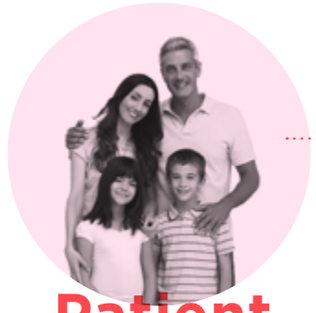
Each record is time stamped.

All patient records (historical) are together and stay with the patient.

Patient has control over the permissions on whom to share with.

Pharma/Research

Distributed patient consent for research / clinical trials enables data sharing, audit trials, and clinical safety analyses.



Patient

Patients use mobile devices to assign access permission to data and to provide public key.

Health Analytics & IoMT ↓

Providers

Providers uses health application to access health data.

Payers

Blockchain network consensus enables disintermediation to automate claim adjudication and payment processing with predefined smart contracts.

Source: https://www.forbes.com/sites/reenitadas/2017/05/08/does-blockchain-have-a-place-in-healthcare/#d0027691c31e

* IoT and healthcare

Connectivity enabled by the IoT will open up new horizons in delivery of efficient, good quality, transparent and low-cost healthcare services. This is extremely important in the context of LAC. Just as we have smart factories, we could have smart hospitals. Hospitals could be able to provide a level of care previously unimagined—while reducing healthcare costs—by continuously analyzing locations, vital signs, the drugs that have been administered, and room sensors and personalizing them to the patient's medical situation. [63] For instance, using a hub-and-spoke model, hospitals could be connected with smaller, rural care units, including video connection and data transfer, so that advanced care can be provided anywhere. With these new capabilities, we can overcome key challenges such as a lack of skilled personnel in the field or patient access to a medical facility. Digital innovation might support the seamless referral of patients and their electronic medical records for future diagnostic and treatment purposes, as well. With the costs of sensors continuing to drop and technologies becoming more and more viable, IoT-enabled medical devices will be an integral part of the patient's daily life.[64]

* 3D printing and healthcare

3D offers enormous possibilities for application in the developing world. An illustrative example in this regard would be the invention of a 3D-printed finger splint. The commercialization of this invention would not only enable inexpensive production of splints but would potentially override the need for developing countries to ship large supplies of splints from overseas. For small clinics located away from major cities, 3D printing will surely be practical when supplies run low. This is especially important in farming communities where patients from the nearby fields who come in with work-related injuries could be outfitted with custom splints that are printed as needed. In Haiti, a 3D printing laboratory has been established that produces umbilical clamps for a local hospital.[65] Having a medical 3D printer following a major disaster such as hurricane or tsunami will permit the production of crutches, splints, and whatever else is needed

63 Suad Aljundi, 2016, IoT Smart London 2016, a Reflection and Applications in Education, at https://innovativetechnology.jiscinvolve.org/wp/2016/05/04/iot-smart-london-2016-a-reflection and-applications-in-education.

64 Carla Kriwet, 2017, The end of one-size-fits-all: how mass customization can transform primary care, at https://medium.com/world-economic-forum/the-end-of-one-size-fits-all-how-mass-customization-can-transform-primary-care-a3c220d91487.

65 iLab Haiti, at http://www.ilabhaiti.org,

on the ground, instead of having to ship everything. Moreover, if a condition is not life-threatening, triage teams can print out casts or splints to take care of people with broken bones by simply inputting the required data into a system. Supplies would be available on a case-by-case basis without being wasteful.

✳ Protecting data privacy in healthcare

As we embrace the potential of personal health data, we must also be mindful of pitfalls we might encounter on the way to a more data-driven future. Privacy is of utmost importance. While data sharing can open the door to potentially transformative conveniences and benefits for patients, in the wrong hands, data can also expose patients to needless risks and discrimination.[66]

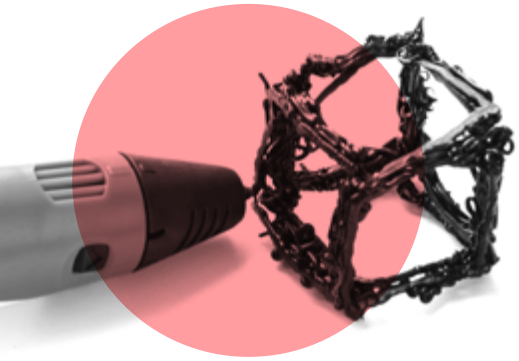
The more data we can mine, the more we will learn. But managing sensitive health data is a complex task. There are significant competitive, regulatory, and logistical barriers to sharing medical data. One approach is the creation of digital "ecosystems" open to partners who agree to share data, using common storage and communications systems.

As individual patients and a society as a whole, we will reap enormous value by sharing health data. But in the era of digital personal avatars, how can we protect an individual patient's confidentiality and still make data available for the common benefit of better healthcare? The success of the cryptocurrency Bitcoin offers a potentially useful model. Only those with an encrypted key—the patient and the doctor, for example—can access the data. Others can share discrete parts of the data only when they have permission. Blockchain technology would make it possible to associate digital twins with their respective human counterparts, while at the same time sharing the data anonymously with third parties.

Rapid change and unprecedented opportunity are now the hallmarks of the healthcare industry. However, the future of health will not just be defined by the innovations we set out to create; it will be equally shaped by how we respond to—and anticipate—the challenges and consequences of each great advancement. The more we know, the more "known unknowns" are revealed. The boundaries of areas left for researchers to explore constantly expand, while possible applications of new technologies proliferate.

66 WEF, 2018, 5 Key Trends for the Future of Healthcare, at https://medium.com/world-economic-forum/5-key-trends-for-the-future-of-healthcare-84885c1d20f9

Education and skills for the future



Imagine a classroom in a rural town in Uruguay where teachers from across the world appear on video screens to teach perfect English, or a woman in Costa Rica who can finally feed her family because the market for her tiny craft business has been vastly expanded through a website. It is all happening, and the emerging technologies of 4IR and their convergence are making it possible. Digital connectivity allows us to search for new information and new solutions to solve problems. LAC students can access the best teachers and databases in the world without borders.

By 2030, over half of the world's young people are projected to reach adulthood without the skills they need to thrive in work and life. More worrisome still is the fact that it will take decades—in some places over 100 years—for children of poor families to catch up to the learning levels of the richest. Faced with this urgent learning crisis, can we chart a new path forward to achieve rapid, equitable educational progress across the globe and in LAC, in particular? [67]

With children increasingly using tablets, and coding becoming part of national curricula around the world, technology is turning into an integral part of classrooms, just like chalk and blackboards. Technology is just one of many disruptive influences in education today. We live in an era during which the wealth of data and the exponential growth in the development of new knowledge is challenging institutions to rethink teaching and learning in a global market. There is also a need to prepare students for increasing competition in the workplace. With technology as a catalyst, education is moving from a knowledge-transfer model to a collaborative, active, self-directed, and engaging model that helps students increase their knowledge and develop the skills needed to succeed in the "learning society." [68]

67 Rebecca Winthrop, 2017, Can Education Innovations Help Us Leapfrog progress?, at https://www.brookings.edu/blog/education-plus-development/2017/09/21/can-education-innovations-help-us-leapfrog-progress/; Rebecca Winthrop, Eileen McGivney, Adam Barton, 2017, Can We Leapfrog? The Potential of Education Innovations to Rapidly Accelerate Progress, at https://www.brookings.edu/research/can-we-leapfrog-the-potential-of-education-innovations-to-rapidly-accelerate-progress.

