CLOUD COMPUTING

Opportunities and Challenges for Sustainable Economic Development in Latin America and the Caribbean

Antonio García Zaballos and Enrique Iglesias Rodríguez

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Foreword

Today, countries around the world are facing new economic challenges posed by the rapid pace of change in innovative technologies. Governments must find ways to enter and benefit from the digital economy, but also to become or remain competitive as the importance of technology continues to grow.

Latin America and the Caribbean is no exception: the region is the fourth largest mobile market in the world, half the population uses the internet, and certain countries process 100 percent of their government purchases electronically. These successes are not uniform across the region however, and countries still face challenges to expand connectivity, information and communication technology infrastructure, and modernization efforts to be key competitors in the digital economy.

Adopting cloud-based services is one way countries in the region can enable this type of progress and growth, and foster the development of new ventures and a new economy. Aimed at cost savings and promoting innovation, the move from traditional IT hardware to cloud services can empower and liberate governments from outdated, inefficient, and slow technology processes that require millions of dollars' worth of investments year after year. Together, the Inter-American Development Bank and leading technology companies can help regional economies realize the benefits of cloud services, including cost savings, security, elasticity, transparency, and economic opportunity.

To leverage the benefits of cloud services and new technology developments, governments need to develop policy frameworks that seek to build trust in new technologies and address concerns about data protection, cybersecurity, financial market regulation, cross-border data transfers, data privacy, and how to provide citizens with the skills for the future world of work. This paper seeks to illuminate these opportunities and highlight practical economic and policy considerations that should be made to realize this potential.

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Introduction*

The Fourth Industrial Revolution. Digital transformation. Information economy. Digital trade. These are some of the technological trends emerging in the global marketplace today. Governments must determine the extent to which they will embrace these trends, since these technologies permeate nearly every area of daily life. Individuals, organizations, and industries are using technology in revolutionary ways to develop more operational efficiency, expand reach, and improve the economy and society. Although they occur within national borders, these activities are global in scope.

The main challenge to governments in this aspect is how to adopt and promote the use of innovative technologies to remain globally competitive. The Latin America and Caribbean (LAC) region is no exception. Many LAC governments have made concerted efforts to increase access to and usage of emerging technologies, particularly cloud services. The diffusion of information and communications technologies (ICT) in the region has grown steadily over the past 10 years, reaching between 80 and 100 percent of small- and medium-sized enterprises (SMEs) (CEO Summit of the Americas, 2015). In 2015, 56 percent of the population in the LAC region had access to the internet, a figure projected to grow to 60 percent by 2019. Broadband penetration, access to mobile phones, and the size of the ICT sector have increased significantly in a relatively short period, and critical investments to strengthen infrastructure continue. However, a significant digital divide persists in the region. Future global competitiveness and development of the LAC region will be contingent on shrinking this divide so that

Cloud computing is a forward-thinking, enabling technology: it is the foundation of key digital technologies, such as big data analytics, artificial intelligence, and the Internet of Things.

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individuals and organizations can readily take advantage of ICT innovations (Fredrikkson, 2013). Considering that a mere 10 percent increase in broadband penetration in the region could boost GDP by 3.2 percent and increase productivity by 2.6 percent (Fredrikkson, 2013), efforts to promote and diffuse ICT goods and services are imperative.

An economy's adoption and use of cloud computing is one vehicle to reduce the divide, because of its ability to reinvent enterprise IT and democratize leading-edge decisions. The economics of cloud computing is such that the unhappy distinction between those that could make the major capital cost investment required to access and update the latest computing technologies and those that couldn't make that investment will largely fade away. With cloud computing, regular interaction with the latest computing technologies should become much more of a reality to the larger community (Gutierrez and Korn, 2014). Economies embracing cloud computing experience the benefits of scalability, lower costs, an improved security posture, and opportunities for innovation. Citizens can leverage cloud services, such as data storage and processing, and compute in ways that were previously cash- or cost-intensive. SMEs can now harness a wide array of capabilities through the cloud to provide information, goods, and services to the global marketplace.

To create cloud-computing capabilities, governments will need to support infrastructure required to extend connectivity, ensure businesses have the right incentives to invest and innovate, and develop the digital skills of the workforce, including in data analytics (Access Partnership, 2017). Over half a million of today's job vacancies in LAC are in technology fields, with demand expected to grow. To meet this demand, training programs in ICT technologies must become more prevalent and accessible. The private sector uses cloud computing to drive exceptional results in manufacturing, banking, and transportation, while the public sector uses it to deliver healthcare, education, and public safety more equitably. It seems that the opportunities to deliver results and drive innovation using cloud computing are limitless.

The LAC region is at a critical juncture in its socioeconomic development: economies in the region must seize opportunities to advance robust digital strategies, including cloud computing. Countries that fail to do so will fall behind more advanced economies and will be disadvantaged in terms of innovation, performance, productivity, and competitiveness. To stay ahead, governments should develop policy frameworks that seek to build trust in technology and address concerns about data protection, cybersecurity, financial market regulation, cross-border data transfers, and data privacy; boost entrepreneurship, efficiency, and cost savings; maintain flexibility and foresight with respect to emerging technologies; and deliver education and training systems capable of preparing people for the

To leverage the benefits of cloud services and new technology developments, governments need to develop policy frameworks that seek to build trust in new technologies and address concerns around data protection, cybersecurity, financial market regulation, cross-border data transfers, data privacy, and how to skill people for the future world of work.

future world of work. Governments should partner with civil society and industry to create an environment capable of responding to these challenges (Microsoft, 2018a).

Governments should also consider the types of assurances that cloud computing and cloud service providers can give their agencies and public-sector organizations to deliver constituent services with cutting-edge technologies and user-friendly features. Recent economic activity and growth forecasts suggest that the LAC region is well positioned to compete in the digitally enhanced economy. This paper seeks to illuminate these opportunities and highlight practical economic and policy considerations that should be taken to realize this potential.

CHAPTER 1

Cloud Technology

THE CLOUD: A NEW FORM OF INFORMATION TECHNOLOGY

There are many advantages of cloud computing over traditional forms of information technology (IT). These include the financial model that evolves from capital expenditure (capex) to operating expenditure (opex), and simplification of the IT infrastructure. With cloud computing, developers and IT managers no longer need to plan for capacity and development tools.

Cloud versus Traditional Information Technology

According to the U.S. National Institute of Standards and Technology (NIST), cloud computing is the "model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (networks, services, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction" (NIST, 2016). On-demand, rapid provisioning and resource access are critical features of cloud usage. With traditional IT, end users interested in scaling up their IT resources would need to provision for and buy software and hardware, such as physical servers, network equipment, cabling, facilities, cooling, and others, to create additional infrastructure and enhanced capabilities to meet projected demands. Organizations and individuals must anticipate their projected IT demand and frontload significant investments to acquire resources to meet the demand. This is one of the main challenges of IT teams, especially in organizations where priorities change and IT must adapt to meet new requirements. Provisioning new servers and getting them installed and ready for development take time and require additional financial resources. This is an ongoing challenge that cloud service providers seek to overcome.

In addition to maximizing investments and avoiding investing in and maintaining legacy IT infrastructure, cloud computing enables public sector organizations and government agencies to meet mission-critical objectives and to innovate.

Cloud service providers (CSPs) manage IT resources and services on behalf of the consumer, and the consumer can acquire services such as storage and computer power on an as-needed basis. Users only pay for what they use—by the compute-hour or storage gigabyte—similar to a utility model used for electricity consumption, for example. The pay-as-you go model serves public sector enterprises and governments well, particularly those with strict budget processes. Government agencies can trade capital expenditures, which can cost millions of dollars, for variable expenses. Those expenses are lower if the user provides its own IT service. With inherent economies of scale, the cloud is simply more efficient than anything a user could build and operate for itself. This fosters agility within the agency and across government, promoting innovation and modern citizen services, as well as greater resource and cost management.

Various government and nongovernmental entities have studied the U.S. government's potential costs savings associated with adoption and use of cloud computing. With such a great variety of systems currently in place, however, projecting a true estimate is challenging. In 2015, the Congressional Research Service estimated that federal agencies

could save approximately 50 percent or more by using cloud services (CRS, 2015). This is significant given the exorbitant amount of money spent by the U.S. government annually to maintain and routinely upgrade legacy IT systems. In the 2018 budget request, the U.S. Office of Management and Budget stated that "from FY 2015 to FY 2018, government-wide legacy spending as a percentage of total IT spending rose slightly from 68 percent to 70.3 percent." This represents approximately US$39 billion, of which the U.S. government could recoup 50 percent simply by migrating to the cloud. These numbers reinforce the arguments made in the "2017 Report to the President on Federal IT Modernization" (U.S. Government, 2017), that unifying and streamlining federal IT systems with particular emphasis on the adoption and use of cloud services can increase the efficiency and efficacy of the federal government.

At the state level, governments are taking bold steps to evaluate how state agencies can fully operationalize cloud services. For example, the Texas Department of Information Resources (DIR) conducted a comprehensive study and pilot program to understand what benefits could be realized through the adoption of cloud computing. The study recommended that Texas adopt a cloud-focused IT policy strategy. This recommendation states that for state agencies, "to fully leverage the potential savings of cloud services, Texas should *require* agencies to evaluate and consider commercial cloud computing services before making any new information technology or telecommunications investment" (House Committee, 2016). Requiring agencies to evaluate cloud computing constitutes a significant change from the previous policy, which merely directed state agencies to consider cloud computing as an option. Key drivers to this language change included the significant cost savings, security features, and agility associated with cloud computing.

Countries around the world have already identified the cost savings that governments could realize by leveraging cloud services and have taken steps to implement procurement policies that require the use of cloud services. One example of a national government adopting and implementing a cloud-native strategy is the United Kingdom. In early 2017, the U.K. government clarified its Digital Strategy, announcing that it would be both "public cloud first" and "cloud-native." The government directed all public sector organizations "to consider and fully evaluate potential cloud solutions first before considering any other options," and added that this would be a mandatory approach for "the central government and strongly recommended to the wider public sector" (U.K. Government, 2017). Further, the government specified that a public cloud, rather than a community, hybrid, or private deployment, would be the preferred model, as "the primary benefits for government come when we embrace the public cloud" (U.K. Government, 2017). The government also clarified that, by itself, a cloud-first policy would be insufficient to meet what it needs against what is emerging or coming new, and as a result, it would employ a "cloud-native" framework. In doing so, the government confirmed that the policy was focused less on directing how it considers IT solutions, and more on the government's ability to organize itself and adapt. Adaptability and responsiveness will be critical for governments, such as that of the United Kingdom, to succeed in today's digital economy.

The vehicle in which it was enacted was the federal guidance issued by Government Digital Service as part of the Technology Code of Practice (U.K. Government, 2017). The Technology Code of Practice sets the standard for ways that government organizations design, build, and buy technology. They are mandatory requirements and standards.

In addition to maximizing investments, utility-based cloud computing enables public sector

organizations and government agencies to meet mission-critical objectives and to innovate.

- Mission-critical objectives: Organizations operating in digital space are increasingly focusing on data security and data protection. The convergence of IT modernization and cybersecurity relies extensively on the use of the cloud to ensure the utmost protection for citizen and government data. In the cloud, security threats can be addressed in real time, where cloud service providers work constantly to combat risks to customer data. Visibility, homogeneity, and automation—all inherent features—greatly benefit security. Unlike traditional IT, where it is seldom achieved, the cloud enables full integration of compliance and security systems. For example, the latest breach of the ransomware "Wannacry" showed the vulnerability of unpatched legacy infrastructure.
- Innovation*:* Cloud computing dramatically increases the speed and agility of user innovation and can lower barriers to entry to previously locked markets. Instead of waiting many weeks to obtain IT infrastructure, users can access virtually unlimited capacity within minutes. Cloud computing allows a user's scarce technical talent to focus on its core mission rather than on maintaining basic computer and storage infrastructure to support it. With the budget challenges that agencies face today, that focus is of great value to government users.

