ICT Infrastructure Project Opportunities in Colombia, Ecuador and Peru

A Resource Guide for U.S. Industry

USTDA

U.S. TRADE AND DEVELOPMENT AGENCY

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The U.S. Trade and Development Agency

The U.S. Trade and Development Agency helps companies create U.S. jobs through the export of U.S. goods and services for priority infrastructure projects in emerging economies. USTDA links U.S. businesses to export opportunities by funding project preparation and partnership building activities that develop sustainable infrastructure and foster economic growth in partner countries.

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1 Introduction

The U.S. Trade and Development Agency (USTDA) helps companies create U.S. jobs by exporting U.S. goods and services for priority development projects in emerging economies. USTDA links U.S. businesses to export opportunities by funding project preparation and partnership building activities that develop sustainable infrastructure and foster economic growth in partner countries.

This guide provides U.S. companies and exporters an overview of infrastructure projects across the information and communications sector in three Andean countries, Colombia, Ecuador, and Peru, primarily over the next three years. Each of the countries and selected ICT project opportunities are profiled following. ICT Sector Overviews are provided in an Annex at the end of the Resource Guide.

When preparing this guide, currency amounts are converted from local currencies to United States Dollars (USD) based on the current exchange rate. Due to fluctuations in currency values, accuracy levels for engineering and cost estimates for different projects, and various timing of cost information publication, this report's monetary values should be considered approximate. Unless explicitly indicated otherwise, all currency values are in United States Dollars (USD).

1.1 Regional ICT Development

From an ICT development perspective, the countries covered in this Resource Guide, Colombia, Ecuador, and Peru, vary somewhat in infrastructure availability and technologies but are generally above world averages on mobile telephone, internet, and broadband access measures. Most ICT sub-segments host private enterprises in the various countries, although the governments still control select elements. All have direct subsea communication cable access, with Peru hosting a satellite, as well.

The Latin American/Caribbean region, in total, represents approximately seven percent of the global ICT market and is generally growing faster than world averages. Within the region, Brazil is the largest ICT market, with an estimated three percent global share. Among the three countries covered here, by virtue of population, Colombia is the largest ICT market.

Colombia, Ecuador, and Peru are importers of ICT goods and services, with ICT goods imports alone representing 9.9, 4.5, and 8.3 percent of all imports, respectively. Therefore, current supply opportunities for U.S. ICT technology providers are attractive. None of the three countries yet exports any appreciable amount of ICT goods. Colombia is the largest ICT services exporter of the three, at 3.6 percent of total exports. (Regional ICT leader, Brazil, stands at about 6.3 percent.)

The remainder of this Resource Guide defines specific sector opportunities relevant to U.S. exporters for these three Latin American countries.

1.2 Authors

The Innovation Network, LLC, based in Lexington, Massachusetts, developed this report under contract with USTDA. Inquiries may be made via our website www.innovationnetconsult.com.

1.3 Acknowledgments

The authors wish to extend their sincere thanks to the United States Commercial Service offices and the United States Embassies in the countries profiled for the support provided in creating this report. We are grateful to the officials at National Ministries and many private sector companies. They generously met remotely with the authors of this report and presented the project opportunities featured in this guide.

2 COLOMBIA

2.1 ICT Demographics

Colombia is a northern South American nation bordering Ecuador, Peru, Brazil, Venezuela, and Panama, in addition to its more than 3,200 kilometers (km) of coastline, of which 1,760 km borders the Caribbean Sea and the balance, the North Pacific Ocean. The country's topography varies widely from its western coastal plain to central highlands and rugged Andean mountainous terrain in its center to eastern lowland plains. Thus, the country's landscape poses some challenges for ICT infrastructure development.

Colombia's landmass is 1,039 million sq km, slightly less than twice the size of Texas. Roughly 54 percent of its land is forest, with another almost 38 percent representing agricultural land. With respect to protecting ICT infrastructure, the highlands may be subject to volcanic eruptions requiring major evacuations of population centers, and the country has experienced occasional earthquakes.

Colombia is home to just over 50.4 million people. The majority of the population resides in the northern and western regions, where most agricultural activities and natural resources are located. Nonetheless, nearly 82 percent of Colombia's citizenry is urban. The capital city of Bogotá (population 7.7 million) is roughly three times the next largest city, Cali. Five Colombian cities have populations near or above one million people each. The southern and eastern grasslands, accounting for about 60 percent of the country's land, are sparsely populated.

2.2 ICT Sector Development

Colombia's existing ICT sector is reasonably well developed with respect to fixed and mobile telephone access, internet use, and broadband access. The country has approximately 132 mobile cellular subscriptions per 100 inhabitants, ranking 56th globally. Nearly 65 percent of the population had internet access by 2018.[1,2]

The country's telecom infrastructure has improved via government programs focused on upgrading services and competition, specifically LTE and 5G and infrastructure in small urban centers and rural areas. A national ICT plan increased broadband and fiber connectivity, adding sufficient terrestrial cable to connect 80 percent of the country.

Colombia offers 2G, 3G, and 4G cellular services at present, with 5G in the early stages. Claro Movil, Movistar, Tigo-Une, and Avantel principally serve the Colombian mobile telephony market. Colombia expects to host its delayed 5G-ready spectrum tender at the end of 2021. Several local operators have expressed interest.

[1] CIA World Factbook https://www.cia.gov/the-world-factbook/countries/colombia/#communications
[2] Index Mundi https://www.indexmundi.com/g/r.aspx?v=4010

The country has a landing point (near Cali, the second-largest city) for the 20,000 km South American Crossing (SAC)/ Latin American Nautilus (LAN) subsea cable.[3] This cable rings South America and offers landing points with onward connectivity to international cables. At present, Colombia does not operate any satellites.[4]

2.3 Regulatory Landscape

The principal telecommunications regulator in Colombia is Comisión de Regulación de Comunicaciones (CRC). All cellular products (voice and data) and devices that connect to the PSTN (Public Switched Telephone Network) require CRC certification. Key regulatory resolutions include:

- *Resolution 087, 1997:* Establishes the general regulations for Telecommunications in Colombia.
- *Resolution 4507, 2014:* Modifications and additions to Resolution 087, 1997.
- *Circular 060, 2007:* Describes the technical requirements for the homologation process implemented for landlines, satellite phones, and cellphones. Updates Resolution 087, 1997 and Resolution 1673, 2006.
- *Resolution 711-2016*: Frequency band regulations in Colombia.

Colombia hosts a combination of state-owned and private broadcast media, with national, regional, and local television stations available. More than 500 radio stations also serve the nation.

2.4 ICT Sectors Profiled

This Resource Guide reviews thirteen Colombian development projects, spanning the following ICT sectors:

- *Terrestrial Telecommunications Network Infrastructure: Telephone, Internet, and Broadband*: Colombia enjoys both good telephone and broadband access. Current focal areas for further enhancing service include the adoption of 5G and providing enhanced telecommunications capabilities to rural communities.
- *Subsea Communications Networks:* Colombia already has access to one subsea communications cable, landing on its Pacific coast and ringing South America. A new, planned cable will offer the country direct access to several Central American and Caribbean nations from a Caribbean Sea landing point, further expanding both regional and international connectivity.
- *Smart Cities and e-Government*: Although several Colombian municipalities have adopted a range of smart cities technologies. (e.g., Medellin's MiMedellin platform for citizen participation and social change), both federal and local governments and an NGO have planned additional projects spanning the justice system, comptroller functions, the news media, cadaster management for environmentally sensitive areas, and multiple portfolios of projects for various municipalities across the country.

[3] Fiber Atlantic http://www.fiberatlantic.com/submarinecablemap/
[4] N2YO https://www.n2yo.com/satellites/?c=&t=country

- *Internet of Things (IoT) and Artificial Intelligence:* Both strong government and private sector support for IoT and AI technologies exist in Colombia. Projects featured in this Resource Guide span the energy and fintech industries to enhancing productivity and incomes for small farmers.

2.5 Projects Profiled

Thirteen Colombian ICT projects are profiled following (Table 1):

Table 1: ICT Development Projects - Colombia

Project	Sponsor
5G Plan and Auction	Ministerio de Tecnologías de la Información y las Comunicaciones (MinTIC)
Centros Digitales	Ministerio de Tecnologías de la Información y las Comunicaciones (MinTIC)
Caribbean Express Subsea Cable	Ocean Networks, Inc.
Digital Transformation of News Media	Ministerio de Tecnologías de la Información y las Comunicaciones (MinTIC)
Multipurpose Cadaster in Protected Areas	Fondo Acción
Bogotá Digital Transformation Agendas	Alcaldía de Bogotá
Digital Transformation of the Justice System	Consejo Superior de la Judicatura
Smart City Initiative	Ministerio de Tecnologías de la Información y las Comunicaciones (MinTIC)
Digital Transformation of the Comptroller General	Contraloría General de la República
DIAN Modernization Project	Dirección de Impuestos y Aduanas Nacionales (DIAN)
Ecopetrol Digital Transformation	Ecopetrol
Digital Transformation for Small-Scale Farmers	C4IR.CO
Procolombia Fintech Portfolio	PROCOLOMBIA

5G Plan and Auction	
SUBSECTOR	**Terrestrial Communications Infrastructure: Telephone, Internet, and Broadband**
LOCATION	**Colombia**
PROJECT VALUE	**>$500 million**

PROJECT SUMMARY

- To support the country's 5G rollout, Colombia has announced a spectrum auction in the 3,500 MHz bands for December 2021.
- The spectrum auction is an essential stage of the country's 5G plan published in December 2019.
- The 5G plan has four principal objectives:
  - Identify public policy, regulatory, and regulatory challenges to enable the deployment and critical mass development of 5G technology.
  - Promote the updating of public policies and the regulatory framework to support deployment and critical mass development for 5G technology.
  - Stimulate the demand for applications and services requiring the features offered by 5G technology.
  - Identify digital security guidelines for new business models based on 5G technology.
- Colombia's last spectrum auction, in December 2019, during its 4G rollout, brought in $1.5 billion in concession fees for assigning 80MHz in the 700MHz band and 60MHz in the 2,500MHz band.

PROJECT BACKGROUND AND DESCRIPTION

Colombia has adopted an ambitious 5G plan that will culminate in a spectrum auction at the end of 2021. The plan contemplates the well-known technical virtues of 5G and social policy implications, including reducing the digital divide and avoiding unnecessary risks.

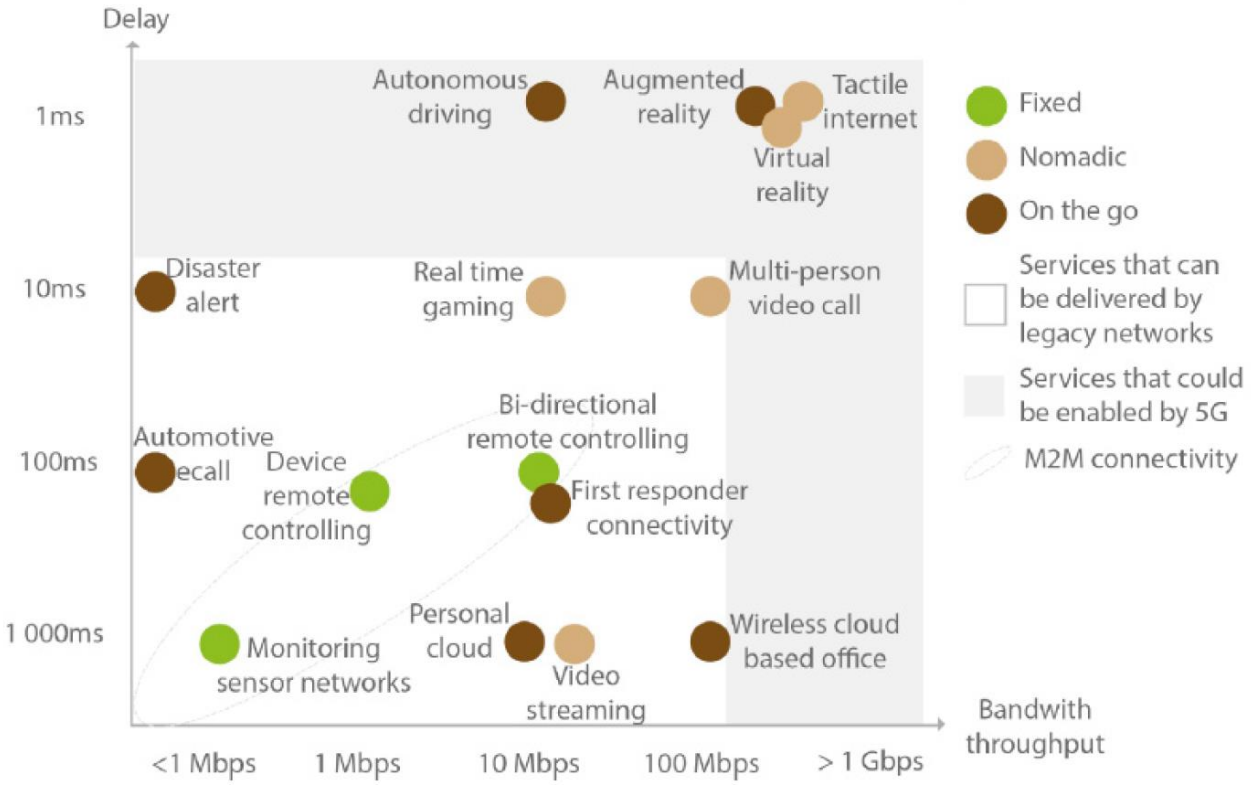
Colombia developed the 5G plan taking into account the following key issues:

- Protecting the rights of users;
- Ensuring cybersecurity is increased;
- Generating competitive conditions to increase service offerings and ensure more competitive rates;
- Stimulating service quality;
- Planning permit grants for efficient use of the spectrum;
- Supporting affordable wireless coverage (e.g., through bands below 1 GHz) to bridge the digital divide as last-mile solutions in sparsely-populated and isolated locations;
- Offering commercial and tax incentives to stimulate investment in 5G networks;

- Reducing the time and, hence, costs for deployment and commissioning of new infrastructure, including both antennae and fiber optics;
- Continuing to enhance 4G services and coverage given the technology's maturity and reasonable costs in light of the scale economies already achieved;
- Harmonizing the spectrum available for 5G with the possible consideration of spectrum sharing between operators; and
- Facilitating pilot tests promoting the development of roadmaps to assist in the deployment of 5G.

The 5G plan also contemplates the technological strengths of 5G to enable other new technologies, as illustrated in Figure 1.

Figure 1: Latency and Bandwidth Profiles for 5G Applications[5]



[5] Source: ITU 2018. Setting the Scene for 5G: Opportunities & Challenges, referenced in Colombia's 5G plan

Colombia's 5G plan has 13 lines of action organized around four key objectives:

Objective 1: Identify public policy, regulatory, or regulatory challenges to enable the deployment and "massification" of 5G technology:

1.1. Identify radio spectrum needs;
1.2. Pilot 5G technology; and
1.3: Identify barriers to the deployment and operation of 5G networks.

Objective 2: Promote the updating of public policies and the regulatory framework for the adequate deployment and "massification" of 5G technology:

2.1. Define a new spectrum management model to facilitate and accelerate the deployment of 5G technology;
2.2. Establish the technical and quality characteristics to be offered by mobile telecommunications services;
2.3. Update spectrum caps to enable the deployment of 5G networks across the country;
2.4. Update and disseminate strategies to remove barriers to infrastructure deployment for 5G; and
2.5. Update and periodically review regulations and norms.

Objective 3: Stimulate the demand for applications and services that require the features offered by 5G technology;

3.1. Drive application and case development in 5G; and
3.2. Identify incentives for business models that require 5G networks.

Objective 4: Identify digital security guidelines for new business models on 5G technology:

4.1. Define the management guidelines and risk analysis associated with 5G technology;
4.2 Promote security oversight models and internal governance in the face of new technologies; and
4.3 Empower citizens in the proper use of new technologies.

In 2020, under Action 1.2, MinTIC awarded temporary licenses in the 3,500MHz band for 5G pilots. Colombia has carried out over 40 5G pilots.

The Secretariat of Digital Innovation of the municipality of Medellín, in a public-private partnership with Nokia, Claro (América Móvil), and Ruta N, carried out one of the first pilots. This pilot test of 5G technology involved an educational application to promote using virtual reality at a teaching innovation center. The virtual education experience included math, biology, and geography classes taught to a group of students. Using 360-degree cameras and high-definition videos, a teacher could impart knowledge remotely to students who received 3D content and interacted through augmented reality glasses. Participants in the pilot included 15 schools and 500 students.

Movistar carried out another 5G pilot at the Central Military Hospital in Bogotá. The pilot supports patient care through a medical trolley for ICU-Covid-19 treatment. Key features of the pilot included:

- Reducing the exposure of health personnel;

- Increasing the frequency of specialist care in COVID-19 areas;
- Decreasing physician-to-patient care time in the emergency room;
- Allowing physicians to virtually access patients from almost anywhere;
- Facilitating consultations between specialists in real-time; and
- Enabling tele-diagnosis and tele-nutrition.

The pilot was also able to "tele-triage" patients in the. Bogotá -based Military Forces Health Clinics, speeding up internal processes and optimizing ambulance resources.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

MinTIC published a draft 5G plan in June 2019. The entity published the final 5G plan in December 2019.

MinTIC awarded 5G pilot projects on the following schedule:

- *December 2019:* Initial announcement;
- *April 2020:* RFP for 5G pilot participation; and
- *May – June 2020:* 5G pilots awarded.

5G pilot licenses were valid for six months.

MinTIC has confirmed the 5G auction for December 2021 and indicated that the terms of reference are currently under review.

However, MinTIC, the National Spectrum Agency, and an external consultant are studying the possibility of structuring the auction differently than originally envisioned. MinTIC is exploring granting regionalized spectrum use permits to reduce concession fees and adding a Private-Public-Partnership structure to eventually deploy infrastructure in areas that are not commercially feasible for mobile operators to invest alone. The envisioned public-private company will offer the infrastructure-as-a-service (IaaS) to mobile operators through National Automatic Roaming. As the study develops, MinTIC will host workshops with interested private parties to receive feedback and adjust its 5G Spectrum Auction terms and conditions. The study is also considering the requirement of Open-RAN implementation achieved through public policy.

PROJECT COST AND FINANCING

MinTIC has not yet published reference values for the 5G spectrum auction.

In December 2019, Colombia's 4G spectrum auction raised 5 trillion pesos ($1.5 billion) by assigning blocks of 80MHz in the 700MHz band and 60MHz in the 2,500MHz band. For the 4G auction, Colombia published reference prices one month before the auction.

Based on the 4G auction, we estimate that the 5G auction will likely yield concession fees greater than $500 million.

U.S. EXPORT OPPORTUNITIES

U.S. companies may participate in the 5G spectrum auction as:

- An entrant operator, with differentiated national automatic roaming costs for the first five years; or
- As a shareholder in the private-public-partnership for the deployment of IaaS for mobile operators in areas where mobile operators are not motivated to deploy by themselves.

Additional export opportunities for U.S. companies in conjunction with Colombia's 5G auction will include:

- Fiber optic network-backhaul hardware, software, and installation and maintenance services;
- Small- and pico-cell, low-power base station hardware, software, and installation and maintenance services;
- Multiple-input/multiple-output (MIMO) technology, antenna modules, and installation, maintenance, and advisory services;
- Beamforming technology and advisory services;
- Centralized radio network (C-RAN) technology, baseband unit hardware and software, and advisory services;
- Giga-bit WiFi technology, hardware, software, and advisory services; and
- Open-RAN compatible technology.

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
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Centros Digitales	
SUBSECTOR	**Terrestrial Communications Network Infrastructure: Telephone, Internet, and Broadband**
LOCATION	**Colombia**
PROJECT VALUE	**$600 million**

PROJECT SUMMARY

- Centros Digitales (Digital Centers) is an ambitious program to provide free Internet connectivity to nearly 10,000 rural and isolated communities throughout Colombia.
- The program will benefit over one million rural inhabitants, connecting:
  - 9,133 rural schools;
  - 81 ethnic minorities;
  - 59 health centers; and
  - 39 natural parks.
- Each Digital Center will provide indoor WiFi for educational activities and free outdoor WiFi for the associated rural community.
- The project sponsor is the Ministry of Information, Technologies, and Communications (MinTIC).[6]

PROJECT BACKGROUND AND DESCRIPTION

Centros Digitales will bring free WiFi via 4G technology to at least 9,410 rural communities in all Colombia departments. The project will install digital centers in:

- 9,133 rural schools;
- 59 health centers;
- 51 military installations;
- 39 natural parks; and
- 47 other sites.

The project will benefit a population of approximately 1.3 million rural inhabitants, including 81 ethnic minority groups. Each Digital Center will include one indoor WiFi connection point for the host building (most often, schools) and two outdoor WiFi connection points for the general community.

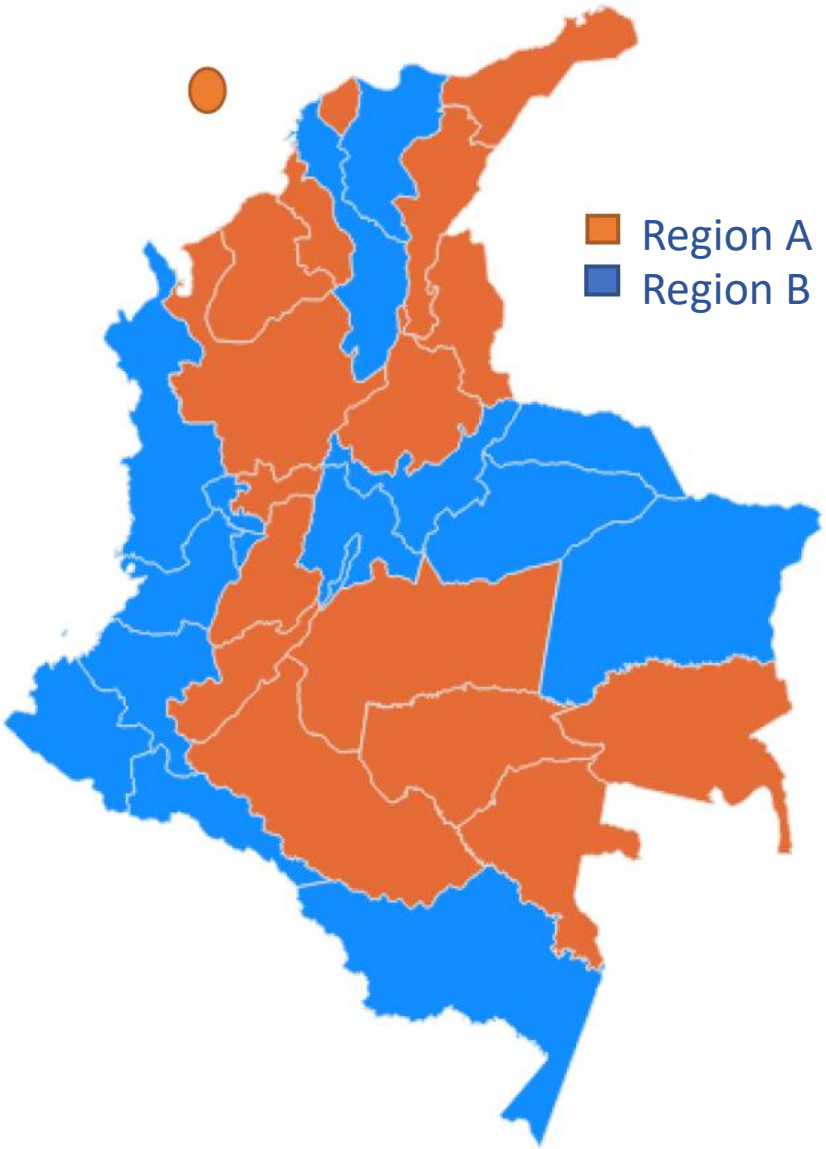
Specifications for the Digital Centers include:

[6] MinTIC – Ministerio de Información, Tecnologías y Comunicaciones

- 4-hours of autonomous power supply;
- Dedication of 60 percent of capacity for educational purposes during schools hours; and
- Minimum availability requirements and connection speeds.

Implementation of the project is based on dividing the national territory into two regions, each with a comparable number of sites and other characteristics. The two regions for project implementation are described in Figure 2.

Figure 2: The Two Regions of Colombia's Centros Digitales Project



In addition to a comparable number of sites, the assignment into two regions for project implementation considered two additional factors:

- Level of conflict in each area; and
- Ease of physical access to the sites.

MinTIC evaluated both factors on a scale of 0 to 1. The average characteristics of the two regions are described in Table 2.

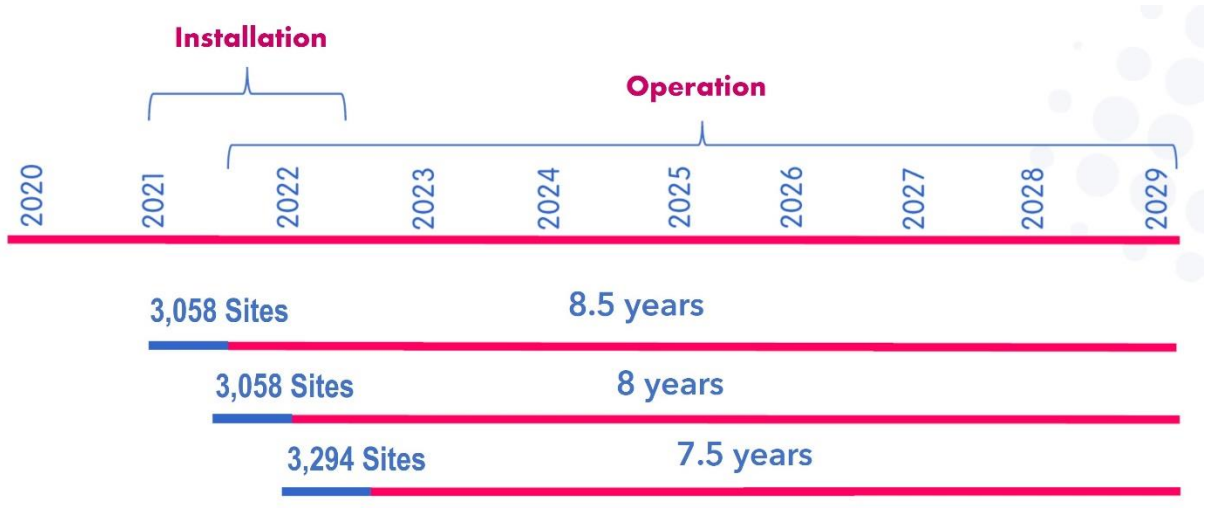
Table 2: Characteristics of the Two Regions of Centros Digitales

Region	# of Departments	# of Sites[7]	Average Conflict Factor, 0 to 1	Average Access Factor, 0 to 1
A	17	4,658	0.447	0.277
B	16	4,752	0.475	0.291
Total	***33***	***9,410***	***0.461***	***0.284***

PROJECT STATUS AND IMPLEMENTATION TIMELINE

The Centros Digitales announced the project in 2020, with a 10-year timeline extending through 2029. The installation phase will be completed by August 2022 and is divided into three stages, as shown in Figure 3.