68 Michelle Selinger, Ana Sepulveda, Jim Buchan, 2013, Education and the Internet of Everything, at https://www.cisco.com/c/dam/en_us/solutions/industries/docs/education/education_internet.pdf

In LAC, the education gap is prevalent, with majority of children not receiving a high-quality, relevant education. Many schools in LAC continue to use antiquated models for education that do not serve 21st-century students. As a result, too many Latin American youth entering the labor force lack the skills necessary to find well remunerated work and participate in an increasingly competitive, information-rich and globalized economy.[69] Moreover, a recent study by the Interamerican Development Bank (IDB) uncovered that, despite an average investment of 5% of GDP in education in Latin America (which is on a par with similar regions), only 30% of children in third and fourth grade actually meet the minimum benchmark for critical skills required in the digital era, such as math proficiency.[70]

The most important competitive asset LAC has is its youth. However, according to industry analysts, there are already 150,000 IT jobs that are unfilled because there are no qualified workers to fill them. At the same time, jobs that require unskilled, manual labor are quickly being replaced by automation. In order to succeed, Latin Americans need to learn new job skills and improve competencies such as critical thinking.[71]

The convergence of 4IR technologies gives the opportunity for LAC countries to "leapfrog," i.e., rapidly accelerate the educational progress to ensure that all young people develop the skills they need to thrive in a fast-changing world. In order to be able to do this, two hurdles will need to be overcome: skills inequality (enduring inequalities in educational opportunity that affect children and youth) and skills uncertainty (in the context of rapid and far-reaching social and economic change. We must prepare youth with a broad suite of skills—including, but going beyond, traditional academic competencies.

Using technology to digitize education across this region could lead to further innovation, social inclusion, job creation and national competitiveness. The digitalization of education has the power to give students the skills they need to generate a more prepared workforce, create jobs, and ultimately make Latin American companies more competitive in a global marketplace. However, Latin America lacks the connectivity infrastructure of other regions.

69 WEF, Botifoll (2016), How can digitalization help young people in Latin America?, https://www.weforum.org/agenda/2016/06/how-can-digitalization-help-young-people-in-Latin-America; WEF, Salazar-Xirinachs (2015) 6 ways Latin America can close its skills gap, https://www.weforum.org/agenda/2015/05/6-ways-latin-america-can-close-its-skills-gap.

70 IDB, 2017, Learning better: public policies for skills development, athttps://publications.iadb.org/bitstream/handle/11319/8495/Learning_Better_%20Public_Policy_for_Skills_Development.PDF?sequence=2&isAllowed=y.

71 Ibid.

Plan Ceibal, an initiative to digitize education in Uruguay, is making good progress in this area, and now is perceived more as a plan for social equity than an education plan. Before this program started, 43 percent of primary schools in the country did not have a computer. If they did, it was much more likely to appear in a wealthy, private school. Low-income public schools averaged one PC per 78 students. Through **Plan Ceibal,** Uruguay became one of the first countries in the world to provide a laptop to every primary school student. Yet a laptop is

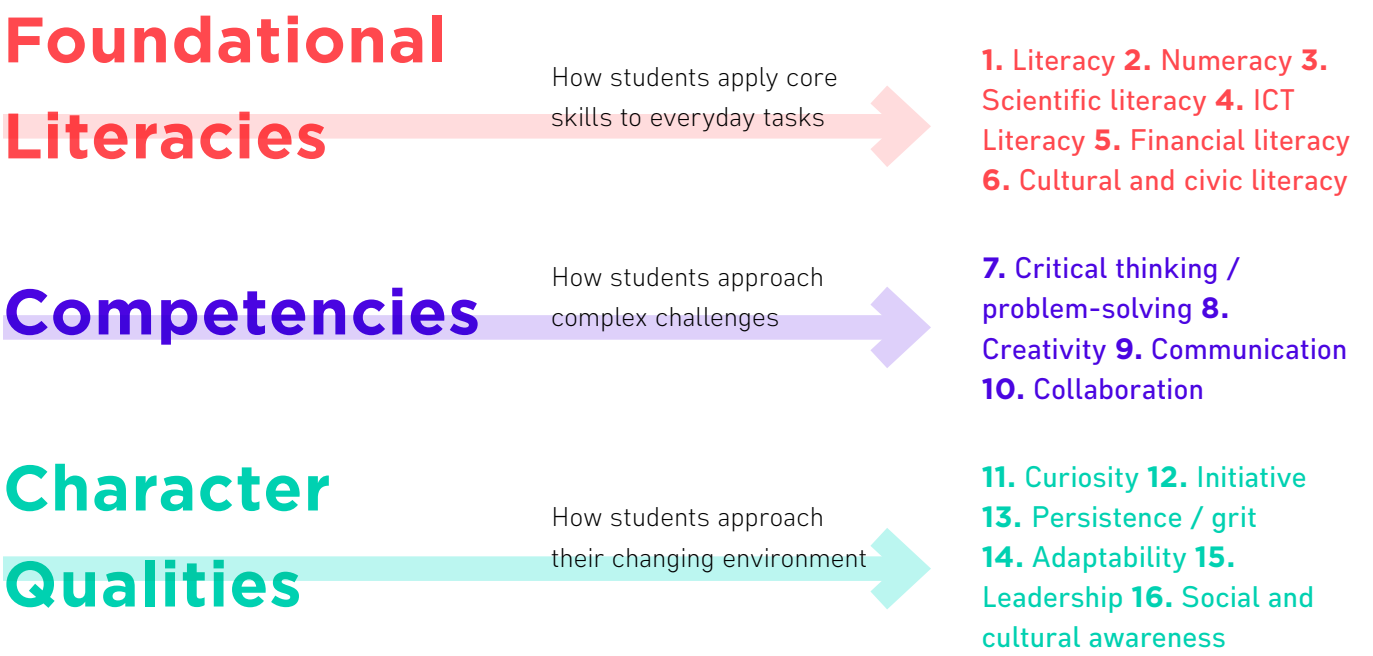
not very useful without internet connectivity. **Plan Ceibal's** program also brings expert English teachers into the classroom via video. Now, almost 80,000 students in Uruguay are learning English through this video conferencing system. There are similar initiatives happening **across LAC.**[72]

72 Ibid.

✳ Skills of tomorrow - DQ

The way students learn and what they need to learn is rapidly changing. Kids today will live and work in a very different reality that is fast changing and mediated by technology. To thrive in the 4IR-influenced world, workers need a different mix of skills than in the past. In addition to foundation skills like literacy and numeracy, they need competencies such as collaboration, creativity and problem-solving and character qualities like persistence, curiosity and initiative. Skilled jobs are increasingly concentrated on effectively analyzing information to solve problems (see Figure 3 below). Technology is progressively replacing manual labor and pervading how we live and work.[73]

Figure 3.
21st Century Skills.



Source: New Vision for Education, World Economic Forum

73 WEF, 2015, New Vision for Education Unlocking the Potential of Technology, at http://www3.weforum.org/docs/WEFUSA_NewVisionforEducation_Report2015.pdf.

Building new skills and competencies requires a reconceptualization of learning—what it is and how it happens in an increasingly connected, digital world—so that kids are not learning by repetition but are instead inspired to wonder, curious to discover, create, and build. This reconceptualization itself requires thinking out of the box.

A generation ago, IT and digital media were niche skills. Today, they are a core competency necessary to succeed in most careers, which is why digital skills are an essential part of a comprehensive education framework. Without a national digital education program, command of and access to technology will be distributed unevenly, exacerbating inequality and hindering socioeconomic mobility. The challenge for educators is to move beyond thinking of IT as a tool, or "IT-enabled education platforms." Instead, they need to think about how to nurture students' ability and confidence to excel both online and offline in a world where digital media is ubiquitous.

People will need to have developed three levels of DQ

1
2
3

The World Economic Forum has come up with the term DQ—an individual's facility and command of digital media that is a competence that can be measured. In order to master the skills of tomorrow, people will need to have developed three levels of DQ: (i) **digital citizenship**, i.e., the ability to use digital technology and media in safe, responsible and effective ways; (ii) **digital creativity**, i.e., the ability to become a part of the digital ecosystem by co-creating new content and turning ideas into reality by using digital tools; and (iii) **digital entrepreneurship**, i.e., the ability to use digital media and technologies to solve global challenges or to create new opportunities.[74]

Of the three, digital creativity is the least neglected, as more and more schools attempt to provide children with some exposure to media literacy, coding and even robotics, all of which are seen as directly related to future employability and job creation. Likewise, there are major education initiatives that promote access to coding education.