Implications of Ignoring Cloud Computing

Today's most exciting technologies, such as the internet of Things (IoT), autonomous transportation, innovations in healthcare and financial services, mobile applications, and social media, are built into and powered by cloud services. The public sector seeks to capitalize on this dynamism. Throughout the world, businesses, educational institutions, and nongovernmental organizations are increasingly adopting cloud services. The advantages in terms of cost savings, efficiency, cybersecurity, and innovation are becoming hard to ignore. Countries such as the United Kingdom and Bahrain are making great strides to fully realize these benefits, taking cloud migration to the next level and formalizing it within policies (e.g., cloud-native or cloud-first) to further leverage the benefits.

The success of cloud migration and cloud adoption depends on government policies on the treatment of data, procurement, digital strategy, and trade, and other regulations governing the use of IT in various sectors. Governments struggle to keep pace with technology development and innovation. It is more critical than ever that governments develop political, regulatory, and economic strategies that embrace innovation in computing technology.

With this scenario in mind, this section poses the question, "can an economy ignore cloud services?" While the answer seems clear, the reality today is that most governments are struggling to establish the types of policies needed to adopt cloud computing. Each economy may be within its own unique stage of technology development, but there is a reality today that those economies that fail to develop a forward thinking approach to technology, inclusive of the use of cloud services, and promote its adoption across all sectors and industries will lose out on a range of social and economic benefits necessary to remain competitive.

Models for Cloud Deployment

Cloud computing manifests as one or more of the following types of services: Infrastructure as a Service (IaaS), Platform as a Service (PaaS),

or Software as a Service (SaaS). Together, these cloud computing models function like a traditional IT environment, with infrastructure supporting platforms and services. Individually, the models are unique despite some commonalities.

NIST defines these cloud computing models as follows:

- Infrastructure as a Service: CSPs offer consumers the capability to provision processing, storage, networks, and other essential computing resources where the consumer can deploy and run arbitrary software. This includes operating systems and applications. The CSP, and not the consumer, manages and controls the underlying infrastructure, but the consumer has control over operating systems, storage, and deployed applications (Mell and Grance, 2011).
- Platform as a Service: CSPs offer the consumer the capability to deploy consumer-developed or acquired applications onto the cloud infrastructure using the CSP's various tools. The CSP, and not the consumer, manages and controls the underlying infrastructure, but the consumer has control over the deployed applications and possibly its configuration settings for the application hosting environment (Mell and Grance, 2011).
- Software as a Service: CSPs offer the consumer the capability to use the CSP's applications running on the cloud infrastructure. The applications are accessible from various client devices through a client interface, such as a web browser, or a program interface. The CSP manages most aspects of the SaaS offering, except limited user-specific application configuration settings (Mell and Grance, 2011).

Different cloud environments host these models, and users use them in a variety of ways:

- Public cloud: the cloud infrastructure is designed for open use by the public. Users—individuals, businesses, academic institutions, or government organizations—own, manage, and operate it. The infrastructure exists on the CSP's premises (Mell and Grance, 2011).
- Private cloud: the cloud infrastructure is designed for exclusive use by a single organization composed of multiple consumers, or business units. It is typically owned, managed, and operated by the organization, a third party, or a combination of the two, and may exist on or off the premises (Mell and Grance, 2011).
- Community cloud: the cloud infrastructure is designed for an exclusive community's use, where consumers across the community have specific concerns and requirements regarding mission, security, or compliance. Members of this community, a third party, or a combination of the two own, manage, and operate the infrastructure, and it may exist on or off the premises (Mell and Grance, 2011).
- Hybrid cloud: the cloud infrastructure is designed combining two or more of the above infrastructures while maintaining their unique entities. Here, they are bound together by standardized or proprietary technology that enables data and application portability (Mell and Grance, 2011).

Regardless of the model or environment in which they are deployed, cloud services allow users to enjoy various degrees of on-demand self-service, broad network access, resource pooling, rapid elasticity, and measured service. Government users can take advantage of the same benefits enjoyed by private commercial entities, according to their own needs and specific requirements.

By using public cloud services, governments will be able to leverage existing cloud infrastructure, dedicating all resources to the development

of new solutions and the active use of existing services without investing in infrastructure and its design. While there could be a perception of greater control and security by building a private cloud, the reality is that a private cloud requires significant investment in designing the private cloud infrastructure. Additional budget resources will be required to maintain the infrastructure, including equipment replacement and upgrades, and security, both physical and in the information systems. In addition to incremental investment, cloud models require an additional level of knowhow to design and operate. However, the additional investment, does not necessarily make the environment more secure, as commercial cloud providers generally invest more resources in security than any other organization. This study recommends that government organizations opting to develop a private cloud should justify the need for the additional investment.

CHAPTER 2

Dependencies, Blockers, and Current Foundation for Cloud Infrastructure

While the transformational power of cloud computing is evident, an economy's ability to migrate to the cloud is not straightforward. In addition to the policy enablers mentioned in this paper, major infrastructure dependencies are required to foster adoption and enable the build-out of cloud infrastructure.

To understand the adoption dependencies, they must be considered from both the demand and the supply perspective. From the supply perspective and referring just to the ability to use cloud services, adoption will depend in the underlying infrastructure, specifically high-speed broadband connectivity. While the internet is flat, distance still matters, and to effectively use cloud applications, all broadband metrics matter, including download and upload speed and, most importantly, latency. If a country's broadband networks are unreliable and slow, users will not be able to adopt cloud computing. In regulated industries such as financial services and healthcare, regulations regarding the use of technology could also become an obstacle to adopting cloud computing if they have not been updated to account for technological advances.

Cloud computing is a relatively new development in IT. Even within the IT community, how to develop IT services in the cloud environment is not well understood. One of the major challenges of organizations is how to migrate legacy IT systems to a new environment. This requires knowledge of both environments and the organizations' IT infrastructure and systems. This expertise is critical and largely absent in the LAC region.

In terms of supply, specifically from the user perspective, a high-speed broadband connection in theory is the bridge to any cloud service provider. However, as mentioned above, distance is still important, and critical applications and workloads have low latency requirements. Therefore, proximity to cloud infrastructure can be an important factor to deliver cloud services. Improving the availability and quality of national networks in the LAC region along with regional and international connectivity can help significantly lower the latency of broadband services.

There have been also efforts to locate infrastructure closer to the consumers. Companies have been investing in cloud infrastructure around the world, including in the LAC region. For example, the Curie Subsea Cable, promoted by Google, will connect Los Angeles to Valparaíso, enabling a substantial reduction in latency, or the American data center operator EdgeConneX, which announced in January 2018 a plan to build a 10MW Data Center facility in Buenos Aires, Argentina (EdgeConneX, 2018). However, the size of an economy, the stability of its government, the soundness of its economic policies, economic growth, and low inflation are not enough to enable the build-out of cloud infrastructure in a particular country. A number of infrastructure dependencies on the supply side must be taken into account.

CHALLENGES OF REGIONAL INFRASTRUCTURE THAT MAY IMPEDE PROGRESS OF CLOUD ADOPTION

One of the critical factors in determining the feasibility and successful use of cloud computing and the build-out of cloud infrastructure in a country is the availability of underlying infrastructure required by the cloud service providers. The underlying infrastructure encompasses high-speed broadband networks both for national transport and local access, redundant access to international capacity, internet exchange points and peering agreements, affordability of service, and renewable energy, as cloud service providers have

robust green commitments. This section examines the current regional infrastructure vis-à-vis international backbones, which aggregate user data for transmission between the cloud and end-users.

Increasing Broadband Penetration: A Top Priority for Governments

Since 2010, broadband access has become a government priority globally and has been considered a critical factor in socioeconomic development. Broadband access correlates directly with net positive impact on GDP growth, job creation, and increase in average household income. As a result, strategic initiatives to drive broader broadband access have been implemented nearly everywhere, and broadband penetration has grown significantly as a result. By the end of 2015, global broadband penetration reached 47 percent, with upward of 3.2 billion users (GSMA Intelligence, 2016).

Countries in Latin America are attempting to tap into this economic potential. In 2010, for example, Brazil launched the first National Broadband Initiative in the region. In 2012, Mexico announced an initiative, AgendaDigital.mx, to increase mobile and fixed broadband, exemplifying a shift in policy and perspective. In 2013, telecommunications reform in Mexico established broadband and internet access as a constitutional right. Colombia followed suit, targeting low-income populations, education systems, and rural areas as priorities for IT sector investment and enhancement. While the comprehensive outcome of these initiatives has contributed to achieving a fixed broadband penetration of 9.2 percent across the region, there is still a significant challenge ahead (Casanova, 2016). Broadband penetration will likely continue to grow as demand surges, particularly in developing countries, where demand is highest. Cloud services have driven this demand as users consume more applications and data and leverage platforms located internationally, such as those within social media networks. As more applications and IT infrastructure migrate to the cloud, the quality and speed of broadband connections will become more critical, particularly with respect to upload speed and latency. High-speed, next-generation networks will be required to support cloud-based services.

Broadband expansion efforts in the LAC region have been challenging due to the high cost to deploy infrastructure, exacerbated in some countries by high tariffs and import costs, lengthy processes to obtain rights of way and construction permits, lack of passive infrastructure, an onerous regulatory regime, additional telecom levies, lack of competitive national transport networks, peering, and access to international capacity. In some countries, there is considerable uncertainty in the legal and regulatory framework. As a result, the deployment of next-generation networks and additional high-speed broadband networks is not sufficient to meet the needs of LAC countries to enable to them to fully leverage the digital economy. Thus, investment in broadband networks has never been so urgent.

Governments must continue to pursue policies that address the challenges of broadband expansion. These include more funding for infrastructure, incentives for telecom operators to invest in new or updated infrastructure, and modernization of the regulatory regime, including to take advantage of underutilized broadcast spectrum to expand internet connectivity.

To foster the development and adoption of cloud services in an economy, this study recommends that governments continue to pursue policies that address the challenges of broadband expansion, ensuring that investments in infrastructure grant internet access for all, as opposed to local data center investments, which tend to benefit only a few (Access Partnership, 2017). These include more funding for infrastructure, incentives for telecom operators to invest in new or updated infrastructure, and modernization of the regulatory regime, including to take advantage of underutilized broadcast spectrum for wireless use on an unlicensed basis to expand internet connectivity (Ivanschitz and Korn, 2018; Microsoft, 2017). Notably, Colombia and Trinidad and Tobago are the first countries in LAC to have published spectrum regulations in this regard.

Government policies need to focus on facilitating investment in high-quality broadband access systems. They also need to ensure that this infrastructure is inclusive and supports affordable access for all (Access Partnership, 2017).

Availability of Broadband, internet Access, and High-Speed Connectivity

There are significant differences among the countries in the region with respect to internet access, despite increases in broadband penetration generally. In 2015, only Chile, Costa Rica, and Uruguay boasted 60 percent household internet penetration rates, while most of the region fell somewhere between 15 and 45 percent (ECLAC, 2016). Moreover, within countries, the rural-urban divide in internet penetration can be up to 41 percent. Still, broadband access does not necessarily correlate to high internet connectivity. No country in the region has even 5 percent of its connections operating at speeds of 15 Mbps (ECLAC, 2016). This generalized lag in internet speeds is another reason to pursue underutilized broadcast spectrum for wireless use given its low cost and relatively quick deployment of 18–22 Mbps speeds with only two channels (Smith, 2017).

A number of factors implicit in broader internet access development affect connectivity. Economies of scale, for example, do not typically exist in the region. Some of the reasons for this are total population size, income distribution, and per capita income in relation to intrinsic broadband costs. Costs to connect to Tier 1 Internet service providers outside the region are higher because of the capacity required for such connections. Users also incur additional transmission costs due to imperfect direct regional connectivity both among and within countries; increasing the number of internet exchange points (IXPs) within countries may be a viable solution in this regard. Therefore, this study recommends considering this solution as a policy priority.