Figure 3: Implementation Timeline for Centros Digitales



[7] Minimum number of sites

When Colombia announced the project in August 2020, the original date for confirming the tender winners for the two regions was scheduled for October 2020. Due to complications during the tendering process, however, contract signing was postponed by about two months.

Centros Digitales connected its first five sites in March 2021.

PROJECT COST AND FINANCING

At the time of tender, the Centros Digitales project had a total budget exceeding 2 trillion pesos (approximately $600 million). The budget distribution by region and cost category is described in Table 3.

Table 3: Centros Digitales Budget Allocation by Region and Cost Category

Concept	Region A	Region B	Total
Number of Sites	4,658	4,752	9,410
CAPEX (billion Pesos)	185	188	373
OPEX (billion Pesos)	881	884	1,765
Total (billion Pesos)	1,066	1,072	2,138

The Government of Colombia is financing Centros Digitales. The schedule of financial guarantees provided by the Government to assure annual payments to each region operator is shown in Table 4.

Table 4: Fiscal Guarantees for Centros Digitales (Billion Pesos)

Year	Region A	Region B	Total
2020	68.9	70.2	139.1
2021	87.2	87.9	175.0
2022	150.8	152.4	303.2
2023	86.6	86.8	173.4
2024	93.1	93.4	186.5
2025	99.8	100.1	199.9
2026	107.1	107.6	214.7
2027	115.1	115.7	230.8
2028	124.0	124.7	248.6
2029	133.0	133.8	266.8
TOTAL	1,065.6	1,072.6	2,138.1

In December 2020, Region A was awarded to Comcel, S.A. Comcel will connect 7,468 Digital Centers in the departments of Antioquia, San Andrés, Atlántico, Caldas, Caquetá, Cesar, Córdoba, Guainía, Guaviare, Huila, La Guajira, Meta, Norte de Santander, Santander, Sucre, Tolima and Vaupés, for a value of $1.06 billion.

Region B was awarded to a temporary joint-venture, Unión Temporal Centros Poblados Colombia 2020; subsequently MinTIC rescinded the contract citing irregularities. The executor of Region B of the project will connect at least 4,752 Digital Centers in the departments of Amazonas, Arauca, Bolívar, Boyacá, Casanare, Cauca, Chocó, Cundinamarca, Magdalena, Nariño, Putumayo, Quindío, Risaralda, Valle del Cauca, and Vichada, for an estimated value of $1.07 billion.

The tendering process specified the annual fiscal guarantees. The award criteria emphasized the number of digital centers and other enhancements to the minimum scope of the project definition. The resulting commitments are thus greater than the minimum number of sites specified in the project. The final scope of the project is provided in Table 5:

Table 5: Number of Sites Offered by Winning Bidders

Number of Sites	Region A	Region B	Total
Original Specification	4,658	4,752	9,410
Offered by Winning Bidder	7,468	7,277	14,745

U.S. EXPORT OPPORTUNITIES

The network rollout to remote areas offers several opportunities for U.S. companies, including:

- Antennae systems, hardware, and software;
- A gateway earth station;
- Fiber optic network hardware and spares;
- Network and location system hardware and software;
- Small- and pico-cell technologies and equipment;
- Wireless telecommunications equipment;
- Information. Technology (IT) laboratory equipment;
- Batteries/battery storage solutions;
- Renewable ICT technologies, including photovoltaics; and
- Advisory services.

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
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Caribbean Express Subsea Cable	
SUBSECTOR	**Subsea Communications Networks**
LOCATION	**Colombia**
PROJECT VALUE	**$300 Million**

PROJECT SUMMARY

- Ocean Networks is an independent ICT infrastructure developer focused on subsea optical fiber cable development and repurposing submarine cable systems for ocean science.
- The company is developing the Caribbean Express cable, which will connect West Palm Beach, Florida to Maria Chiquita, Panama (east coast, near Colon), with onward service to Corozal (west coast). The cable will provide intermediate connections to Cartagena, Colombia, and Cancun, Mexico.
- The project cost is estimated at $300 million.
- Ocean Networks projects a cable system Ready for Service date (RFS) for Q2 2024.

PROJECT BACKGROUND AND DESCRIPTION

Ocean Networks, Inc. (ONI) was established in 2013, with headquarters in Atlanta, GA (USA). The company develops submarine cable systems for governments, carriers, content providers, and research and education groups. The company is privately held and currently owns more than 8,000 km of submarine cable systems; it is repurposing for ocean science observatory applications through a subsidiary, Submarine Cable Salvage, Inc.

While numerous regional cables traverse the Andean region, service to many locations is limited. Further, an absence of available dark fiber pairs has constrained additional competitors from serving what is often an expensive market for consumers and governments. Additional capacity offers advantages for both customers and suppliers. The history of the market indicates that traffic demand is doubling approximately every two years in the region.

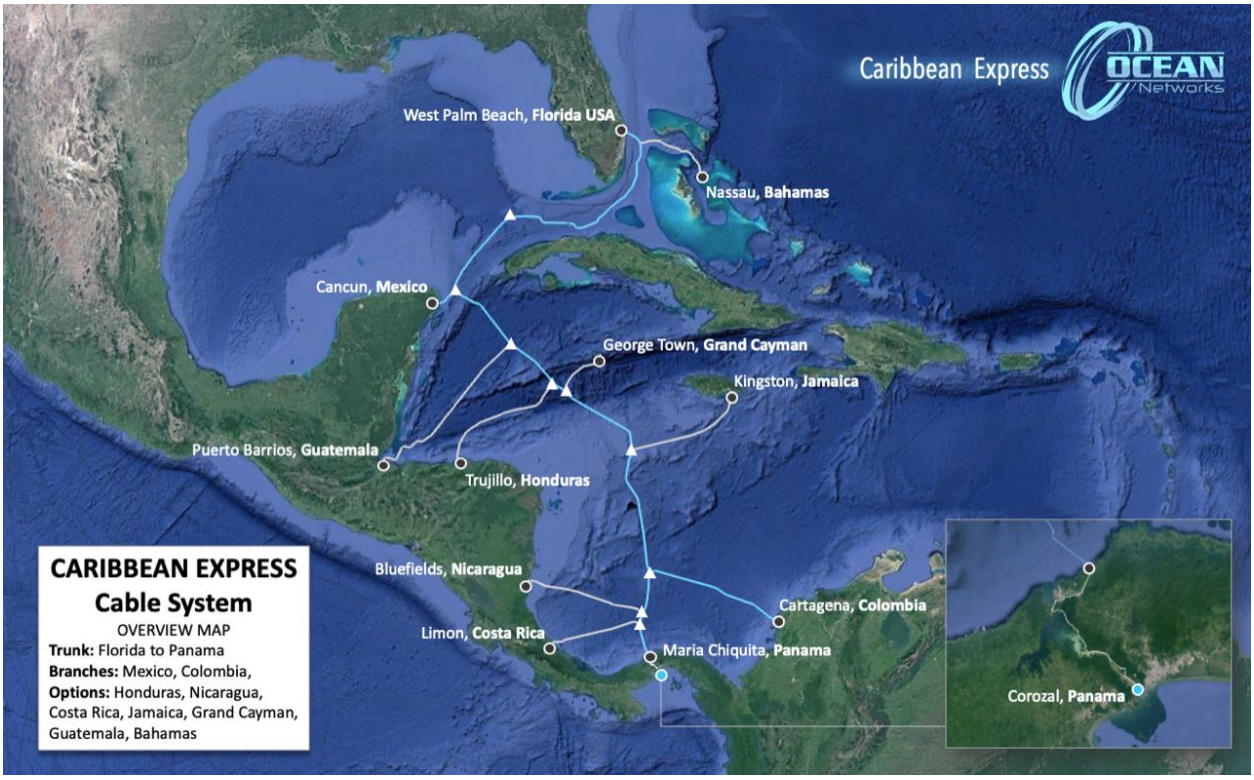
The Caribbean Express (CX) is a new-build submarine cable system in development by ONI. The carrier-neutral CX system is designed to connect at least twelve locations spanning North, Central, and South America and the Caribbean, as described in Table 6.

Table 6: Caribbean Express Cable Landing Points

Connection Type	Country	Landing Point
PoP[8]/Trunk	United States	West Palm Beach, FL
PoP/Trunk Branch	Panama	Maria Chiquita Corozal
Branch	Mexico	Cancun
Branch	Colombia	Cartagena
Future Branch	Bahamas	
Future Branch	Costa Rica	
Future Branch	Grand Cayman	
Future Branch	Guatemala	
Future Branch	Honduras	
Future Branch	Jamaica	
Future Branch	Nicaragua	

Figure 4 depicts the planned cable route.

Figure 4: Caribbean Express Planned Cable Route



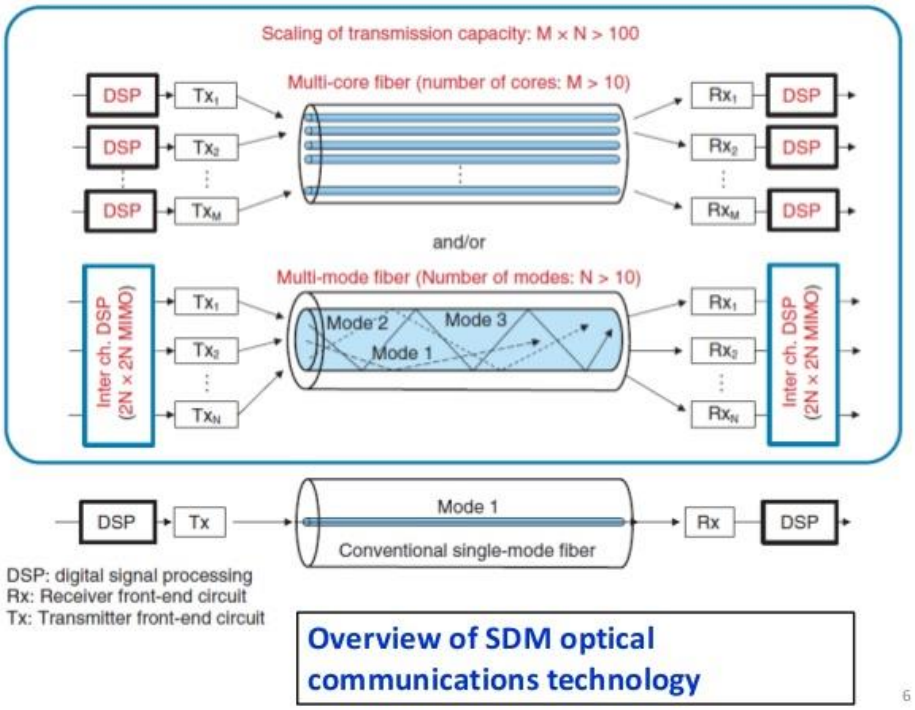
[8] Point of Presence

The CX system will fill a requirement for the emerging markets by providing low latency connectivity to the network access points (NAP) at Miami and Jacksonville, FL. The CX system will be the only system in the Caribbean region that can offer full fiber pairs to the market.

The CX system features 18 fiber pairs linking Florida to Panama. The estimated cable length initially is 3,472 km. At completion, ONI expects the total cable length to be 5,333 km.

The system uses the latest technology in Space Division Multiplexing (SDM). Using several light shapes simultaneously in a multimode optical fiber as if they were independent channels, SDM enables a bandwidth increase in the optical fibers, as shown in Figure 5.

Figure 5: Space Division Multiplexing (SDM) Technology[9]



ONI has positioned branching units in strategic locations along the CX route to enable future connectivity easily. The CX system will provide rapid, simple access to new markets with diverse routing options, high-speed connectivity, and very low latency. Upon completion, CX will be the only system to offer new dedicated dark fiber pair Indefeasible Rights of Use (IRUs) in the Caribbean market. IRUs are permanent lease contractual agreements between the owner and a customer of a communications system. An IRU provides both supplier and customer certainty, typically over 5 to 25 years, and cannot be undone.

[9] NTT https://www.ntt-review.jp/archive/ntttechnical.php?contents=ntr201412ra3.html

PROJECT STATUS AND IMPLEMENTATION TIMELINE

ONI's Caribbean Express project is in the development stage. The company has invested significant capital in advancing the route development, including market analysis, permit and environmental studies, and securing landing party agreements.

In conjunction with the remaining capital commitments, supplier RFQs will be issued in April 2021 to system suppliers, with the awarded Contracts in Force (CIF) by August 2021. The planned Ready for Service (RFS) date will be in Q2 2024.

PROJECT COST AND FINANCING

The ONI CX system will require an investment of approximately $300 million. ONI has retained Commenda, an Atlanta, GA merchant bank, to arrange financing. Funding sources typically engaged by Commenda include strategic and governmental funds, U.S. and foreign banks, and family offices.

U.S. EXPORT OPPORTUNITIES

Export opportunities for U.S. firms include:

- Fiber optic cabling hardware;
- Fiber optic network-management hardware and software;
- Network modeling, design, and engineering services;
- Ship services/oversight;
- Installation/testing services/oversight; and
- Other technical and management advisory services.

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
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Digital Transformation of News Media	
SUBSECTOR	**Datacenters and Cloud Computing**
LOCATION	**Colombia**
PROJECT VALUE	**$23 million**

PROJECT SUMMARY

- The Colombian Ministry overseeing ICT has issued a request for proposals from news media organizations to support their digital transformation.
- Over 2,000 news media groups are eligible, spanning television, radio, newspapers, magazines, and digital media.
- Eligible project activities include:
  - Business culture transformation;
  - Transformation of business processes (operational and support processes); and
  - Development and implementation of technology for digital transformation (IT infrastructure acquisition, emerging technologies, and migration to digital product delivery).

PROJECT BACKGROUND AND DESCRIPTION

In 2019, Colombian law 1978 established a National Fund for Information Technologies and Communications (FUTIC[10]) as a special administrative unit under the Ministry of Information Technologies and Communications (MinTIC[11]). FUTIC merged two previous funding mechanisms, one oriented toward the deployment of ICT and the other for television platforms and content. FUTIC has three objectives:

- Finance plans, programs, and projects to facilitate universal access to information and communication technologies;
- Assure the strength of public television, the promotion of multiplatform contents of public and cultural interest, and the productive use of information and communication technologies; and
- Provide administrative and technical support to MinTIC and the National Agency of Spectra.

Law 2063 of 2020, establishing the fiscal year 2021 budget, authorizes the FUTIC to finance the implementation of plans, programs, and projects to support the digital transformation of news media. FUTIC provides this support under the pact for digital transformation within the National

[10] FUTIC – Fondo Único de Tecnologías de la Información y las Comunicaciones
[11] MinTIC – Ministerio de Tecnologías de la Información y las Comunicaciones

Development Plan. Support for private entities is justified due to the expected societal return and is designed based on efficiency and equity criteria.

The following news media are eligible for support under this project:

- Television;
- Radio, both commercial and community service;
- Newspapers;
- Magazines; and
- Electronic Media (web-based).

The geographic service area of media can be national (public or private), regional (less than national scope but larger than local), or local (a single municipality or metropolitan area). Over 2,000 news media entities are eligible for this project, as shown in Table 7.

Table 7: News Media in Colombia

Scope	Television	Radio	Newspapers	Magazines	Digital	Total
National	3		5	20		28
Regional	1		44			45
Local	376		85	33		494
Commercial		660				660
Community Service		624				624
Digital Media					240	240
Total	**380**	**1,284**	**134**	**53**	**240**	**2,091**

The project contemplates three funding areas:

Area 1 – Business Culture Transformation
Area 1 focuses on implementing strategies and methodologies to strengthen management skills and generate confidence in technology and e-commerce. It also addresses sociocultural and cognitive barriers that could prevent the development of digital transformation processes in companies. Activities carried out in this area include in-person and virtual training to support knowledge transfer in digital transformation.

Contents for training programs under Area 1 may include:

- Digital business transformation;
- Digital skills;
- Innovation and digital transformation;
- Emerging technologies;
- Business transformation;
- ICT tools; and
- Operational processes of the organization.

Area 2 - Transformation of Business Processes
Area 2 supports the transformation of critical operational business processes and support functions. The digital transformation of business processes can provide significant benefits to both the company and its customers, including improved customer service times, optimization of human and financial resources (both reduction of costs and increases in revenue and profit margins), improvements in service quality, and shorter process times. Transformation of business processes often begins by diagnosing the organization's baseline, followed by digital strategy development and priority enumeration.

Area 2 comprises two funding lines:

2.1: Updating and acquiring hardware and software specific to the operational processes: This line focuses on specific operational processes within each organization. For example, for audiovisual content production, hardware can refer to cameras, antennas, console mixers, microphones, headsets, monitoring equipment, speakers, and specialized production equipment.

2.2: Digitization of processes: This line focuses on support, evaluation, and control processes.

Area 3 - Development and Implementation of Technology for Digital Transformation
Area 3 promotes the implementation of state-of-the-art technologies with scalable models that allow flexibility for growth. These technologies add higher levels of automation, thereby promoting e-commerce growth strategies, supported by expanded storage capacity, faster processing speeds, and enhanced cybersecurity.

This area includes three funding lines:

3.1: Actualization, acquisition, and implementation of information technology (IT) infrastructure: This line focuses on architecture that can be deployed in either a cloud computing system or on the organization's premises. It may include:

- *Hardware:* hardware includes servers, data centers, personal computers, routers, switches, and other equipment. Infrastructure also includes the facilities housing and cooling the data centers and those responsible for providing security and power.
- *Software***:** software refers to the applications used by the company, such as web servers, content management systems, computer security, and operating systems.
- *Networks***:** networks consist of Internet connection, communication systems, security, and other hardware elements such as routers, switches, structured cabling, et al.

3.2: Implementation of emerging technologies: This line allows recipients to acquire or update hardware, software, and cloud-based subscriptions and acquire licenses for the development of new technologies resulting in radical changes to the organization's processes. Such investments may include:

- Cloud computing;
- Internet of Things (IoT);
- Robotics;

- Augmented reality;
- Virtual reality (VR);
- Artificial intelligence (AI);
- Blockchain;
- Data mining;
- Design for the implementation of emerging technologies;
- Datasheets; and
- Risk analysis.

3.3: Migration to digital product delivery: This line funds the migration of traditional media to a digital format, ensuring that the new developments have unique domains and are of exclusive use of the press. Projects under this funding line must include the following concepts:

- *Functional requirements***:** submitters must prepare a document describing the functions of the software to be developed, the programming language to be used, the device on which the software will be implemented (e.g., website or app), and indicating the timeframe of software development;
- *Non-functional requirements:* a report of the software to be developed concerning availability, stability, interoperability, fault tolerance, security, and any other important risk factors.
- *Source code:* the ownership of the source code must be specified;
- *Licenses on additional tools, if required*;
- *Estimated development hours*; and
- *Hosting and domain.*

PROJECT STATUS AND IMPLEMENTATION TIMELINE

MinTIC published a draft of the request for proposals (RFP) for comment in March 2021. The entity received 725 observations and questions regarding the draft RFP.

MinTIC published the final RFP on May 27, 2021. The original deadline for responses was June 25, 2021. On June 11, 2021, MinTIC published additional addenda to the RFP. MinTIC extended the deadline for submission until July 8, 2021. MinTIC has scheduled awards for August 18, 2021. If oversubscribed, MinTIC will award contracts randomly.

Projects should be completed by December 31, 2021, as project funding is intended to provide a post-pandemic stimulus.

PROJECT COST AND FINANCING

Table 8 describes the distribution of the 85 billion peso funding from FUTIC for project implementation.

Table 8: Funding for Digital Transformation of New Media

Type of Media	Billion Pesos	$ Million[12]
Radio	30.9	8.2
Television	11.2	3.0
Newspapers	28.0	7.5
Magazines	10.6	2.8
Digital Media	4.3	1.1
Total	**85.0**	**22.6**

U.S. EXPORT OPPORTUNITIES

U.S. export opportunities for the project include:

- Hardware:
  - Datacenter componentry (servers, racks, power, HVAC, site security, et al.); and
  - Other (networking hardware, fiber optic cabling, components, routers, switches, power management hardware, et al.)
- Emerging technology solutions:
  - Internet of Things;
  - Robotics;
  - Augmented reality;
  - VR;
  - AI; and
  - Blockchain.
- Software:
  - Access to Software as a Service (SaaS) and related cloud-based programs;
  - Custom software/applications, including civil registry and tax administration tools, and electronic payment systems; and
  - Cybersecurity solutions.
- Advisory services:
  - Training and awareness for digital transformation;
  - Networking design, implementation, and security; and
  - Application design, development, testing, and implementation.

[12] Exchange rate applied: 1USD = 3,750COP

CONTACTS

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Multipurpose Cadaster in Protected Areas	
SUBSECTOR	**Smart Cities and e-Government (Records Digitization)**
LOCATION	**Colombia**
PROJECT VALUE	**$43 million**

PROJECT SUMMARY

- The project will develop and implement a multipurpose cadaster[13] in municipalities with national environmentally-protected areas, deforestation hotspots, and other national environmentally significant and strategic areas.
- The project comprises four components:
  - Institutional strengthening of environmental authorities;
  - ICT development and strengthening of the Colombian Environmental Information System;
  - Implementation and maintenance of the multipurpose cadaster in environmentally sensitive areas; and
  - Project management support.
- The project is financed by a $43 million grant from a fund administered by the International Bank for Reconstruction and Development (IBRD).

PROJECT BACKGROUND AND DESCRIPTION

The Colombian National Council of Economic Policy (CONPES[14]) approved CONPES Document No. 3859 on June 13, 2016, mandating the creation of the multipurpose cadaster. Two aspects of this policy are particularly noteworthy:

- CONPES will scale up the cadaster creation process from several regions to the whole country; and
- The data collected in developing the cadaster will provide information on parcels, rights, and land values critical for future planning.

Before approval of Document No. 3859, 28 percent of the country's municipalities had no cadaster, and the existing cadasters were outdated in 52 percent. The multipurpose cadaster is a critical element for:

- Territorial and land use planning;
- Formalization of land tenure;

[13] A cadaster is an official register showing details of ownership, boundaries, and value of real property in a district, made for taxation purposes

[14] CONPES - Consejo Nacional de Política Económica y Social

- Municipal property taxation;
- Sustainable land management for climate change mitigation and adaptation; and
- Establishing priorities for public investments.

In particular, the multipurpose cadaster will support adapting to climate change and mitigating its impacts on land degradation, water quality, and agricultural production.

Between 2017 and 2018, the National Planning Department (DNP[15]) carried out seven cadaster pilots in an equal number of municipalities. The objective of these pilots was to provide information and lessons for the subsequent 2019-2025 national-level implementation of the multipurpose cadaster. These pilots provided the opportunity to test and evaluate several elements, including:

- Surveying methodology and standards;
- Implementation mechanisms (including private sector participation and outsourcing possibilities);
- Availability of information and variables to be included; and
- Identification of the costs and measures required to improve efficiency during a subsequent scaling-up phase.

The implementation of the multipurpose cadaster project started in 2019 with a $100 million loan from the World Bank and a $50 million loan from the Inter-American Development Bank (IADB). In 2021, Colombia expanded the project to include specific provisions for environmentally protected areas.

The 2018-2022 National Development Plan (PND[16]) puts forward a set of "comprehensive, differentiated, and definitive" plans to respond to social and environmental-related conflicts associated with land tenure in environmentally protected areas. The PND places a particular focus on vulnerable communities' land rights, including, among others, those communities whose livelihoods depend on rural economic activities in environmentally protected areas. The PND also provides formal land-use instruments while balancing social and ecological considerations in these strategic areas.

Intense deforestation is present in municipalities affected by the armed conflict or where unregulated agricultural activity and livestock grazing still occur. Cattle ranching, and the cultivation of illicit crops, are the leading causes of deforestation. Deforestation is closely linked to illegal activities, including forced displacement, illegal mining, and illicit crop production.

The Colombian legal framework recognizes the importance of environmentally protected areas (i.e., National Natural Parks) and mandates that said areas might not be subject to different uses. However, private property rights are recognized where land titles pre-date the establishment of a PNN. Therefore, an individual who can demonstrate land tenure rights within a protected area must follow land-use provisions aimed at preserving the ecological function of the land.

[15] DNP – Departamento Nacional de Planeación
[16] PND – Plan Nacional de Desarrollo

In Colombia's National Parks, 96.4 percent of cadaster data is out of date, and cadastral systems cannot interoperate regarding parcel-based land rights with land use restrictions and responsibilities. Given the limited interoperability, local administrations do not rely on cadastral records as a source of value-added for information policy design and municipal land use plans. Currently, there are no guidelines for environmental authorities to adopt and implement interoperability standards with cadaster and property registration data.

The Ministry of Environment administers the Colombian Environmental Information System (SIAC[17]) in close collaboration with the Institute of Hydrology, Meteorology and Environmental Studies, other research institutes, and regional or local environmental authorities. Therefore, a need exists to ensure interoperability between the multipurpose cadaster and the SIAC to guarantee a more systematic approach to environmental public policy.

The SIAC depends on a network of organizations that share data and information on renewable natural resources and the environment. Any organization can contribute data to the SIAC within specific parameters. The network of organizations has agreed to develop standards and interoperability patterns on par with international best practices, given the wide range of thematic data sets around climate and sustainable management that SIAC must administer. The strengthening of SIAC at the regional and local levels will facilitate integrating a set of regional environmental information, including actors, policies, processes, and technologies, to facilitate the generation of knowledge, decision-making, education, and social participation for sustainable development in a sub-national context.

In March 2021, the World Bank signed additional financing for the Multipurpose Cadaster Project to strengthen sustainable management in environmentally protected areas. The scale-up of activities will allow the overall project to incorporate environmental sector entities into the modernization of the national cadastral information system.

The project comprises four components:

Component 1 - Institutional Strengthening of Environmental Authorities

Component 1 will strengthen the institutional, technical, and human talent capacity of the Environment sector and Sustainable Development (SADS[18]), supporting information management of the multipurpose cadaster according to the guidelines of the Colombian Spatial Data Infrastructure (ICDE[19]). The development of activities focused on the planning of cadastral information management in strategic environmental areas will follow a multipurpose approach and ICDE guidelines. The project will also design and implement strategies to strengthen SADS capabilities to ensure geospatial data quality. The project will develop outreach and communication strategies associated with cadastral information management. This Component will also include activities focused on capacity-building for human talent to provide cadastral services in environmentally strategic areas.

Component 2 - Development of ICT and Strengthening of the Colombian Environmental Information System (SIAC)

[17] SIAC – Sistema de Información Ambiental de Colombia
[18] SADS – Sector Ambiental y Desarrollo Sostentible
[19] ICDE – Infraestructura Colombiana de Datos Espaciales

The objective of Component 2 is to strengthen SADS geospatial data policies, standards, and protocols. This Component will strengthen SIAC's ICT capabilities and public environmental entities by using and appropriating sectoral business architecture for cadastral and environmental information management.