Digital entrepreneurship has also been actively encouraged, particularly in tertiary education. Many top universities have adopted and developed new courses or initiatives such as technopreneurship and entrepreneurship hackathons to encourage a culture of innovation. There are even global movements that nurture social entrepreneurship among children through mentoring programs—such as the Mara Foundation[75] and school programs, such as that at the Ashoka Changemaker School.[76]

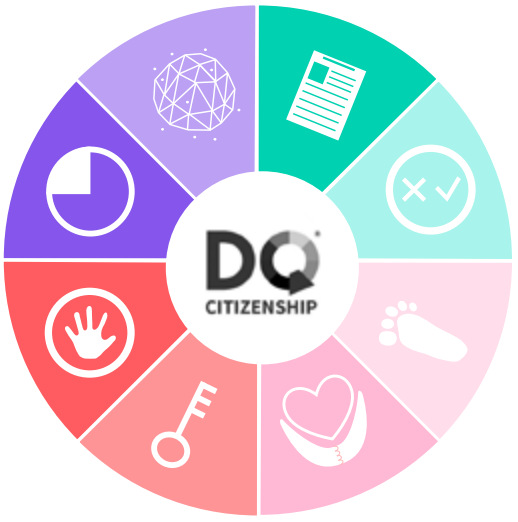
74 DQ Project, at http://www.dqproject.org.

75 Mara Foundation, at http://www.mara-foundation.org.

76 Ashoka Changemaker School, at https://www.ashoka.org/en/program/changemaker-schools

However, digital citizenship has often been overlooked by educators and leaders, despite the fact that it is fundamental to a person's ability to use technology and live in the digital world, a need that arises from a very young age. A child should start learning digital citizenship as early as possible, ideally when it starts actively using games, social media or any digital device (refer to the Figure 4 below).

Figure 4.
Digital intelligence.



Digital Citizen Identity

Ability to build and manage a healthy congruent identity online and offline with integrity

Privacy Management

Ability to hande with discretion all personal information shared online to protect one's and others' privacy

Screen Time Management

Ability to manage one's screen time, miltitasking, and one's engagement in online games and social media with self-control

Critical Thinking

Ability to distinguish between true and false info, good and harmful content, and trustworthy and questionable contacts online

Cyberbullying Management

Ability to detect cyberbullying situations and handle them wisely

Digital Footprint Management

Ability to understand the nature of digital footprints and their real-life consequences and to manage them responsibly

Cyber Security Management

Ability to protect one's data by creating strong passwords and to manage various cyber attacks such as SPAM, SCAM, and phishing

Digital Empathy

Ability to be empathetic towards one's own and other's needs and feelings online

Source: DQ Institute at https://www.dqinstitute.org/what-is-dq/

A quality digital citizenship education must include opportunities for assessment and feedback. The assessment tools should be comprehensive as well as adaptive in order to evaluate not only hard but also soft DQ skills. Ultimately, such assessments should serve as a means of providing feedback that gives children a better understanding of their own strengths and weaknesses, so that they may find their own paths to success.[77]

National leaders need to understand the importance of digital citizenship as the foundation of digital intelligence. National education leaders should make it a priority to implement digital citizenship programs as part of an overall DQ education framework. There is no need to wait. In fact, there is no time to wait. Children are already immersed in the digital world and are influencing what that world will look like tomorrow. It is up to us to ensure that they are equipped with the skills and support to make it a place where they can thrive.[78]

✳ Integrating new technologies into curricula—innovative LAC examples

Forward thinking educators are integrating new technologies into their curricula and improving traditional classrooms in the process. A host of new technologies, both cloud-based and hands-on, are bridging curriculum gaps and establishing new educational pathways. These technologies are helping to supplement teachers' lessons in the classroom, creating a new educational infrastructure, and engaging students with hand-on experimentation, all with a mission to prepare today's students for tomorrow's reality. In fact, some of the most interesting advances in education are coming from people outside the traditional education space. These new players are helping re-think yesterday's educational model, using new technologies and big ideas. Many are already working with ministries of education and schools, with highly encouraging early results.

Innova Schools in Peru, designed with help from global innovation firm IDEO, have incorporated "blended learning" into their model, which combines traditional classroom methods with individual, independent study delivered through online content. This method allows students to have control over the pace, time, and place of learning, and is thus more adaptable to the needs of each student. Innova students spend a portion of each day working

77 http://www.dqproject.org/what-is-dq/#dqreport.

78 Yuhyun Park, 2016, 8 Digital Life Skills All Children Need – and a Plan for Them, at https://www.weforum.org/agenda/2016/09/8-digital-life-skills-all-children-need-and-a-plan-for-teaching-them.

through a challenge posed by their teacher. In small groups, they sketch out solutions by using the internet and physical handouts. Another part of the day is dedicated to independent learning in front of a computer as students engage in lessons through programs such as Khan Academy, a personalized learning platform (see below - MOOCS), which students begin to use in middle school. In both activities, the teacher acts as a guide through the exercise to encourage students, monitor their pace of learning, and offer advice on how and where to look for further resources. This kind of active learning uses technology to motivate students to search for answers and build knowledge themselves.

Duolingo, created by a tech entrepreneur, is a platform that teaches language through gaming. Named Apple's 2013 App of the Year, Duolingo has proven in a number of studies to be extremely effective in learning a new language. In 2012, the company began to tailor its app to schools, where it not only continues to motivate students to learn better than traditional methods, but also gives the teacher a deeper look into an individual student's learning needs. If a student consistently hesitates before answering a certain type of question, the teacher can identify that through the platform, and determine the areas where the student needs more practice. The government of Colombia recently adopted the program for official use in public schools, as have the governments of Costa Rica, Guatemala, and parts of Brazil.[79]

Innovative solutions and new technologies are emerging around the world—many from unlikely players—that hold the potential to help countries in Latin America leapfrog the most pressing challenges they face in education. The region has not yet effectively capitalized on these new technologies to improve learning. The sharing of best practices that are working in the region and across the globe will allow for a cross-fertilization that will bring Latin American schools into the 21st century.[80]

79 WEF, 2016, The case for disruption in Latin America's classrooms, at https://www.weforum.org/agenda/2016/05/a-case-for-disruption-in-latin-america-s-classrooms.

80 Ibid.

* Massive open online courses (MOOCS) as adaptive learning platforms

The advent of massive open online courses (MOOCs) is another step toward global education. MOOCs are aimed at large-scale interactive participation and open access via the web. Some of the world's leading universities are making their top professors available free of charge, and online forums that are linked to MOOCs will become spaces for new networks to develop and grow, connecting people from all walks of life and giving education to those who do not have access to high-quality content or instructors in their own locale. We have already witnessed the rise and impact of education technology especially through a multitude of adaptive learning platforms such as Khan Academy and Coursera that allow learners to strengthen their skills and knowledge.

The 2,700 online course modules offered by the Khan Academy range from math to history of art. Each lesson is free and open to anyone. The website includes a sophisticated analytics engine that allows teachers and parents to track student progress through experience points gained as the students master various subjects. The five years' worth of data Khan now has on how students learn could eventually enable the academy to create lessons personalized to each student's learning. At least 36 schools have incorporated Khan Academy videos and teacher dashboards that track students' individual statistics into their teaching model.[81]

The impact such resources have on all phases of education could be significant in emerging economies where access to high-quality educational resources will help support and improve teaching and learning. In many developing countries, access to localized resources is limited, textbooks are often outdated and expensive, and funds for developing new materials are in short supply. Additionally, access to learning beyond basic education is often limited by economic status. Free access to MOOCs and resources such as Khan Academy will improve the quality of life for many people who cannot afford a formal education.

81 Harvard Business Review, 2014, Salman Khan on the Online Learning Revolution, at https://hbr.org/2014/01/salman-khan-on-the-online-learning-revolution.

✳ Experiential learning through AI and VR

Imagine lifelong learning companions powered by AI that can accompany and support individual learners throughout their studies—in and beyond school—or new forms of assessment that measure learning while it is taking place, shaping the learning experience in real time. High costs remain a challenge for developing countries, but the day when AI and VR tools will be as accessible as smartphones and desktop computers is around the corner.[82]

Intelligent machines are playing a major role in delivering customized relevant knowledge to learners, where and when needed. For instance, Content Technologies Inc., a US-based AI research and development company is leveraging deep learning to deliver customized books. The company launched Cram101 and JustFact101 to turn decades-old text books into smart and relevant learning guides, making study time efficient.[83]

For decades, experiential learning was confined to science experiments in the school's archaic laboratory or to summer holiday assignments. But with VR and AI, experiential or hands-on learning has an all new meaning. A variety of VR tools including Microsoft's HoloLens, Oculus Rift, or Google Expedition are translating traditional lessons into meaningful real-world experiences.[84]

Imagine a room full of students exploring the wreck of the Titanic, watching dinosaurs walk around them, discovering the Amazon, or simply landing on the moon as astronauts.[85] Educators are moving away from just learning a subject or topic to "feeling" the content. This is not simply an engagement tool or a gimmick; it allows students to explore, experience or be involved in something, as if they are actually present in that environment or place.