IXPs and international/national backbones are integral to data transmission and fundamental for the ability for users, government agencies, and companies to use cloud-based applications. If the backbone is not robust, users cannot achieve the full speed of their local connection. This is the case in both rural and urban areas. IXPs can help reduce the cost of international bandwidth by routing and managing internet traffic domestically as opposed to internationally, and reduce latency, a critical network metric that impacts time-sensitive applications (Fredrikkson, et al. 2013). The cost of IXPs fell in Chile, where the high rate of connectivity makes it possible to differentiate wholesale prices between national and international traffic (such that national traffic has become considerably cheaper). IXPs allow content providers to cache data in the country once traffic reaches a certain volume. This improves latency and creates a better user experience with stronger performance (Fredrikkson, 2013). Therefore, developing IXPs across the LAC

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The quality of the user experience will also depend on the type of connection available, whether a digital subscriber line, cable modem, or fiber optics—all considered fixed broadband. Each offers different speeds, with fiber optics being the fastest, but speed depends on many factors related to how the connection is established. DSL remains the prominent fixed broadband connection available and used around the globe, but it fails to deliver the speed and quality of service required in the world of cloud and IoT (Fredrikkson, 2013). Next-generation and 4G wireless networks are best suited to support cloud service usage, which allows more proportional upload and download exchange, and low latency (Fredrikkson, 2013).

Without the proper backbone in place, however, bottlenecks can emerge. Download speed is a key metric in assessing broadband performance, and a typical user of broadband downloads more data or content than they upload. Video content, where cloud services offer movies in high quality, for example, increases the ratio of downloaded content significantly. In 2012 alone, some 1.3 billion internet users watched an average of 162 online videos per month (Fredrikkson, 2013). Cloud services require consideration of both download and upload speed, as well as low latency. Offline storage, file sharing, and back-up services require that users upload data to the cloud (a remote server).

Next-generation and 4G wireless networks are best suited to support cloud service usage, as they allow more proportional upload and download exchange and low latency.

Policies related to broadband offers are also critical to foster internet usage and cloud-based services. Limited bandwidth and data caps could limit users' adoption. They are critical considerations for regulators in evaluating the benefits of such pricing models. While they might encourage adoption, they could also limit the use of applications that bring the most benefits to consumers.

The challenges in LAC go beyond the metropolitan and national transport networks. The region also lacks international capacity, and countries have few submarine cables and cable landing stations to connect to the rest of the world (ITU, 2013).

Growth of Mobile Broadband Penetration

Mobile broadband, in contrast to fixed broadband, is a single-user technology and its speed depends on the type of connection used. Mobile typically suffers from higher latency than fixed broadband, and most mobile broadband in the region operates across 3G networks (GSMA, 2016). In 2017, 80 percent of the region had access to 4G and there

were only 64 live 4G networks currently available (GSMA, 2016). Individuals access mobile broadband through smart phones; by 2020, 79 percent of the region will enjoy mobile broadband connection through some 577 million smartphones (GSMA, 2016).

As smartphone adoption continues to grow, network providers will likely seek ways to expand network coverage. Brazil is a case in point: Brazil leads in 4G adoption, with projected adoption rates to hit 50 percent by 2020 (GSMA, 2016). Network operators have invested heavily in 4G networks and are driving commercial efforts to incentivize consumers to make the switch (GSMA, 2016). However, despite this effort, the availability of 4G and 5G services across the LAC region is behind that of most developed countries.

HIGH TAXES ON UTILITIES AS A DETERRENT TO FOREIGN INVESTMENT IN INFRASTRUCTURE

Tax schemes in the LAC region related to utilities impose exorbitantly high rates. For CSPs and other technology companies hoping to make infrastructure investments in the region, this can be a deterrent to investment. CSPs seek to maintain lower cost structures and price points for their customers, an approach applied uniformly throughout every facet of the supply, from use of services to consumption of energy. Where taxes are higher, service providers are forced to offset higher costs by passing them on to consumers. The inability to maintain a lower cost structure and price points for consumers may discourage technology companies from operating domestically.

Governments should consider various forms of tax waivers for cloud infrastructure investment, particularly on energy utilities supporting cloud services. Cloud infrastructure investment will stimulate economic activity in myriad ways, and the potential economic growth will offset lost revenue from previously taxed utilities. Where modernization and digitization efforts continue to expand, technology companies and CSPs may be governments' best customers, particularly when they are situated to invest in infrastructure.

FUTURE ENERGY CAPACITY: A CHALLENGE TO PROGRESS ON CLOUD ADOPTION

Another challenge in the satisfaction of the region's demand for IT is electricity and energy supply. Migrating to the cloud can help address both. Cloud computing is greener, both in how CSPs run and manage data center operations and by eliminating upfront investments in IT infrastructure that consume exorbitant amounts of energy. Today, IT services consume more than 2 percent of total global energy use. In an energy-volatile region like LAC, this has the potential to be extremely costly financially and environmentally. This is why the move to cloud computing is imperative for countries suffering from this lack of energy security.

Cloud Services as a Greener Solution for IT

Governments that outsource IT management to a commercial CSP reduce energy consumption. This translates into reduced carbon emissions, as a result of which cloud computing has been called "green IT" (Gutierrez and Korn, 2014). The Mexican Institute for Competitiveness estimates that Mexico's medium and large-sized business sector would in the aggregate reduce carbon emissions equivalent to removing 90,000 cars from circulation by migrating to the cloud. Cloud computing

addresses energy inefficiencies by reducing excess capacity, flattening peak loads, employing large-scale virtualization, and optimizing data centers. Underutilization of servers is a major problem for organizations wishing to undertake their own IT resource management. With commercial cloud computing, servers are powered on an as-needed basis, which helps eliminate energy waste. Global models of cloud computing most commonly deployed by large-scale commercial CSPs maximize hardware utilization by diversifying where workloads are processed or stored. Scale and flexibility also help to contain energy costs for both CSPs and their customers, particularly because managing virtual environments is easier and cheaper than managing physical infrastructure. Commercial CSPs are also experts in data center design: they have developed rooms and server cooling techniques that address energy waste and increase energy efficiency.

The Need for a Robust Power Infrastructure

A robust power infrastructure is critical for cloud services. Countries that experience regular power outages and intermittent access to electricity struggle to provide cloud services and to attract CSPs. A reliable power supply is essential for hosting cloud infrastructure, including data centers.

IT infrastructure, including servers, routers, and switches, consumes significant amounts of energy. CSPs make an important contribution by rationalizing IT energy consumption. They increase the utilization of IT infrastructure and reduce idle capacity and redundant infrastructure across the IT ecosystem in a given country. Nevertheless, energy consumption by a data center, even in a developed country with strong energy infrastructure, can be enormous. A 2008 report found that the amount of energy consumed by data centers, on average, has doubled every five years (Chao, 2016). At that rate, this would amount to nearly 2 percent of total U.S. electricity supply (Fehrenbacher, 2016). IT energy consumption would grow at an even higher rate if CSPs did not exist.

Since the cost and the impact on the environment can be considerable, CSPs have made concerted efforts to implement best practices in the area of efficiency and use of renewable energy to curb excess consumption. In the United States, data centers consumed 70 billion kilowatt hours in 2014 (or roughly 1.8 percent of total U.S. electricity consumption) (Fehrenbacher, 2016). This represents a decline in the overall rate of growth of electricity consumption, but it is still significant. Due to these efforts, cumulative costs savings were estimated at US$60 billion (Fehrenbacher, 2016).

Securing the capacity to support data center infrastructure in the LAC region could be challenging, as the increase in energy needs to power data centers remains in the double digits (Fehrenbacher, 2016). This is due in part to growth in the data center market in the region, but also to electricity challenges and weak implementation of energy efficiency practices (Fehrenbacher, 2016).

To attract cloud infrastructure to the region, it is critical that governments in LAC develop policies to address the expected demand by fostering new green energy generation projects, investing in transmission networks, and developing a competitive market place.

Generally, the Latin American region suffers from energy insecurity amidst increasing demand. Growing populations, limitations to infrastructure, and climate change affect this situation. Electricity demand grows in tandem with population growth, particularly as technology becomes a basic need. Thus, the region's power consumption is likely to double between 2010 and 2030 (Levine, 2014).

Building out the necessary infrastructure for electricity generation capacity to meet this demand has been difficult. Common experiences exemplifying this challenge include prospective projects stalling amid human rights and environmental concerns, over-dependence on fossil fuels, and domestic terrorism destroying existing infrastructure (Levine, 2014). At this time, nearly US$430 billion in investments to the electrical grid are needed to revitalize infrastructure to meet anticipated demand (Levine, 2014). Research suggests that even the best outcomes in supply generation will be insufficient to meet demand.

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Impact of Climate Change on Projected Electricity Supply and Demand

Climate change has called into question previous electricity and power strategies and projects and forced governments to consider alternative sources for energy. Some countries have experienced heat-related blackouts and peak power demand during frequent heat waves, while others have lost dam-generated electricity where rain and water supplies have diminished.

New solutions are necessary to promote reliability and efficiency in the regional electric grid amid social and environmental changes. Renewable, or green, energy across the region could potentially address the current lack of supply. Argentina, Brazil, Chile, and Mexico are considered to have some of the most attractive renewable energy sites in the world, and the Dominican Republic, Panama, Peru, and Uruguay are generating similar buzz among investors in renewable energy (Bokor, 2017). The region's total endowment of renewable resources is estimated to be approximately 93 Petawatts per hour, comprising a variety of sources, including hydro, solar, wind, and geothermal (Bokor, 2017).

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CHAPTER 3

Education and Workforce Development in the New Digital Economy

There is consensus on how the skills gap in the ICT space is slowing down technology adoption and thus economic growth and competitiveness. IDC, an ICT research firm, estimates that in 10 LAC countries, demand for personnel with networking skills in 2016 surpassed supply by over 470,000 FTEs (full-time equivalents), and by 2019 there will be a gap of 628,000 (IDB 2016).

Two questions shape strategies for education and workforce development in a growing digital economy: (i) How can government, business, and society leverage technology to better educate populations, for students of all ages? and (ii) How can we educate and train people to have the necessary skills to compete for the jobs of the future?

These questions are not new. While this paper develops some of the key points, it also seeks to bring a new perspective to how cloud technology can contribute to the policymaking process. As new cloud-based education systems and applications are adopted in the region, there will be more data that can be used in new ways. Big data, especially artificial intelligence (AI), could play a key role in contributing to the development and adoption of adaptive learning and efforts to personalize education. The successful implementation of AI in the education system will depend on the determination of government leaders to enter into partnerships with startups. In this regard, opening up space to mine data and bring new ideas as well as the support from CSPs could make available the computing capacity to leverage the vast amount of data that an education system could provide.

STATE OF EDUCATION IN LATIN AMERICA TODAY

In Latin America, efforts to improve the education system have focused on access to education, enrollment, and increasing human and physical resources. Educational attainment rates have improved significantly as a result. Today, the average individuals in the region progress through 12 years of schooling (Inter-American Dialogue, 2016). Skill levels remain poor, however. More than half of students in Latin America do not have basic-level proficiency in reading, math, or science, and less than 1 percent perform at the highest levels of proficiency in each category. This extends throughout the education system and more than two-thirds of youth in the region are low-skilled and lack tertiary education.

Educational attainment determines labor market outcomes for individuals and broader populations. With a low supply of highly educated workers, it will be difficult to fill jobs. This is already occurring; 50 percent of firms in the region do not find candidates with the necessary skills. This is significant across science, technology, engineering, and math fields in the region, where shortages of engineers, technicians, and skilled trade workers are felt across all sectors and industries. There are already 150,000 ICT jobs left unfilled in the region today.