Component 3 - Implementation and Maintenance of the Multipurpose Cadaster in Municipalities with Environmentally Protected National Areas, Critical Deforested Areas, and Other Environmentally Significant and Strategic National Areas

Component 3 will implement cadaster procedures with a multipurpose approach in municipalities prioritized by SADS. This Component will provide cadastral managers and other SADS entities with property registration inputs from the Superintendency of Notary and Registration (SNR[20]) and inputs of national land agency (ANT[21]) awards. Key elements of this Component include:

- Generating information and developing cadastral operations with a multipurpose approach in the municipalities most affected by prioritized deforestation;
- Implementing the information quality assurance model for the multipurpose cadaster;
- Promoting the production, processing, and availability of standardized information in strategic environmental areas located in areas of high deforestation;
- Implementing processes of regularization of land occupation and granting of rights of use in environmentally strategic areas; and
- Implementing conservation agreements with vulnerable peasant families living in strategic environmental areas located in deforestation nuclei.

Component 3 will also carry out prior consultation with indigenous peoples of decrees and normative instruments for the multipurpose cadaster.

Component 4 - Project Management

Component 4 aims to support the development of administrative procedures, financial management, procurement, monitoring and evaluation, and monitoring of safeguards. This Component also pertains to facilitating external financial audits.

The DNP coordinates the overall Multipurpose Cadaster Project. A local NGO, Fondo Acción, manages additional funding for enhancing the cadaster in environmentally protected areas[22].

PROJECT STATUS AND IMPLEMENTATION TIMELINE

The IBRD and Fondo Acción signed a grant agreement on March 8, 2021. The project's expected closing date is January 31, 2025.

[20] SNR – Superintendencia de Notariado y Registro
[21] ANT – Agencia Nacional de Tierras
[22] Fondo Acción – Fondo para la Acción Ambiental y la Niñez

The only contracting scheduled for the first half of 2021 is for a program manager and specialists for the project management unit within Fondo Acción. Procurement of goods and services for project implementation will commence in the second half of 2021.

PROJECT COST AND FINANCING

The total funding for the Multipurpose Cadaster Project is $193 million, as follows:

- A $100 million loan from the IBRD;
- A $50 million loan from the IADB; and
- A $42.974 million grant from the IBRD for the environmentally protected areas.

The grant for the project component described here, i.e., for environmental protected areas, comes from the AF Colombia Land Administration Support Multi-Donor Trust Fund, administered by the IBRD. The grant comes from the International Climate Fund of the U.K. Department for Business, Energy, and Industrial Strategy.

U.S. EXPORT OPPORTUNITIES

U.S. export opportunities for the project include:

- Software as a Service (SaaS) and cloud-based solutions for document management;
- Document management services to conserve, digitize, organize, index, and migrate cadaster information;
- GIS cadaster solutions;
- Platform as a Service (PaaS) and virtual cloud-based servers; and
- Specialized consulting services to support environmental institutions and cadaster development.

CONTACTS

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Bogotá Digital Transformation Agendas	
SUBSECTOR	**Smart Cities and e-Government**
LOCATION	**Colombia (Bogotá)**
PROJECT VALUE	**Approximately $60 million**

PROJECT SUMMARY

- In November 2020, the city of Bogotá announced an ambitious Digital Transformation (DT) Plan, organizing 100 initiatives into nine DT agendas:
  - Green Transformation;
  - District Care System;
  - Open Government;
  - Cultural Agenda;
  - Networked, Preventive and Territorial Health;
  - Education;
  - Reactivation and Economic Well-Being;
  - Simplify Day-to-Day Life; and
  - Territory in Peace and Security.

PROJECT BACKGROUND AND DESCRIPTION

The main objective of the nine Bogotá DT agendas is to use technology strategically to transform Bogotá into a more sustainable city while generating new opportunities and empowering citizens to take part in the most critical municipal decisions. The agendas are also intended to deploy technology, data, and innovation to improve the quality of life of Bogotá citizens.

The DT Plan comprises 100 initiatives grouped into nine specific agendas:

- ***Green Transformation:*** 19 initiatives that will allow citizens to change their habits and work for an environmentally sustainable Bogotá;
- ***District Care System:*** 11 initiatives that accompany the implementation of the District's care system, based on the use of technology to improve social and care services in Bogotá;
- ***Open Government:*** eight initiatives where technology, data, and innovation are placed at the service of transparency, participation, and collaboration to empower citizens;
- ***Cultural Agenda:*** seven initiatives that, through technology, will allow citizens to develop creative capacities, become involved in citizen culture actions, and enjoy the sports, cultural, and heritage offerings of the city;
- ***Networked, Preventive and Territorial Health:*** six initiatives to improve how citizens interact with the health system, based on the needs of the territory and the population;

- ***Education:*** six initiatives designed to accelerate the digital transformation of education, allowing citizens to develop the necessary skills for the fourth industrial revolution;
- ***Reactivation and Economic Well-Being:*** 13 initiatives focused on digitally transforming mini-, small-, and medium-sized enterprises, strengthening the ecosystem of entrepreneurship and innovation, and boosting the economic reactivation of the city;
- ***Simplify Day-to-Day Life:*** 27 initiatives designed to consolidate a digital government that impacts the quality of life of its citizens through the digitization of services, data-based decision-making, and the strengthening of ICT management of public entities.
- ***Territory in Peace and Safety:*** three initiatives allow the construction of a safe territory and the transformation of security dynamics and care in the city using technology.

Bogotá's nine DT agendas are depicted in Figure 8.

Figure 6: Bogotá's Nine Digital Transformation Agendas

Several of the DT agendas, including Open Government and Simplify Day-to-Day Life, are e-Government programs. Specific e-Government initiatives include:

- ***Single Window and Virtual Office for Construction (VUC[23]):*** The VUC combines a single window, virtual channel for all processes and procedures related to urban planning, permitting, and construction in Bogotá. The VUC includes the following functionalities:
  - Electronically consult requirements and procedures associated with the processes of urban development and construction;
  - Schedule appointments with appropriate entities;
  - Download forms and formats;
  - Submit virtual requests for procedures, communications, and requirements;
  - Consult the status of individual procedures;
  - Access simulators;
  - Send and receive alarms between entities; and
  - Consult the histories of specific projects.

[23] VUC – Ventanilla Única de la Construcción

- ***Virtual Finance Office:*** The Virtual Finance Office will facilitate the interaction of citizens with their financial obligations and contributions. Functionalities will include:
  - Unified property taxes;
  - Motor vehicle fees;
  - Taxes on industrial and commercial activities (ICA); and
  - ICA withholdings.

- ***Multipurpose Cadaster:*** The municipality of Bogotá will offer multipurpose cadaster services to other territorial entities. Expected multipurpose cadaster benefits include:
  - Greater legal certainty;
  - Improved efficiency of the real estate market;
  - Urban development and land-use planning;
  - Integration with the public registry of immovable property;
  - Digitization and interoperability between information systems in the territory; and
  - Better allocation of public resources.

Key initiatives in the areas of healthcare and education include:

- ***Unified Electronic Health Record:*** The Unified Electronic Health Record is a new platform that will revolutionize access to health services in Bogotá. Citizens will have access to their medical histories, appointment scheduling, and management of medical formulas. Benefits from this system will include:
  - More agile attention;
  - Confidentiality of patient data;
  - Avoiding trips for administrative procedures related to the health system;
  - Higher levels of efficiency;
  - Fewer duplicate tests;
  - Reduced paper use;
  - Improved control of the demand for scheduled medical care;
  - Improved management of drug inventories; and
  - Reduced fragmentation of information.

- ***Reducing the digital gap in education:*** This initiative will provide infrastructure, connectivity, and devices in the education sector to reduce the digital gap in the city. The effort will apply criteria of coverage and relevance to supply necessary goods to the educational population, focused on both the urban and rural environments of the city.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

Bogotá's city government announced the nine DT agendas in November 2020. Citizens and interested parties are invited to participate in the planning process. Specific implementation timelines will be announced for each of the 100 initiatives grouped into the nine DT agendas.

PROJECT COST AND FINANCING

The municipality has set aside a 43.4 billion pesos ($12 million) budget during 2021 for the project entitled Digital Transformation and ICT Management for an Intelligent Territory. Based on the first-year budget, we estimate a five-year implementation budget of approximately $60 million.

U.S. EXPORT OPPORTUNITIES

U.S. export opportunities for the project include:

- Hardware:
  - Datacenter componentry (servers, racks, power, HVAC, site security, et al.); and
  - Digital operations center equipment (networking hardware, fiber optic cabling, and components, power management hardware, et al.).
- Software:
  - Access to Software as a Service (SaaS) and related scalable programs;
  - Custom software/applications for e-Government, smart city technologies, healthcare IT, and e-Education; and
  - Cybersecurity solutions.
- Advisory services:
  - e-Government design and development services and consulting;
  - Networking design, implementation, and security; and
  - Application design, development, testing, and implementation.

CONTACTS

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Digital Transformation of the Justice System	
SUBSECTOR	**Smart Cities and e-Government**
LOCATION	**Colombia**
PROJECT VALUE	**$100 million**

PROJECT SUMMARY

- Colombia's constitution guarantees access to the administration of justice promptly. The duration of most cases in the judicial system currently exceeds stipulated maximum time frames. Citizen satisfaction with the judiciary is low.
- The objective of this project is to support the digital transformation of the judicial system.
- The project will improve judicial processing times and increase transparency and coordination.
- The project comprises three principal components:
  - Institutional Strengthening of the Justice System;
  - Digital Services and Technology for Justice; and
  - Digital Environment and Culture.
- An IADB loan will support the project.

PROJECT BACKGROUND AND DESCRIPTION

Colombia's 1991 Political Constitution establishes the fundamental right of every person to access the administration of justice, a public function, promptly, with efficient procedural times.

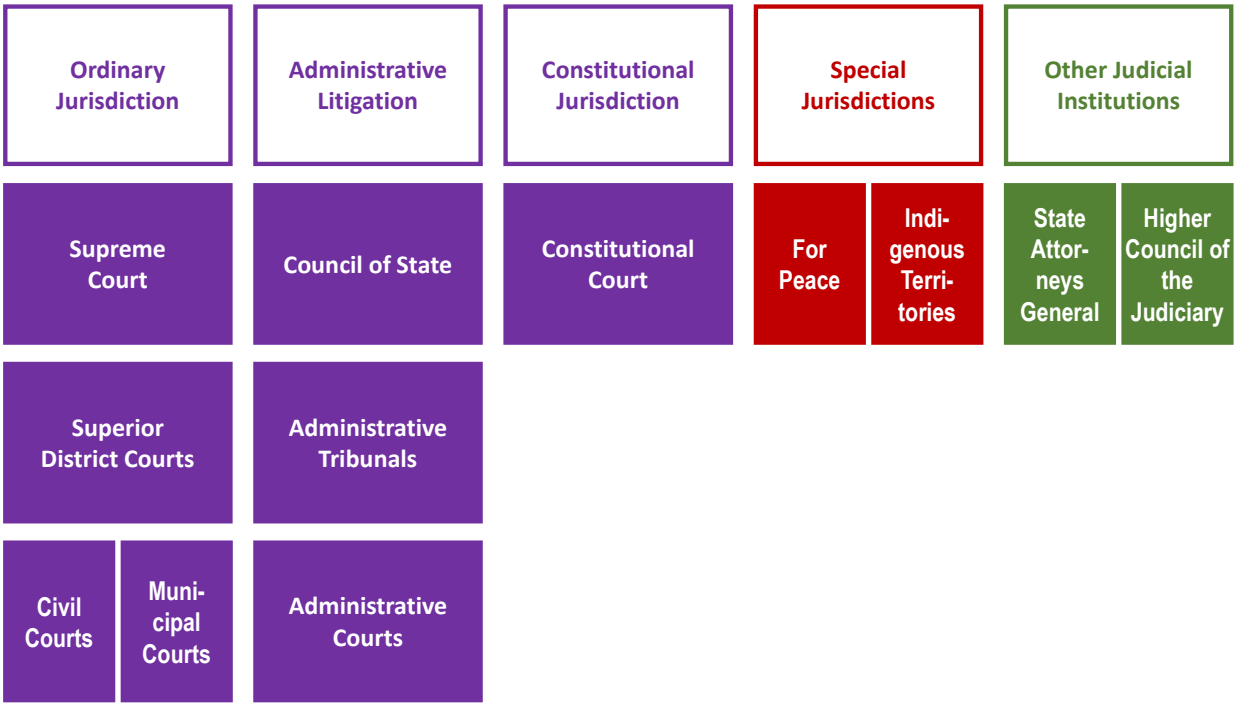
The judicial branch consists of four jurisdictions:

- Ordinary (Supreme Court of Justice);
- Administrative litigation (Council of State);
- Constitutional (Constitutional Court); and
- Special (Special Jurisdictions for Peace and Indigenous Territories).

The high courts function as final instances in a system comprising nearly 6,000 courts of different specialties and ranks. Colombia has an average of 10.95 judges per 100,000 inhabitants. Colombia's judicial system structure includes the four jurisdictions defined above and two additional jurisdictional institutions, the State Attorneys General and the Higher Council of the Judiciary (CSJ [24]), which are described in Figure 9.[25]

[24] Consejo Superior de la Judicatura
[25] Data from the Project Profile for IADB Project CO-L1256

Figure 7: Organization of the Colombian Judicial System



Between 1993 and 2018, annual claims for justice grew from 748,063 to 2,723,771 cases, an overall increase of 264 percent or a compound annual growth rate (CAGR) of just under 8.5 percent. The resulting increase in the demand per court has grown from 0.8 to 2.2 cases daily.

In Colombia, a judicial process in the first instance takes 670 days on average, while the average in OECD countries at first instance is 240 days. Many Colombian cases require more time to adjudicate than the maximum permitted under law. The shares of different court processes currently exceeding stipulated timeframes include:

- Forty-nine percent of civil procedures;
- Fifty-eight percent of labor processes; and
- Sixty-eight percent of criminal cases.

Recent measurements demonstrate increasing, unfavorable citizen opinion of the judicial system, from 57 percent in 2010 to 80 percent in 2018. In addition, 70 percent of the general population considers justice to be slow or very slow.

The Sectoral Development Plan of the Judicial Branch 2019-2022 "Modern Justice with Transparency and Equity" establishes technological modernization as one of its pillars. The aim of applying technology is to advance the realization of a digital transformation in judicial management, yielding public value generation during the service of administering justice.

At present, the CSJ alone has a total of 31 different information systems. Each of the high courts has its own registration and tracking tools. Unfortunately, many of these different information systems are unable to cooperate and interchange data.

This project aims to support the digital transformation of justice in Colombia with both medium- and long-term visions. Phase 1 of the project aims to increase the effectiveness and efficiency of the judicial system through improved opportunity, transparency, and coordination to resolve judicial processes.

Phase 1 consists of three components plus a project management module:

- ***Component 1 - Institutional Strengthening of the Justice System:*** The organizational, technological, and management capabilities of the justice system for digital transformation will be strengthened through:
  - Studies and activities for the definition of data governance;
  - Capacity building for CSJ operational management through consulting and non-consulting services;
  - Development of a comprehensive judicial map; and
  - Development and implementation of a smart judicial delivery unit for the judicial system.

- ***Component 2 - Digital Services and Technology for Justice:*** This component will support the creation of a digital ecosystem to improve access, transparency, and integration of the judicial system through:
  - Acquisition of consulting services and goods for the development and implementation of a case management system;
  - Design and implementation of a model for the management of high-value groups;
  - Design of cybersecurity and information protection strategies and applications; and
  - Design and implementation of new business processes and architecture.

- ***Component 3 - Digital Environment and Culture:*** This component seeks to strengthen change management by fostering a culture that promotes digital transformation through:
  - Design and implementation of a citizen service model;
  - Implementation of the judicial system's internal and external communications strategy;
  - Modeling and planning transition architectures; and
  - The development and implementation of strategies and support schemes for the implementation of digital tools.

The primary beneficiaries of the digital transformation will be citizens and businesses obtaining greater effectiveness and efficiency in the judicial system through improved opportunity, transparency, and coordination to resolve judicial processes. Project implementation results will be measured using the following indicators:

- Improvement in procedural times to ensure greater opportunity in decisions;
- Increased transparency in responding to citizen demands; and
- Improved coordination between the different tools of the judicial system.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

The project profile was approved in February 2020. The IADB approved the technical assistance to support the design of this project in March 2020.

Due to delays caused by the COVID-19 global pandemic delays, the IADB and the government of Colombia signed a protocol in March 2021 to reiterate the project's importance and commitment to successful implementation.

The implementation timelines for the three components of Phase 1 described above are currently under evaluation.

PROJECT COST AND FINANCING

Phase 1 has a budget of $100 million, as shown in Table 9.

Table 9: Colombia Justice System Digital Transformation Phase 1 Project Budget

Project Component	Budget, $ Million
1 Institutional Strengthening of the Justice System	28.5
2 Digital Services and Technology for Justice	38.0
3 Digital Environment and Culture	28.5
4 Project Management	5.0
Total	100.0

The IADB will finance the project with a conditional credit line for investment projects (CCLIP) of $500 million. Phase 1 represents the first individual operation, $100 million, under the CCLIP. The government of Colombia seconded the CCLIP, and the IADB in the Protocol was signed on March 17, 2021.

U.S. EXPORT OPPORTUNITIES

U.S. export opportunities for the project include:

- Hardware (servers, racks, power, HVAC, site security, networking hardware, fiber optic cabling and components, power management hardware, et al.);
- Software;

- Access to Software as a Service (SaaS) and related scalable programs;
- Custom software/applications – judicial case management as well as the management of high-value groups; and
- Cybersecurity solutions.

- Advisory services:
  - Capacity building and communication strategy;
  - e-Government design and development services and consulting;
  - Networking design, implementation, and security; and
  - Application design, development, testing, and implementation.

CONTACTS

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Smart Cities Initiative	
SUBSECTOR	**Smart Cities and e-Government**
LOCATION	**Colombia**
PROJECT VALUE	**$342 million**

PROJECT SUMMARY

- The Ministry of Information Technologies and Communications supports 61 municipalities in a voluntary program to foster smart city technologies and projects throughout Colombia.
- The program's first step was to develop and apply a smart city maturity model, offering benchmarking and gap analysis along six smart city dimensions and five horizontal enabling factors.
- In December 2020, the Ministry announced an estimated budget of $342 million for project implementation.

PROJECT BACKGROUND AND DESCRIPTION

The smart city initiative is an ambitious undertaking by the Ministry of Information Technologies and Communications (MinTIC[26]) to foster smart city initiatives throughout Colombia. The project's genesis dates to 2018, when MinTIC and the National Planning Department (DNP[27]) started working jointly to develop mechanisms to promote smart cities and territories.

Although the implementation of smart city initiatives occurs at a local level, coordination at the national level provides several benefits:

- Guiding the implementation of related projects in a structured way;
- Minimizing implementation times; and
- Reducing costs by avoiding duplication of efforts.

Participation in the initiative by individual cities is voluntary. Nevertheless, interest and involvement in the program are considerable. Sixty-one municipalities participated in the initiative's first phase, developing and applying a smart city maturity model. Over 100 representatives of academia, industry, and the public sector participated in a December 2019 workshop to develop the smart city maturity model.

The smart city maturity model comprises six dimensions and five enablers. Dimensions are specific, functional areas where progress is possible by designing and implementing smart city

[26] MinTIC – Ministerio de Tecnologías de la Información y de las Comunicaciones
[27] DNP – Departamento Nacional de Planeación

initiatives. Enablers are basic, cross-cutting elements that support the implementation of smart city initiatives along multiple dimensions.

The six dimensions of the smart city maturity model are:

- ***Quality of Life:*** The municipality's inhabitants way of life of including sub-dimensions such as leisure, well-being, citizen safety, and health;
- ***Economic Development:*** The possibility of creating wealth in the municipality, including sub-dimensions such as entrepreneurship and innovation, the productive and competitive environment, employment, digital transformation, and the circular economy;
- ***Governance:*** The form of governance of the municipality, including sub-dimensions such as open government, collaborative exercises, citizen participation, multi-level governance, and digital oversight;
- ***Habitat:*** The environment in which citizens live, including sub-dimensions such as intelligent mobility, intelligent infrastructures, public services, and public space management;
- ***Environment:*** The environmental impact generated by the municipality, including sub-dimensions such as resource management, environmental quality, risk management, waste management, and climate change; and
- ***People:*** The personal interactions between citizens, including sub-dimensions such as education, equity, inclusion society, citizen culture, and social cohesion.

The five enablers of the smart city maturity model are:

- ***Institutional Strength and Innovation:*** elements related to the management of human activities in the city or territory, the management of innovation and knowledge within entities, and the regulatory and financial conditions for the development and implementation of initiatives;
- ***Digital Infrastructure and Interoperability***: elements related to the development, deployment, and management of technological networks and communications infrastructure for interaction between different actors in the city ecosystem;
- ***Leadership and Human Capital***: elements related to the leadership and strengthening of the human capital of entities to develop smart city initiatives and apply knowledge and skillsets to enable the safe and efficient use of information and communications technologies.
- ***Technology and Standards***: elements related to incorporating, implementing, and managing new technologies and technical standards within the smart city.
- ***Analytics and Data Management***: capabilities related to accessing public information by citizens, academia, the private sector, and public entities. The use of such information to solve social problems, improve decision-making processes, and create wealth.

The smart city maturity model maps the six dimensions and 26 sub-dimensions for each city or territory using a uniform scale from 1 to 10. Separate scores are developed for objective evaluations based on results as well as citizen perceptions. This technique facilitates both benchmarking among participants and gap analysis to support planning by individual municipalities. The smart city maturity model also includes a composite index used for ranking.

The rankings and composite index scores for the 61 cities participating in 2020 are provided in Table 10.

Table 10: 2020 Participating Municipalities, Ranks, and Indices

City	Rank	Index	City	Rank	Index
Bogotá	1	4.4	Sincelejo	32	3.4
Manizales	2	4.2	Galapa	33	3.3
Barranquilla	3	4.1	La Dorada	34	3.3
Ibagué	4	4.1	Valledupar	35	3.2
Cajicá	5	4.0	Santa Rosa de Osos	36	3.2
Neiva	6	3.9	Montería	37	3.2
Pereira	7	3.9	Tunja	38	3.1
Medellín	8	3.8	Chinchiná	39	3.1
Cali	9	3.8	Villavicencio	40	3.1
La Ceja	10	3.8	Yumbo	41	3.1
La Estrella	11	3.7	Caldas	42	3.1
Zipaquirá	12	3.7	Sogamoso	43	3.0
Rionegro-Antioquia	13	3.7	La Virginia	44	3.0
Fusagasugá	14	3.7	Candelaria	45	3.0
Mosquera	15	3.6	Flandes	46	2.9
Cartagena	16	3.6	Madrid	47	2.9
Bucaramanga	17	3.6	La Mesa	48	2.9
Paipa	18	3.5	Villa del Rosario	49	2.9
Buga	19	3.5	Puerto Colombia	50	2.9
Floridablanca	20	3.4	Coper	51	2.8
Duitama	21	3.4	Montenegro	52	2.8
Popayán	22	3.4	Puerto Boyacá	53	2.7
Barrancabermeja	23	3.4	Arauca	54	2.7
Pasto	24	3.4	Rionegro-Santander	55	2.6
Yopal	25	3.4	Jamundí	56	2.6
Acacías	26	3.4	Villa De Leyva	57	2.6
Tocancipá	27	3.4	Aguachica	58	2.5
Funza	28	3.4	Corozal	59	2.5
Calarcá	29	3.4	Espinal	60	2.4
Armenia	30	3.4	Buenaventura	61	2.2
Cúcuta	31	3.4			

Most of Colombia's largest cities and heads of Departments participated in this voluntary program. Some smaller municipalities also participated, including Coper (population 3,000), Villa de Leyva (population 17,000), and Aguachica (population 18,000).

Each municipality is responsible for implementing its own smart city master plan. MinTIC will provide institutional support. MinTIC's support is structured in 30 activities under 12 specific goals within four program areas. The four program areas are:

- Encouraging the adoption of the e-Government policy to consolidate smart city development;
- Fostering the digital transformation of the municipality as a tool for the development of smart cities;
- Establishing access to financing resources for smart city initiatives and projects; and
- Facilitating the adoption and use of digital technologies.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

Each municipality will implement smart city technologies and projects according to its unique implementation timeline.

During 2020, MinTIC contracted advisory services from EY to prepare the indices of the 61 voluntary participants using the smart city maturity model. The results were published in early 2021. The maturity model prepares benchmarks and gap analyses for each participating municipality, thus facilitating implementation.

In addition, MinTIC will initiate a series of regional smart city workshops with the following goals:

- Creating smart city project templates;
- Facilitating access to finance;
- Including all smart city projects in an accessible database; and
- Ensuring that projects with "low hanging fruit" are implemented promptly.

PROJECT COST AND FINANCING

The Smart City and Territory Initiative does not have a global budget since each municipality will implement its specific smart city technologies and projects.

During the GSMA Thrive Latin America event, held online in December 2020, Jorge Barrera Medina, Director of Communications Industry with MinTIC, indicated a total budget of $342 million for project implementation.

U.S. EXPORT OPPORTUNITIES

Export opportunities exist for U.S. firms offering smart city solutions. The Project requires a wide range of ICT systems, software, and services to support the Smart Cities Initiatives implementation. These include:

- Smart city pilot infrastructure:
  - Wireless communications infrastructure;
  - Metro network infrastructure;
  - Data centers;
  - City service operation centers; and
  - Smart city ICT infrastructure planning and execution.
- Smart city applications;
  - Smart parking;
  - Electric vehicle charging;
  - Transit;
  - Video surveillance;
  - Water and waste management;
  - Lighting;
  - Energy;
  - Resident security & safety; and
  - Personal healthcare.
- Additional smart city solutions:
  - Municipal data platforms;
  - Business services data platforms;
  - Network security; and
  - Advanced traffic management systems (ATMS).

CONTACTS

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Digital Transformation of the Comptroller General	
SUBSECTOR	**Smart Cities and e-Government**
LOCATION	**Colombia**
PROJECT VALUE	**$30 million**

PROJECT SUMMARY

- The Comptroller General carries out financial control and auditing of over 5,000 public entities in Colombia.
- Digital transformation of the Comptroller General has three objectives:
  - Improve productivity to audit a total of 5,677 control subjects effectively;
  - Increase efficiency to engage in preventive functions before contract disbursements; and
  - Enhance citizen participation.
- The project has a duration of four years. Funding will be provided by a loan from the Inter-American Development Bank (IADB).