Intelligent tutoring systems such as Carnegie Learning[86] or Third Space Learning[87] are helping teachers break free from the one-size-fits-all approach. These one-to-one tutoring platforms leverage big data and

82 Rose Luckin, Wayne Holmes, Mark Griffiths, Laurie B. Forcier, 2016, Intelligence Unleashed Publication, at https://www.pearson.com/content/dam/corporate/global/pearson-dot-com/files/innovation/Intelligence-Unleashed-Publication.pdf.

83 http://contenttechnologiesinc.com.

84 Shane Haumpton, 2017, 7 Top Educational Virtual Reality Apps, at http://www.gettingsmart.com/2017/05/7-best-educational-virtual-reality-apps.

85 http://immersivevreducation.com.

86 https://www.carnegielearning.com.

87 https://www.thirdspacelearning.com.

learning analytics to provide tutors with real-time feedback about their students' performances, strengths and weaknesses. The feedback helps teachers determine exact learning needs and skills gap of each student and provide supplemental guidance. Automation will help simplify basic teaching tasks and help school leaders address key challenges to quality instruction—namely, variations in teacher quality, wide-ranging student needs, and added expectations placed on teachers.[88]

✳ Personalized learning through AI

Personalized learning, which tailors educational content to the unique needs of individual students, has become a huge component of K–12 education. A growing number of college educators are embracing the trend, taking advantage of data analytics and artificial intelligence to deliver just-right, just-in-time learning to their students. The digital transformation trends of blended learning and adaptive learning are two ways to personalize the educational experience.

Blended learning personalizes lessons, allowing students to focus on discovery and to make their own decisions about direction and pace. The idea is to combine technology (such as a mobile learning platform or other online environments) with face-to-face interactions. This combination provides students with more ownership.

Similar to blended learning, adaptive learning allows students more freedom in designing their own educational paths. Adaptive learning technology analyzes a student's input and instantly adjusts the student's learning materials and assessments. Adaptive learning tools can increase classroom agility and support student achievement.

On a more futuristic note, some predict the development of a "lifelong learning companion."[89] Like an imaginary friend, learning companions would accompany students—asking questions, providing encouragement, offering suggestions and connections to resources, helping you talk through difficulties. Over time, the companion would "learn" what you know, what interests you, and what kind of learner you are.

88 Sebastien Turbot, 2017, Artificial Intelligence in Education: Don't Ignore It, Harness It!, at https://www.forbes.com/sites/sebastienturbot/2017/08/22/artificial-intelligence-virtual-reality-education/#211f0afe6c16

89 Professor Picard et al, Affective Learning Companion project, at http://affect.media.mit.edu/projectpages/lc.

✳ Using blockchain in education

As education becomes more diversified, democratized, decentralized and disintermediated, we still need to maintain reputation, trust in certification, and proof of learning. The increased focus on relevance and employability may also push us in this direction, as we also need more transparency. Blockchain could provide just such a system: a massive open, online, secure database.[90]

As educational institutions cluster and cooperate, the need for shared repositories of certification and achievement become real. An example is the group of universities, Delft, EPFL, Boston, ANU and UBC, that recently formed a codeshare-like agreement on certification. It could also be used by affiliated organizations that form a global alliance or a global group of schools. Whatever the constellation of institutions or bodies, blockchain gives them a cheap, shared resource.

Blockchain can disrupt the current system of educational certification. A paper system is subject to loss, even fraud. With an increasingly mobile population of students and workers, a centralized database of credentials and achievements makes sense. Some sort of secure, online repository would be helpful, and here is where blockchain comes in.[91] One such example is Sony Global Education, which has developed a blockchain-based platform to house assessment scores. They want schools and universities to use the service so that individuals can share the data with third parties such as employers, LinkedIn, etc. Their aim is to offer a global service.[92] [93]

Mass adoption of blockchain certificates fundamentally flips the power relationship and turns each individual into a lifelong registrar. Combined with the proliferation of accredited education providers and movement to a more skills-based economy, the technical breakthrough provides the means for individuals to collect evidence of learning and achievement that cannot be taken away or erased.

Traditionally, institutions have been a source of trust: universities, for example, are trusted "brands." In finance, where blockchain is nowadays a ubiquitous hot topic, banks exist to enact transactions, creating an environment in which its advantages are readily obvious. In education, however, there needs to be

90 JRC, European Commission (2017) Blockchain in Education, http://publications.jrc.ec.europa.eu/repository/bitstream/JRC108255/jrc108255_blockchain_in_education%281%29.pdf.

91 Ibid.

92 Sony Global Education, 2016, Sony Global Education Develops Technology Using Blockchain for Open Sharing of Academic Proficiency and Progress Records, at http://www.sony.net/SonyInfo/News/Press/201602/16-0222E/index.html

93 http://www.blockcerts.org/

trust beyond the technology. We are looking at a hybrid model rather than a wholesale blockchain takeover. Reputation will still matter, and this will continue to be derived from the quality of the instruction, teachers, research, and so on. However, blockchain can play a role here too, as one could imagine a sort of web of teachers and learners that deploys blockchain to cut out institutions.[94]

Blockchain can also be used to power online education platforms with token scholarships and tech talent acquisition. An illustrative example in this regard is the BitDegree platform that will offer students the best online courses with a clear and transparent blockchain-based reward system and achievement tracking. It is also a unique tool for businesses to recruit tech talent and shape global education to their needs. Think of it as Coursera and HackerRank merged together, powered by the decentralized blockchain technology.[95]

* IoT and education

The applications of the IoT in education are numerous, and the implications for this disruption are tremendous. The rise of mobile technology and the IoT allows schools to improve the safety of their campuses, keep track of key resources, and enhance access to information. Teachers could even use this technology to create "smart lesson plans," rather than the traditional stoic plans of yesteryear.

The IoT adds another dimension to the digital transformation phenomenon, allowing for a more efficient and immersive educational experience. From tracking resources to creating better student plans, the IoT is changing the way things are taught and learned. Smart schools are using IoT technology to track school buses, attendance and student ID cards, and to monitor lighting and security systems, among other things.

The IoT can be effectively utilized in high school and university settings, where students are already moving away from paper textbooks in favor of e-books on laptops and tablets. By using cloud-connected devices, professors can monitor which students need individual attention and track their progress.This surge in connected technology means that teachers can utilize their time and resources on more personalized instruction, as the IoT would automate

94 Donald Clark, 2016, 10 Ways Blockchain Could Be Used in Education, at https://oeb-insights.com/10-ways-blockchain-could-be-used-in-education.

95 https://www.bitdegree.org/en/token#what-are-we.

processes that were previously conducted manually. For example, sensors could detect the presence of students within a classroom, negating the need to manually take attendance, thus saving precious time.[96] Automatic attendance tracking using radio frequency identification is one potential application at the K–12 level. An RFID chip could be embedded in a student's ID card or mobile device and would be constantly trackable. However, it should not be forgotten that security and personal privacy issues arise in every potential application of IoT, and this type of student tracking is no exception.

Special needs students also have a lot to gain from this shift to technological means. For instance, students with impaired vision can be given special cards that are detected automatically and can inform connected devices to display text at a larger font. Through these advancements, the IoT can facilitate equal access to education for all students.

Through IoT technology, teachers would be able to push out real-time information to students from multiple sources, rather than using one outdated textbook. This represents a cultural change for educators as well—not just teaching from a textbook but being able to have real-time data. Connected classrooms will enrich the learning experience for students everywhere.97 The implications of this in education are enormous. For example, as part of their studies, learners could tag physical objects, collect data about those objects, and then feed that information to other programs for analysis, improving the accuracy of their research. Learners could also access data from research initiatives, monitor programs on oceanography or climate change, or watch animals in their natural habitats via live webcams then collect data on their movements through sensors attached to the animals' bodies. The authenticity of such data will have a huge impact on learners' interests. Furthermore, collecting data remotely will also help people reduce their carbon footprints through fewer field trips.[98]

The IoT is streamlining processes within the education system, making learning faster, safer and more efficient. The next few years should see a rise in connected and smart schools, transforming the education sector for the better.[99]

96 Beas Dev Ralhan, 2016, How IoT Is Transforming The Education Sector, at https://inc42.com/resources/io-transforming-education.