By 2019, Latin America will have a shortage of almost half a million technology professionals. By 2025, approximately 1.25 million software developers will be needed (Laboratoria, 2017). Moreover, demand for low-skilled, manual labor is likely to change. There have been minor shifts of unskilled labor into higher quality jobs in more productive sectors. Today, even those jobs require a component of skills training, as job functions across the supply chain incorporate more technology and, in some cases, are replaced by technology. Targeted investments and strategic remediation to elevate education, train workers, and redesign job functions for the future are necessary to address this skills gap.

This information has been documented in numerous reports about the challenges of ICT in LAC, yet governments in the region have not taken decisive action. This paper echoes these findings

and recommends that governments in the region take action.

BRINGING TECHNOLOGY INTO THE CLASSROOM

There is significant evidence that the use of technology in the classroom can revolutionize education (IDB, 2011). Digitizing education can provide access to innovative technologies, new skillsets, global content, and information. Students, in turn, have more opportunities to gain practical experiences with new technologies and to develop skills for the workforce. Teachers who use these technologies can have opportunities for professional development and can gain access to global content to drive educational attainment and meet curriculum objectives.

In several parts of the region, this is as simple as improving infrastructure for schools, namely, increasing the number of computers, laptops, and tablets available to students, leveraging education applications, and improving internet connectivity in the classroom. Students and teachers can engage with technology and access content relevant to basic and more technical curricula. Cloud services are a vehicle to deliver critical content to schools. Students and teachers can access a variety of educational materials and programming available on the internet, in the form of software, platforms, or web-hosted materials from cities in the country as well as global institutions. This can have a phenomenal impact for programs seeking to improve literacy, develop stronger content in the classroom, and increase awareness while reducing social isolation for students in some of the poorest and most remote areas of the region.

Many economies in the region have struggled to incorporate IT skill development into the classroom. Cloud services can deliver this type of specialized content. ICT courses delivered over a network can help students to build, operate, and troubleshoot networks; develop programs and applications for desktop and mobile; and experience the use of cloud for cybersecurity, IoT, or AI. Learning and content are available through cloud services, and innovation and invention is possible with the cloud. The scalable, on-demand, and low-cost nature of the cloud allows students to develop and experiment with new ideas with minimal risk.

This paper recommends that ICT leaders approach ministries of education and work together to immerse students in technology. A comprehensive education plan should include the following elements:

- High-speed connectivity in schools (1 Gbps per 100 students)
- Connectivity to the classroom
- Online education content
- An ICT curriculum that requires computer science classes with coding
- Devices
- A cloud education platform to host the content to guarantee quality of service and performance
- Teacher training

THE ROLE OF TECHNOLOGY IN FUTURE JOBS AND ECONOMIC COMPETITIVENESS

LAC countries and regional industries feel the impact of shortages of skilled labor. Among the top ten countries where employers face the most difficulties meeting job demand, five are in the LAC region: Argentina, Brazil, Colombia, Panama, and Peru (Pezzini and Schleicher, 2015). Organizations with operations in these countries are three times more likely to face operational challenges due to

the shortage of human capital. This will test the ability of industries to thrive regionally and within countries, creating serious economic shortfalls around competitiveness and profitability.

Industries are evolving to accommodate innovative approaches to work, production, manufacturing, and management of human capital. This is driven by new advancements in technology, which requires a workforce with technology skills and experience, and retooling of the current workforce. Pemex, Mexico's state oil and gas company, recently announced that it will need to replace one-third of its workforce in the next ten years (approximately 50,000 workers) with individuals with different skills (Pezzini and Schleicher, 2015).

Workforce changes will be in demand to match the new ways that technology is being used. Technologies such as cloud computing, IoT, and AI are nearly ubiquitous across industries. Among manufacturers, cloud-hosted services will account for nearly half of all organization-level software usage by 2023 (Ezell and Swanson, 2017). Cloud-application usage within manufacturing will stretch from enterprises to production. The automotive industry will leverage cloud, IoT, and machine learning to develop innovations in car safety, self-driving vehicles, and fuel efficiency.

An economy that relies heavily on technology will also need human expertise on its use and deployment. There will also be demand for a workforce skilled in cybersecurity, containerization, enterprise application development, enterprise migration, database technologies, analytics, machine learning, and big data. The U.S. Bureau of Labor Statistics (2017) reports that forecasted demand for jobs in the realm of information security is expected to grow at a rate of 37 percent annually in the decade from 2012 to 2022. Additionally, there will be demand for this type of expertise in financial services, healthcare, defense, and other niche industries.

Creating a skilled workforce mirroring job demand and an evolving technology will be imperative to economic competitiveness for countries in the future. Innovation and technology translate into investment in fixed capital and workforce, which will create higher productivity. For the most part, economies are hedging and driving skills attainment for jobs that do not yet exist. Low-income and developing countries will need to stay ahead and narrow the digital divide where possible.

RETHINKING EDUCATION TO REMEDY THE SKILLS SHORTAGE

Technology professions lead to enhanced individual economic opportunities. In Mexico, for example, web development is a top-paying profession across all industries. Average salaries have increased 25 percent within five years (Laboratoria, 2017). In Peru, systems engineers' salaries are some of the most competitive nationally. Degrees in these technologies also translate into fast employment. In Chile, nearly 100 percent of individuals with computer science degrees obtain jobs in the field within one year of graduation (Laboratoria, 2017).

Formal education programs at universities or colleges for technology-based skills development and degrees reinforce national interests and broader development strategies around digital inclusion and the digital economy. However, alternative pathways for professional development and skills training exist outside of these programs as well.

Training programs, vocational training, and certification programs offer students at all phases of their careers a chance to develop new skills in relevant technology fields. Public, private, and public-private initiatives of this type globally and across the region have been established to address skill shortages in the ICT sector. Cibertec in Peru, a leading technical-vocational institution

with over 14,000 students, is an example. It delivers training programs in ICT, business, and design, with content tailored to help enrolled individuals obtain jobs in Peru's job market (Guaqueta Ospina, undated). Cibertec is managed by Laureate, an international network of private universities, with the support of Cisco, Microsoft, and Oracle (Guaqueta Ospina, undated). Amazon Web Services delivers AWS Educate, a personalized development program for cloud-based learning that includes content, knowledge checks, and badging that guides students through the learning process, through a network of public sector partners. Individuals who successfully complete the program have access to the AWS Job Board, which connects job seekers to employers looking for individuals with cloud skills. Through the Microsoft Professional Program (MPP), Microsoft has begun training people directly in skills needed to work with cloud technologies, Big Data, and internet development. As of August 2017, 70,000 people had enrolled in the program, with more than 30,000 from the United States and Canada, and over 5,400 from Latin America. The first MPP certificates for Data Science were issued in February 2017, and programs in Big Data Engineering and Front-End Web Development were launched in June 2017 (Ivanschitz and Korn, 2018). In addition, Microsoft Azure offers free online training and certification programs.[1]

Without an adequately skilled workforce, countries will face enormous difficulty thriving in the new digital economy. Opportunities for developing relevant skills, from early education and onward, in technology will be essential to maintaining a strong workforce and encouraging economic growth and competitiveness. Some ways to approach this include increasing connectivity and access to broadband and mobile for schools, promoting procurement frameworks that allow school systems to obtain and utilize new technologies like the cloud, and encouraging schools to incorporate technology-based curricula. Governments must be strategic in preparing young people for jobs of the future and in preparing the existing workforce with opportunities for retraining, career repositioning, and jobs. They should focus on labor market regulations that can promote competitiveness while balancing workers' rights. Governments can also incentivize organizations to take on employment policies that promote training and encourage entrepreneurship, for example through tax breaks. Governments should also look to help create a skills-based marketplace, moving away from a system based on traditional degrees to one based on recognizable credentials that are portable, stackable, and valued by employers (Microsoft, 2018b).

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However, it is important to recognize that governments alone will not be able to resolve the skills shortage and it is critical that the private sector invests and partners with governments in this journey.

[1] https://azure.microsoft.com/en-us/training/.

INNOVATION IN THE DIGITAL ECONOMY: NEW OPPORTUNITIES FOR SMEs

Over the past several decades, the global economy has witnessed the rapid pace of innovation, which has reshaped the way people operate in almost every aspect of life. Key to that rapid innovation has been the way we use, process, analyze, and store data. IT has been the key enabler behind most of the important innovations in our society. In addition to cloud computing, other innovations include IoT and machine learning. Connected devices are quintessentially IoT. By exchanging data at incredible velocity, individuals can communicate with one another and devices can communicate directly with one another. This collected data is processed in the cloud to serve IoT consumers to improve efficiency within the home through smart devices; in business to streamline production and manufacturing processes; and even among government entities for research and development in fields like space exploration or to aid in emergency/disaster recovery assistance. AI works much the same way: it is being harnessed in fields from healthcare to supply-chain management.

With respect to micro- and macro-level economics, cloud computing has driven economic activity for organizations and entities of all types and sizes and across all sectors. Startups as well as SMEs have truly gained value from the inclusivity and accessibility of commercial public cloud services. Traditionally in years past, SMEs were disadvantaged in comparison with large enterprises because they could not acquire the necessary IT capacity because of its complexity and cost. The low-cost and low-risk investment in cloud computing makes it an attractive resource for SMEs. They can manage their IT needs in real time without having to make significant upfront investments for infrastructure and capability. This way, SMEs can meet their IT needs against business demand and overall business wealth without facing sunk costs. SMEs can also have access to various IT services for storage, computing, and processing that can carry out thousands of functions.

SMEs also benefit from the cloud's scalability: they can harness the cloud to manage larger workloads as business evolves. This can be accomplished without having to hire an arsenal of skilled IT professionals to support potential growth. A critical component of scalability is scope. SMEs that embrace cloud technology can scale and compete beyond their local marketplace. The cloud serves as a gateway to the global marketplace, whether through social media, email, or web hosting.

Thus, cloud services eliminate economic barriers to entry. According to the World Bank (2017), it takes an average of 83.6 days to build a new business and roughly 4.3 percent of per capita income. This makes the value proposition for cloud computing even more compelling, particularly for a startup or SME in the first few years of the business. Individuals with new ideas can build a business or concept almost on demand and with minimal investment to launch. Organizations can focus on their business objectives and core competency, while accessing supercomputing capabilities and managing potentially impressive amounts of data. A Boston Consulting Group survey of SMEs in five countries, including the United States and Brazil, found that SMEs using cloud technologies grew jobs nearly twice as fast as SMEs not in the cloud (Boston Consulting Group, 2013).

Startups in the healthcare, financial technology (FinTech), and production sectors that rely on heavy data analytics and computation capabilities benefit from using the cloud. These are the sectors where some of the most dynamic startup activity in the LAC region is occurring. In 2016, Latin American FinTech startups totaled nearly 1,000 (Lustig, 2017). They also received more investment

in 2015 than any other startup sector in the region, accounting for almost 30 percent of the IT sector's total investment in 2015 and 40 percent in 2016. A sizeable part of the regional population remains unbanked;[2] the opportunities for startups to disrupt the market and create impact are numerous. Strategic partners from the private and public sectors and harmonization of regulations are needed to get these startups off the ground.

What has led to the creation of Latin America's startup culture? Increased access to technology, urbanization, economic tumult, and a large youth demographic have spurred new dynamism. The cities of Buenos Aires, Medellin, Sao Paulo, and Santiago are generating buzz around the globe for their startup culture and growth in the startup economy. The region has many success stories, such as Mercado Libre,[3] NuBank,[4] and IguanaFix.[5] Governments, with the aid of strategic partnerships with the private sector, continue to encourage and invest in entrepreneurship and startup culture. Buenos Aires created Academia Buenos Aires Emprende, an initiative to educate citizens about building enterprises and businesses (Egusa, 2017). AreaTres, also in Argentina and one of the largest co-working spaces in LAC with over 220 members and more than 65 companies, recently announced a strategic partnership with Google (Egusa, 2017). Visa and IBM invested US$100 million in StartUp Farm (Brazil) to fund over 200 startups (Egusa and Carter, 2017). Amazon Web Services has sponsored startup competitions in Chile and Argentina, and is providing grants in the form of cloud services training to entrepreneurs through accelerators such as Start-up Chile (2014). Microsoft for Startups is a program that provides free resources and access to Azure in the form of grants and coding resources. The program also connects startups with Fortune 500 customers through co-selling to help them scale, with more than 20,000 startups involved regarding cloud technologies (Baboo, 2018).