PROJECT BACKGROUND AND DESCRIPTION

The Comptroller General of the Republic (CGR[28]) carries out the public entities' financial control and auditing activities. Since 1991, CGR's control oversight was limited to national-level entities. However, Legislative Act 04 of September 18, 2019, introduced significant changes to Colombia's financial control system, giving the CGR authority over public entities at all levels, including departments, municipalities, and districts. Thus, the authority of the CGR expanded from 1,711 control subjects to a total of 5,677. In addition, the reform granted the CGR preventive control exercisable before signing public sector contracts.

Complicating the situation further, the emergence of the COVID-19 global pandemic led to changes in procurement and procurement patterns by public entities in Colombia. Between January and May 2020, 17 percent of government procurement (US$932 million) went to COVID-19-linked inputs or services. There was also an increase in emergency procurements. Of 19,882 contracts awarded between March and July 2020 linked to COVID-19, 85 percent were through direct procurement.

The CGR observes that digital transformation will facilitate the expansion of skills and control authority within the challenging context of the global pandemic and beyond. The CGR project aligns well with the objectives of the country's 2018-2022 National Development Plan, particularly with the pacts for effective public management and digital transformation.

[28] CGR - Contraloría General de la República

Digital transformation for the CGR seeks three results:

- Improve productivity;
- Increase effectiveness; and
- Enhance CGR's citizen participation strategy.

The challenges and opportunities for each of these three areas are further described below:

- ***Productivity Improvement to Fulfill New Functions:*** The CGR faces using existing resources to cover an increase of approximately 300 percent of public entities that, by law, it must monitor. Automation of internal processes should generate efficiencies in time, information management, and costs. Also, information integration and interoperability between systems are likely to improve productivity in information flows.

- ***Efficiency Increases to Implement New Preventive Functions:*** The Directorate for Information, Analysis, and Immediate Reaction (DIARI[29]), generates alerts for contracting situations that require further investigation. At present, only 24 percent of the notifications are investigated. Digital tools will improve the ability to process and analyze information for decision-making. Thus, the CGR will be able to focus resources for preventive functions in an efficient manner.

- ***Digital channels to enhance citizen participation:*** The CGR has made significant progress in promoting mechanisms for citizen participation. Digital channels will facilitate additional levels of social participation in all aspects of the financial control cycle.

The project comprises three components plus a program administration function:

- ***Component 1 - Institutional capacity building for digital transformation:*** This component will improve productivity by designing and implementing a digital transformation strategy:
    - Implementing data governance and the definition of standards according to new agency competencies;
    - Developing process management capacity and implementing process automation;
    - Developing interoperability mechanisms with control subjects and entities such as the National Government Procurement Agency, the Ministry of Finance, and the National Planning Department; and
    - Designing and implementing a risk model for financial control.

- ***Component 2 - Strengthening Digital Control Tools:*** This component will strengthen the CGR's capacity to achieve more effective control through the development and rollout of digital tools, including:
    - A system for monitoring and evaluating the financial control cycle for decision-making;
    - A georeferenced financial control map;
    - Remote financial control mechanisms;

[29] DIARI – Dirección de Información, Análisis y Reacción Inmediata

- Analytical tools and monitoring processes for preventive financial control;
- Enhanced ICT management, infrastructure, and services; and
- Cybersecurity strategy and tools.

- ***Component 3 - Citizen Approach and Integrity: This component seeks g***reater citizen participation in the financial control cycle through:
  - Development and implementation of digital tools for participation;
  - A system for traceability of citizen complaints or requirements;
  - A strategy to strengthen integrity in the institution; and
  - A cultural change management strategy for strengthening the use, innovation, and adoption of digital financial control tools.

The IADB is supporting this project with a Technical Assistance (TA) grant for the design phase. The TA seeks to accelerate designing and implementing innovative tools in the financial control system to help the CGR increase its levels of efficiency and institutional quality standards and become increasingly citizen-oriented. The TA comprises three tasks:

- ***Task 1 - Characterization of Digital Transformation in Financial Control:*** This task will finance activities to identify progress in the latest digital and transparency tools in financial control, including those resulting from the emergence of COVID-19.

- ***Task 2 - Start of Implementation and Dissemination:*** This task will finance consensus-building activities on digital transformation processes.

- ***Task 3 - Identification of enabling factors for citizen participation and digital transformation:*** This task will finance pilot projects for knowledge validation to facilitate the adoption of digital tools in the financial control cycle.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

Project implementation has an estimated timeline of four years. The IADB tentatively schedules Board consideration of the loan proposal for August 2021. Project implementation will commence shortly after loan approval.

PROJECT COST AND FINANCING

IADB will finance the TA to accelerate project design under a $150,000 grant.

The estimated cost for project implementation is $30 million. IADB will provide all of this funding under a loan to the Republic of Colombia. The implementation budget breakdown by project component is provided in Table 11.

Table 11: Project Implementation Budget

Project Component	Amount, $
1. Capacity building for digital transformation	9,200,000
2. Digital control tools	15,300,000
3. Enabling factors for citizen participation	4,000,000
4. Program administration	1,500,000
Total	**$30,000,000**

U.S. EXPORT OPPORTUNITIES

U.S. export opportunities for the project include:

- Hardware (servers, racks, power, HVAC, site security, networking hardware, fiber optic cabling, components, power management hardware, et al.)
- Software:
  - Access to Software as a Service (SaaS) and related scalable programs;
  - Custom software/applications – judicial case management as well as the management of high-value groups; and
  - Cybersecurity solutions and services.
- Advisory services:
  - Capacity building;
  - Citizen participation;
  - e-Government design and development services and consulting;
  - Networking design, implementation, and security; and
  - Application design, development, testing, and implementation.

CONTACTS

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DIAN Modernization Project	
SUBSECTOR	**Smart Cities and e-Government**
LOCATION	**Colombia**
PROJECT VALUE	**$500 million**

PROJECT SUMMARY

- The National Tax and Customs Directorate (DIAN[30]) administers and controls tax and customs requirements.
- This project aims to increase tax and customs management effectiveness by improving both institutional governance and technology management.
- The project comprises three components:
  - Institutional organization and human resources;
  - Tax and customs control and compliance; and
  - Technology platform, data, and information security.
- The IADB is financing the project with a $250 million loan.
- Over 75 percent of the loan amount will finance ICT investments in Component 3.

PROJECT BACKGROUND AND DESCRIPTION

The National Tax and Customs Directorate (DIAN) is an administrative unit of the Government of Colombia that carries out the administration and control of tax and customs requirements. The DIAN is critical for its financial security since it collects over two-thirds of all national government tax revenue.

During 2020, the DIAN collected 146 trillion pesos, as shown in Table 12. Special taxes include a 0.4 percent Tobin tax on financial movements and gasoline, diesel, and wealth taxes.

Table 12: 2020 DIAN Revenue Collection[31]

Type of Tax	Revenue, Trillion Pesos	USD Equivalent, $billion
Income Tax	69.7	20.4
Value-Added Tax (VAT)	39.5	11.5
Special Taxes	13.3	3.9
Import Duties and VAT	23.8	7.0
Total	146.3	42.8

[30] DIAN – Dirección de Impuestos y Aduanas Nacionales
[31] Source: DIAN. Year-end exchange rate of 1USD = 3,422 COP

The DIAN has nearly 11,000 employees staffing 49 regional offices for taxes and customs throughout Colombia. IT spending by the DIAN represented 4.5 percent of its operating budget in 2019, a level substantially below Chile's 7.7 percent, the OECD average of 10.2 percent, and Brazil's 17.1 percent.

The project's general objective is to improve the effectiveness and efficiency of the DIAN's tax and customs management. Specific project objectives include:

- Improve the institutional governance model to increase the effectiveness of tax and customs management; and
- Improve the efficiency of technology management.

The project comprises three components:

- ***Component 1 - Institutional Organization and Human Resources:*** The objective is to provide the DIAN with a structure and staff compatible with its role of collecting taxes and facilitating foreign trade, drawing from successful experiences around the world. This component includes:

  1.1 – Strengthening strategic planning and institutional structure:
  - Implementing a new organizational structure; and
  - Implementing a communications plan for change management and a new institutional culture.

  1.2 – Updating the human resources model:
  - Implementing a skills-based human resources management model; and
  - Implementing a plan for strengthening the School of Higher Studies for Tax, Customs, and Exchange Administration.

- ***Component 2 - Tax and Customs Control and Compliance:*** The objective is to provide the DIAN with operational processes aligned with international best practices. This component will oversee the optimization of tax and customs management processes to increase the efficiency of generating increased revenues while enhancing risk management. Component 2 includes:

  2.1 – Optimizing processes for managing domestic taxes and customs duties:
  - Establishing a tax and customs control model based on risk management;
  - Establishing a model for integrating electronic invoicing into DIAN control processes; and
  - Creating a model for preparing a prefilled income tax return.

  2.2 – Improving traceability and customs control processes:
  - Managing cargo movements using new technologies;
  - Strengthening the cargo and passenger monitoring and control center;
  - Modernizing control processes and physical and technological infrastructure at ports of entry; and

- Strengthening the economic operator support system and early declaration mechanism.

- ***Component 3. Technology Platform, Data, and Information Security:*** This component includes actions for the digital transformation of the DIAN to ensure management is based on timely, high-quality information and includes:

  3.1 – Strengthening the technology platform to streamline the tax and customs cycle:
  - Developing a Strategic Plan on Information Technology. Once this plan is implemented, the annual cost of IT will increase from US$24.5 million (2018) to US$38.3 million. During the transition period, the annual cost may be higher during the transition period, as the old and new systems will be used simultaneously.
  - Establishing a platform based on modern technology (Platform as a Service (PaaS)), which includes:
    - Support for assessing the current platform's status, as well as preparation and implementation of a strategy for migrating to the new platform;
    - Hybrid cloud service (public and private, container-based) for the entire platform of applications and institutional services, and for a single data repository to include storage, communication, security, application processing, software licenses, updates, and support; and
    - Equipment and cabling, LAN network, VoIP equipment, WAN, surveillance cameras, physical access controls, and control room upgrades.
  - Implementing a comprehensive management system for domestic taxes and customs duties, which includes the following subsystems:
    - Domestic taxes and shared services subsystem;
    - Customs subsystem; and
    - Digital services subsystem.
  - Establishing a data governance model.
  - Introducing data architecture and a single repository for all information assets, including electronic invoicing.
  - Establishing an office for technological projects, including design, management, and control of projects for the digital transformation of the DIAN.

  3.2 – Establishing a strategy for information security (internal) and cybersecurity (external):
  - Establishing a conceptual and regulatory framework for information security;
  - Establishing an access control system for the entire DIAN;
  - Implementing an identity control system (identity governance);
  - Establishing a database backup model; and
  - Establishing a Security Operations Center (SOC) and Computer Security Incident Response Teams (CSIRTs) for operating IT security instruments, including:
    - Information security and event management software;
    - Hiring of SOC-CSIRT staff; and
    - Expansion of technological support instruments for information security (servers, intrusion prevention system [IPS], firewalls, web application firewall).

PROJECT STATUS AND IMPLEMENTATION TIMELINE

The loan for project implementation was approved on November 6, 2020, and signed on December 24, 2020. Project execution is scheduled for the period 2021 to 2025. Expected annual disbursements are shown in Table 13.

Table 13: Annual Disbursements for DIAN Modernization Project

Year	Annual ($ Million)	Cumulative ($ Million)
1	25.9	25.9
2	55.1	81.0
3	68.9	149.9
4	54.9	204.8
5	45.2	250.0

PROJECT COST AND FINANCING

The IADB will provide a $250 million loan to finance the project. Most of the budget is for ICT expenses under Component 3, as shown in Table 14. The second loan of $250 million is contemplated for additional institutional strengthening.

Table 14: DIAN Modernization Project Budget

Project Component	Budget, $ Million
1. Institutional organization and human resources	26.2
1.1. Strengthening strategic planning and institutional structure	*18.9*
1.2. Updating the human resources model	*7.2*
2. Tax and customs control and compliance	21.0
2.1. Optimizing processes for managing domestic taxes and customs duties	*8.6*
2.2. Improving traceability and customs control processes	*12.5*
3. Technology platform, data, and information security	192.7
3.1. Strengthening the technology platform in order to streamline the tax and customs cycle	*174.4*
3.2. Developing a strategy for information security (internal) and cybersecurity (external)	*18.3*
Administrative and technical management costs	3.1
Fiduciary administrative costs	1.5
Contingencies	5.5
Total	**250.0**

U.S. EXPORT OPPORTUNITIES

Opportunities for U.S. exports of goods and services in the project's purchasing plans include:

- A. hybrid cloud technology platform:
  - Four-year global agreement including storage, communication, security, cloud-based applications, software licenses, upgrades, and technical support;
  - Equipment upgrades including cabling, LAN, WAN, VOIP, security cameras, and physical access controls; and
  - Migration services.
- An integrated system for managing domestic taxes, customs, and DIAN digital services.
- Off-the-shelf IT solutions, including:
  - Access control;
  - Identity control; and
  - Data protection.
- A security operations center (SOC).

CONTACTS

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Ecopetrol Digital Transformation	
SUBSECTOR	**Internet of Things (IoT) and Artificial Intelligence (AI)**
LOCATION	**Colombia**
PROJECT VALUE	**$100 - 150 million**

PROJECT SUMMARY

- Ecopetrol recently announced the second phase of its digital transformation, spanning 2021 to 2023, with a budget between $100 and 150 million.
- The first phase, including a 10-project Digital Agenda, was completed at the end of 2020 with a budget of $120 million.
- Ecopetrol's digital transformation is based on three pillars:
  - Generating real value;
  - Innovating; and
  - Transforming.
- Ecopetrol's digital transformation technologies include elastic cloud computing, big data, AI, IoT, robotics, blockchain, and advanced analytics.

PROJECT BACKGROUND AND DESCRIPTION

Ecopetrol announced the first phase of its digital transformation in 2018, comprising ten specific projects with a budget of $120 million and a target completion date of end-of-the-year 2020. Recently, Ecopetrol announced a second digital transformation phase to extend through the end of 2023, with a budget between $100 and $150 million.

Digital transformation in Ecopetrol is based on three fundamental pillars:

- ***Generating Real Value***: For example, the first phase of transformation had a budget of $120 million for ten projects known as the Digital Agenda. These investments have an estimated return of $300 million.
- ***Innovating:*** Becoming a benchmark company in oil and gas innovation in Latin America. Serving as an engine of development of the digital ecosystem in Colombia, aligned with the objectives of the national government.
- ***Transforming:*** Developing new ways of working, capabilities, and a culture that leverages organizational transformation.

The first phase included the following projects:

- ***Integrated Field Management:*** Integration of digital enablers for real-time information on the production from all fields. This application provides more reliable and accurate data to grow and sustain production.

- ***Exploration and Sites:*** Advanced analytical solutions to support improved decision-making about potential reservoirs, aiming to reduce the evaluation time to start exploratory activities by at least 3.5 percent.

- ***Integrated Transportation Management:*** A digital solution for the transport segment, allowing the end-to-end monitoring of each product molecule.

- ***Optimization of the Gross Refining Margin:*** A tool to monitor and visualize real-time refining information in Barrancabermeja and Cartagena, supporting operational decision-making.

- ***Integrated Business Management:*** Three modules to integrate business management:
  - A commercial platform to visualize data and operate tools for trading, market intelligence, and logistics;
  - Risk modeling and optimized contract management; and
  - Consolidating data into a single repository, eliminating redundancies, and applying advanced analytics to real-time data.

- ***Digital Financial Management:*** A finance platform that automatically integrates information associated with planning, execution, and budget projections from all subsidiaries.

- ***Central Employee:*** Fully optimize, integrate, and automate the human talent management process.

- ***Digital Sourcing Management:*** A digital supply solution to streamline contracting and integrate the purchasing process systems. Ecopetrol implemented this solution within the enterprise resource planning (ERP) solution acquired from SAP.

- ***Document Management: A*** unique documentation warehouse that performs automatic context analysis by combining multiple sources.

- ***Legal Management: A*** document database to support legal decision-making in a more agile, uniform, and secure way, leveraging technologies like artificial intelligence.

The first phase of Ecopetrol's digital transformation embraced key fourth industrial revolution technologies that will be further deployed in the second phase, including:

- Elastic cloud computing;
- Big data;
- Artificial Intelligence (AI);
- Internet of Things (IoT);

- Robotics;
- Blockchain; and
- Advanced analytics.

Examples of technology deployment include:

- Using elastic cloud computing at exploration and production sites to better understand the subsurface represented in seismic information, reducing analysis times from days to minutes.
- Using IoT technologies for integrated field management to bring real-time information from production fields to a data warehouse that monitors the status of all such locations in real-time. Machine learning algorithms generate early alerts and enable decision-making and action to maintain production, monitor, and manage large quantities of information.
- Applying Integrated Transportation Management on a blockchain, keeping the state of volumetric information immutable at all times.
- Deploying more than 100 robots to automate manual and repetitive tasks in processes that include finance and sourcing.

Phase II of the Digital Transformation seeks to develop dozens of new applications, taking advantage of technical expertise and ecosystem developments from Phase 1. The second phase includes over 40 robotics initiatives. Ecopetrol expects Phase II, like Phase I, to demonstrate a solid financial return on investment.

Ecopetrol works with the National Government, Innpulsa Colombia, the Bogotá Chamber of Commerce, Ruta N de Medellin, and other public and private entities to strengthen the digital ecosystem. In addition, through an Open Innovation Program, Ecopetrol reaches out to other companies, organizations, and external professionals as part of its digital ecosystem.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

Phase I of Ecopetrol's digital innovation was announced in 2018 and completed at the end of 2020. The effort provided significant benefits to the company during the global pandemic. In 2019, Ecopetrol won the ANDICOM (International ICT Congress) first prize for digital transformation in the large corporation category.

Phase II and its budget was announced in March 2021 and will extend through 2023.

PROJECT COST AND FINANCING

In February 2021, Ecopetrol announced $12 to 15 billion of capital expenditures through the end of 2023. The budget includes upstream investments as well as significant investment amounts in decarbonization and innovation.

The plan allocates $600 million for decarbonization (solar parks, water initiatives, and improved fuel quality) and $100 to 150 million for Digital Transformation. Ecopetrol will self-finance the Digital Transformation and expects to generate a considerable return on the investment amount.

U.S. EXPORT OPPORTUNITIES

U.S. technology company capabilities align well with likely Ecopetrol needs under Phase II of its Digital Transformation. Export opportunities will include:

- Artificial Intelligence (AI):
  - Oil- and gas-specific application and AI tool and software development; and
  - Technical and business advisory services.
- Cloud Computing:
  - High-capacity remote location-to-data center technologies;
  - Edge computing and cloud center access; and
  - Technical advisory services.
- Internet of Things (IoT):
  - Upstream remote and preventive maintenance support;
  - Midstream environmental management and compliance reporting; and
  - Downstream real-time supply chain and inventory management.

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
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Digital Transformation for Small-Scale Farmers	
SUBSECTOR	**Internet of Things (IoT) and Artificial Intelligence (AI)**
LOCATION	**Colombia**
PROJECT VALUE	**$10 million (for a demonstration on 1,000 sites)**

PROJECT SUMMARY

- The Colombian Center for the Fourth Industrial Revolution, affiliated with the World Economic Forum, is working in eight project areas, one of which is the digital transformation of agriculture.
- The strategic use of data and technologies 4.0 may be critical to reinforcing agriculture as a fundamental pillar of the country's economy.
- The project has adopted a model of the economic valuation of data that it has developed with experts for three crops:
  - Cocoa;
  - Haas avocados; and
  - Coffee.
- Project implementation will involve optimum data gathering using techniques that range from IoT sensors to third-party data providers. The model facilitates a quantitative determination of the benefits provided by project implementation.
- During 2021, the project will pilot project implementation at ten sites.

PROJECT BACKGROUND AND DESCRIPTION

This project is sponsored by the Colombian Center for the Fourth Industrial Revolution (C4IR.CO). C4IR.CO, affiliated with the World Economic Forum (WEF) for the Fourth Industrial Revolution in Colombia, was co-founded by the Ministry of Trade, Industry, and Tourism and the Mayor of Medellin. C4IR.CO began operations in August 2019 and is located in Medellin's innovation center, Route N. Of thirteen such WEF Centers, across five continents, C4IR.CO is the only Spanish-speaking center; it was the sixth to join the network.

C4IR.CO is working in eight project areas:

- ***Strengthening Productivity and Competitiveness by Adopting Emerging Technologies***: Generate guidelines for implementing technology and data use to increase productivity in small and medium enterprises (SMEs).
- ***Blockchain in Supply Chains:*** Develop a roadmap to leverage blockchain as a strategy to improve the efficiency and productivity of supply chains.

- ***Strategic Use of Data and AI in the Public Sector of Latin America***: Formulate, execute, and evaluate public policies, provision of services to citizens, and international management of the sector through the strategic use of data and AI.
- ***IoT in SMEs***: Develop and promote guidelines allowing the adoption of technologies to optimize enhancement possibilities along the SME production process value chain.
- ***Digital Transformation of Agriculture:*** Establish protocols and strategies for the implementation of digital transformation in Colombian agriculture;
- ***G-20 Smart Cities Initiative***: Create a platform approach for implementing technologies in cities under a common framework of guiding principles.
- ***G-Fair: Gender-Neutral AI***: Design strategies for generating, using, and validating training data and AI solutions-oriented to gender neutrality.
- ***Moonshot: Data Marketplace:*** Build a data hub and an emerging technology platform to attack the main challenges and pitfalls in the country and the region.

The project reviewed here falls within the program area of Digital Transformation of Agriculture.

Historically, agriculture has undergone several changes that have improved farmers' productivity and competitiveness. In Colombia, the average productivity of the agricultural sector increased beginning in the 1990s due to the beginning and importance of permanent export-oriented crops. However, Colombian agriculture suffers from relative technological stagnation, with a few exceptions (sugar cane, African palm, rice, and coffee). One of the changes Colombia is targeting involves the digitization of the agricultural sector as part of the new data-driven economy. This project addresses a significant challenge in Colombia; the adoption of data-intensive technologies by producers, particularly small- and medium-sized farmers.

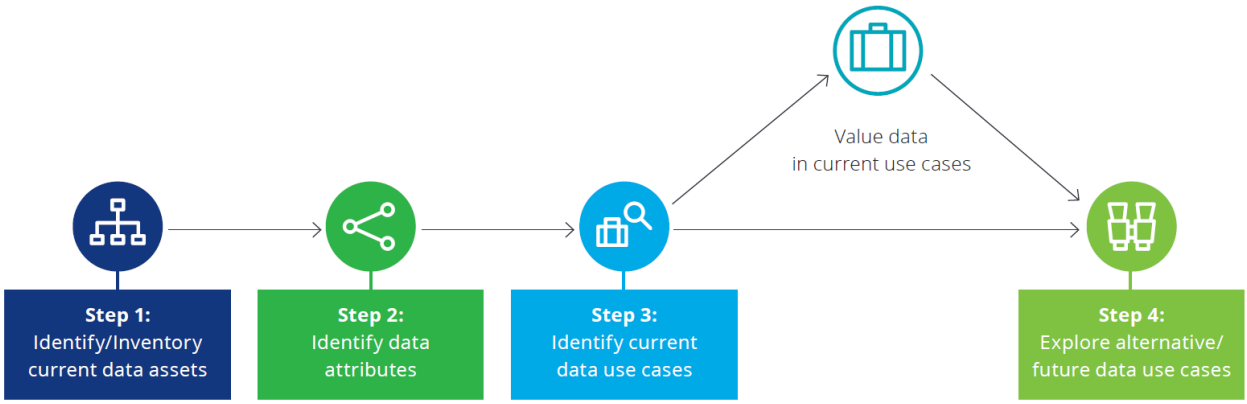
The strategic use of data and technologies 4.0 may be critical to reinforcing agriculture as a fundamental pillar of the country's economy. In the new data economy, decision-making based on information obtained from multimodal data processing would enable agricultural processes to be optimized in an increasingly efficient and sustainable manner. Although data plays a crucial role in digital agriculture, there is no generally accepted mechanism for assigning monetary value to information. Further, the selection and application of a valuation model based on projected market analysis, costs, or revenue is highly dependent on the use case taken as a starting point. Therefore, the value of the same data set may vary depending on the purpose and approach used.

This project uses a four-step data valuation model proposed by Deloitte, as shown in Figure 8.

C4IR.CO has completed a pilot exercise of Steps 1 and 2 focusing on three important crops in Colombia:

- Coffee beans;
- Cocoa; and
- Haas avocados.

Figure 8: Four-Step Data Valuation Model



In consultation with experts, the project team identified a significant role in data optimization surrounding fertilizer use. Here, such insight plays a substantial role in the productivity and competitiveness of small farmers. The group of experts identified ten categories of relevant data:

- Toxicity from salts and sodium and aluminum;
- Risks of plagues and diseases;
- Availability of oxygen;
- Availability of nutrients;
- Availability of moisture;
- Conservation of soil;
- Conditions for root development;
- Climate conditions;
- Farming conditions; and
- Other variables.

Within these ten categories, the group of experts identified the following important variables:

- 20 for Haas avocados;
- 24 for coffee beans; and
- 27 for cocoa farming.

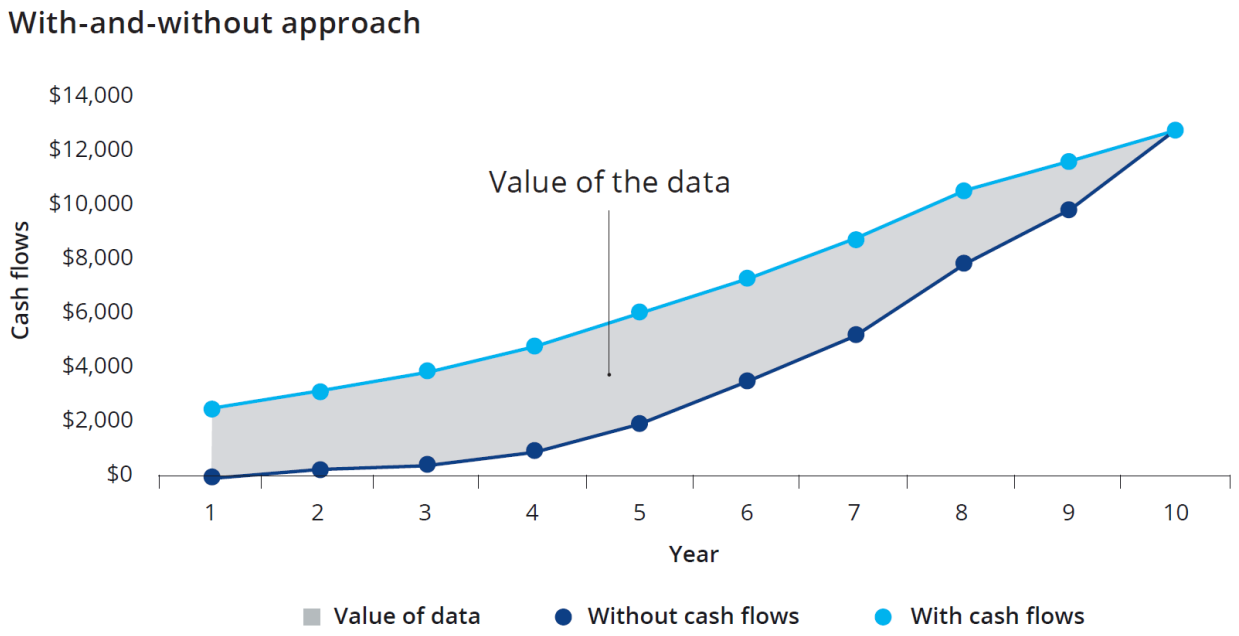
In addition to optimization of fertilizer use, the project is also focusing on other key farming decisions, including:

- Appropriate and timely use of pesticides to control the spread of diseases and pests, thereby preventing crop losses;
- Early detection of pests and diseases through intelligent monitoring with drones and satellite images;
- Intelligent irrigation systems for optimizing water use;
- Marketing channel intelligence for insight into the demand for various products to initiate sales negotiations even before planting, thereby avoiding commodity losses;

- Historical price models to identify the time windows in which crops are most likely to obtain greater profits;
- Raw materials market intelligence to optimize purchasing strategies; and
- Intelligent assessment of historical supply, demand, and pricing information to support product pricing.