97 Jessica Leigh Brown, 2017, How Will the Internet of Things Impact Education?, at https://edtechmagazine.com/k12/article/2017/03/how-will-internet-things-impact-education.

98 Michelle Selinger, Ana Sepulveda, Jim Buchan, 2013, Education and the Internet of Everything, at https://www.cisco.com/c/dam/en_us/solutions/industries/docs/education/education_internet.pdf.

99 Akshata Mehta, 2017, The Potential of IoT in Education, at http://edtechreview.in/trends-insights/trends/2891-the-potential-of-the-iot-in-education.

Gender, diversity and emerging technologies

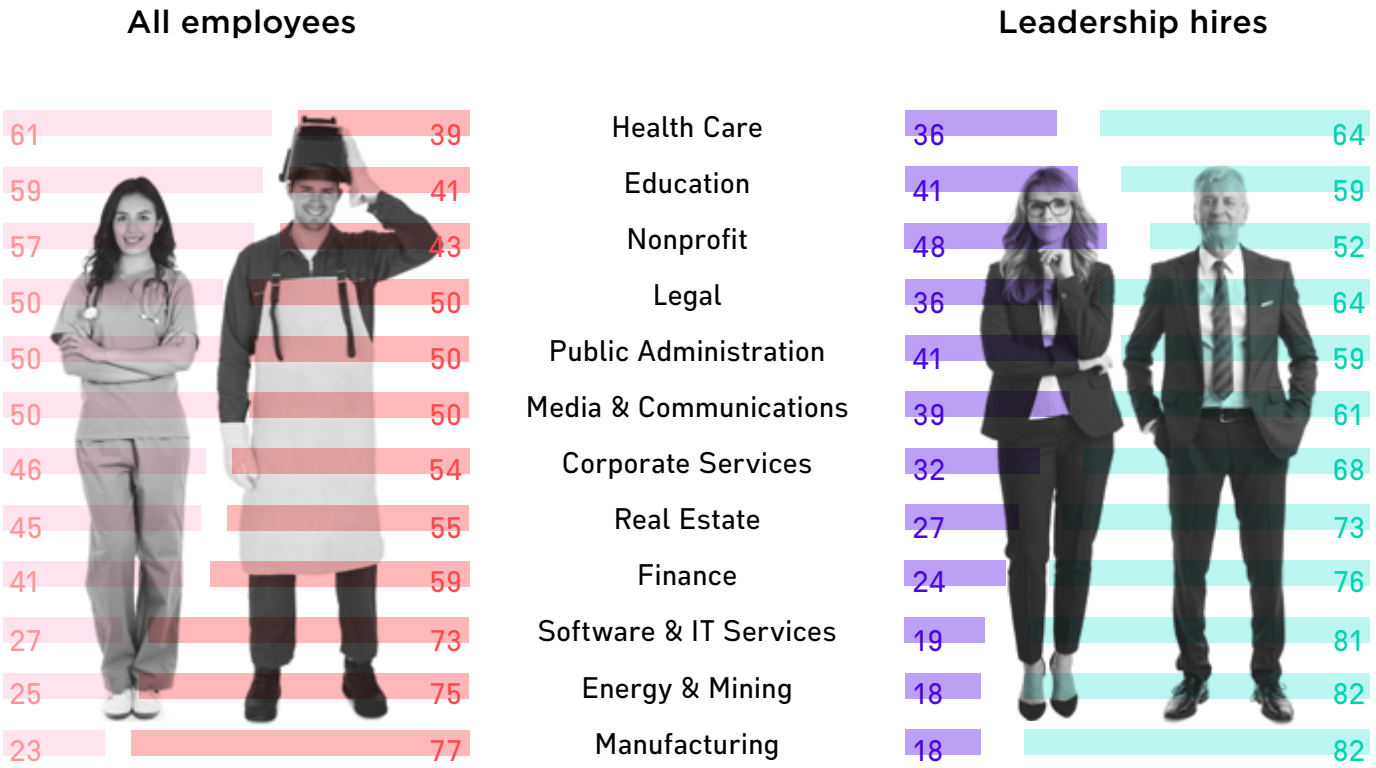
In five years' time, we might travel to the office in driverless cars, let our fridges order groceries for us and have robots in the classroom. Yet, according to the World Economic Forum's Global Gender Gap Report 2017, it will take another 100 years before women and men achieve equality in health, education, economics and politics. Furthermore, economic parity is worsening: it will take some staggering 217 years to close the gender gap in the workplace. How can it be that the world is making great leaps forward in so many areas, especially technology, yet it is stumbling backwards when it comes to gender equality?[100]

100 WEF, 2017, The Global Gender Gap Report 2017, at https://www.weforum.org/reports/the-global-gender-gap-report-2017.

⁕ Changing face of work and gender equality

The Figure 5 below shows how the percentage for men and women vary across sectors, from the talent pipeline to leadership. In an age where innovation is best generated by diverse teams, we need to take bigger strides toward gender parity and diversity in all its forms.

Figure 5.
Industries out of balance – gender perspective.



Source: WEF Global Gender Gap Report

The entrenched inequalities and discriminatory social norms that keep women restricted to low-paid, poor-quality jobs could be magnified by the impacts of the 4IR. Illustrative examples can be found in abundance. The careers platform LinkedIn, for instance, had an issue where highly-paid jobs were not displayed as frequently for searches by women as they were for men because of the way its algorithms were written. The initial users of the site's job search function were predominantly male for these high-paying jobs so it just ended up proposing these jobs to men – thereby simply reinforcing the bias against women.[101]

Although many countries are ideally poised to maximize women's economic potential, they are currently failing to reap the returns from their investment in female education. In addition, too few countries are preparing to meet the challenges and harness the gender parity opportunities posed by the changing nature of work.[102]

⁎ Digital gender divide

The challenge of connectivity is not always a matter of overcoming the physical barriers. It is also about surmounting cultural biases and social mores (misogyny, cyberbullying and harassment among the others) that make it difficult for women to access the digital world, even where its benefits are already available.

According to the International Institute for Sustainable Development's Women's Rights Online research there are extreme gender inequalities in internet access, digital skills, and online rights across developing countries. For instance, across urban poor areas in 10 cities, including Lagos, Nairobi, Jakarta and Bogotá, women are 50% less likely than men to be online, and 30-50% less likely than men in the same communities to use the internet for economic and political empowerment. The root causes of this difference are high costs, lack of digital know-how, scarcity of content that is relevant and empowering for women, and barriers to women speaking freely and privately online.[103]

101 Bettina Büchel, 2018, AI will only learn what we teach it. This is a problem for gender equality, at https://www.weforum.org/agenda/2018/03/artificial-intelligence-could-reinforce-our-gender-equality-issues.

102 WEF, Closing the gender gap, https://www.weforum.org/projects/closing-the-gender-gap-gender-parity-task-forces.

103 International Institute for Sustainable Development, 2017, What is the Gender Digital Divide, and Why Should it Matter for the SDGs?, at http://sdg.iisd.org/commentary/guest-articles/what-is-the-gender-digital-divide-and-why-should-it-matter-for-the-sdgs.

The numbers presented by the International Telecommunications Union (ITU) are grim. Internet penetration rates are higher for men and boys than women and girls in all regions of the world today. The global Internet user gender gap grew from 11% in 2013 to 12% in 2016. The gap remains large in the world's Least Developed Countries (LDCs) - at 31%. In 2016, the regional gender gap is largest in Africa (23%) and smallest in the Americas (2%).[104]

⁎ Emerging technologies as a positive force

The 4IR can be a positive force, and used properly, technology could help to close the gender gap, but only if we avoid hardwiring in our current biases and limitations. How do we balance the realities of our current world with our aspirations for more equality and fairness? Unlike humans, algorithms cannot consciously counteract learned biases. And as AI permeates more aspects of our lives, the stakes will get higher.