Beyond strategic partnerships and increased investment and promotion of startups, governments can continue to encourage startups by eliminating the red tape and barriers to market entry. Complex regulatory frameworks for licensing, registration, and permitting, and policies favoring incumbent companies are typical for the region and are substantially more onerous in LAC than in OECD countries (OECD, 2016). These barriers deter young firms, which drive growth and job creation, limit the potential for innovation, and stymie investment prospects. Governments should recognize the dynamic link between access to technologies, startup culture and innovation, and economic growth and should facilitate economic and political incentives to encourage it.

EDUCATION, BIG DATA, AND ARTIFICIAL INTELLIGENCE

Big data, specifically AI, enabled by CSPs, could play a key role in the development and adoption of adaptive learning, the efforts to personalize education, and the resolution of some of the challenges of the education system itself. There are no

[2] In Latin America and the Caribbean, 51 percent of adults had an account in 2014, up from 39 percent in 2011. Across the region, 28 percent of adults make payments directly from their account using a debit card, as compared to 14 percent in developing countries on average (World Bank, 2014).

[3] MercadoLIbre Inc. is an Argentine company incorporated in the United States that operates online marketplaces dedicated to e-commerce and online auctions, including mercadolibre.com.

[4] Nubank is the leading digital finance company in Brazil.

[5] IguanaFix is an online on-demand home improvement and car repair marketplace and service provider. It connects professionals such as plumbers and electricians with individual consumers and client companies.

limits to the opportunities, and most ideas may come only after AI initiatives move forward. TeachThought, an organization dedicated to innovation in education, recently published a post providing some examples of how AI could be leveraged in education (TeachThought, 2017). The ideas include the automation of basic activities in education, such as grading, adaptive learning, tools to help students find the right tutors, curriculum improvement, feedback to teachers and students, new ways to find and interact with information, and experimentation, among others.

The successful implementation of AI in the education system will depend on the determination of government leaders to enter into partnership with startups. Startups need space to mine data and bring new ideas. Support from CSPs can make the computing capacity available to leverage the vast amount of data that an education system could provide.

CHAPTER 4

Government Adoption of Technology and Use of Cloud Computing

If the global and regional economies are embracing digital, and the benefits around cloud adoption are apparent, why have more organizations, particularly in the public sector, not moved to the cloud? What prevents these entities from modernizing when there is ample evidence that cloud computing improves efficiency and security and saves money?

Two main themes prevent governments from considering the technology: (i) misinformation about cloud computing, specifically, how the use of the cloud might affect cybersecurity, data protection, and privacy; and (ii) a lack of strategy or policy framework in place to address critical issues and empower organizations to use and adopt cloud services. These themes hinder progress on broader modernization efforts.

The reality for many governments is not whether to modernize, but when and how to do so. Against the rate of innovation and the prevalence of digital exchange, where data transmission is occurring over expansive networks across the globe, governments who do not modernize will be left behind. This will have an impact on their populations, national security, and economic competitiveness.

To address misinformation, more education and awareness are needed about how cloud services can truly serve governments' and citizens' needs. Clarifying how the use of cloud services can best help the government meet mission-critical objectives around cybersecurity, data protection, and data privacy is essential. Policy trends on these topics suggest that there is still limited understanding of cloud services and their impact on personal data and potential cyber-threats.

In 2015, the U.S. Congressional Research Service estimated that federal agencies could expect cost savings of 50 percent or more by using cloud services.

Policy frameworks must be developed with new technologies, such as cloud, in the baseline. Whether these frameworks relate to procurement, data protection and privacy, energy and infrastructure, information security, banking and health regulation, telecommunications, or trade, policymakers should promote legal and regulatory flexibility that facilitates the free flow of data across borders and empowers public sector organizations to access and gain utility from the cloud.

THE ROLE OF CLOUD SERVICES IN PROMOTING A MORE RESPONSIVE, EFFICIENT, AND INNOVATIVE GOVERNMENT

Modernizing government, digitizing government processes, promoting e-government, and digitizing constituent services are common justifications by governments to incorporate ICT tools. The theme of governments "going digital" signals a keenness to improve government functioning, including enhanced cybersecurity, operating in a green, less energy-intensive environment, or facilitating interactions with citizens.

Cloud services are a critical component of these processes. The OECD describes cloud services as "underpin[ning] digital transformation of the economy and society, and increasingly of government" (OECD, 2017a). This is because cloud computing allows government customers to access industry-shaping technology at a speed, cost, and scale previously reserved for the largest companies in the private sector. Governments can essentially do more with less and use newly freed resources to address key challenges. Opportunities to develop solutions are greater in the cloud as well; cloud capacity can be scaled up or down to meet project

Cloud computing allows government customers to access industry-shaping technology at a speed, cost, and scale typically reserved for the private sector. Governments can essentially do more with less and use newly freed resources to address key challenges.

objectives or citizens' demands without having to invest in additional hardware or software. Citizen registration services, such as for voting or schools, that are cyclical or subject to periodic changes are a perfect example of where government can benefit from the cloud. Digitizing these services across e-platforms hosted on the cloud is another way governments can capitalize on innovative approaches.

Smart cities are defined as cities that use data collection and analysis to facilitate better management and greater efficiency of city resources as well as a better city experience for citizens and tourists. Cities such as Rio de Janeiro are beginning to implement smart solutions to improve urban planning and operations. The following examples are common features of smart-city architecture:

- Smart transportation systems that use data, applications, and technology to help people and goods move more quickly, cheaply, and efficiently
- Connected intersections that help connect and manage traffic signals and traffic networks
- Fleet management systems that enable public transit and city fleet vehicles to communicate with their home agency when it is time for maintenance or replacement
- Delivering increased connectivity to city centers
- Operationalizing networks of connected vehicles, including taxis, trash collection trucks, and public bus fleets

Cloud services make these activities possible and help generate the value they offer. Governments and citizens alike generate millions of data points in their city life, whether those occur over digital networks and technologies or in human-to-human, or human-to-organizational exchanges. These data points can be collected and stored in the cloud and subsequently analyzed through the cloud—as is or through additional technologies—to generate critical information for governments to innovate and solve basic problems for city dwellers.

Panama City leveraged the cloud to address traffic and parking congestion in its Casco Viejo neighborhood. By developing a centralized valet parking scheme where electronic tags stored in the cloud allow drivers to park and pick up cars from anywhere in the neighborhood, visitors to Casco Viejo have better access in and out of the city and parking is streamlined. By switching to the cloud, Miami's municipal government enabled building inspectors to issue permits while onsite by accessing documents remotely, thus speeding development (Ivanschitz and Korn, 2018). 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 reduction of nearly 60 percent in voter absenteeism in 2016 compared to the 2011 presidential elections. The government of Antigua and Barbuda created a Citizen's Portal that, in the words of Minister of Information, Broadcasting, Telecommunications and Information Technology Melford W. Nicholas, delivered increased citizen engagement and provision of services online to include the renewal of

driver's licenses, applications for entry visas, and access to the land and company registries at a "reduced cost in terms of total cost of ownership [and with] the additional benefit of it being scalable based on demand". And, the Tax Authority of Mexico (SAT) optimized one of its most important functions: processing electronic invoices. In 2012, SAT processed 25 million invoices a month. After moving to the cloud in March 2015, SAT achieved the processing of 35 million invoices in one day.

Big Data/Open Data

Cloud services help to facilitate open data initiatives, making large government data sets accessible to individuals and entities for a variety of purposes. These initiatives promote government transparency, but also facilitate the use of government-collected data for data analytics and enhanced research and development. Open data sets can provide various parties a transparent view of government activity and can establish benchmarks on government accountability. Chile, for example, created an open data initiative that allows visibility of the public sector budget through its Open Budget platform (OECD, 2017b). Brazil publishes all government expenditures online on its Transparency Portal (OECD, 2017b). Creating a central and open repository of public data can also contribute to output across government, the economy, and society and can improve productivity and efficiency within the public sector. Open data sets are stored and hosted on a government-procured cloud services platform where government agencies, public sector organizations, or individuals can access the data sets for use or re-use. Entities using these data sets can then use cloud computation capabilities to locate, download, customize, and analyze data more quickly than with traditional IT. The cloud facilitates a highly elastic, computational environment where datasets such as satellite imagery or genomic data would have taken hours, days, and even weeks to interact with.

Cloud services help facilitate open data initiatives, making large government datasets accessible to individuals and entities for a variety of purposes. These initiatives promote government transparency, but also facilitate the use of government-collected data for data analytics and enhanced research and development. Open data sets can provide various parties a transparent view on government activity and can establish benchmarks on government accountability.

Colombia's Big Data Strategy, a partnership with the Massachusetts Institute of Technology, is an example of an initiative capitalizing on the big data analytics potential within the public sector. This initiative focuses on how big or open data sets can be leveraged to address challenges in urbanization, transportation, healthcare, education, and crime. Individuals and organizations generate data intentionally or unintentionally all the time; the point of open data initiatives such as the Big Data Strategy is to understand patterns, draw similarities, and develop awareness through the aggregation and use of these pieces of information. With respect to crime, data generated from phone calls, credit card payments, online interactions, and app usage can be uploaded to the cloud, processed,

and analyzed in real time to identify likely times, locations, and occurrences for criminal activity.

While the technology and the data sets are available to harness big data-analytic potential, this potential will be limited unless governments can develop a broader ecosystem to fuel it. This involves building the technical and technological capacity of the government and communities and a workforce to do so.

FREEING GOVERNMENT TO ADOPT NEW INITIATIVES

The utility-based pricing model—pay as you go or use—offered by many CSPs leads to substantial cost reductions compared to traditional IT budgeting demands. This is particularly important for public sector enterprises that are constrained by strict IT budget processes. Traditional IT budgets for most countries can reach well into the millions and sometimes into the billions of dollars. There are also significant cost implications associated with traditional IT expenditures, particularly for upfront investments (initial and maintenance) and the costs associated with unused or underutilized hardware and software. Public sector enterprises in need of ICT resources must often anticipate their IT needs at the outset of a budget process. They then purchase those resources. However, these resources are often underutilized or not utilized. Servers used in traditional, on-premises schemes typically deliver between 5 and 15 percent of their maximum computing output over the course of a year. The underutilization of these servers is compounded over time and contributes to comatose servers (i.e., servers that have not delivered information or computing services in six months or more). Estimates suggest that there are nearly 10 million comatose servers worldwide; therefore, budget dollars dedicated for future needs are wasted.

The cloud eliminates the need for anticipatory budgeting. Government agencies working with CSPs can exercise more control throughout the budget year or political cycle. These entities have greater agility under the utility-based pricing model to execute, scale, or even terminate programs and services without being tied to large capital IT expenditures. If a program or project does fail, agencies can pivot and better contain immediate and sunk costs. The aggregation of demand in the cloud also means greater efficiency in CSP services, enabling greater economies of scale (OECD, 2016).

However, in some countries in the region, there is almost no regulatory framework for contracting computing services in a consumption model, which can lead to an inefficient allocation of public funds.

Cost savings of this magnitude frees governments and government budgets to dedicate resources to new projects and endeavors. Transitioning to cloud services allows organizations to divert capital expenditures to operational expenditures, making it feasible to do more with less. This is particularly important for developing countries that have limited financial resources.