The data-based approach will allow the project to quantify benefits from implementation resulting from the value of the new information collected and used in decision-making. A graphic representation of data value is provided in Figure 9.

Figure 9: Value of the Data Using a With- and Without Approach



PROJECT STATUS AND IMPLEMENTATION TIMELINE

To date, the project has published the following documents:

- Methodological Proposal for the Identification of an Economic Data Valuation Model in Colombia's Agricultural Sector;
- Strategic Use of Data in Agriculture: A Guide to Small- and Medium-Sized Farmers; and
- Seeking and Prioritizing Variables of Interest in Coffee, Cocoa, and Avocado Crops.

Activities scheduled for 2021 are:

- Ten pilots to validate the model of economic valuation of data;
- Outreach and streamlined data gathering strategies for small- and medium-sized farmers; and
- Public policy recommendations to improve competitiveness and profitability for small- and medium-sized farmers from optimum data gathering strategies and industry 4.0 technologies.

C4IR.CO has not yet announced project plans beyond 2021 since its original charter has a duration of only three years.

PROJECT COST AND FINANCING

The Ministry of Information, Technologies, and Communications (MinTIC) has provided funding for project implementation to date.

C4IR.CO has not yet prepared an implementation plan for project rollout. Beyond the initial ten pilots, a further demonstration rollout to approximately 1,000 sites may be supportable. We estimate that such a rollout would require an investment on the order of $10 million.

U.S. EXPORT OPPORTUNITIES

Numerous opportunities exist for U.S. exports for project implementation. These include:

- Site hardware and devices:
  - Sensors;
  - IoT devices;
  - IoT machinery, including land and aerial vehicles (drones, UAVs); and
  - Robotic farm implements and systems.
- Software and apps:
  - Data analytics;
  - AI for agriculture;
  - Weather applications;
  - Agricultural GPS applications;
  - Agronomy applications and soil analysis;

    - Product quality and traceability applications; and
    - Land, crop, and animal management.
- Network hardware, devices, software, and services.
- Agricultural marketplace access and advisory services.
- Agricultural and agronomy software and services, including soil and water testing.
- Other agricultural automation advisory services.

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
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Fintech Portfolio	
SUBSECTOR	**Internet of Things (IoT) and Artificial Intelligence (AI)**
LOCATION	**Colombia**
PROJECT VALUE	**$15 million present funding round**

PROJECT SUMMARY

- PROCOLOMBIA is promoting a portfolio of technology opportunities. Three selected fintech opportunities include:
  - ***Tpaga*** – a mobile wallet targeting banked and unbanked (65 percent of the Colombian population) consumers. Tpaga also provides a white label solution to corporate clients seeking to offer their own mobile wallet.
  - ***ABL Capital*** -- a fintech boutique focused on lending and other financial services for small and medium enterprises (SMEs) in Colombia.
  - ***Vaki*** – a crowdfunding platform focused on developing countries with specialized solutions including rewards-plus-donation, pre-sales, subscription, political, and personal/friends.
- The combined funding targets for the portfolio exceed $15 million. In addition, the portfolio has prospects for future rounds.

PROJECT BACKGROUND AND DESCRIPTION

PROCOLOMBIA is an investment promotion agency with functions designed for globalized business opportunities, including:

- Identification of market opportunities;
- Design of market penetration strategies;
- Advisory services for company globalization;
- Action-plan design coaching;
- Contact among entrepreneurs through commercial promotion, investment, and international tourism activities;
- Specialized services to foreign entrepreneurs interested in acquiring Colombian goods and services or who wish to invest in Colombia; and
- Alliances with national and international private and public entities to support a variety of business initiatives and promote the development and growth of the service portfolio.

PROCOLOMBIA is promoting a portfolio of fintech opportunities, of which we selected three to describe below:

Tpaga

Tpaga seeks to be the first financial super-app in Latin America. Tpaga allows consumers to receive, store, and send money via their phones through its mobile wallet. Tpaga offers many of the value propositions of a bank in a single app.

Over 400 million adults in Latin America remain unbanked (i.e., without an account at a financial institution or through a mobile money provider). The distribution of the unbanked population across the continent is described in Figure 10.

Figure 10: Unbanked Population in Latin America[32]

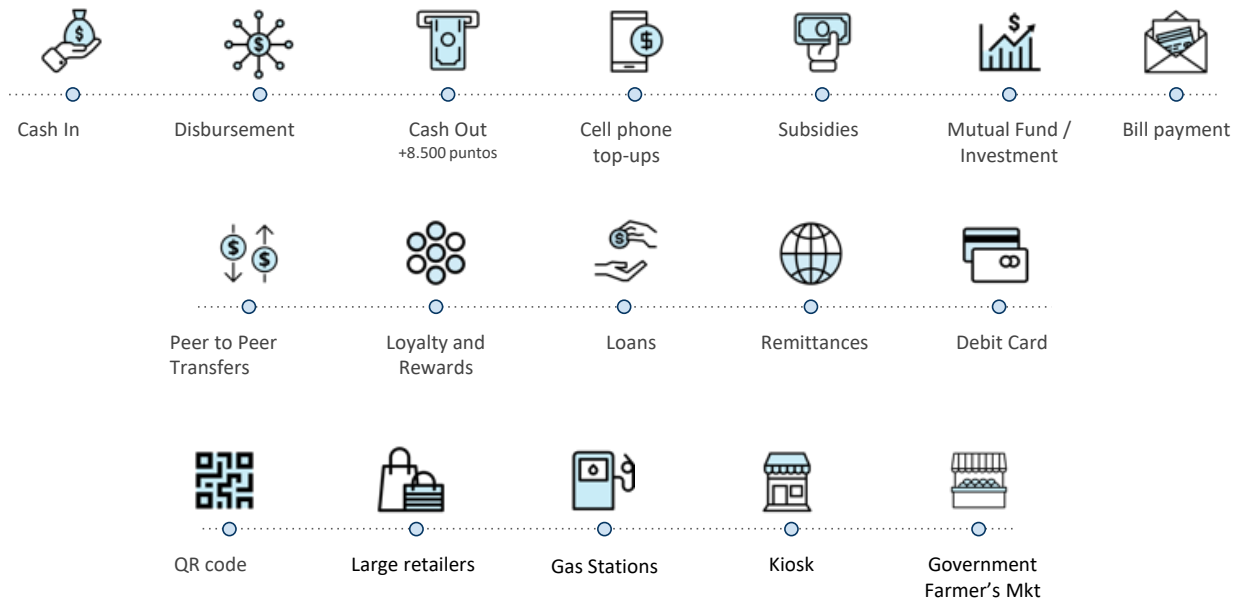
Tpaga observes Latin America as an untapped market for fintech, noting:

- Over 400 million people do not have a bank account;
- The majority of regional countries have over 100 percent cell phone penetration; yet
- Latin America does not have a continental financial super-app such as Mpesa, Alipay, or PayTm.

Tpaga recently decided to offer its technology to corporate customers looking for mobile wallets and other fintech solutions. The multiple functionalities available within the Tpaga environment are described in Figure 11.

[32] Global Findex Database, World Bank Group

Figure 11: Tpaga Functionalities



Tpaga has raised over $5 million to date. Investors of record include Green Visor Capital and Greyhound Capital. Tpaga's founders previously created Tappsi, the largest taxi-hailing app in Colombia. The exit from Tappsi was one of the largest in Colombia's tech history.

ABL Capital

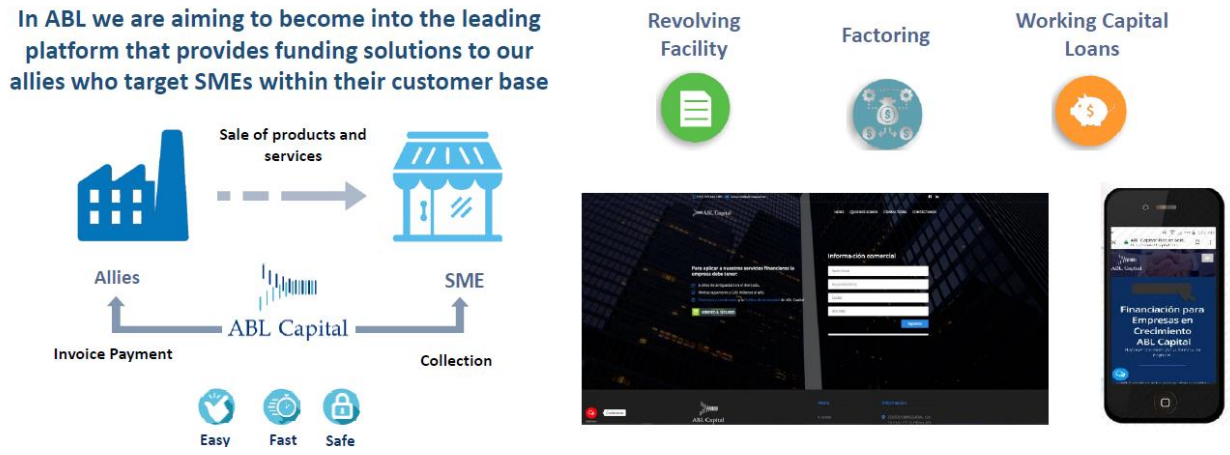
ABL Capital has the objective of becoming the leading fintech that focuses on SME lending in Colombia. ABL Capital works with allies and customers – entities that provide financing to SMEs. ABL Capital's business model includes:

- Leveraging the commercial strategy with allies who use ABL's risk model to finance the SME segment via digital working capital loans, revolving facilities, and factoring operations;
- Providing an automated and risk-proof technological platform allowing customers to grow their relationships with SMEs; and
- Targeting a market where ABL can generate high social impact due to low financial inclusion while simultaneously generating financial profitability.

ABL Capital focuses on three financial products for SMEs, as shown in Figure 12:

- Revolving loan facilities;
- Factoring; and
- Working capital loans.

Figure 12: ABL Capital Product Offerings



ABL Capital has developed its technological platform internally over the past three years. Uses for funds from its next round include:

- Improving the technological platform;
- Validating the risk model; and
- Growing assets under management.

Vaki

Vaki is a crowdfunding platform focusing on developing markets. Vaki notes several challenges with crowdfunding in Latin America:

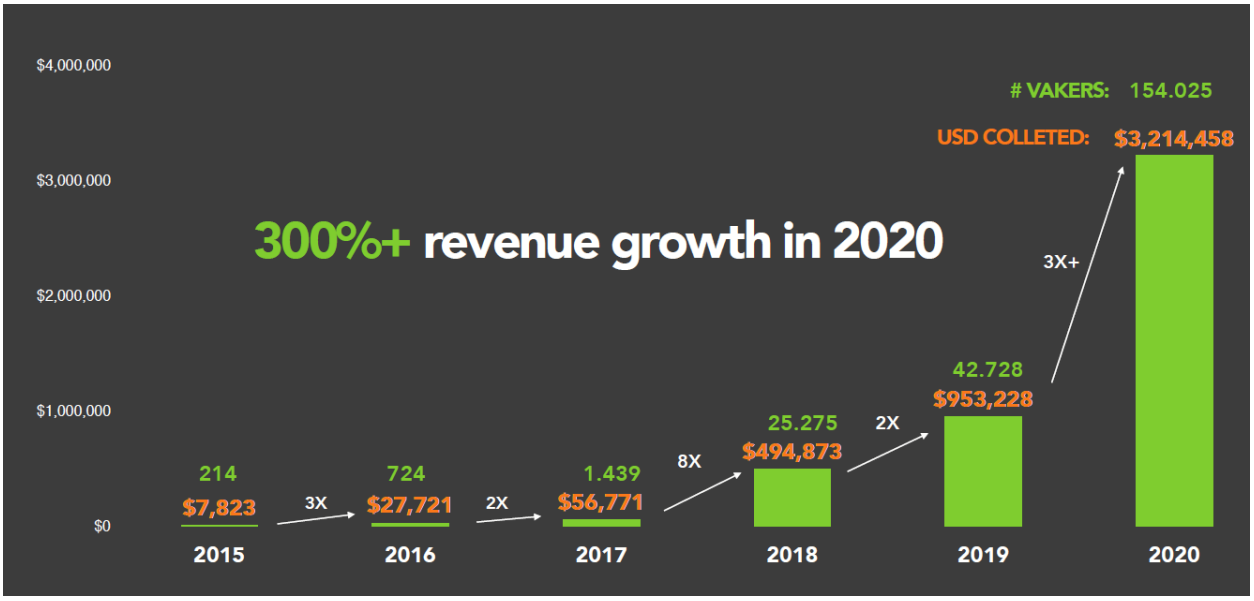
- Citizens have no control over what projects are being funded;
- Funding is expensive, hidden, or just for a few; and
- Crowdfunding in Latin America has existed for over nine years but enjoys less than one percent of the global market.

Vaki's solution focuses on the following needs of the crowdfunding community:

- Change the mindset that a donation is not charity, but rather, activism;
- Promote curated projects to an active community (known as "Vakers");
- Allow Vakers to check project updates; and
- Allow clients to save time and money when fundraising.

Vaki started up in 2015 and has achieved exponential growth, as shown in Figure 13.

Figure 13: Vaki Revenue Growth



Key features of the Vaki product include:

- A search engine optimized landing page;
- A project and payments dashboard;
- Multiple payment gateways for local payments all over Latin. America; and
- Access to crowdfunding experts' support during funding campaigns.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

Each of the FinTech opportunities has its own history and implementation timeline:

- Tpaga was launched in 2016;
- ABL Capital was launched in 2018; and
- Vaki was launched in 2015.

PROJECT COST AND FINANCING

The combined funding targets for the three opportunities in the portfolio exceed $15 million. PROCOLOMBIA will provide access to further information for interested parties.

U.S. EXPORT OPPORTUNITIES

Opportunities for U.S. companies to participate in PROCOLOMBIA's FinTech portfolio include:

- Chatbot and virtual assistant applications and support;
- Robo-advisor applications and support;
- Credit assessment applications and support;
- Legal and compliance applications and support;
- Blockchain technology;
- AI and robotic process automation;
- SaaS and cloud-based solutions for FinTech;
- Advisory services; and
- Project commercialization and technology transfer support.

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
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3 ECUADOR

3.1 ICT Demographics

Ecuador is a South American nation bordering Colombia and Peru, and its more than 2,237 kilometers of Pacific coastline at the equator. The country's topography varies from a western coastal plain to inter-Andean central highlands to an eastern, tropical, Amazonian jungle. As a result, the country poses some challenges for ICT infrastructure development.

Ecuador's landmass is 277,000 sq km, slightly smaller than the U.S. state of Nevada. About 39 percent of its land is forest, with another 30 percent representing agricultural land. With respect to protecting ICT infrastructure, the country is subject to frequent earthquakes, volcanic activity, and flooding.[33]

The country is home to just over 17 million people. Approximately half the Ecuadorian population resides in the interior in the Andean intermountain basins and valleys. Secondarily, the western coast is also a site of population density. The eastern rainforests are sparsely populated. Almost 65 percent of the population is urban. Guayaquil is the largest city, with a population of about 2.7 million inhabitants. Quito, the capital, with just under two million residents, is second. Other Ecuadorian cities host populations of less than half a million people each. Poverty and income inequality primarily affect rural populations.

3.2 ICT Sector Development

Ecuador's existing ICT sector is developing with respect to mobile telephone access. Per 100 inhabitants, Ecuador had 94.97 mobile telephone subscriptions as of 2019, ranking 156th globally.[34]

In 2018, Ecuador ranked 55th globally in terms of the percentage of its population with access to the internet, with just over 57 percent of the population having access.[35] The country ranked 54th globally with respect to fixed broadband subscriptions, at 12.53 subscriptions per 100 inhabitants.

CNT, Claro Movil, and Movistar Movil are the principal Ecuadorian mobile telephony providers. Claro began testing 5G service in Guayaquil in 2020. In February 2021, CNT announced its collaboration with Nokia to modernize existing 3G/LTE infrastructure in the provinces of Guayas, Los Rios, Manabi, Bolivar, Morona Santiago, and Santa Elena, with the intent of developing 500 sites for a seamless migration to 5G services. Nokia will also deploy the first 5G non-standalone (NSA) sites in Guayaquil and Manta, enabling CNT to plan services in conjunction with its 5G launch.

[33] CIA World Factbook https://www.cia.gov/the-world-factbook/countries/ecuador/#geography
[34] Index Mundi https://www.indexmundi.com/g/r.aspx?v=4010
[35] CIA World Factbook

Ecuador is a landing point for three subsea telecommunications cables.[36] The cables include the 6,000 km Pacific Caribbean Cable System (PCCS) landing near Manta and the 25,000 km South America 1 (SAm-1) and 7,050 km Pan American (PAN-AM) cables, landing near Salinas. All of these cables ring the region and offer landing points with onward international connectivity.

In 2013, Ecuador launched two small cube satellites; the NEE 01 Pegasus and NEE02 KRYSAOR.[37] Given their age and type, it is unlikely these are still operating.

3.3 Regulatory Landscape

The Telecommunications Regulatory and Control Agency (Agencia de Regulacion y Control de las Telecommunicaciones or ARCOTEL) is the principal telecommunications regulator in Ecuador. The entity also manages the radio spectrum. ARCOTEL creates policies and regulations implemented by the Ministry of Telecommunications. The Agency also grants licenses to operators and promotes competition within the regulatory framework.

Ecuador hosts approximately 60 national media outlets, with the federal government controlling 12 and multiple radio stations. Numerous privately-owned TV networks and many local channels, and more than 300 radio stations also broadcast. The media is required by law to give the government free airtime to broadcast programs produced by the state. The Ecuadorian Government is the country's largest advertiser. Antimonopoly and communications laws limit ownership and investment in the media by non-media businesses.

3.4 ICT Sectors Profiled

This Resource Guide reviews four Ecuadorian development projects, spanning the following ICT sectors:

- *Terrestrial Telecommunications Network Infrastructure: Telephone, Internet, and Broadband*: while Ecuador has reasonable telephone, internet, and broadband infrastructure, current development focal points include 5G, connecting the entire population with a goal to better deliver health, education, and streamlined public sector procedures, and ensuring access in remote and environmentally sensitive locations such as the Galápagos Islands.
- *Submarine Communications Systems:* In support of efforts to provide better telecommunications to remote and environmentally sensitive locations, a subsea cable is in development for the Galápagos Islands. Currently served by satellite, the region will gain substantially greater broadband spectrum at the same cost and eventually have access to 4G and 5G technologies.
- *Utilities Automation:* Ecuador is undertaking two sizable projects to deploy ICT technology to digitize and automate key portions of its electric power sector. The projects will use various hardware, software, IoT, and AI technologies to ensure power availability,

[36] Fiber Atlantic http://www.fiberatlantic.com/submarinecablemap/
[37] Ny2o https://www.n2yo.com/satellite/?s=41770

efficient management, and rapid response to operating challenges across power generation and transmission activities.

3.5 Projects Profiled

Four Ecuadorian ICT projects are profiled following (Table 15):

Table 15: ICT Development Projects -- Colombia

Project	Sponsor
Ecuadorian Connectivity and e-Government Plan	Ministerio de Telecomunicaciones y Sociedad de la Información
Galápagos Islands Submarine Cable	Galápagos Cable Systems
CENACE Control Center Upgrade	CENACE
Transelectric Digital Transformation	Transelectric (CELEC)

Ecuadorian Connectivity and e-Government	
SUBSECTOR	**Terrestrial Communications Networks – Telephone, Internet, and Broadband** **Smart Cities and e-Government**
LOCATION	**Ecuador**
PROJECT VALUE	**Approximately$140 million**

PROJECT SUMMARY

- The Ecuadorian connectivity and e-Government plan has three central foci:
  - Connecting 100 percent of the country's population;
  - Expanding e-Education and e-Healthcare; and
  - Implementing e-Government approaches to streamline public sector procedures and reduce corruption.

PROJECT BACKGROUND AND DESCRIPTION

The Ecuadorian government points to the UN's e-Government Development Index (EGDI) as a useful benchmarking tool. Ecuador was ranked 74 out of 193 countries in 2020. In South America, 70 percent of regional neighbors lagged, as shown among the 2020 EDGIs for South American countries profiled in Table 16.

Table 16: Selected 2020 EGDI Ratings[38]

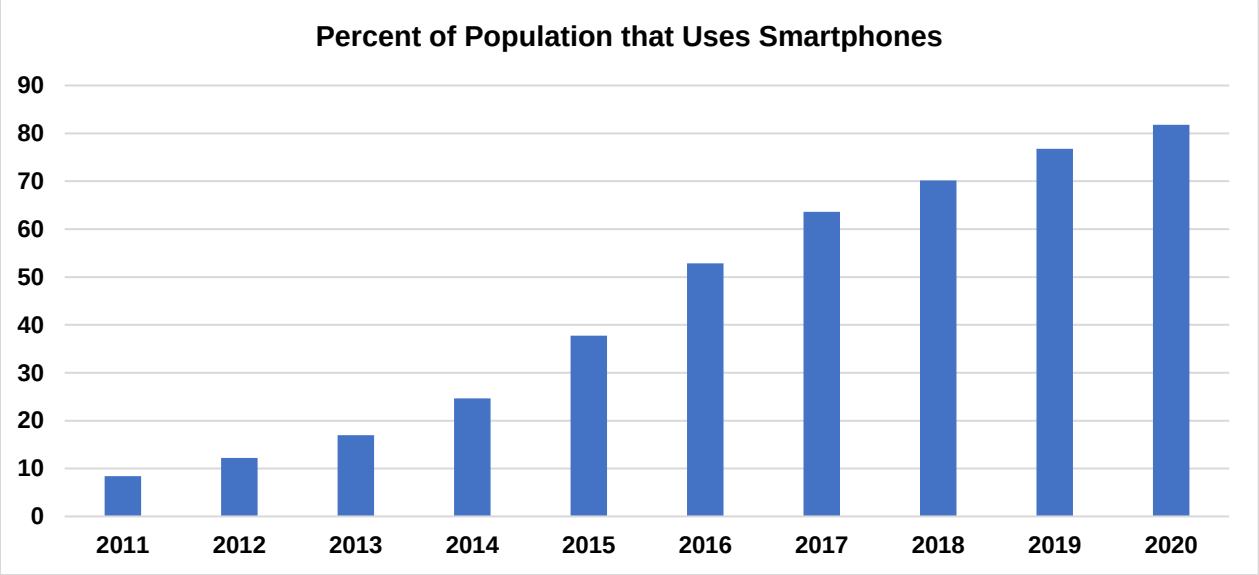
South American Country	Rank 2020	EGDI Rating
Uruguay	26	0.850
Argentina	32	0.828
Chile	34	0.826
Brazil	54	0.768
Colombia	67	0.716
Peru	71	0.708
Ecuador	74	0.702
Paraguay	93	0.649
Bolivia	97	0.613
Venezuela	118	0.527

[38] https://publicadministration.un.org/egovkb/Data-Center

Ecuador cites Uruguay as a helpful benchmark. The country has 1,630 central government procedures, where online access exceeds over 90 percent. Ecuador has more than 4,800 central government procedures, limiting online access to fewer than 60 percent. The new government's plan calls for streamlining and simplifying central government procedures before hosting them online, further, as a precondition to e-Government, e-Education, and e-Healthcare.

Ecuadorian smartphone use has increased substantially over the past decade, as shown in Figure 14. Smartphone use in the population above five years of age averages 82–86 percent in urban areas and 70 percent in rural areas.

Figure 14: Smartphone Use in Ecuador[39]



Ecuador proposes to enhance connectivity further by several means:

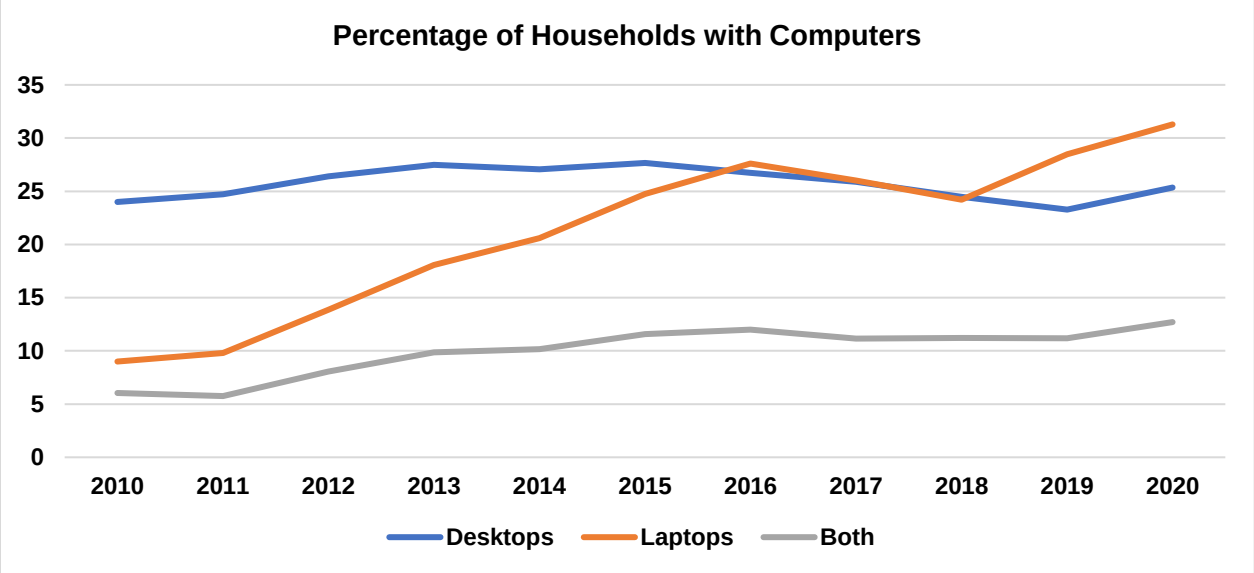
- Installing internet access in 100 percent of schools;
- Installing and upgrading 2,000 communication kiosks throughout the country; and
- Reforming the Organic Telecommunications Law to provide incentives for private operators to upgrade their networks and service offerings.