In the same way that we are learning to tackle unconscious bias in the way we hire and promote people, we need to make sure we do not allow bias to permeate the technology that will build our shared future. Only then can we create a better working world for all of us. The current moment offers a strategic win-win opportunity to proactively enhance gender equality and prevent widening gender and skills gaps. To navigate the uncertainties and new opportunities of the 4IR, all sectors need to increase diversity within their talent pools and their leadership.

It is critically important to understand the barriers hindering parity across distinct sectors and job families and to harmonize strategies for effectively overcoming these hurdles.[105] By some accounts, if we double the pace at which women become frequent users of digital technologies, the workplace could reach gender equality by 2040 in developed nations and 2060 in developing nations — much earlier than current projections.[106] Women's digital inclusion can help to catalyze broader gender equality in social, economic and political dimensions — benefiting not only women themselves, but also their communities and the broader economy.

104 ITU, ICT facts and figures 2016, at https://www.itu.int/en/ITU-D/Statistics/Documents/facts/ICTFactsFigures2016.pdf.

105 Alison Kay, 2017, Artificial Intelligence Could Hardwire Sexism Into Our Future. Unless We Stop It, at https://www.weforum.org/agenda/2017/12/sexist-bias-hardwired-by-artificial-intelligence.

106 Accenture, Getting To Equal How Digital is Helping Close the Gender Gap at Work, at https://www.accenture.com/t00010101T000000__w__/ar-es/_acnmedia/PDF-9/Accenture-Getting-To-Equal.pdf.

Jobs, income and social protection

CEOs across many sectors describe one painful current predicament: "I have to lay off hundreds of people because their jobs have disappeared, and I do not need their skills—and I have hundreds of job openings I can't fill because I can't find people with the right training and skills." This mismatch is bad for everyone: lives are derailed, families and communities damaged, business opportunities lost.[107]

✳ Jobs and income

According to the World Economic Forum, current estimates of global job losses due to digitalization range from two million to two billion by 2030. There is great uncertainty, with related concerns on wages and working conditions.[108] The McKinsey Global Institute found that about half the activities people are paid to do globally could theoretically be automated using currently proven technologies. Very few occupations, less than five percent, consist of activities that can be fully automated. However, in about 60 percent of occupations, at least one-third of the constituent activities could be automated, implying substantial workplace transformations and changes for all workers. Why is this happening?[109]

While the transition from agriculture took more than a century, by some estimates 4IR technologies could displace 10 percent of the world's workforce in less than 15 years. New digital and communications technologies are changing how work gets done and the nature of work itself.

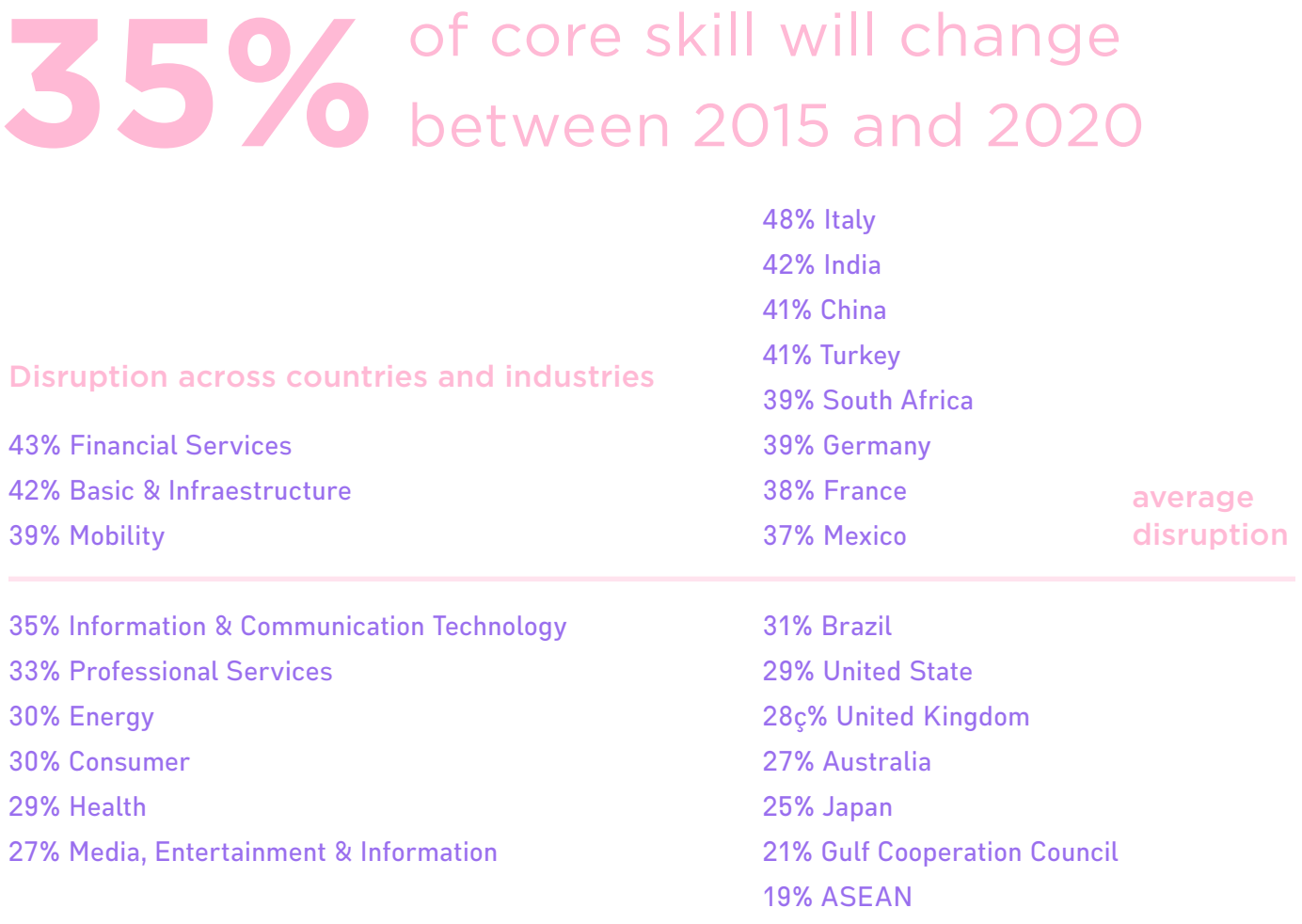
107 WEF, 2018, How to Survive the Fourth Industrial Revolution, at https://medium.com/world-economic-forum/how-to-survive-the-fourth-industrial-revolution-26ba89f136f4.

108 WEF (2016), Understanding the impact of digitalization on society, at http://reports.weforum.org/digital-transformation/understanding-the-impact-of-digitalization-on-society.

109 James Manyika, Michael Chui, Mehdi Miremadi, Jacques Bughia, Katy George, Paul Willmont, Martin Dewhust, 2017, Harnessing Automation for a Future That Works, at https://www.mckinsey.com/global-themes/digital-disruption/harnessing-automation-for-a-future-that-works.

The growth of the gig economy and advances in AI are changing who does the work. Even the question of what work looks like is coming under examination as a continually evolving marketplace drives organizations to explore new business models, such as Uber and Airbnb. Some studies suggest that 65 percent of children entering primary school today will have jobs that do not yet exist and for which their education will fail to prepare them, exacerbating skills gaps and unemployment in the future workforce. To adapt, societies will need agile education options to help their workforce reskill (see Figure 6 below).[110]

Figure 6.
Skills Disruption.



Source: Future of Jobs Report, World Economic Forum.

110 WEF, Mulligan (2018), We have the tools to reskill for the future. Where is the will to use them?, https://www.weforum.org/agenda/2018/01/tools-reskill-future-will-labour-disruption-automation/; Jack Karsten, Darell M. West, 2015, How Robots, AI, and Machine Learning Will Affect Employment and Public Policy, at https://www.brookings.edu/blog/techtank/2015/10/26/how-robots-artificial-intelligence-and-machine-learning-will-affect-employment-and-public-policy.

MGI estimates that automation potential in LAC will be near 50 percent, which means that half of the total full-time equivalent time spent at work is potentially automatable.