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Improving Exchange with Citizens

Migration to the cloud offers opportunities for government to deliver public and constituent services in new and innovative ways. Governments across the region are developing e-government platforms that provide data and information, allow constituents to submit documents and forms, and facilitate the exchange of information between inter-government agencies and offices. This includes enabling citizens to pay taxes online, submit forms, and register to vote or even to vote online.

Colombia has made many of its government services available through the internet, in an effort to reduce paper. Colombian citizens can track and update their civil registration, medical records, academic or military documents, or apply for a passport. The net effect is efficiency: going digital means that the "paperwork" is simpler than before. It also encourages the government and citizens to engage with technology, increasing technology literacy and creating additional demand for technology.

Access and transparency are added benefits: nearly all governments in the LAC region have websites that share relevant information and even data sets about government functions. Through these e-platforms, citizens gain greater awareness about the functions of their government and how they can best engage with it more substantively.

There are still opportunities to enhance interactions between citizens and the government over digital platforms. The OECD finds that only 35 percent of total OECD internet users submit electronic forms through e-government services. Conducting business registration, licensing, and compliance transactions online eliminates significant costs to individual entrepreneurs, obviating the need to physically engage a government office. Public procurement is another great example; conducting public procurement online in a single platform makes procurement fairer and more transparent for buyers and sellers.

Fostering Transparency and Accountability

The use of cloud services facilitates increased transparency and accountability, which can assist in the fight against political corruption. Access to information is a key tool in addressing corruption in institutions of all types. Governments that leverage cloud services signal to constituents their willingness to combat corruption.

Open data initiatives and public-sector modernization efforts are emblematic of this trend toward greater transparency and accountability. Historically, the inability to gain access to and compute efficiently large and closely held datasets have made it difficult for citizens/institutions to expose corruption. The cloud's computing and processing capabilities revolutionize the ways that corruption detection, prevention, and analysis can be conducted, and encourage new data management techniques to prevent fraud and address abuse. Forensic tools can be deployed in the cloud to conduct evaluations of suspicious transactions or activities in payments and procurement. Where technology leads to automation, human discretion is eliminated; this helps make processes more transparent and reduces opportunities for corruption and reputational risk to the government (Silveira, 2016).

Security in the Cloud

The transformational quality of cloud computing extends beyond its efficiency, agility, and potential for innovation to the quality of the security that large-scale CSPs provide. They operate and protect services that address security risks across multiple sectors (commercial, public, regulated), with customers of all sizes and while facing threats that constantly evolve. The security capabilities that are native to CSPs empower customers to create novel architectures for mitigating access risks.

On-premise and similar facilities lack the homogeneity, economies of scale, visibility, and automation that can bring major security advancements. These advances are necessary to construct highly secure systems that can counter evolving threats seen both externally and internally. On-premises facilities struggle to employ these new operating concepts due to the resource requirements for network refactoring and new system procurement, as well as the human labor required due to the lack of software-defined infrastructure. In a 2012 study of 70,000 security breaches at 1,600 companies, AlertLogic found that on-premises computing systems were more vulnerable to attacks than cloud applications. Forty-six percent of corporate servers were hit with "brute force" attacks, compared to 39 percent of cloud systems (Gutierrez and Korn, 2014). CSPs build a level of agility and adaptability into their infrastructure to organically implement these security advancements. This means that customers can use new advancements more readily since they are natively integrated into the CSP's platform. The result is that customers can craft systems using novel architectures such as micro-segmentation, polymorphic designs, and multi-level deception networks.

Cloud consumers rely on these services to embody security practices that are responsive to real-time threats. Used properly, customers dramatically improve their security posture using modern cloud platforms. Cheap and easy access to massive amounts of storage and processing enables users to leverage the cloud to secure it. Running big data analytics on security data or log data, for example, can provide more insight into an organization's security posture. This type of visibility is superior to that provided by traditional systems and enables much faster remediation of security threats and attacks.

CSPs, for their part, have all the right incentives to maintain world-class cybersecurity. A security failure impacting customer data in a commercial cloud service carries severe, long-term consequences, including the impacts associated with a system compromise, loss of customer trust, and brand damage. Thus, best-of-breed security is mandatory for a successful CSP. It must be fully integrated into the design, development, and operations of cloud services.

Data Protection and Privacy in the Cloud

Several questions emerge in the area of data protection and data privacy in a virtualized environment.[6] For government, healthcare institutions, and academia, datasets and workloads that depend on ICT solutions will likely involve data considered personal, sensitive, or confidential. When transitioning to cloud services and operating across more digital and interconnected platforms, governments will demand more assurances around data protection and data privacy to protect citizens.

While CSPs offer assurances with respect to enhanced security in the cloud, technically ensuring greater data protection and privacy within the cloud is considered a joint responsibility of data processors and data controllers. Most data protection schemes differentiate between the data controller (also referred to as "user") and the data processer and divide responsibilities between them. The data controller is responsible for implementing

[6] Data protection is the safeguarding of personal data (i.e., personally identifiable information, or PII) that is processed or stored in a system. According to the International Standards Organization, PII is any information that (i) can be used to identify the PII principal to whom such information relates, or (ii) is or might be directly or indirectly linked to a PII principal. Data protection is a responsibility that CSPs perform using technical, operational, and managerial security controls applied to implement privacy policies.

appropriate technical and organizational measures to protect personal data against unlawful destruction or accidental loss, alteration, or unauthorized disclosure. When a data processor carries out processing on the data controller's behalf, the data controller is also responsible for choosing a processor that provides sufficient technical and organizational measures governing the processing. These distinctions help delineate responsibilities between outsource providers and their customers.

Where visibility of data is a concern, users of cloud services are encouraged and empowered to use encryption as a tool to further safeguard their data. Encryption renders the content unintelligible to any entity other than the one with the encryption keys. In this case, a data processor transmitting data would not be able to "see" or gain additional knowledge from the datasets or workloads processed. Data controllers should consider the sensitivity of their data, accounting for encryption wherever personal, sensitive, or confidential data are concerned. Additionally, organizations should establish clear guidelines for those individuals responsible for handling data internally. Who owns the keys can matter just as much as the security of the infrastructure where data is being processed and hosted.

The location of stored or processed data has become a recurring theme of debate in the context of data protection, infiltrating policy, and legal debates. CSPs and security experts emphasize that the physical location of data has little or no impact on the threats propagated over the internet and the security of the data. Proponents of data localization argue without substantial evidence that without physical control or the ability to identify/control where data are located, data are at greater risk.

The vast majority of major data compromises have occurred through erroneous, manipulated, or malicious behavior by users who had the right to access the data. The high-profile breaches of the last few years were largely attributed to poor cyber hygiene practices. The most common insider threat scenarios include:

- Inadvertent: credentials that are lost or mismanaged such that an attacker can act within a system as a valid user.
- Social engineering: phishing and social engineering attacks that trick users or administrators into disclosing credentials to attackers.
- Malicious: classic insider threat—bad actors within the organization with nefarious intent.

These realities have shown that storing data on an organization's private servers in a private datacenter does not guarantee more security in the cloud. Additionally, data localization can make a company less resilient (e.g., a more resilient approach would be to have backups in different geographic locations).

POLICY FRAMEWORKS FOR CLOUD AND FUTURE TECHNOLOGIES

A key question for governments and government organizations is how best to manage adoption of emerging technologies in their everyday systems and processes. Whether IoT, big data analytics, or AI, governments must enable the vehicles to deliver these tools and their associated services to

CSPs and security experts emphasize that the physical location of data has little to no impact on the threats propagated over the internet and the security of the data.

citizens. Governments should also educate relevant organizations through the adoption process with the goal of promoting a uniform, cohesive approach to IT.

Cloud-Native Policy Approach

Cloud computing for business (has delivered optimal results against traditional IT infrastructure, in terms of cost, scalability, and security. However, the lack of uniform adoption across government agencies can affect how effectively and efficiently government can achieve those results. Policy frameworks focused on directing government agencies to become cloud native can accelerate the realization of these benefits and modernize government institutions as technology evolves.

Policymakers use various terms to help direct government to adopt cloud computing: cloud enabled, cloud first, cloud preferred, and cloud native. With the exception of cloud native, the previous examples are only recommendations and lack enforceability or accountability particularly if policy language conditions cloud adoption on budgetary funds. The outcome under these policy frameworks is a lack of uniformity across government agencies that creates several negative outcomes. First, governments adopting varied amounts of traditional IT versus cloud will have limited interoperability between IT systems, which inevitably hinders the delivery of services. Second, costs will be difficult to control, as traditional IT requires significant upfront investment whereas cloud services do not. Third, this leaves governments susceptible to cyber threats, which will require several unique strategies and considerable resources to actively combat them.

Adopting a cloud-native policy approach represents a full embrace of the future. Policy frameworks focused on directing government agencies to become cloud native can deliver a solution that accelerates the realization of these benefits and modernizes government institutions as technology evolves.

A cloud-native policy framework eliminates the disparate usage of IT solutions facing many governments. A cloud-native framework incorporates accountability and enforceability into a cloud-first directive and propels institutions to adopt and utilize cloud-based services that represent the most innovative, capable, and adaptable IT solutions available in the market. It changes the evaluation construct from “How about cloud?” to “Why anything other than cloud?” which can revolutionize the way governments operate. Under this framework, government is empowered, driven to procure cloud computing, and situated with a new set of resources, tools, and strategies to confront new technological complexities and citizen challenges. While cloud contracts generally provide regulatory authorities the opportunity to audit data center policies and facilities, regulators concerns are most frequently addressed remotely through various audit and access tools that cloud companies provide to their regulated customers. Additionally, much of the cloud is based on open-source technology, which is more resilient and transparent and facilitates both data and workload portability in the event of a systemic issue with an IT provider. Finally cloud computing brings tools to spur economic development by making both core infrastructure and advanced capabilities like AI more accessible to developers and companies of all sizes.

Of note, even as governments increasingly adopt cloud-first policies, many public-sector decision makers understandably remain cautious about moving to the cloud, making the uptake of cloud services slower in the public sector than in the private sector. This is largely due to governments' unique role as stewards of data that impact national security or national sovereignty (Mutkoski, 2016). In this regard, data classification can be a valuable starting point for governments as they chart their migration to the cloud. Data classification allows public sector authorities to assign relative values to data so that they don't need to treat all of their data in the same way. With data classification, governments may identify the workloads that may be immediately suitable for migration to the cloud, as opposed to data that for national security or national sovereignty reasons the government may never move to the cloud (Mutkoski, 2016). With data classification, governments can see that while they hold some highly sensitive information, the vast majority of the information they create and store is not highly sensitive. It turns out that much of the data that governments create and store is either not sensitive or of low or moderate sensitivity (Mutkoski, 2016). While there is no doubt that for a government's most sensitive national security data the increased costs of keeping data on premises are worthwhile and governments may be unwilling to experiment with new technologies like cloud computing for such highly sensitive information. However, governments should take advantage of the major cost reductions offered by the cloud for the bulk of government data that is less sensitive (Mutkoski, 2016). Hybrid cloud options allow on-premises systems to interact seamlessly with the cloud so that, from the government's perspective, managing data both on-premises and in the cloud is one integrated experience.

A cloud-native policy framework eliminates the disparate usage of IT solutions facing many governments.

LAC governments have yet to implement a cloud-native approach to their ICT strategies, but governments around the globe are already implementing and benefiting from this type of policy. These countries can serve as models of the feasibility of adopting a cloud-native directive for governments of all types and sizes.