Improved connectivity is a critical element of enhancing the country's healthcare. The digital transformation in the healthcare system will improve the quality and efficiency of Ecuadorian medical care. Patients will experience reduced waiting times. Via the digitization of procedures, medical personnel will spend more time with patients and less on administrative burdens. In addition, digital transformation will allow all hospitals, clinics, health centers, and other providers to exchange patient health information. Further, e-Healthcare will expand medical care to difficult to access rural areas.

[39] Source: INEC – Instituto Nacional de Estadística y Censos

Concerning digitally enhancing education, while over 90 percent of Ecuadorian households have smartphones, fewer than half have portable or desktop computers, as shown in Figure 15.

Figure 15: Households with Computers in Ecuador



The lack of household infrastructure posed a barrier to e-Education during the COVID-19 global pandemic. Thus, the Ministry of Education plans to distribute tablets to all primary and secondary education students.

The Ministry of Telecommunications and Information Society coordinates with the Ministries of Health and Education for further e-Healthcare and e-Education initiatives.

For the implementation of e-Government more generally, existing problems with manual procedures are a motivating factor. Many face-to-face processes are slow, vulnerable to corruption, and exclusionary for people with fewer resources. The lack of standardization of processes makes procedures particularly vulnerable to corruption. Further, during the COVID-19 global pandemic, the need for more virtual procedures became evident and their availability indispensable.

The e-Government initiative will promote the homogenization of procedures at all levels to reduce the administrative and financial burden currently falling on citizens and companies in Ecuador. Digital paperwork and services can solve many of the problems of modern bureaucracies, as they are faster, cost less, and reduce corruption.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

In June 2021, 54 local communities were connected in the provinces of Esmeraldas, Manabí, Pichincha, Tiungurahua, Chimborazo, Bolívar, Napo, Orellana, and Sucumbíos. The implementation timeline for achieving 100 percent connectivity extends to the end of 2022.

Programs for e-Education, e-Healthcare, and e-Government have longer implementation timelines through 2025.

PROJECT COST AND FINANCING

The project does not have a single budget. Rather, each component has a budget and financing sources:

- The Ministry of Telecommunications and Information Society has a budget of $140 million for the installation and upgrading of 2,000 information kiosks.
- The Ministries of Education and Health, respectively, will fund e-Education and e-Healthcare initiatives.
- The Ministry of Telecommunications and Information Society negotiating with multilateral financing institutions, including the World Bank and the Inter-American Development Bank, to finance the other e-Government initiatives.

U.S. EXPORT OPPORTUNITIES

U.S. export opportunities for the project include:

- Network hardware, devices, software, and services including:
  - Connectivity hardware and cabling;
  - Control and network management systems;
  - Network management software and cybersecurity; and
  - Management, qualification, and training services.
- Hardware:
  - Datacenter componentry (servers, racks, power, HVAC, site security, et al.); and
  - Digital operations center equipment (networking hardware, fiber optic cabling, components, power management hardware, et al.)
- Software:
  - Access to Software as a Service (SaaS) and related scalable programs;
  - Custom software/applications – e-Government, e-Education, and e-Healthcare; and
  - Cybersecurity solutions.
- Advisory services:
  - e-Government design and development services and consulting;
  - Networking design, implementation, and security; and
  - Application design, development, testing, and implementation.

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
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Galápagos Islands Submarine Cable	
SUBSECTOR	**Subsea Communications Networks**
LOCATION	**Galápagos Islands and Manta, Ecuador**
PROJECT VALUE	**$65 million**

PROJECT SUMMARY

- At relatively slow speeds and high costs, satellite connection provides present telecommunications services on the Galápagos Islands.
- This project will establish a subsea fiber-optic connection from the Islands to mainland Ecuador, increasing bandwidth by a factor of 2,500 at a cost similar to the existing satellite service.
- The project will provide quality national and international telecommunications services, both fixed and mobile, wideband internet, 4G mobile service, and the potential for 5G in the future.

PROJECT BACKGROUND AND DESCRIPTION

Ecuador enacted the first legislation protecting the Galápagos Islands in 1930. In 1959, the centenary year of publishing Darwin's The Origin of Species, Ecuador declared the islands a national park. UNESCO recognized the islands as a world heritage site in 1978 and as a biosphere reserve in 1985.

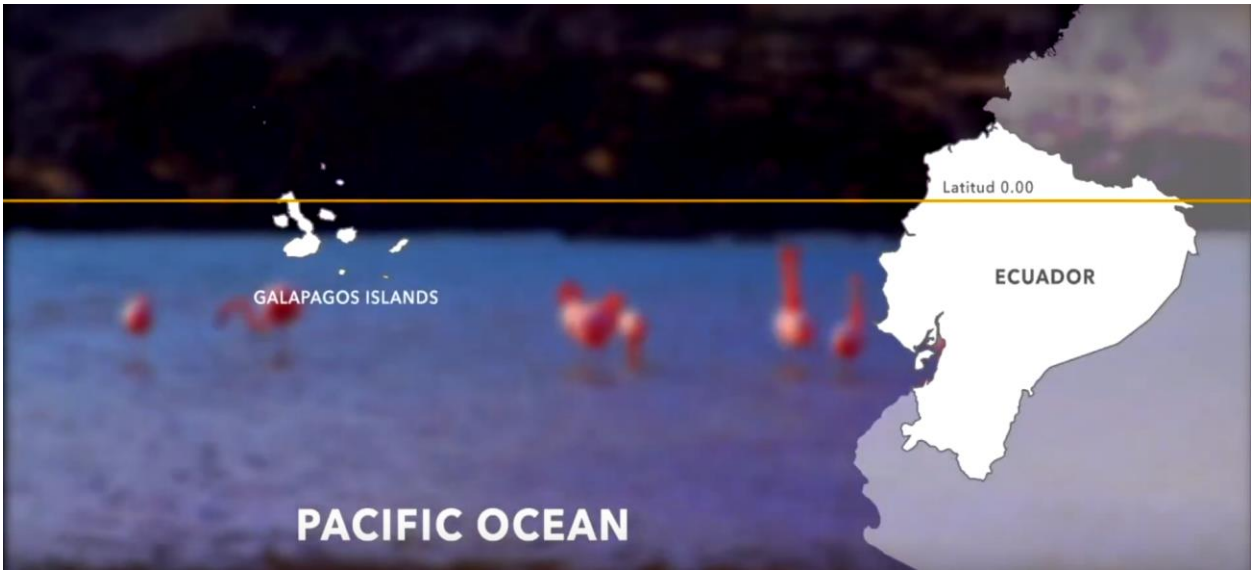
The Galápagos Archipelago consists of 18 main islands, three smaller islands, and 107 rocks and islets. The islands are administered by a provincial government and divided into three cantons; San Cristobál, Santa Cruz, and Isabela, the three most populous islands.

The population of the Galápagos Islands was 25,244 in the last census. Tourism is the main economic activity. Tourism centers on 116 land- and sea-based visitor sites. Local guides must accompany small groups to protect the islands' fragile ecosystem.

This project will connect the Galápagos Islands to the Ecuadorian mainland using a subsea fiber optic cable, as shown in Figure 16. The subsea cable will run from Manta in Manabí province to three points on the islands:

- Puerto Baquerizo Moreno in San Cristobal;
- Port Ayora in Santa Cruz; and
- Port General Villamil in Isabela.

Figure 16: Subsea Cable Project Location



The project will install a 1,280 km submarine cable with a design capacity of 20 terabits per second. The project will increase bandwidth in the islands by more than 2,500 times the current capacity. Key benefits from project implementation include high-capacity and -quality national and international telecommunications services spanning fixed and mobile (4G with the potential for 5G in the future) and wideband internet.

Xtera, a subsea fiber optic solutions provider, was selected as the EPC contractor to provide turnkey design and construction services. Xtera reports it will source all of the project's terminal equipment from the U.S.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

The national telecommunications company CNT[40] commenced a feasibility study for the project in 2018. The Ministry of Environment issued the environmental permit for the project in October 2019. CNT selected a private sector partner for project implementation by inviting proposals from 29 potential candidates.

In March 2021, as shown in Figure 17, the President of the Republic announced that Galápagos Cable Systems (GCS S.A.) would implement the project.

[40] CNT – Compañía Nacional de Telecomunicaciones

Figure 17: Project Kickoff on March 11, 2021

The implementation timeline for the project is approximately 15 months and includes the following phases:

- Marine survey to determine the exact project route;
- Baseline surveys;
- Construction of landing sites;
- Laying of subsea cable; and
- Commissioning.

PROJECT COST AND FINANCING

The project will cost an estimated $65 million. GCS is responsible for financing the investment amount. CNT will pay GCS annual concession fees of $9.5 million once the project is operational.

CNT currently spends $8.6 million annually for satellite coverage for the Galápagos Islands telecommunications services. For approximately the same amount, the project will provide thousands of times greater bandwidth. CNT will also be investing $1.7 million to upgrade the existing copper-based infrastructure on the islands to fiber-optic connections.

U.S. EXPORT OPPORTUNITIES

Export opportunities for U.S. firms include:

- Fiber optic cabling hardware;
- Fiber optic network-management hardware and software;
- Network modeling, design, and engineering services;
- Ship services/oversight;
- Installation/testing services/oversight; and
- Other technical and management advisory services.

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
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CENACE Control Center Upgrade	
SUBSECTOR	**Utilities Automation**
LOCATION	**Ecuador**
PROJECT VALUE	**$25 million**

PROJECT SUMMARY

- CENACE[41] is the Ecuadorian national electric power grid system operator and a public entity led by the Ministry of Energy.
- The CENACE control center carries out automatic and manual control of electricity generation and transmission assets and manages international energy transactions.
- The technology at the core of the current control center is becoming obsolete and requires upgrading.
- CENACE's principal hardware and software comprise four Operational Technologies (OT): the SCADA/EMS (Supervisory Control and Data Acquisition / Energy Management System), the WAMS (Wide Area Monitoring System), the SPS (Special Protection Scheme / System Injury Protection Scheme), and the AMI (Advanced Measurement Infrastructure) for commercial purposes.
- The upgrade will consider the Andean regional power market (Colombia, Ecuador, Peru, Bolivia, and Chile).
- The control center upgrade will also contemplate demand growth and new requirements for the national grid from developing generation and power user technologies.

PROJECT BACKGROUND AND DESCRIPTION

CENACE is the system operator and commercial administrator for energy transactions across the Ecuadorian national grid (SNI[42]). CENACE carries out these functions with the following objectives, in order of priority:

- Assuring continuity of the national power supply;
- Guaranteeing the quality of the power supply in the SNI; and
- Achieving the minimum possible cost.

CENACE was created by the Electricity Sector Law of 1996 as a non-profit, civil corporation under private law. However, CENACE's legal structure was modified in 2015, causing it to become a public entity led by the Ministry of Energy and Non-Renewable Natural Resources.

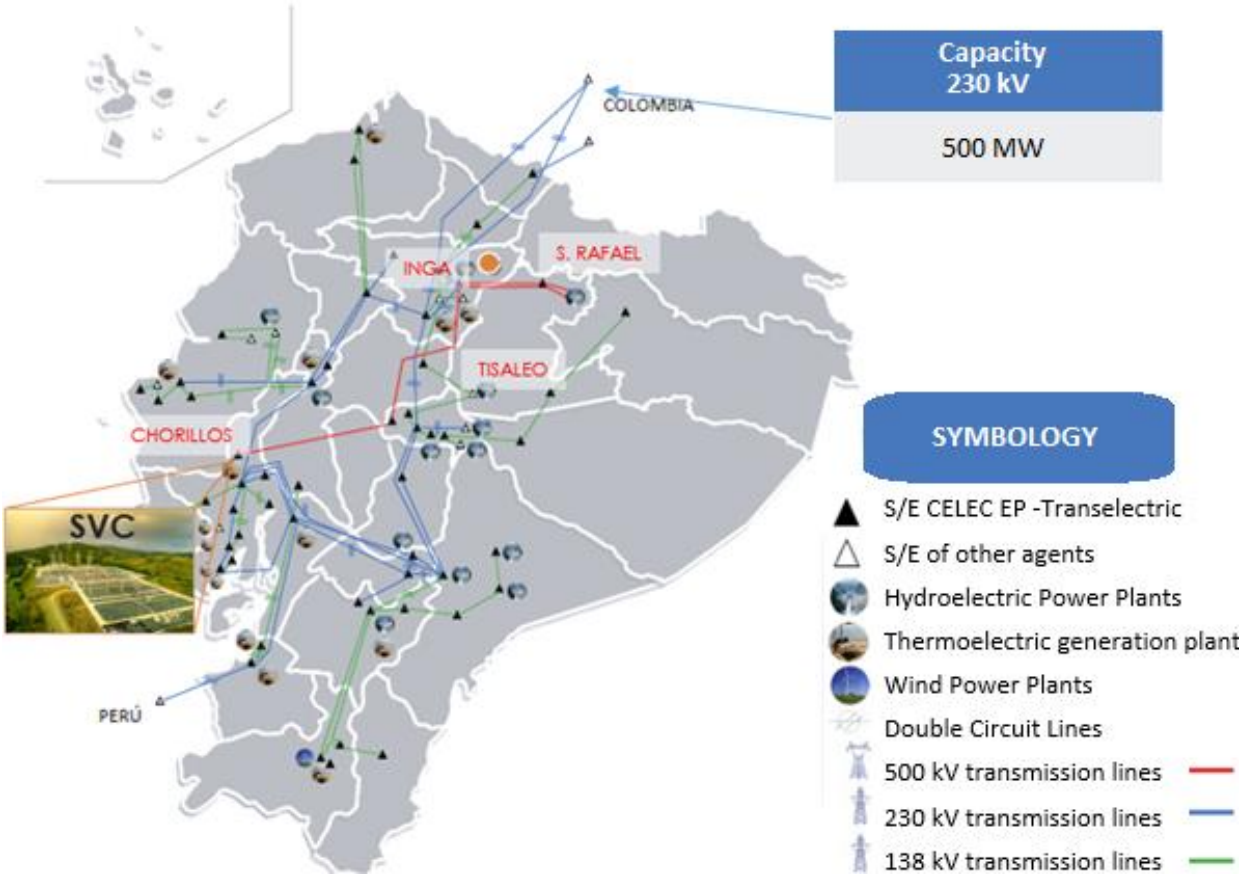
CENACE's functions are divided into three distinct areas:

[41] CENACE - Centro Nacional de Control de Energía de la República del Ecuador
[42] SNI – Sistema Nacional Interconectado

- ***Planning:*** Bi-annual (updated quarterly), monthly, weekly, and daily;
- ***Real-Time Operation:*** Automatic and manual control of electricity generation and transmission assets and international energy transactions; and
- ***Settlement:*** Robust assignment of hourly power transactions to SNI participants, accounting for system losses.

The SNI serves 97.33 percent of the country's power demand. The balance is handled by isolated systems, mainly found in the upper Amazon basin area. The power plants and transmission lines that structure the SNI are detailed in Figure 18.

Figure 18: The Ecuadorian National Grid (SNI)



The CENACE national control center supervises and directs the real-time operation of the generation, transmission, and distribution facilities. The center also coordinates the operative function at the national level and over international interchanges. Key functional links include connections with:

- The Colombian system operator XM and the Peruvian system operator COES;

- TRANSELECTRIC, the transmission business unit of Corporación Eléctrica del Ecuador **(**CELEC);
- Automatic Generation Control (AGC) with the country's largest power generators including Coca Codo Sinclair (CCS), Minas San Francisco, Delsitanisagua, and hydro units located on the Paute River: Sopladora, Molino, and Mazar, collectively known as the Generation Management System (GMS);
- Backup AGC with Hidropaute; and
- Distribution control centers.

CENACE indicates that the SCADA / EMS[43] at the heart of its control center will soon be obsolete and thus requires upgrading. CENACE notes the following:

- It acquired the hardware platform for the SCADA / EMS in 2012.
- Both the hardware and software components of the SCADA / EMS were designed for a power system one half the size of today's SNI before introducing the 500 kV transmission grid and installing the largest power generators.
- The system consoles have increasing performance deficiencies.
- The contract for maintenance and upgrades expires in November 2019.
- The processing, storage, and management platforms will not be supported by the supplier beyond 2021.

The SCADA/EMS upgrade will consider important interoperability features:

- CENACE introduced a WAMS platform in 2013; the SCADA/EMS upgrade should be capable of functioning in coordination with WAMS; and
- A similar situation exists with SPS.

Therefore, the project will also consider the possibility of upgrading or improving the WAMS and SPS to ensure that these OTs operate in an entirely interoperable environment.

On the other hand, the current AMI platform functions in a completely independent manner. It has a lengthier sampling period than the SCADA/EMS and lacks a modern communication architecture. Therefore, it must also be upgraded to develop a modern, big data infrastructure together with the other OTs. The big data infrastructure will combine data obtained from the four OTs using advanced analytics and visualization tools.

CENACE's control center is located in a building inaugurated in 2018, which already incorporates video walls, as shown in Figure 19.

[43] SCADA / EMS – Supervisory Control and Data Acquisition System / Energy Management System

Figure 19: The CENACE Control Center

The control center upgrade will consider the following global sector trends:

- Distributed generation;
- Utility-scale renewable generation;
- Electric vehicles;
- On-grid storage; and
- Demand response.

The upgrade will also consider important national and regional sector trends, including:

- Increased power generation from non-hydro renewable sources;
- Upgraded interconnection between Ecuador and Peru;
- Support of the Andean regional power market (Colombia, Ecuador, Peru, Bolivia, and Chile);
- Critical sector electrification, including crude oil production, mines, shrimp farming, et al.;
- A 500 kV network expansion; and
- Increased industrial value-added (and hence power consumption) by converting local raw materials into specialized products.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

CENACE expects to finalize the design phase of the project by mid-2022. The design phase includes functional analysis, technical specifications, cybersecurity review, interoperability architecture, budget and funding sources identification, and implementation planning.

The design study will specify the implementation timeline. Implementation will begin in 2023.

PROJECT COST AND FINANCING

The total cost for project implementation is estimated to be $25 million. The project cost estimate will be revised during the ongoing design study.

The design study is being financed by a USTDA technical assistance grant. The study includes assessing potential sources of financing for project implementation, including:

- Extraordinary budget assignment from the Ministry of Finance and Economics;
- Vendor financing; and
- Bilateral or International Financial Institution (IFI) financing.

U.S. EXPORT OPPORTUNITIES

A variety of export opportunities exist for U.S. companies concerning project implementation, including:

- IT hardware;
- Other hardware, such as sensors, interfaces, and remote controls;
- Software licensing and maintenance agreements;
- Licensing arrangements for third-party information sources;
- Factory development and test services for new solutions and systems;
- Implementation, installation, and test services for new solutions and systems;
- Database and display migration support; and
- Project management services, including those specialized in mission-critical systems, ensure the SNI's continuity during system migration.

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
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Transelectric Digital Transformation	
SUBSECTOR	**Utilities Automation**
LOCATION	**Ecuador**
PROJECT VALUE	**$100 million**

PROJECT SUMMARY

- Transelectric, a business unit of the national utility CELEC, owns and maintains all of Ecuador's transmission assets.
- The company is initiating a digital transformation to consider:
  - Substation automation (SA);
  - Digital protective relays;
  - Advanced asset management;
  - Convergence of information technology (IT) and operational technology (OT);
  - Advanced applications; and
  - New smart grid functions.
- Transelectric expects demonstrable business and performance benefits from its digital transformation.

PROJECT BACKGROUND AND DESCRIPTION

Transelectric is the transmission business unit of the national utility CELEC EP (Corporación Eléctrica del Ecuador). Transelectric owns and maintains all of the country's transmission assets, including:

- 6,091.91 km of transmission lines:
  - 610.17 km at 500 kV;
  - 3,239.90 km at 230 kV; and
  - 2,241.84 at 138 kV.
- Sixty-nine substations (including four mobile units) with a total of 16,661.20 MVA transformation capacity.
- 5,842.25 km fiber-optic cable.

Transelectric employs nearly 800 personnel across Ecuador. The operation and maintenance of Transelectric's assets are structured into four zones: northeast, northwest, southeast, and southwest.

Transelectric is one of CELEC's 14 business units. The other business units include eight renewable power generators (seven hydroelectric units and one mixed hydroelectric and wind generator) and five thermal power plants.

Transelectric's digital transformation will focus on six trends for power transmission owners:

- ***Substation Automation:*** Substation automation (SA) systems use various devices integrated into a complete solution with communications technology for monitoring and controlling the substation. Intelligent electronic devices (IEDs) form the system's base layer, sensing substation status and operating the substation. Typical substation IEDs include load meters, revenue meters, protective relays, power equipment controllers, and programable logic controllers (PLCs). SA systems are commonly connected to a SCADA (supervisory control and data acquisition) system for real-time network operation. SCADA control may be exercised via remote terminal units or equivalent system solutions. Modern SA systems are also connected to a data warehouse from which other IT and OT systems or applications can access substation data.

- ***Digital Protective Relays:*** Transmission protection systems proactively identify the location of faults and isolate the faulted section. A single digital relay can be programmed to perform the functions of multiple electromechanical relays. Digital technology provides better flexibility using electronics (versus deploying moving (mechanical) parts), resulting in better reliability. Digital relays also deliver pre- and post-fault data to assist in determining the cause of a fault and whether protective devices functioned as expected. Digital relays can also provide an accurate indication of fault location to facilitate service restoration.

- ***Advanced Asset Management:*** Advanced asset management involves streaming online and near real-time data to a monitoring and diagnostic (M&D) center. The streamed data is analyzed with advanced pattern recognition software and other analytic techniques to identify degrading and failing equipment. The M&D center allows asset management to evolve from scheduled (preventive) maintenance to more cost-effective, predictive maintenance. The M&D center provides increased diagnostic data with more lead time and a better situational understanding of the overall equipment health. Some M&D and analysis centers also provide operational support. Collectively, these efforts reduce or avoid costs, increase system reliability, and improve equipment maintenance practices.

- ***Convergence of IT and OT:*** The convergence of IT and OT is a trend that started years ago and is being catalyzed by industry 4.0 technologies, particularly Internet-of-Things (IoT) technologies. Traditionally, OT has included the hardware and software on the "shop floor," such as SCADA and PLCs. IT includes hardware (laptops, servers, and peripherals), software, and enterprise system software such as ERPs and other business-related tools. Increasing internet connectivity, particularly wireless internet, allows direct connectivity (machine-to-machine), thus breaking down the traditional barriers between IT and OT.

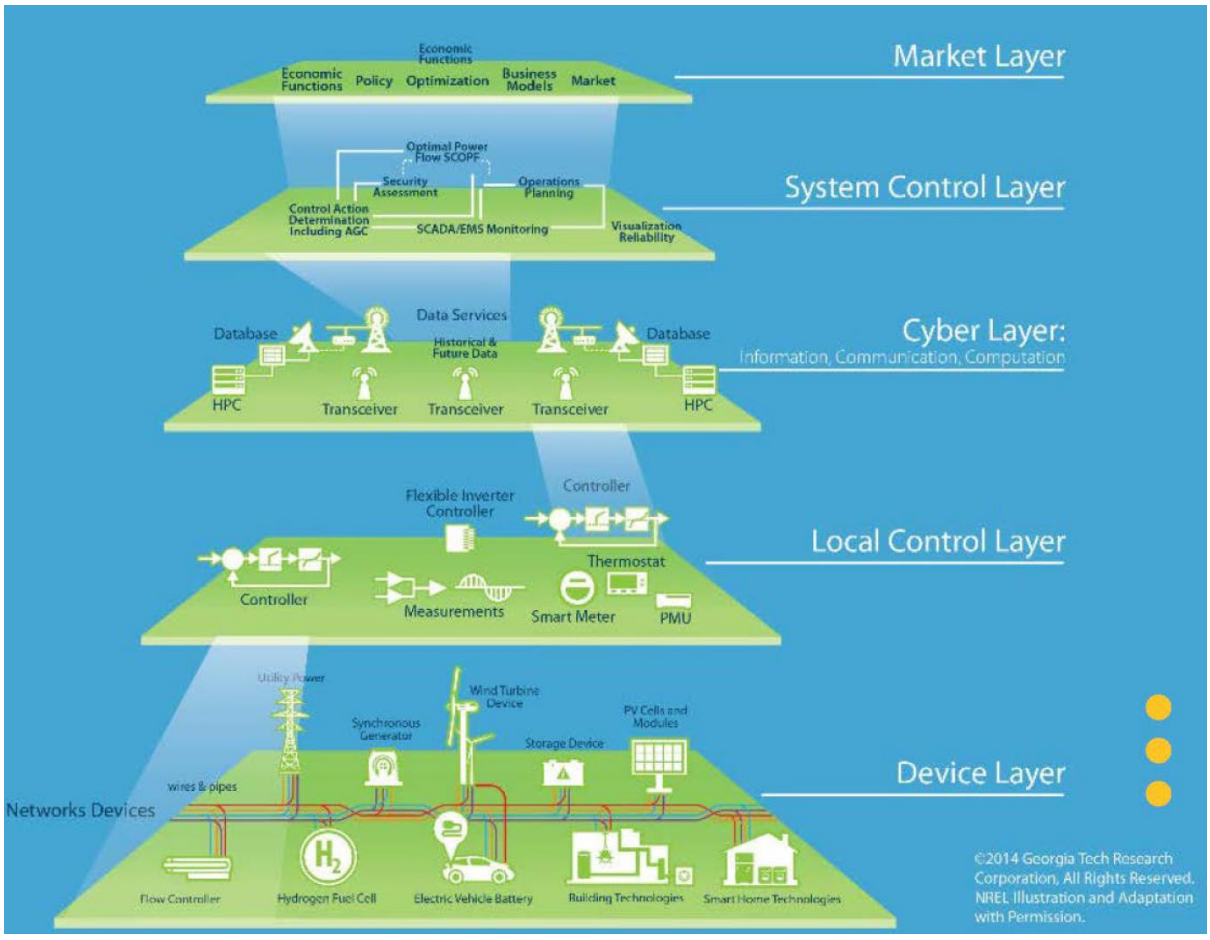
- ***Advanced Applications:*** Advanced applications for power transmission utilities include:
    - Mobile solutions for remote maintenance crews;
    - Cloud solutions to unite vendors and partners;
    - Big data platforms to bring together previously siloed information;
    - Drone inspections of transmission assets;

- 3-D laser scanning and advanced image processing for lines and substations; and
- Cognitive computing for field workforce optimization.

- ***New Smart Grid Functions:*** Power grids are becoming intelligent as new functions are required, including the integration of increasing generation from intermittent sources, electric vehicle charging, on-grid energy storage technologies, and enhanced participation of demand response. In Ecuador, these are critical issues for the power sector planner (the Ministry) and the system operator, CENACE. Transelectric supports the Ministry in power sector planning with some of the country's most sophisticated modeling capabilities.