The McKinsey Global Institute (MGI) estimates that automation potential in LAC will be near 50 percent, which means that half of the total full-time equivalent time spent at work is potentially automatable. A recent IDB study highlights that a substantial share of exports and employment in LAC are concentrated in activities that run the risk of being automated, such as labor-intensive manufacturing, natural resource extraction, and medium-skill services such as accounting, legal, or management services.[111]

The OECD Survey of Adult Skills shows that two-thirds of people surveyed lack the basic skills needed to function in "technology-rich environments." These skills include not only information technology (IT) skills, but also foundational skills, such as information processing, self-direction, and problem-solving, which make workers more flexible. Moreover, according to the World Bank Enterprise Surveys, 36 percent of firms say they struggle to find an adequately qualified work force, in LAC a percentage higher than in any other region in the world, compared to a global average of 21 percent and an OECD average of 15 percent. The skills challenges in LAC should not be considered in isolation, but against the background of the new global geographies of talent. The expansion of highly educated, highly competent workforces in a number of emerging countries, including but not limited to China and India, means LAC is competing not just with low-skilled, low wage-labor, but with highly-skilled talent pools in the rest of the world.[112]

All these challenges are critical, because as digitalization progresses, most of our children will do jobs that have yet to be invented. The active engagement of LAC governments, employers, trade unions, educational and training institutions, and individuals is crucial to ensure that lifelong learning opportunities exist and that all individuals have the capacity to develop the skills needed in a world that changes on a daily basis. The imperative for LAC countries is to step up education and training to prepare people for those new roles, and to put policies in place that mitigate the impact on individuals during the transition to a more automated world.[113]

111 IDB (2017), Integration and Trade Journal: Volume 21: No. 42: August, 2017: Robot-lución: The future of work in Latin American Integration 4.0 at https://publications.iadb.org/handle/11319/8487.

112 Jose M. Salazar-Xirinachs, 2015, 6 Ways Latin America Can Close Its Skills Gap, at https://www.weforum.org/agenda/2015/05/6-ways-latin-america-can-close-its-skills-gap.

113 McKinsey Global Institute, Where will Latin America's growth come from? (2017), at https://www.mckinsey.com/~/media/mckinsey/global%20themes/employment%20and%20growth/how%20to%20counter%20three%20threats%20to%20growth%20in%20latin%20america/mgi-discussion-paper-where-will-latin-americas-growth-come-from-april-2017.ashx.

New Social Protection Systems: A Whole-of-Life Approach

New systems will need to address gaps in social protection across typical life events including periods of education, raising families, work including career gaps, retirement, and later elder care. Systems will need to provide sufficient flexibility to support individuals following substantially different life and career paths while maintaining some inter-group equity and bolster individual resilience. A sustainable social protection system needs to address the changes and challenges described above, ensuring fair payments from employees and employers during times of earning to fund payments that ensure appropriate income support when earnings are not possible. New social protection systems could include a range of approaches, with selected innovations set out below.

Unchaining health and income protection from individual employers or jobs

Intermittent, part-time and informal employment or self-employment, with frequent career changes, is becoming the norm in developed as well as developing economies, but most pension systems are still built on the model of continued employment throughout life. Health benefits are provided irrespective of employment in most European nations and Canada but continue to be largely tied to employment in the United States. Potential responses include creating portable health and pension plans to maintain coverage as workers move geographically and between employers, or between periods of formal employment and periods of unemployment or self-employment; and ensuring that risk and responsibility for social protection continue to be shared by the state, employer and employee. Employers' contributions to funding social protections could be recast to benefit society as a whole rather than their employees only.[114]

Revamping pension models in line with the new realities of work and ageing

Typically, pension systems, whether state or occupational, are diminishing in value because of worsening tax concessions, a lower interest-rate environment, increasing life expectancy, and increasing regulation and complexity. Compounding the problem is the shortened lifespan of

114 Ibid.

companies, which is undermining the sustainability of funds from company-sponsored pension systems. One potential response is to introduce simpler and more flexible plans linked to better advice and guidance. Products need to be more accessible and flexible to accommodate unique retiree needs, providing a secure income and the flexibility to access capital when needed for life events other than retirement. They need to incorporate affordable options that allow individuals to manage longevity and provide better information about the need to finance later life, with robo-advice likely to become the norm. Another response is for employers to provide pensions on an opt-out only basis with default asset allocations, so the default position is that employees' contribution and investment levels should create sufficient income in later life.[115]

Implementing policies to increase "flexicurity"

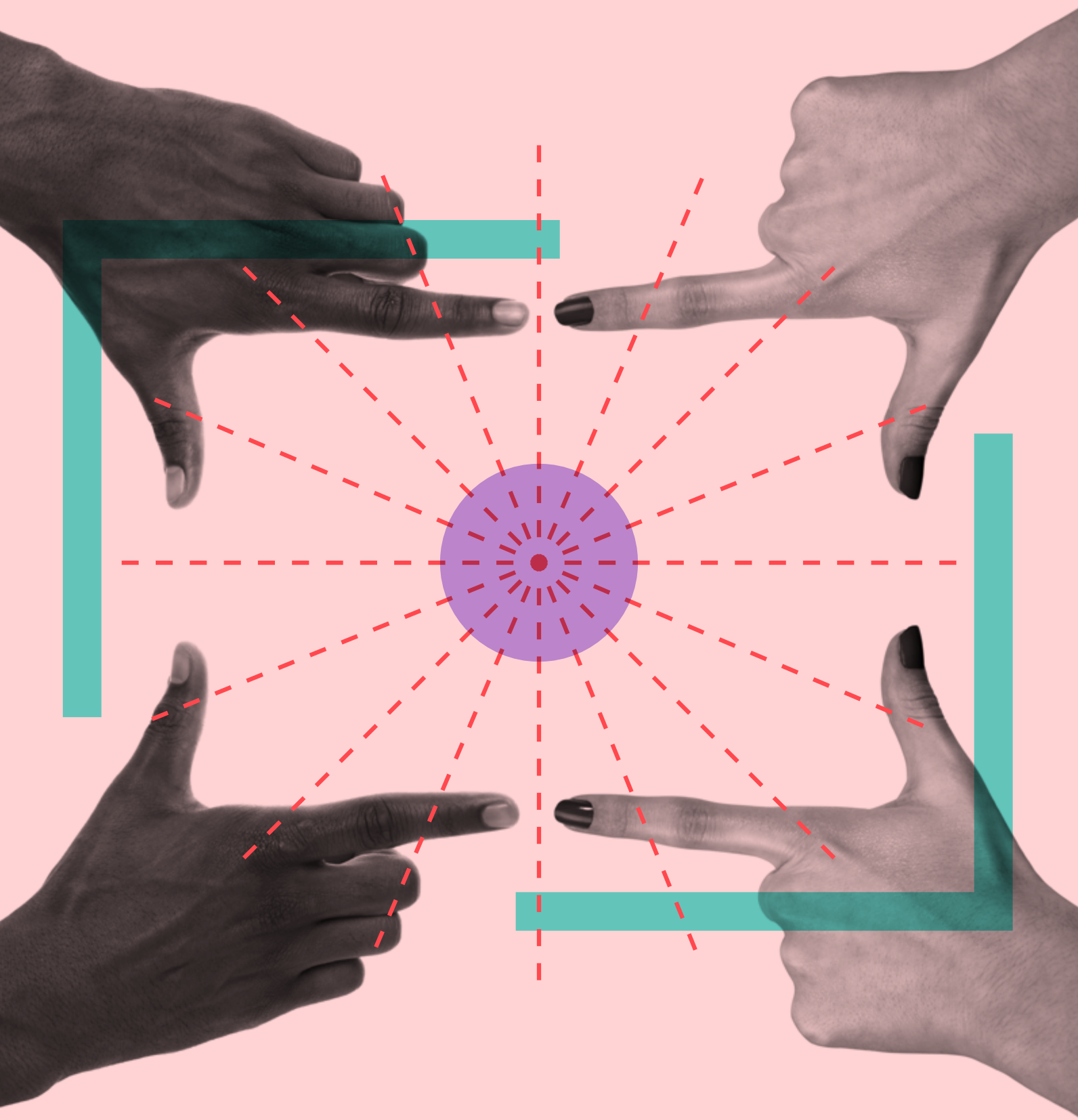
If we end up in a situation with many people who are unemployed or underemployed for significant periods of time, we need a way to provide healthcare, disability, and pension benefits outside of employment. Called "flexicurity" or flexible security, this idea "separate(s) the provision of benefits from jobs."[116] The changing needs of businesses and individuals in the 4IR require giving employers access to a flexible labor force while providing individuals with the security of a safety net and active help in securing employment. One way to do this is to increase public spending on active labor market policies (ALMPs) that either reduce the cost of labor or help people find jobs. For example, Denmark brings together more flexible rules for hiring and firing workers with generous guaranteed unemployment benefits, and spends 1.5 percent of its GDP on active labor market policies to offer guidance, education, or access to a job to all unemployed workers who are looking for one. Equalizing rights and benefits for employees and self-employed would incentivize entrepreneurship and provide personalized pathways through the social protection system rather than offering distinct protections for different types of labor. A battle around this issue is already under way as, for example, Uber drivers challenge their status as self-employed independent contractors in the UK courts.[117]

115 Ibid.

116 Darrell M. West, 2015, What Happens if Robots Take the Jobs? The Impact of Emerging Technologies on Employment and Public Policy, at https://www.brookings.edu/wp-content/uploads/2016/06/robotwork.pdf.