United Kingdom

One example of a national government adopting and implementing a cloud-native strategy is the United Kingdom. In early 2017, the government clarified its digital strategy to announce that it would be both "public cloud first" and "cloud-native" (U.K. Government, 2017). The government directed all public sector organizations "to consider and fully evaluate potential cloud solutions first before considering any other options," and that this would be a mandatory approach for "central government and strongly recommended to the wider public sector." Further, the government specified that a public cloud, "rather than a community, hybrid, or private deployment" would be the preferred model as, "the primary benefits for government come when we embrace the public cloud." The government also clarified that a cloud first policy by itself would be insufficient to meeting what it needs against what is emerging, and as a result would employ a cloud native framework (U.K. Government, 2017). In doing so, the government confirmed that the policy was focused less on directing how it considers IT solutions, than on the ability of the government to organize itself and

adapt. Adaptability and responsiveness are qualities that will be critical for governments to operate and succeed in today's digital economy.

Australia

A cloud-centered ICT policy framework often emerges from both demand and need. The Australian government recognized both when it implemented its cloud policy directive, stating that innovative ICT is transformative for society and that citizens expect their government to be responsive, particularly considering these transformations. Cloud services offered a solution that was both innovative and responsive, and the Australian government executed a new ICT directive focused on the use of cloud computing. In the words of the government, "the availability of cloud services offers an opportunity for government to deliver services more efficiently, as well as providing services that are more responsive to business and community needs" (Australian Government, 2014).

Under the government's cloud policy, agencies were told they *must* adopt cloud computing where it is fit for purpose, provides adequate data protection, and delivers value for money. Value for money was a major opportunity for government in this situation: the Australian government procured roughly US$6 billion in ICT services across all levels in 2014 when this policy was first initiated (Australian Government, 2014).

Philippines

The government of the Philippines is developing a comprehensive approach to facilitate the widespread adoption and use of the cloud across all organizations. Eager to reduce the cost of government ICT by eliminating duplication and fragmentation, the government instituted a cloud policy across all levels. The government prioritizes the cloud as the preferred ICT strategy, and the use of an alternative strategy must be justified by its cost effectiveness and satisfactory compliance with government requirements. All departments, government agencies, and government-owned and controlled corporations, including state universities and colleges, are encouraged to adopt cloud computing as the preferred ICT deployment strategy for their own administrative use and delivery of government services, except:

> 1) When it can be shown that an alternative ICT deployment strategy meets special requirements of a government agency; and 2) when it can be shown that an alternative ICT deployment strategy is more cost effective from a total cost of ownership (TCO) perspective, and demonstrates at least the same level of security assurance that a cloud computing deployment offers (Republic of the Philippines, 2017: 5).

The government went further to clarify policy around procurement, data classification, data migration, data ownership, and data security, incorporating critical features and consideration for the use of cloud services. In this way, government entities would have established guidelines and best practices to make the transition to cloud computing.

Bahrain

In 2017, Bahrain's Information and e-Government Authority (IGA) implemented a cloud-first policy that empowered its various government offices to migrate to the cloud. At the time of the announcement in late September, the government had already migrated workloads from the IGA, the Ministry of Education, the Bahrain Institute of Public

Administration, and the Ministry of Justice and Islamic Affairs. The policy directive is transformative, not only because of the technology it embraces, but also with respect to the country itself. Bahrain is the first country in the Middle East to implement a cloud-first policy directive, and the first to embrace commercial cloud computing across its public-sector institutions. Implementing the policy is one step in a broader government strategic plan to modernize institutions and deliver higher quality services to citizens at lower cost. According to the IGA, the move to the cloud would help to reduce IT costs from 30 to 90 percent.

Promoting Cross-Border Data Flows for Economic Competitiveness

Governments must consider how their national policies work to advance or impede economic growth and workforce development opportunities empowered by cloud computing. Cloud technology is the enabler for commercial and public-sector advancements, and the extent to which governments promote or oppose the principle of cross-border data flows will impact the strength of their local economies as well as their global competitiveness.

Enabling the free flow of data across borders has a significant net positive impact on the global economy. Recent studies emphasize this impact, and others highlight the cost of establishing barriers to data flows. A February 2016 report by McKinsey Global Institute estimated that cross-border data flows contributed nearly US$2.8 trillion to the global economy in 2014[7] by enabling the flow of goods, services, and other resources. The reports estimate that this figure could reach US$11 trillion by 2025.

Countries that seek to limit cross-border data flows through localization policies or data sovereignty requirements face negative economic consequences. The European Centre for International Political Economy (ECIPE), an independent policy think tank, issued a study on the economic impact of data localization requirements that discriminate against foreign suppliers in seven jurisdictions: Brazil, China, the European Union, India, Indonesia, South Korea, and Vietnam (ECIPE, undated). Their research concluded that unilateral restrictions on cross-border data flows and access to foreign markets negatively impact economic growth and recovery because they limit access to competitive pricing, job growth in many sectors, and investment opportunities. The study noted that data residency requirements not only impact data flow proper but also a broader set of commercial expansion opportunities that rely on cross-border data flows.

Self-regulation mechanisms for cross-border data flows have proven to be quite successful. Thus, countries should consider the possibility of adopting them, especially since several countries do not have legislation or authorities specialized in data protection. They do, however, have consumer protection or similar authorities. For example, the Cross Border Privacy Rules System of Asia-Pacific Economic Cooperation, in which several countries of the hemisphere already participate, is a collaborative mechanism that allows the free flow of data in an informed and safe manner, and includes efficient redress mechanisms for data subjects.

The World Bank studied six developing countries and the 28 Member States of the European Union and found that data localization requirements can reduce GDP by up to 1.7 percent, investments up to 4.2 percent, and exports by 1.7 percent.[8] This impact is most felt by small businesses and startups.

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[7] http://www.mckinsey.com/business-functions/digital-mckinsey/our-insights/digital-globalization-the-new-era-of-global-flows.

[8] http://documents.worldbank.org/curated/en/961621467994698644/pdf/102724-WDR-WDR2016Overview-ENGLISH-WebResBox-394840B-OUO-9.pdf.

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Through the cloud, individuals and SMEs can access IT resources at a cost and scale once accessible only to entities with far greater capitalization. SMEs are primary drivers for new job creation. Cloud computing lowers barriers to business creation and market access, enabling more startups to form and ultimately create more jobs. According to the European Commission, firms facing significant costs to adapt to various national laws believe that the costs of selling online outweigh the benefits. Most recently, in May 2017, the Information Technology and Innovation Foundation, a non-partisan research institute, independently arrived at similar findings (Cory, 2017).

ECIPE concluded that unilateral restrictions on cross-border data flow and access to foreign markets negatively impact economic growth and recovery because they limit access to competitive pricing, job growth in many sectors, and investment opportunities.

A key conclusion consistent across these studies is that prohibiting cross-border data flows in the form of data residency requirements can impact local and regional economic growth and global competitiveness, with the greatest impact borne by SMEs. Governments misunderstand that data protection does not generally depend on *where* the information is stored, but rather *what* measures are used to secure it. In other words, a secure system in the European Union is no more or less secure than a server in Latin America. Physical location generally has no relevance. Because data centers are almost always connected to broadly accessible networks. Thus, real security depends on the technical, operational, and managerial practices and processes implemented by the CSP and the customer (Cory, 2017).

Countries enforcing barriers to data flows can limit their citizens from taking advantage of innovative services that improve their quality of life and limit government services delivery. For example, AI and machine learning (AI/ML) applications require customized hardware for optimal functioning. While global CSPs continue to expand their data center footprint, it is unrealistic to assume that data centers will be established in every country in the short to medium term. Hence, as AI/ML is increasingly used to improve services, such as health care prognoses and weather forecasting for emergency preparedness, citizens will lag behind in accessing technological breakthroughs if innovators and professionals can only work with a limited set of solution providers that meet outdated and unnecessary data residency requirements.

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There are also cascading socioeconomic costs to limiting data flows, specifically on trade competitiveness and workforce development. As cloud technology becomes ubiquitous and more strongly tied to economic advancement, digital trade (and reducing the barriers to it) will become a higher priority for governments. Countries allowing free data flows will be at an advantage by accessing leading edge technology, which will in turn impact the modernization of commercial and public services, improve worker productivity, and accelerate local job and skills growth across sectors. Countries restricting data flows and digital trade will, in time, notice a competitive disadvantage.

Regional Trade Policies and Frameworks: A Template for Best Practices in the Digital Economy

LAC economies have enjoyed tremendous growth and development opportunities due to the diffusion and prevalence of new digital technologies. Individuals and entities are increasingly exchanging information, goods, and services across digital networks, and data are becoming both a resource and a form of currency. Policies fostering and promoting digital trade bilaterally, regionally, and internationally are needed to help economies, like those within LAC, to realize their full economic and competitive potential in the global digital economy.

Digital trade flows—international trade in which the internet and internet-based technologies play a major role in building, finding, ordering, producing, marketing, and delivering products and services (Suominen, 2017)—are transforming regional and global markets. To this end, adding strong digital economy chapters to trade agreements is a fundamental step in fostering the digital economy.

The Intersection between Cybersecurity, Data Protection, and Data Sovereignty

The move toward digital and the increasing frequency of digital exchanges have created new challenges for policymakers, particularly with respect to data management and protection. Governments are paying more attention to this topic, particularly as data breaches and cybercrimes become more prevalent. The threat is real. According to some calculations, the cost of cybercrime worldwide is US$575 billion a year, which represents 0.5 percent of global GDP. That is almost four times the total amount of global development assistance.

Cybercrime in LAC costs US$90 billion a year. Governments are very concerned about the economic and social challenges of digital security and how cyberattacks, including cybercrime and cyber espionage, will affect national security. This concern is growing in the context of cloud services, where governments perceive the lack of physical infrastructure as a risk to data security. Legislative, regulatory, and compliance initiatives are being developed to address these concerns and others through cybersecurity, data protection and privacy, and data sovereignty and localization frameworks. The IDB–OAS 2016 Cybersecurity Report presents a comprehensive picture of the state of cybersecurity in LAC. One of the recommendations of the report is that LAC countries should modernize their legal framework to address cybercrime through effective criminal justice measures (IDB, 2016).

There is a growing trend in the LAC region to develop policies to address these topics. There are significant differences among the strategic frameworks or response mechanisms in place in LAC countries to address cybersecurity or data protection challenges. Four out of five countries do not have cybersecurity strategies or critical infrastructure protection plans. Two out of three do not

have command centers and cybersecurity control. Most prosecutors lack the capacity to pursue cybercrimes. These policies are essential to enable governments to strengthen the stability and security of digital networks and cyber resources.

Understanding that digital exchange will soon be the norm, governments are implementing new or amending existing data protection policies to account for this dynamic. Currently, 70 percent of LAC countries have some type of data protection clauses in their constitutions. Some countries (e.g., Antigua and Barbuda, Colombia, Costa Rica, Mexico, Peru, and Uruguay) have already enacted data protection laws, and others (e.g., Argentina, Chile, and Brazil) are drafting such laws. A common feature of these proposals is forced data localization. It mandates that data be stored and held within country borders or on in-country infrastructure, and limits data transfers outside the country. A widely held but erroneous view is that containing data within borders or within data centers in a country or exerting specific control on where data flows will ensure enhanced data protection and promote greater cybersecurity.

Public sector organizations continue to express concerns about the security of their data when they are processed and stored by large-scale, multi-national CSPs. General cybersecurity concerns as well as the perceived overreach of government surveillance by some countries have contributed to a continued focus on keeping data in-country, and other country-specific requirements that are a barrier to the adoption of cloud services. Data residency reflects a combination of issues primarily associated with perceived security risks around third-party access to data, including foreign law enforcement agencies. Public sector customers want assurances that their data are protected from unwanted access by hackers or other governments. However, enforcing high levels of data protection and preserving regulatory sovereignty, while taking advantage of the powerful, efficient, and agile platforms provided by cloud services, are not mutually exclusive.

Data residency requirements fail to address the common avenues used by attackers to gain access. These emerge most commonly when basic cyber hygiene practices, such as system inventory management, configuration management, data encryption, and privileged access management, are not followed. Encryption provides customers with an additional layer of security and assurance in the confidentiality and integrity of their data in transit and at rest.