Transelectric is anticipating its digital transformation will involve a layered architecture, as shown in Figure 20.[44]

Figure 20: NREL Functional Layers



Transelectric projects demonstrable business and performance benefits from its digital transformation, including:

[44] NREL. Workshop on Integrating Renewables into Power Systems in Central America. 2016

- Greater operational efficiencies deferring the need for investments and reducing the costs of electricity transport service;
- Improved grid resiliency, reducing disruptions, accelerating grid recovery, and increasing social productivity;
- Fewer losses, resulting in lower primary energy needs;
- Better incorporation of renewable resources to reduce carbon emissions and other environmental impacts;
- Reduced travel needs to remote sites;
- Fewer requirements for conducting work in hazardous environments; and
- Enhanced electricity supply services to critical and export industries.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

Transelectric is preparing a master plan for its digital transformation. Focal aspects of the master plan include:

- Present situation baselining and gap analysis;
- Digital transformation architecture and strategy;
- Digital transformation for power transmission utilities;
- Substation automation planning;
- System resilience planning;
- Transmission line monitoring planning;
- Flexible ac transmission (FACTS) implementation planning; and
- An overall implementation plan.

The implementation timeline for the digital transformation master plan will likely last up to ten years.

PROJECT COST AND FINANCING

The global budget for Transelectric's digital transformation is presently estimated to be approximately $100 million. More than 75 percent of this amount will be used for substation automation and digital relays.

The digital transformation master plan, under development, will likely revise this budget estimate.

U.S. EXPORT OPPORTUNITIES

The project budget contemplates acquiring nearly $100 million of equipment, solutions, and services. Capabilities of U.S. technology companies align well with these needs, offering U.S. export opportunities for:

- Substation automation;
- Digital relays;
- Asset management solutions;
- Transmission line monitoring systems and solutions;
- Flexible AC Transmission (FACTS) components and solutions; and
- Other digital solutions.

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
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4 PERU

4.1 ICT Demographics

Peru is a South American nation bordering Ecuador, Colombia, Brazil, Bolivia, and Chile and its more than 2,400 kilometers of South Pacific coastline. The country's topography varies widely from its western coastal plain to high and rugged Andean mountainous terrain in its center to an eastern Amazon basin lowland jungle. The country's landscape poses some challenges for ICT infrastructure development.

Peru's landmass is 1,285 million sq. km, nearly the size of the U.S. state of Alaska and almost twice the size of Texas. Roughly 53 percent of its land is forest, with another 19 percent representing agricultural land. With respect to protecting ICT infrastructure, the country is subject to earthquakes, tsunamis, flooding, landslides, and occasional mild volcanic activity.

The country is home to just over 32 million people. Approximately one-third of the Peruvian population resides along the coastal desert belt in the west, particularly in the metropolitan area of the capital city of Lima. The Andean highlands, or sierra, hosts roughly half of the overall population and is strongly identified with the country's Amerindian population. The eastern slopes of the Andes and adjoining rainforest are sparsely populated.

4.2 ICT Sector Development

Peru's existing ICT sector is reasonably well developed with respect to fixed and mobile cellular telephone subscribers. Nonetheless, fixed-line density is among the lowest in South America due in part to geographic inaccessibility. Mobile subscriptions exceed 39 million, or approximately 124 per 100 inhabitants. On that basis, for mobile cellular, Peru ranks 62nd globally.[45]

Peru offers 2G, 3G, and 4G cellular services at present, with 5G in the early stages. Bitel Movil, Claro Movil, Entel Movil, and Movistar Movil serve the Peruvian market, with cellular services most densely present along the western coastal region. Peru's Transport and Communications Ministry (MTC) has authorized 5G services under the non-standalone standard (NSA) and greenlighted initial implementation for the provinces of Ica, Trujillo, Arequipa, Cañete, Huarochirí, Callao, and Lima. Claro offers 5G in parts of Lima's metropolitan area and will gradually expand coverage to other cities. Entel has 5G available in Surquillo and soon in Lima, Chiclayo, Trujillo and Arequipa. As of March 2021, Claro and Entel received approval to offer 5G services under the fixed wireless access modality, which MTC believes will allow technology testing to deliver faster speeds at lower prices.[46]

Fixed broadband is limited in Peru, with only 2.3 million total subscriptions, or about seven subscriptions per 100 people. Nonetheless, in terms of total fixed broadband subscriptions, Peru ranks 52nd globally.

[45] Index Mundi https://www.indexmundi.com/facts/indicators/IT.CEL.SETS.P2/rankings
[46] BNAmericas https://www.bnamericas.com/en/news/peru-reaches-milestone-with-5g-nsa-authorization

In 2018, Peru ranked 111th globally in terms of the percentage of its population with access to the internet, with just under 53 percent of the population having access.[47] By 2019, however, 60 percent of the Peruvian population had internet access.[48]

Peru is a landing point for three international, subsea telecommunications cables, all near Lima.[49] The cables include the 25,000 km South America-1 (SAm-1), 20,000 km South American Crossing (SAC)/ Latin American Nautilus (LAN), the 7,050 km Pan American (PAN-AM) cables. All of these cables ring the region and offer landing points with onward connectivity to international cables.

Peru has operated two telecommunications satellites; the PERUSAT 1 launched in 2016, and the PUCP-SAT 1 launched in 2013.[50] PERUSAT 1 is a reconnaissance satellite for both the defense and civilian sectors. The vehicle was built by Airbus Defense and Space for the government of Peru and designed for a 10-year lifetime. The French government helped facilitate the agreement for Airbus to provide the spacecraft and ground systems, train engineers, and transfer technological know-how under contract to CONIDA, the Peruvian national space agency. PERUSAT 1 is reportedly the most capable earth-observing spacecraft owned by a Latin American country. PUCP-SAT 1 is inactive (no longer operational).

4.3 Regulatory Landscape

The principal telecommunications regulator in Peru is Organismo Supervisor de Inversión Privada en Telecomunicaciones (OSIPTEL), which serves as the supervisory agency for private investments in telecommunications, as part of the Prime Minister's cabinet. OSIPTEL's mission is "to regulate and supervise the telecommunications market to promote competition, service quality and the respect for users' rights." The organization was created in 1991 to guarantee the quality and efficiency of the telecommunications service provided to users and to protect the telecommunications public services market from practices contrary to free and fair competition. OSIPTEL undertakes seven functions:[51]

- ***Regulatory:*** set rates for telecommunications public services, although currently, rates are freely established by each operating company, according to the supply and demand conditions in the market. Nonetheless, OSIPTEL may establish limit rates for certain services.
- ***Normative:*** promulgates rules regarding the issues necessary to regulate in the telecommunications public services market, including rate systems, complaint procedures, OSIPTEL's internal organization, approval process for rules, standards and regulations, guidelines, and criteria for the existence of separate accounting in the operating companies, guidelines for the interconnection of services and networks, quality standards and conditions for service use, relations between the selling and operating companies and

[47] Index Mundi https://www.indexmundi.com/facts/indicators/IT.NET.USER.ZS/rankings
[48] World Bank https://data.worldbank.org/indicator/IT.NET.USER.ZS
[49] Fiber Atlantic http://www.fiberatlantic.com/submarinecablemap/
[50] Ny2o https://www.n2yo.com/satellite/?s=41770
[51] OSIPTEL https://www.osiptel.gob.pe/en/your-osiptel/institutional-information/functions/

between these companies and the users of the service to the commercialization of telecommunications traffic.

- ***Inspecting and Sanctioning:*** impose sanctions and corrective measures to the operating companies and other companies or persons for non-compliance with the applicable standards, regulations, and obligations contained in the concession contracts.
- ***Sanctioning:*** address infractions that may not be provided for in the Telecommunications Law and determine the corresponding sanctions.
- ***User Complaint Resolution:*** acknowledge and resolve the complaints filed by users against operating companies pertaining to service billing or collection, service activation or installation, and service transfer.
- ***Dispute Resolution:*** resolve the conflicts and disputes that may arise, both among operating companies and between these and the users, except intellectual property disputes.
- ***Supervisory:*** verify compliance with the legal, contractual, and technical obligations and other rules on the parts of the operating companies.

Peru hosts ten major television networks, of which one is state-owned. Cable television services are also available. Peru hosts in excess of two thousand radio stations.

4.4 ICT Sectors Profiled

This Resource Guide reviews seven Peruvian development projects, spanning the following ICT sectors:

- *Terrestrial Telecommunications Network Infrastructure: Telephone, Internet, and Broadband*: Peru enjoys reasonable telephone and broadband access. Current focal areas for further enhancing service include the eventual adoption of 5G, expansion of 4G service to rural communities, and, as a result of the COVID-19 global pandemic, a plan for better connectivity nationwide to facilitate e-Government, e-Education, and e-Healthcare.
- *Smart Cities and e-Government*: Peru has several smart cities initiatives, with a particular focus on the adoption of IoT applications, Smart City Peru. In addition, via the nationwide connectivity effort, Todos Conectados, the federal government is also actively supporting the extension of e-Government. Other government projects include centralizing emergency response, creating a digitized urban cadaster, and digital transformation of financial management. A private effort to create a digital commerce ecosystem focused on international trade has been piloted successfully with plans to expand.
- *Cybersecurity:* In 2017, the Peruvian government created the Secretary of Digital Government ('SEGDI') in an effort to regulate cybersecurity and minimize growing threats to digital security. As the country's ICT sector continues rapid growth, the need for more sophisticated cybersecurity tools and protocols increases in parallel and will be an important consideration in the government's transformation of its financial management. In addition, the Peruvian financial services regulator recently promulgated integrated regulations for the management of information- and cybersecurity. All regulated entities must design and implement a compliant information security and cybersecurity management system, including a comprehensive cybersecurity program.

4.5 Projects Profiled

Seven Peruvian ICT projects are profiled following in Table 17:

Table 17: ICT Development Projects -- Peru

Project	Sponsor
Rural 4G PPP	PROINVERSION
Todos Conectados	PRONATEL
Centralized Emergency Response System	PRONATEL
National Urban Cadaster	COFOPRI
Digital Transformation of Financial Administration	Ministry of Economy and Finance (MEF)
The Connected Economy	APESOFT
FSS Cybersecurity	Superintendencia de Banca, Seguros y ALF

Rural 4G PPP	
SUBSECTOR	**Terrestrial Communications Network Infrastructure: Telephone, Internet, and Broadband**
LOCATION	**Peru**
PROJECT VALUE	**$289 million**

PROJECT SUMMARY

- PROINVERSION, the Peruvian Private Investment Promotion Agency, launched a special public tender in May 2021 of two mid-spectrum bands to provide mobile telecommunications services: 60 MHz (30+30 MHz) in the AWS-3 and 30 MHz in the 2.3 GHz radio spectrum bands.
- The Concession duration will be 20 years.
- In exchange for the awarded bands, operators will have to deploy 4G mobile networks that will connect at least 1,561 new rural towns with more than 300,000 inhabitants in total.
- PROINVERSION has scheduled network buildout for 2022 and 2023. The entity estimates a required investment of $289 million.

PROJECT BACKGROUND AND DESCRIPTION

Mobile data consumption has grown by 132 percent annually in Peru since 2015, as shown in Figure 21. Nevertheless, coverage in Peru is considerably lower than in some other countries in the region. Furthermore, the digital divide in Peru is considerable, as shown in Table 18.

The tender includes the auction of two mid-spectrum bands, each with distinct investment requirements. Thus, the project is divided into two contracts, each with unique specifications. Figure 22 shows the potential locations benefiting from the investments and the obligations associated with the award of the regional requirements for the AWS-3 band contract.

Figure 21: Mobile Data Consumption Growth in Peru (source PROINVERSION)

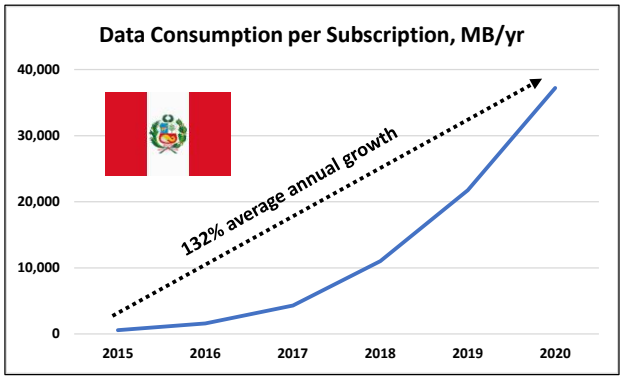
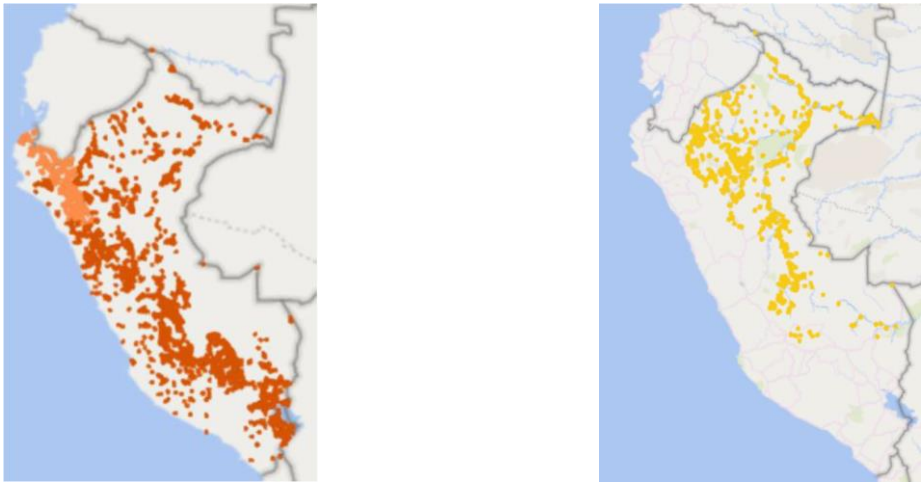


Table 18: Digital Divide in Selected Latin American Countries[52]

Country	Urban Coverage Index	Rural Coverage Index	Digital Divide (Ratio)
Bolivia	0.523	0.211	2.48
Brazil	0.763	0.469	1.63
Costa Rica	0.717	0.432	1.66
Ecuador	0.591	0.305	1.94
Honduras	0.462	0.196	2.37
Paraguay	0.556	0.295	1.89
Peru	0.514	0.207	2.48
Weighted Average	0.710	0.368	1.93

Figure 22: Regional Distribution for the AWS-3 Band Contract



The AWS-3 band contract has the following regional requirements:

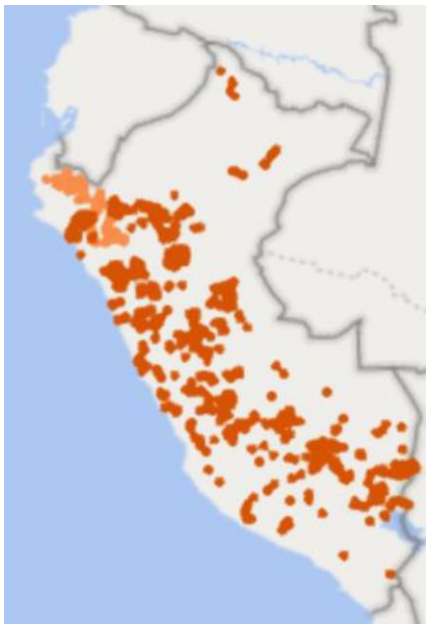
[52] Source: IICA, IADB and Microsoft, Conectividad Rural en América Latina y el Caribe, 2020

- Five hundred ten fixed localities in the regions of Cajamarca, Piura, and Tumbes (shown in light orange in Figure 22);
- Five hundred forty-three minimum discretionary localities to select from a list of 2,044 candidates (shown in dark orange in Figure 22); and
- One hundred eighteen minimum localities in the region of the Valleys of the Apurímac, Ene, and Mantaro rivers and the jungle area of the country, to be selected from a list of candidates, of which 37 must be in the jungle region, 26 in the region of Loreto, four in Madre de Dios, and seven in Ucayali (shown in yellow in Figure 22).

The AWS-3 band comprises one block of 30+30 MHz. The radio spectrum includes 1,750-1,780 MHz and 2,150-2,180 MHz.

Figure 23 shows the potential locations benefiting from the investment and the obligations required in exchange for the 2.3 GHz band contract award.

Figure 23: Regional Distribution for the 2.3 GHz Band Contract



The 2.3 GHz band contract, a single block, has the following regional requirements:

- 156 fixed localities in the regions of Cajamarca and Piura (shown in light orange in Figure 23); and
- 234 minimum discretionary localities selected from a list of 881 candidates (shown in dark orange in Figure 23).

The AWS-3 band and the 2.3 GHz band contracts share some similar requirements:

- The rural localities selected cannot have existing mobile coverage (2G, 3G, or 4G);
- Minimum download speeds are stipulated to be 6 Mbps; minimum upload is 1 Mbps; and
- Minimum service availability, both voice, and data is 96 percent.

Table 19 shows the minimum requirements for prequalification to participate in the tender process.

Table 19: Minimum Requirements for Bidders

Requirement	AWS-3 Band Contract	2.3 GHz Band Contract
LTE Experience	At least five years in Peru or other countries	
Number of Subscribers	At least three million subscribers in Peru or other countries	
Fixed Assets	$175 million	$55 million
Net Worth	$110 million	$35 million
SPV Equity	$44 million	$14 million

Contracts will be awarded to the bidders with the highest ratings, based on the number of localities offered and technical scores assigned by the group of localities.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

PROINVERSION initially scheduled the project for launch in October 2020 but delayed initiation until May 2021 due to the COVID-19 global pandemic.

The schedule published in May 2021 articulates:

- August 2021: response to questions and submission of qualifications;
- September 2021: submission of proposals;
- Contract signing date to be determined; and
- Network buildout: two years, approximately 2022 to 2023.

PROJECT COST AND FINANCING

PROINVERSION estimates the investment required to be $289 million, distributed approximately as:

- $212 million for the AWS-3 band contract; and
- $77 million for the 2.3 GHz band contract.

Required project investments will be the full responsibility of contract holders.

U.S. EXPORT OPPORTUNITIES

The project is an opportunity for mobile operators interested in entering the Peruvian Mobile market to compete for a spectrum award. In addition, the project provides export opportunities for U.S. companies, including:

- Fiber optic network-backhaul hardware, software, and installation and maintenance services;
- Small- and pico-cell, low-power base station hardware, software, and installation and maintenance services;
- Multiple-input/multiple-output (MIMO) technology, antenna modules, and installation, maintenance, and advisory services;
- Beamforming technology and advisory services;
- Centralized radio network (C-RAN) technology, baseband unit hardware and software, and advisory services; and
- Giga-bit WiFi technology, hardware, software, and advisory services.

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
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Todos Conectados	
SUBSECTOR	**Terrestrial Communications Network Infrastructure: Telephone, Internet, and Broadband**
LOCATION	**Peru**
PROJECT VALUE	**$90 million**

PROJECT SUMMARY

- In February 2021, the government of Peru, via emergency decree, approved a program to reduce the digital divide during the COVID-19 global pandemic.
- The program, known as "Todos Conectados" (All Connected), has three components:
  - Internet access for over 1,000 public institutions via satellite connection in remote locations in the upper Amazon river basin;
  - Implementation and operation of over 6,500 free WiFi hot spots in the town squares of rural localities; and
  - Implementation of over 1,000 digital access centers equipped with computers, tablets, and other digital equipment.

PROJECT BACKGROUND AND DESCRIPTION

The Peruvian government established by Decree in 2007 the Telecommunications Investment Fund (FITEL)[53] to provide universal access to telecommunications services throughout the national territory. In 2018, the Ministry of Transportation and Communications MTC[54] absorbed FITEL. At the same time, the MTC created the National Telecommunications Program, PRONATEL[55], whose objective is to provide universal access to telecommunications services. Other functions of PRONATEL include:

- Development of Broadband connectivity in rural areas where operators are not targeting network development in the medium-term;
- Promotion of new services, content, applications, and digital skills; and
- Reduction of the digital divide in coordination with other public entities.

Through FITEL and more recently PRONATEL, Peru has been developing broadband telecommunications infrastructure projects to provide rural internet access. Lessons learned to date indicate that telecommunications infrastructure alone does not guarantee a reduction in the digital divide. Further, the COVID-19 response imposed isolation and social distancing measures, highlighting the need for the entire Peruvian population to have access to telecommunications

[53] FITEL – Fondo de Inversión en Telecomunicaciones
[54] MTC – Ministerio de Transportes y Comunicaciones
[55] PRONATEL – Programa Nacional de Telecomunicaciones

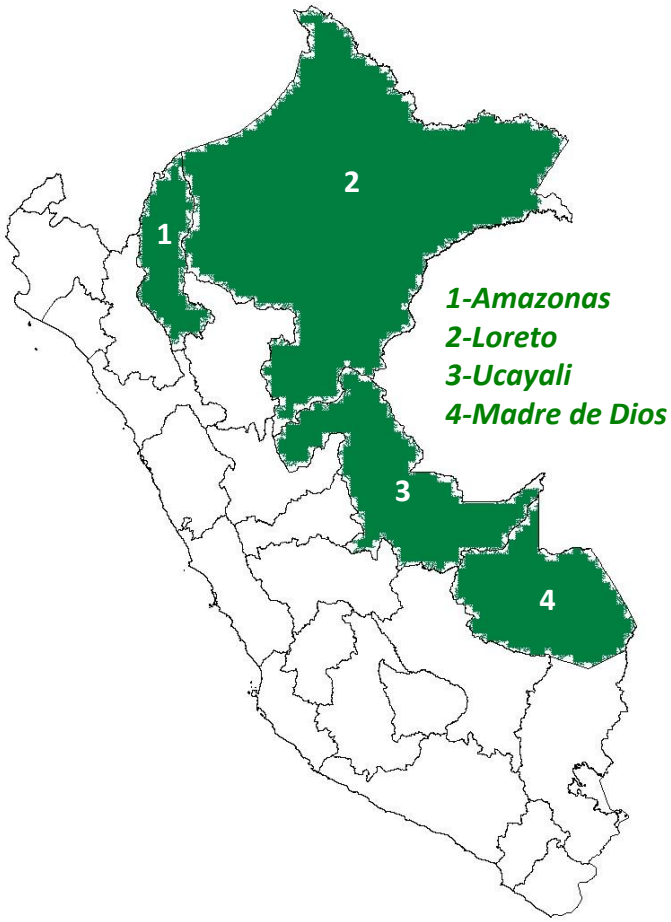
services. These services are now an essential need for executing daily activities. Technological tools deliver and provide access to distance education, virtual medical consultations, and electronic commerce.

As a result, the government adopted Urgent Decree 014/2021 in February of 2021 to roll out internet connections in a program known as "Todos Conectados" (All Connected). Todos Conectados will reach over 6,500 rural locations by the end of 2023. The program comprises three components:

1 Internet Access via Satellite Connection in the Amazon Region

The first component, known as "Conecta Selva" (Connected Jungle), will provide internet access in remote areas of the departments of Loreto, Ucayali, Madre de Dios, and Amazonas, all in the upper Amazon basin, as shown in Figure 24.

Figure 24: Departments Included in "Conecta Selva"



Under this component, PRONATEL has the authority to contract internet access services for public educational institutions – either publicly or privately managed - and public health establishments in isolated locations. The component includes:

- Creation of internet services for connectivity and social development in selected, isolated localities;
- Creation of a communications network for the integral connectivity and social development of the localities of the river basins of Napo and Putumayo and the river basins of Huallaga, Marañón, and Amazonas in the Yurimaguas-Iquitos section; and
- Creation of a communications network for the integral connectivity and social development of the district of Manseriche, province of Datem del Marañón, in the department of Loreto.

In February 2021, the government originally announced goals to provide Internet access to 1,151 public institutions in 860 locations. In June 2021, the MTC announced more ambitious goals of providing Internet access for this component of reaching:

- 1,034 isolated locations in the Amazon;
- Nearly 200 thousand Peruvians; and
- 1,316 public institutions (1,212 educational institutions and 104 health centers).

Conecta Selva launched during a ceremony in June 2021. Dignitaries at the ceremony included the Minister of Transportation and Communications, the Regional Governor of Ucayali, the Deputy Minister of Communications, congresspeople, and local authorities.

2 Free WiFi Hot Spots in the Town Squares of Rural Localities

The second component of Todos Conectados is the implementation and operation of 6,531 wireless points located in the squares of rural localities. Local inhabitants will have direct and free access to the Internet at estimated speeds between 20 and 40 Mbps. The proposed solution is known as "Public Spaces of Digital Access" (EPAD[56]).

The MTC estimates that more than 2.2 million people will benefit from this component. The regions of Huancavelica, Ayacucho, Apurimac, Lambayeque, Cusco, and Lima will be the first to have this service. The next rollout phase will include the regions of Junín, Puno, Tacna, Moquegua, Huánuco, and Pasco.

PRONATEL is selecting EPAD sites based on two criteria:

- No current internet access; and
- Not among localities included in the commitments assumed by the operators of public telecommunications services with completion scheduled in the next two years.

[56] EPAD – Espacios Públicos de Acceso Digital

3 Digital Access Centers

Digital Access Centers (CADs[57]), as shown in Figure 25, are environments enabled with computers, tablets, and other equipment intended to contribute to digital skills development, expansion of internet access, and facilitation of enhanced rural internet access. Component 3 of "Todos Conectados" will roll out approximately 1,000 CADs in rural localities across Peru.

Figure 25: Example of a Digital Access Center

PROJECT STATUS AND IMPLEMENTATION TIMELINE

Urgent Decree 014/2021, initiating "Todos Conectados," was published on February 4, 2021. The MTC has announced targets for the project's three components through the end of 2023. The project schedule calls for approximately half of the program to be implemented by year-end 2021.

The Urgent Decree gave PRONATEL special relief from standard contracting requirements through June 1, 2021. Contracting of remaining items under the program will follow standard public sector contracting regulations through the end of the program.

PROJECT COST AND FINANCING

The MTC has announced a budget of 180 million soles (approximately $45 million) to implement "Todos Conectados" during 2021. Of this amount, 130 million soles are from PRONATEL's 2021

[57] CAD – Centro de Acceso Digital

budget, and 50 million soles are from MTC's budget. The program required no additional public sector financing during 2021.

The 2022 and 2023 MTC budgets will likely provide future program funding. The MTC has not announced a global budget for "Todos Conectados." Still, the technical targets for 2021 represent about one-half of the total program's goals. Hence we estimate the total budget to be $90 million.

U.S. EXPORT OPPORTUNITIES

The network roll-outs for "Todos Conectados" offers several opportunities for U.S. companies, including:

- Antennae systems, hardware, and software;
- Fiber optic network hardware and spares;
- Network and location system hardware and software;
- Small- and pico-cell technologies and equipment;
- Wireless telecommunications equipment;
- Renewable ICT technologies, including photovoltaics and battery storage solutions; and
- Advisory services.