117 WEF (2017) The Global Risks Report 2017, The Future of Social Protection Systems; http://www.oecd.org/els/emp/wcms_556984.pdf.

CONCLUSIONS



There is hope: we have emerging technologies

The 4IR and the digital transformation do not only contribute to productivity and efficiency, but also to broader socio-economic development. They can give rise to a more inclusive and diverse society and better governance arrangements; enhance access to key services such as health, education and banking; improve the quality and coverage of public services and political participation; and expand the way that individuals collaborate and create content. This in turn requires governments to reach across traditional policy silos and across different levels of government to develop a whole-of government approach to policymaking. In a networked environment where torrents of data are generated, every policy, in areas ranging from science to farming, must consider issues of data security, privacy, access and stewardship. It is hard to predict where the future will take us, but it is clear that governments need to accept that times have changed and that they should use the tools of big data analytics, AI and machine learning to improve policy design, deployment and evaluation.[118]

Digital citizens are asking for better services, more transparency, and meaningful participation. Their rising expectations concern the quality of the services public stakeholders ought to provide, as well as the standards of integrity, responsiveness, and fairness of bureaucracy in their daily dealings. A recent IDB study shows that citizens' satisfaction with public services is not only determined by the objective quality of the service, but also their subjective expectations and how fairly they felt they were treated.[119] LAC governments are struggling to meet these ever-growing expectations, while at the same time facing significant constraints on public spending. Digital citizens expect immediate responses to their concerns and immediate fixes for public services. The expectations of LAC's digital citizens have grown exponentially as a result of a rising middle class and an increasingly connected youth, who are more digitally savvy and digitally

118 Andy Wyckoff, 2017, Re-booting government as a bridge to the digital age, http://www.oecd.org/internet/re-booting-government-as-a-bridge-to-the-digital-age.htm.

119 IDB, 2016, Simplifying Lives: Quality and Satisfaction in Public Services, at https://publications.iadb.org/handle/11319/7975.

demanding. Weak public institutions, corruption and insufficient public services will no longer be tolerated. Citizens want better services and more integrity, but many governments fail at this, resulting in record-low trust in government. Civic tech innovations and advanced data analytics have tremendous potential for restoring trust in city government and making it fit for purpose in a fast-paced, changing environment. We are witnessing a change of paradigm in our economies, driven by the new digital economy of the 4IR. This new economic model is based on civic trust and, ultimately, the depth of our societies' civic capital.

Looking ahead...

In order to address the challenges and immense opportunities that the digital transformation presents, governments need to acknowledge that real life is the digital life. A rapid but comprehensive "reboot" of analogue-era policies for a digital age is needed, along with a real effort to bolster skills and digital capacity in government. Governments should foster a spirit of experimentation, exploration and innovation.

The benefits offered by the 4IR will be only fully realized when they are accessed and used intensively by most of the population and a majority of businesses, government agencies, and civil society organizations. Digital technologies can indeed help serve the needs of citizens better, through easier access to health care, financial services and learning, and create new economic opportunities for firms and individuals. But access and usage of digital technologies are not uniform: the digital divide poses a major challenge for LAC countries. We should also bear in mind that the 4IR poses challenges to privacy and security. Some say digitalization could be a chance to make up for the shortcomings of globalization by reducing the divide between those profiting and those feeling left behind. Achieving this means actively tackling digital divides.

Equipping workers with appropriate skills to deal with structural change resulting from automation and other technology-driven changes is necessary to reduce inequality and divide between generations. While young women are just as much "digital natives" as young men, gender gaps remain to be addressed in use of digital technologies and involvement in

digital-oriented industries. Better distribution of the benefits of the digital transformation will help rebuild the dwindling trust between governments, the private sector and citizens.

Recognition of the gap between technology 4.0 and policy 1.0 is pushing digital issues higher up on policy agendas. Addressing inclusion is a critical facet of closing this policy-technology gap. There is much work to do in ensuring that the digital economy is open to all, avoiding domination by a few, and building in protection of consumers and marginalized groups. A more proactive, whole-of-government approach, including unions, civil society and the tech community, can help shape the digital transformation to work better for people and the society as a whole. An illustrative example in this regard are public innovation labs through which many LAC governments tackle difficult challenges through design thinking, crowdsourcing techniques, and data analytics tools. Chile, Colombia, Mexico, Brazil, and Uruguay have developed such social innovation labs within government structures. As a recent IDB report notes, these mechanisms come in different forms. Large cities such as Buenos Aires, Mexico City, Quito, Rio de Janeiro, and Montevideo are at the forefront of testing these laboratory mechanisms and institutionalizing tech-driven and citizen-centered approaches through innovation labs.[120] For instance, in 2013, Mexico City created Laboratorio para la Ciudad, a hub for civic innovation and urban creativity, relying on small-case experiments and interventions to improve specific government services and make local government more transparent, responsive, and receptive. It spearheaded an open-government law for the city that encourages residents to participate in the design of public policies and requires city agencies to consider those suggestions.[121]

Better anticipating trends through strategic foresight could assist policy across all policy domains. Foresight processes can also bring benefits in themselves, such as strengthened stakeholder networks. Long-term and pro-active thinking is also essential to help respond to the ongoing transformation. Leaders in business, unions, civil society and government must be ready to examine the policy implications of the transformation and prepare for developments. This also requires constant reflection on how policy priorities might need to evolve, for instance as a consequence of technological change itself.

120 IDB, 2016, Innovation for Better Management: The Contribution of Public Innovation, at https://publications.iadb.org/handle/11319/7874.

121 Santiso Carlos, 2017, Going Digital: Restoring Trust In Government In Latin American Cities, at https://www.rockefellerfoundation.org/blog/going-digital-restoring-trust-government-latin-american-cities.

The digitalization of government is not without inherent challenges and vulnerabilities. Ensuring the privacy, security and integrity of personal data is a defining challenge as digital identity is a critical enabler of the digital revolution. It also requires smart regulations as well as governments with the capabilities for designing fit-for-purpose legal, policy and regulatory frameworks. Better strategies geared towards enhancing trust and social acceptance should be developed. Such strategies need to strike the right balance between the social and economic benefits of enhanced reuse and sharing of data and analytics, and individuals' and organizations' legitimate concerns about such openness, including the protection of privacy and intellectual property rights. Co-ordinated privacy strategies at the national level would enhance privacy protection in an increasingly data-driven environment.[122]

LAC public authorities need to foster regional cooperation and establish effective frameworks in order to harness so-called digital dividends,[123] namely, opportunities for digital transformation, while at the same time mitigating risks in terms of the widening of the digital gap between the digital "haves" and "have-nots," which compounds social and gender inequality. This is precisely why the challenge of the new Digital Agenda for Latin America (eLAC2018) is framed around the ubiquity of the Internet, technological convergence, high-speed networks, the digital economy, electronic governance and macro-data analytics, without putting aside the unresolved needs regarding access and use of ICTs. In the coming years, eLAC2018 must develop a digital ecosystem that fosters a society based on knowledge, inclusion, equality, innovation and environmental sustainability.

122 Ibid.

123 The World Bank, 2016, World Development Report: Digital Dividends, at http://www.worldbank.org/en/publication/wdr2016.

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