Forcing localization in some cases can impede the strength of security. Managing physical infrastructure is a time- and cost-intensive process. A 2015 study by an information security company evaluated the cost of an in-country data center model versus leveraging global CSPs. The study found that the cost of cloud services can increase substantially depending on the availability of alternative services. The study found that if Brazil had enacted data localization as part of its "internet Bill of Rights" in 2014, companies would have had to pay an average of 54 percent more to use cloud services (of all categories) from local CSPs compared with the lowest-cost worldwide CSP. In large, heterogonous government enterprises, everything from the floor tiles in the data center to the open ports on a virtual server or firewall is managed manually. In modern infrastructure, these types of security checks and assessments are done via software, completed in a more time-efficient manner. The best mechanism to protect, detect, respond, and recover is to use the transformational security that a CSP provides.

LAC governments seeking to modernize digital policy and regulation must balance the need to be responsive to actual data threats and risks, with the promotion of flexible frameworks that do not hamper innovation or economic growth. Governments

can implement standards that help promote security in digital exchanges and encourage the adoption of cloud services. They should consider some of the following policies to strike this balance:

1. Develop policies and requirements that allow the use of out-of-country data processing facilities if the data are processed and stored in a modern, highly secure cloud environment.
2. Align national policies and regulatory requirements to the principle of free movement of data across borders to effectively balance security, economic, and IT modernization goals.
3. Classify data and define data-handling roles and responsibilities to determine appropriate data protection obligations for each party. Governments can work with CSPs to adequately understand and apply data protection responsibilities for the controller versus processor for each of the cloud service models.
4. Ensure that CSPs and third-party contractors demonstrate robust security controls to address unauthorized third-party access to data, systems, and assets through internationally recognized third-party accreditations (e.g., ISO 27001, ISO 27018, SOC, PCI DSS, etc.).
5. Ensure customer understanding and implementation of security services for encrypting their data.
6. Engage in bilateral and multilateral efforts to update the mutual legal assistance treaty process so that it empowers law enforcement to do its job while respecting individual privacy and national sovereignty.

Procurement Policies and Processes: Empowering Organizations

ICT procurement is a challenge for governments because technologies are constantly evolving, and understanding of the technical components of such technologies remains limited. Governments are accustomed to buying IT infrastructure as hardware or software. Cloud services represent an anomaly for these entities, in the way it is delivered (standardized delivery model with a low degree of customization) and how it is priced (utility style). When using the cloud, customers do not own physical assets. This is a benefit to customers and taxpayers, as it helps them avoid vendor lock-in. When customers are not forced to buy physical assets and CSPs provide the ability to move up the IT stack and move down it again, they can enjoy greater portability and interoperability than with the old IT paradigm.

What can be particularly problematic for many governments is how to categorize cloud services. IaaS, PaaS, and SaaS deployments of cloud services do not perfectly fit into traditional procurement categories of technology goods and services. Cloud computing should be purchased as a commercial item. Commercial products such as cloud computing perform the same for all users and customers, commercial and government alike. Special consideration should be given to the type of deployment as well as the goals and objectives of the government's ICT strategy.

The following are examples of the aspects that governments should consider to facilitate stronger procurement practices:

- Performance-based requirements: These focus on performance-based solutions, service level agreements, and terms and conditions that prioritize workloads and outcomes, as opposed to traditional "prescriptive" procurement requirements that specify what the underlying infrastructure stack should consist of (and traditionally focus on contractual means to mitigate risk, rather than looking to technical means).
- Direct/indirect purchase and contract vehicles: A contract to buy cloud services should

consider using both direct CSP involvement and a pool of partner vendors around the cloud platform. CSP partners can provide cloud infrastructure and services such as labor for planning, developing, executing, and maintaining cloud migrations and workloads as one comprehensive solution; however, cloud infrastructure should be regarded as a separate "service" with distinct roles and responsibilities, service level agreements, and terms and conditions.

- Pricing: Embracing on-demand, utility-style cloud pricing driven by commercial competition significantly reduces costs and creates efficiencies by ensuring that consumers only pay for the cloud resources they consume.
- Security and assurance/audit: Understand that security and compliance responsibilities are shared between the CSP and cloud customers. Leverage industry best practices on security and audit. They provide assurances that CSPs have effective physical and logistical security controls in place, as opposed to mandating traditional on-premises security controls or unique audit requirements that are incompatible with a cloud computing model.
- Terms and conditions: Understand that different approaches to procurement are needed when purchasing each XaaS model. Recognize that cloud services are purchased as a commercial item, and consider which terms and conditions are appropriate (and not appropriate) in this context. CSP terms and conditions are designed to reflect how a cloud services model functions (i.e., physical assets are not being purchased, and CSPs operate at massive scale offering standardized services); thus it is critical to incorporate and use a CSP's terms and conditions to the fullest extent practicable.

An estimated 63 percent of LAC countries have a clearly defined procurement policy framework in place to account for ICT procurement. Brazil and Chile have implemented the most robust ICT-related procurement strategies, while Guatemala and Nicaragua have tried to formalize ICT within procurement frameworks to speed up development efforts. These policy frameworks are focused on the central government, while a few LAC countries have extended ICT procurement strategies to the subnational level. However, these strategies do not fully embrace cloud services and do not clearly instruct government consumers on how to purchase it. Additionally, multiple platforms and procurement vehicles create confusion, which can create inequities throughout the procurement process.

Governments that create the "right" procurement strategy stand to benefit significantly. Public procurement, an essential government activity, accounts for at least 17 percent of GDP among OECD countries. Failure to develop a user-friendly procurement process can hamper economic activity for government and businesses seeking to sell to government customers. It can also reduce what is available to prospective consumers of goods and services within government. For example, if procuring cloud computing is not properly accounted for within an existing procurement framework, or information to assist in guiding procurement is not readily available, government usage of the cloud becomes less likely. One way to address this is to direct governments to establish single, online platforms for public procurement, integrating all government entities, buyers, and sellers into one marketplace or portal. This enables a more efficient and transparent procurement process, where companies and consumers have equal access to information.

Governments should also facilitate better tactics around information-sharing with agencies responsible for procurement. Specifically, government should help clarify how existing policies and

regulations may affect procurement offerings involving new technology. Organizations with limited understanding of existing laws or policies may unintentionally influence customers in the procurement process, preventing them from purchasing and utilizing these services. It is important that as governments modernize, particularly when executed top-down, information on the feasibility, use, and requirements to adopt new technologies is disseminated clearly.

Conclusions

The LAC region is well positioned to participate in the digital economy and leverage its opportunities. Cloud computing is a forward-thinking, enabling technology: it forms the foundation of big data analytics, AI, and IoT and is one of the main pillars of the digital economy. Cloud computing allows government customers to access industry-shaping technology at a speed, cost, and scale typically reserved for the private sector. Governments can essentially do more with less and can use newly freed resources—in cost and human capital—to address key challenges they face. In addition to maximizing investments and avoiding investing and maintaining legacy IT infrastructure, cloud computing enables public sector organizations and government agencies to meet mission-critical objectives and to innovate.

Cloud services help to facilitate open data initiatives, making large government data sets accessible to individuals and entities for a variety of purposes. The initiatives promote government transparency, but also facilitate the use of government-collected data for data analytics and enhanced research and development. Related to transparency, open data sets can provide various parties a clear view on government activity and can establish benchmarks on government accountability.

Cloud computing also represents a unique opportunity for LAC governments to increase productivity in the private sector and facilitate technology adoption. By eliminating competitiveness, the upfront costs of IT infrastructure, and having thousands of IT tools and almost unlimited computing capacity available with a pay-as-you-go model, cloud computing also represents a unique opportunity for SMEs and large corporations to adopt and use state-of-the-art IT solutions.

To leverage the benefits of cloud services and new technology developments, governments in LAC need to undertake public policy initiatives to develop policy frameworks that quell concerns around data protection, cybersecurity, financial market regulation, and data privacy. Equally important is enabling the free flow of data across borders. Countries that seek to limit cross-border data flows through localization policies or data sovereignty requirements face negative economic consequences. Unilateral restrictions on cross-border data flow and access to foreign markets negatively impact economic growth and recovery because they limit access to competitive pricing, job growth in many services and goods sectors, and

investment opportunities. Data residency requirements impact not only data flow but also a broader set of commercial expansion opportunities that rely on cross-border data flows.

Enabling the free flow of data across borders has a significant net positive impact on the global economy. A February 2016 report by the McKinsey Global Institute estimated that cross-border data flows contributed nearly US$2.8 trillion to the global economy in 2014 by enabling the flow of goods, services, and other resources (McKinsey & Company, 2016). The report estimates that this figure could reach US$11 trillion by 2025.

Protecting the security of the government's data and IT infrastructure and the privacy of citizens should be addressed with sound national cybersecurity plans and a modern legal and regulatory framework for the digital economy. Cloud computing is an additional resource at governments' disposal to accomplish this policy objective.

One of the critical factors in determining the feasibility and successful adoption of cloud computing and the build-out of cloud infrastructure is the availability of the underlying infrastructure required by cloud service. The underlying infrastructure encompasses high-speed broadband networks both for national transport and local access, redundant access to international capacity, internet exchange points and peering agreements, affordability of broadband services, and availability of renewable energy.

With respect to the underlying telecom infrastructure, next-generation networks and 4G and 5G wireless networks are best suited to support cloud services usage. This infrastructure allows for more proportional upload and download exchange and low latency, a key requirement for cloud-based applications. IXPs and international/national backbones are integral to data transmission and are fundamental for the ability of users, government agencies, and companies to use cloud-based applications. Therefore, the development of IXPs across LAC is essential to cloud computing. To address these challenges, governments in the LAC region need to pursue policies that address the challenges of broadband expansion by providing more funding for infrastructure, developing incentives for telecom operators to invest in new and updated infrastructure, and modernizing the regulatory regime. They should also develop policies that foster green energy generation projects, invest in transmission networks, and develop a competitive energy marketplace.

An important role for governments is to provide people with knowledge to participate in the digital economy. Cloud computing is one of the main technologies leading the transformation to the digital economy. Thus, governments in LAC should offer their workforce opportunities to educate themselves in cloud computing. Cloud training programs offer students of all ages a chance to develop new skills in relevant technology fields. Public, private, and public-private initiatives of this type have been established to address skill shortages within the ICT sector. This study recommends that governments in LAC develop comprehensive cloud training programs at vocational and professional institutions.

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APPENDIX A

CLOUD COMPUTING TRAINING

An important role for governments is to create enabling environments that can provide their populations with the appropriate knowledge to participate in the digital economy. Cloud computing is one of the technologies leading the transformation to the digital economy. Thus, it is fundamental that governments in LAC provide their workforce with opportunities to learn about cloud computing.

This study recommends that governments in LAC develop comprehensive vocational and professional cloud training programs. The following is a proposed syllabus of what a cloud training program should cover. It would provide basic knowledge about cloud computing, using cases on how to leverage the cloud in different environments.

PROPOSED SYLLABUS FOR A COMPREHENSIVE CLOUD TRAINING PROGRAM

Modules

1. Cloud Fundamentals: Basic Concepts and Definitions
    a. Compute
    b. Storage
    c. SaaS, PaaS, and IaaS
    d. Virtualization
    e. Server less
    f. Networking and Content Delivery Network
    g. Monitoring and Auditing
    h. Analytics
    i. IoT
    j. Big Data
    k. Machine Learning and AI
2. Benefits of Cloud Technologies for Business and Public Sector
3. Cloud Infrastructure
4. Cloud Platform
5. Cloud Technologies and Applications
6. Cloud Governance
7. Application Development, Web Apps, and Mobile Apps
8. Cloud Services Ecosystem
9. Market Overview
10. Cloud Service Providers
11. Cloud Services—Security and Risks
12. Cloud Strategies and Migration Planning
13. Additional Cloud Computing Certifications