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
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Centralized Emergency Response System	
SUBSECTOR	**Smart Cities and e-Government**
LOCATION	**Peru (Greater Lima Area)**
PROJECT VALUE	**$45 million**

PROJECT SUMMARY

- This project will integrate, into a single 911 center, Peru's principal existing emergency response numbers: the national police, the mobile emergency care system, and the corps of voluntary firefighters.
- The project covers the greater Lima area and seeks to reduce dispatch times from a current baseline of 17 minutes to 3.5 minutes.
- The project comprises six components:
  - Physical Infrastructure;
  - Integrated Platform;
  - 911 Response Protocols;
  - Interconnection of Police Cameras;
  - Use and Awareness of 911 Platform; and
  - Project Management.
- A $36 million World Bank loan will provide the majority of project funding.

PROJECT BACKGROUND AND DESCRIPTION

Peru has three principal entities serving as first responders to emergencies:

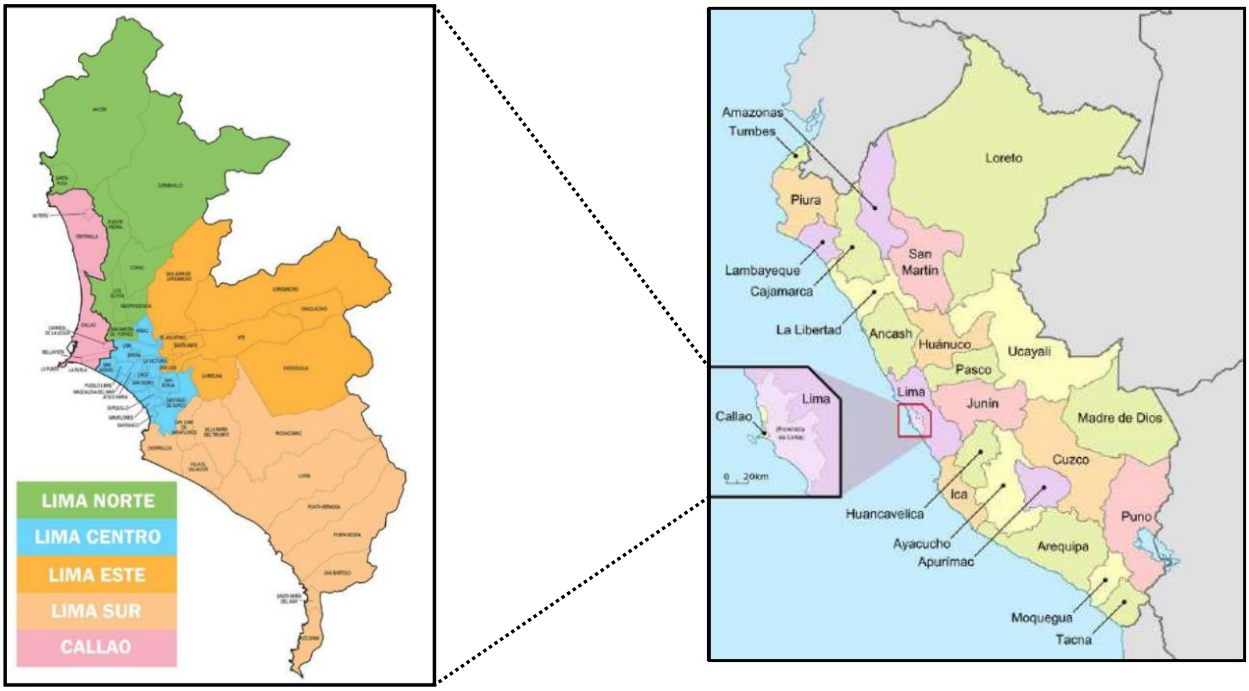
- The national police of Peru, under the Ministry of Interior (MoI);
- The Peruvian corps of voluntary firefighters, also under the MoI; and
- The mobile emergency care system, under the Ministry of Health (MoH).

Each first response unit has a different emergency response contact number, which creates confusion among the citizens regarding the most suitable number to call for a given emergency. In addition, the lack of a unique contact point leads to delays in answering calls and delivering efficient emergency service responses. Further, each first response unit has its own communications systems and infrastructure to respond to emergencies and urgencies. This structure reduces coordination among entities involved and duplicates early response efforts. Currently, the national police receive over 75 percent of the country's emergency and urgency calls.

The emergency response centralization project covers the greater Lima area, shown in Figure 26. Currently, the average response time (the time between responding to an emergency call and arriving at the place of the incident) in the greater metropolitan area is 45 minutes. This time is

much higher than in neighboring Ecuador, where the average response time is less than 13 minutes. Average priority one (life-threatening situation) response times in major U.S. cities range from 5 to 12 minutes.

Figure 26: Greater Lima Area

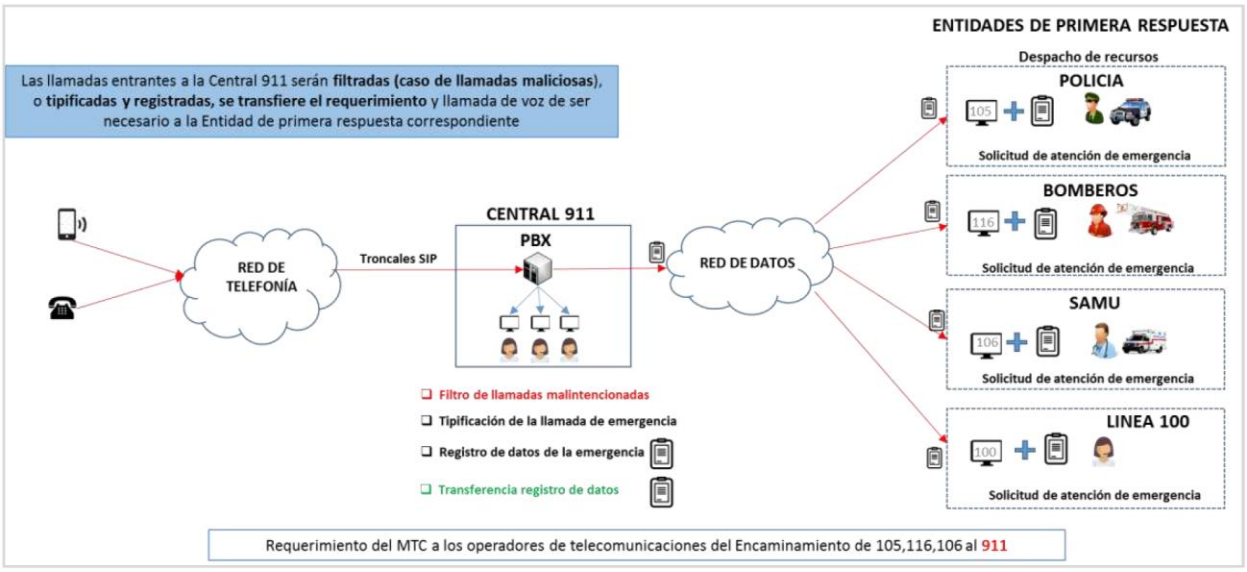


Components of the average response time in the greater Lima area include:

- Average call answering time (Phase 1 – the time taken by the operator to pick up an emergency or urgency call) of 10 minutes;
- Average duration of the connection time (Phase 2 - the time taken by the operators to register all the data from an emergency or urgency call, categorize it, and transfer it to the dispatchers) of 3 to 4 minutes;
- Average dispatch time (Phase 3 the time taken by the dispatchers to evaluate the emergency based on the information sent by the operator and to send this information to the response unit(s) that will intervene) of another 3 to 4 minutes; and
- 'In transit time' (Phase 4 - the time from which a first response unit effectively dispatches a response unit to the site of an emergency and the time it arrives on the scene), the majority of the overall emergency response time, of an estimated at 28 minutes.

As shown in Figure 27, the proposed project seeks to integrate the three existing emergency response numbers into a single 911 center: the national police of Peru, the mobile emergency care system, and the Peruvian corps of voluntary firefighters. The project also seeks to reduce emergency call management time (Phases 1 through 3 above) to 3.5 minutes from the existing baseline of about 17 minutes.

Figure 27: Integrated Project Framework Structure



The project comprises six components:

Component 1: Physical Infrastructure
Component 1 focuses on constructing the 911 center and providing all the furnishings needed to operate the 911 emergency response service in the Lima Metropolitan area and Callao. The 911 Center and the new national emergency operations center will be constructed 100m apart. The location is not classified as having a danger zone for mudslides, landslides, or debris floods.

Component 2: Integrated Platform
Component 2 will supply the necessary digital infrastructure to be housed at the 911 center to respond to emergencies in a coordinated manner. This component includes a geolocation system that will automatically pinpoint all calls received by the 911 center. Technical specifications of all equipment will promote open standards and, therefore, interoperability with future 911 centers planned in other parts of the country.

Subcomponent 2.1: 911 Platform - This subcomponent will supply and install software and hardware for 911 operator communications. Further, the technologies will support the transfer of standardized and unified relevant information to the dispatchers. The 911 platform will receive, categorize, transfer, and perform traceability of the calls sent to the first response units.

Subcomponent 2.2: Data communications equipment (Data Center) - This subcomponent will supply and install a data center complete with adequate backup, power systems, and cooling for optimal performance. The data center will be housed within the 911 center and will include the following: equipment, routers, switches, firewall, servers, and databases, and the necessary communications cabinets.

Subcomponent 2.3: Telecommunications networks - This subcomponent will finance installing an internal, dedicated communications network within the 911 center to transmit data, voice, and video between the user terminals, the 911 platform, and the data center. The network will include various security measures, including firewalls, web filters, and encrypted communications mechanisms.

Component 3: 911 Central Response Protocols
Component 3 aims to increase coordination between the 911 operators and the first response units by designing and developing standardized protocols.

Component 4: Interconnection of the Video Cameras of National Police to the 911 Platform
Component 4 aims to increase the efficiency in response time by integrating the national police video cameras with the 911 platform.

Component 5: Use and Appropriation of 911 Platform
Component 5 focuses on training and general communications and public relations through two subcomponents:

Subcomponent 5.1: Capacity Building - This subcomponent will build capacity and train vital participating entities in the adequate usage of the 911 platform for emergency management and response, including emergency response protocols.

Subcomponent 5.2: Raise Awareness of the 911 Emergency Response System - This subcomponent will finance awareness campaigns in the Lima Metropolitan area and Callao concerning the importance of the 911 service. The communication campaigns and citizen engagement activities under this subcomponent will reduce the number of malicious and non-emergency calls and promote the correct use of the 911 emergency number.

Component 6: Project Supervision and Management, and Technical Studies
Component 6 provides project management and supervision, including preparation and review of required technical studies.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

Peru and the World Bank signed the loan supporting the project, and the transaction closed on July 16, 2020. Implementation is scheduled for 2020 to 2024. Table 20 describes the expected annual disbursements of the World Bank IBRD loan.

The contract to prepare technical specifications for the integrated emergency response platform was awarded on June 7, 2021. Contracting of the integrated emergency response platform is scheduled to commence in the fourth quarter of 2021.

Table 20: Expected Annual Disbursements of the Project Loan

Year	Annual, $ Million	Cumulative, $ Million
2020	0.3	0.3
2021	4.8	5.1
2022	16.5	21.6
2023	12.6	34.4
2024	1.9	36.3

PROJECT COST AND FINANCING

Project financing consists of a $36.32 million IBRD loan plus $8.76 million counterpart funding totaling $45.08 million. Table 21 describes a breakdown of project funding by component and funding source. ICT expenditures represent 55 percent of the total project cost, spanning ICT infrastructure, ICT services, and other ICT (31, 22, and 2 percent, respectively).

Table 21: Project Cost by Component and Funding Source

Component	Project Financing, $ Million		
	World Bank	Counterpart	Total
1 Physical Infrastructure	14.3	2.6	16.9
2 Integrated Platform	17.1	3.1	20.2
3 911 Response Protocols	0.1	0.0	0.1
4 Interconnection of Police Cameras	1.8	0.3	2.1
5 Use and Awareness of 911 Platform	1.4	0.3	1.7
6 Project Management	1.5	2.5	4.0
Total	**36.3**	**8.8**	**45.1**

U.S. EXPORT OPPORTUNITIES

U.S. export opportunities for the project include:

- Hardware:
  - Datacenter componentry (servers, racks, power, HVAC, site security, et al.);
  - Networking hardware; and
  - Fiber optic cabling and components.
- 911 Platform Software Solutions.
- Network security measures.
- Advisory services:
  - Emergency response center design;
  - Capacity building; and
  - Public awareness campaigns.

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
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National Urban Cadaster Project	
SUBSECTOR	**Smart Cities and e-Government**
LOCATION	**Peru**
PROJECT VALUE	**$32 million**

PROJECT SUMMARY

- Only eight of Peru´s 522 urban municipalities have complete and updated cadasters.
- The project objective is to improve the coverage of urban cadaster services in 22 selected municipalities to enhance revenue generation and urban management.
- The project comprises three components:
  - Strengthening municipal systems in the 22 selected municipalities;
  - Strengthening the national institutional framework; and
  - Project management.
- A $50 million World Bank loan plus $30.9 counterpart funding supports the project.
- ICT expenditure represents 39 percent of the project's budget.

PROJECT BACKGROUND AND DESCRIPTION

Peru has shifted from just over 50 percent urban population in 1965 to almost 80 percent today. The urban population continues to urbanize at a rate of 1.72 percent annually, slightly higher than the Latin American average of 1.49 percent per year.

Only eight of the 522 cities in the country have complete and updated cadasters. Municipalities may significantly improve their capacity to manage urbanization more sustainably by leveraging updated cadastral information in urban areas.

The primary actors involved in developing policies and enacting programs for urban cadasters and land use planning are the Ministry of Housing, Construction and Sanitation (MVCS) and the municipalities. The MVCS is responsible for setting the policies, standards, guidelines, and technical specifications related to the national urban cadastral information. The Ministry designates the Agency for Informal Property Formalization (COFOPRI) as the entity responsible for implementing, managing, and updating the national urban cadaster and as a platform to improve the policy actions and investments of government agencies at all levels.

This project aims to improve the coverage of urban cadaster services in selected municipalities to enhance local government capacities for revenue generation and urban management. The project will work with 22 prioritized cities located in 4 provinces: Lima, Chiclayo, Lambayeque, and Piura. The 22 were selected based on the following criteria:

- Potential for increased property tax collection;
- Potential for fiscal decentralization (municipalities with nonexistent or outdated cadasters, significant potential revenue gap, within main cities);
- Areas affected by the 2017 flooding where reconstruction efforts are taking place;
- Rapid urban development and expansion; and
- Municipalities where the MVCS is supporting the development or updating of urban plans.

The 22 selected municipalities and their respective provinces are identified in Table 22 and mapped in Figure 28.

Table 22: Municipalities Selected for the Project

Districts of Lima	Other Municipalities
Breña	Chiclayo, Chiclayo
Chorrillos	José Leonardo Ortiz, Chiclayo
Comas	Pimentel, Chiclayo
El Agustino	Lambayeque, Lambayeque
Independencia	26 de Octubre, Piura
La Victoria	Castilla, Piura
Lima Metropolitana	Catacaos, Piura
Los Olivos	Piura, Piura
San Juan de Miraflores	
San Luis	
San Martin de Porres	
San Miguel	
Surquillo	
Villa El Salvador	

Figure 28: Location of Project Sites

The project comprises three components:

Component 1: Strengthening Municipal Systems, Services, and Capacities to Generate and Maintain Urban Cadasters in Project Municipalities

Subcomponent 1.1: Creation of an Urban Cadastral Information System for Tax Purposes and Urban Management in Selected Municipalities

This sub-component includes the following activities:

- A communication campaign that targets messaging for men and women about the project;
- The implementation of cadastral surveys in project municipalities, including the collection of property status information, disaggregated by gender;
- The generation of property valuation maps in project municipalities;
- The updating of municipal databases used for property tax collection based on the new cadastral information; and

- The acquisition of hardware and software required to use and maintain the cadaster system at both the national and local levels.

Subcomponent 1.2: Strengthening Municipal Capacity
This sub-component includes in-person training and creating a virtual learning platform to build capacities in the selected municipalities to collect, use, maintain, and update cadastral information. Further, the subcomponent focuses on using this information for property tax collection, land use planning, urban and financial management, and disaster risk management.

Component 2: Strengthening of the National Institutional Framework
Component 2 includes the following activities:

- Updating of national-level methodologies, procedures, and standards for urban cadastral formation, maintenance, and dissemination;
- Updating of the property valuation methodology to reflect market prices;
- Development and implementation of a national-level cadastral information system;
- Development of guidelines for the use of climate and hazard data with the cadaster data for disaster risk management decisions; and
- Institutional strengthening activities for the MVCS and COFOPRI in urban management.

Component 3: Project Management
Component 3 focuses on project management and the successful delivery of project objectives.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

Peru and the World Bank signed the project loan on May 22, 2020. Implementation is scheduled for 2020 to 2025. Table 23 describes the expected annual disbursements of the World Bank loan. ICT expenditures are planned for the latter half of the project.

Table 23: Expected Annual Disbursements of the Project Loan

Year	Annual, $ Million	Cumulative, $ Million
2020	0.3	0.3
2021	5.0	5.3
2022	9.5	14.8
2023	10.0	24.8
2024	14.1	38.9
2025	11.1	50.0

PROJECT COST AND FINANCING

Project financing consists of a $50 million IBRD loan plus $30.9 million counterpart funding from the Peruvian Ministry of Finance. Table 24 provides a breakdown of project funding by component and funding source.

Table 24: Project Cost by Component and Funding Source

Component	Project Financing, $ Million		
	World Bank	Counterpart	Total
1 Strengthening Municipal Systems	44.7	24.4	69.1
1.1 22 Cadastral Information Systems	*40*	*23.6*	*63.6*
1.2 Strengthening Municipal Capacity	*4.7*	*0.8*	*5.5*
2 National Institutional Framework	5.3	1.0	6.3
3 Project Management		5.5	5.5
Total	**50.0**	**30.9**	**80.9**

Of the total project cost of $80.9 million, ICT expenditure represents 39 percent, or roughly $32 million. The majority of the remaining budget supports cadaster surveys in the 22 municipalities.

U.S. EXPORT OPPORTUNITIES

U.S. company export opportunities for the project include:

- SaaS and cloud-based solutions for document management;
- Document management services to conserve, digitize, organize, index, and migrate cadaster information;
- GIS cadaster solutions;
- PaaS and virtual cloud-based servers; and
- Specialized consulting services to support environmental institutions and cadaster development.

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
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Digital Transformation of Financial Administration	
SUBSECTOR	**Smart Cities and e-Government**
LOCATION	**Peru**
PROJECT VALUE	**$92.5 million**

PROJECT SUMMARY

- The Peruvian Ministry of Economy and Finance recently approved a digital transformation master plan.
- The Ministry approached the IADB for support in implementing new platforms and solutions within the project.
- The IADB loan comprises four components:
  - Improvement of the functional processes for financial administration;
  - Modernization of the Ministry's computer systems;
  - Expansion of the technology infrastructure; and
  - Project management.

PROJECT BACKGROUND AND DESCRIPTION

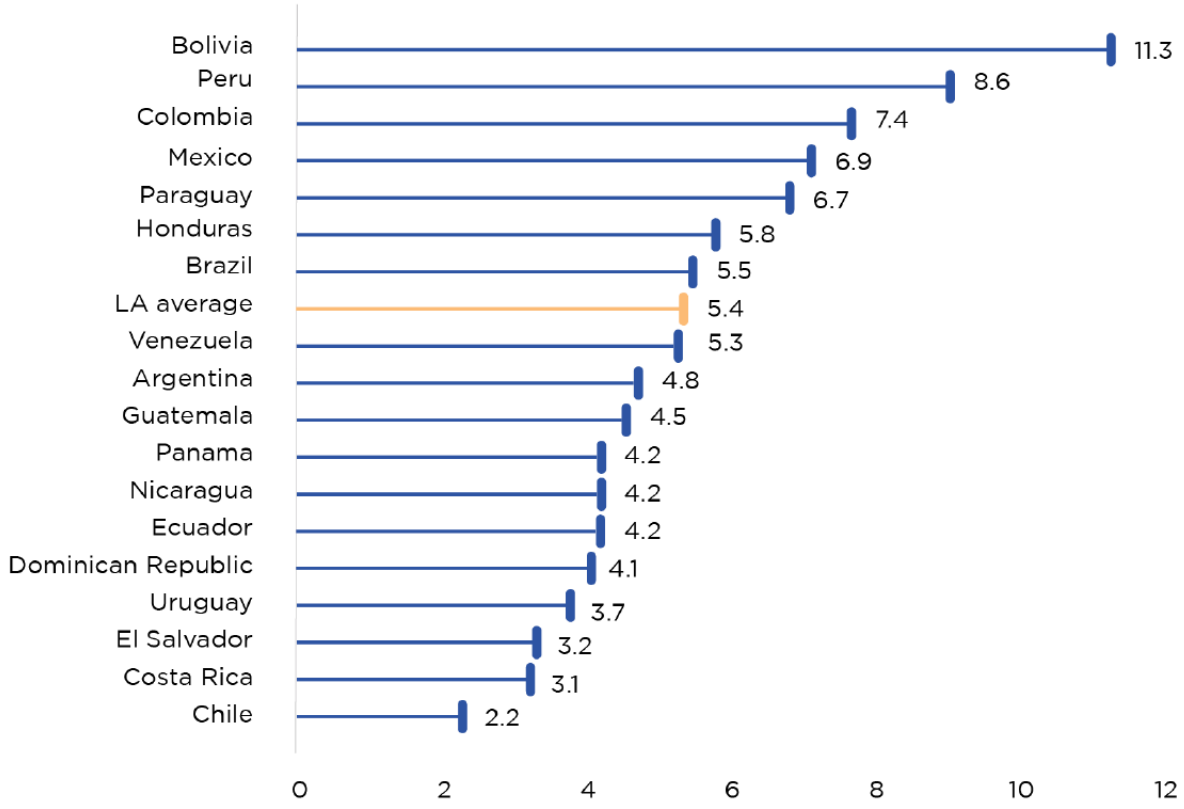
In early 2021, the Ministry of Economy and Finance (MEF) adopted a digital transformation master plan. The plan establishes six ambitious goals:

- Improve the level of leadership and digital capacity of human resources to facilitate the digital transformation of the entity.
- Redesign the organization's internal processes and procedures to facilitate the digital transformation of the entity.
- Develop user-friendly digital services to support the management of institutions at all three levels of government.
- Develop a comprehensive model of digital security focused on risks to manage information security, cybersecurity, and cyber-defense.
- Develop a modern technological infrastructure model which provides flexible, scalable, and interoperable public digital solutions.
- Develop innovative historical, predictive, and prescriptive data analysis models to improve decision-making capacity in financial and economic policies at all three levels of government.

The digital transformation master plan emphasizes using technology to improve user experiences for all levels of government, private institutions, and citizens. The master plan cites a 2018 report published by the IADB titled *Wait no More: Citizens, Red Tape, and Digital Governance*. Figure

29 depicts the average number of hours required to complete government transactions in Latin American countries.

Figure 29: Hours to Complete Government Transactions in Latin American Countries



In 2018, Peru established a new legal framework for the financial administration of the public sector aimed at improving the management, productivity, efficiency, and effectiveness of public entities. Further, the framework incorporated strengthening the interoperability and integration between systems and entities. The new legal framework establishes new functionalities MEF's existing systems do not possess, including:

- Budget execution over a multi-year horizon;
- Implementation of budgetary amendments;
- Effective cash management;
- Automatic online accounting;
- Integration of debt management functions corresponding to the "front/middle/back office";
- Central management of the payroll of all public entities;
- Administrative management of public assets;
- Budget forecasting;
- "Workflow" modality with staged expenditures and online cost analysis; and
- Direct processing of vendor invoices.

In addition to the need for new system functionalities, MEF has observed weaknesses in its existing technology infrastructure in areas including:

- Insufficient security for access to applications given platform obsolescence;
- Insufficient processing and storage capacity to support the new functionalities;
- Lack of availability of tools for reporting and data mining;
- Existing integration mechanisms impeding interoperability and new connections; and
- Ineffective documentation and methodologies for developing, monitoring, and maintaining systems.

This project comprises four components:

Component 1: Improvement of the Functional Processes for Financial Administration
Component 1 includes the following activities:

- Develop a functional model for all macro processes related to programming, execution, monitoring, and analysis of expenditures, public debt, payroll, and administration of assets;
- Revise and update classification tables for all accounting operations;
- Ensure compliance with the new legal framework for the financial administration of the public sector;
- Develop a methodology for estimating and forecasting public costs;
- Implement a training and certification program for personnel; and
- Implement a change management program to support the transition.

Component 2: Modernization of MEF's computer systems
Component 2 includes the following activities:

- Develop new modules to implement the macro processes in the functional model, including management of master tables, budget, accounting, treasury, debt, payroll, administrative oversight of assets, cost management, and integration with supply systems and public investment;
- Implement electronic files for all processes and documents; and
- Develop an invoice console for direct registration of the suppliers in the system.

Component 3: Expansion of the technology infrastructure
Component 3 includes the following activities:

- Acquire and install new hardware, including servers, storage, telecommunications, and workstations;
- Implement a cloud-based environment to increase the processing and storage of data;
- Implement a monitoring tool to improve user experience;
- Expand data analytics capacity and tools for reporting and data mining;
- Develop and implement a cybersecurity strategy (software/hardware) with identity management for authentication and authorization; and

- Develop and implement an information exchange platform with other internal and external entities and systems through the national interoperability platform.

Component 4: Project Management
Component 4 focuses on project management and monitoring the achievement of the project goals.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

In February 2021, Peru approved MEF's digital transformation master plan for 2021-2023. The project specifies an implementation timeline through the end of 2023. An IADB loan currently in preparation contemplates later phases of MEF's E-Government development plan scheduled to start in 2022.

PROJECT COST AND FINANCING

The estimated project cost has evolved during the project definition and preparation phase. The IADB initial project profile estimated a project cost of $75 million, of which $60 million would be provided by an IADB loan and $15 million would be counterpart funding. An updated project estimate suggests a $74 million IADB loan and $18.5 million counterpart funding for a total cost of $92.5 million is required.

U.S. EXPORT OPPORTUNITIES

U.S. export opportunities for the project include:

- Hardware:
  - Datacenter componentry (servers, racks, power, HVAC, site security, et al.); and
  - Digital operations center equipment (networking hardware, fiber optic cabling, components, power management hardware, et al.)
- Software:
  - Access to Software as a Service (SaaS) and related scalable programs;
  - Custom software/applications; and
  - Cybersecurity solutions.
- Advisory services:
  - E-Government design and development services and consulting;
  - Networking design, implementation, and security; and
  - Application design, development, testing, and implementation.

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
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The Connected Economy	
SUBSECTOR	**Smart Cities and e-Government**
LOCATION	**Peru**
PROJECT VALUE	**$11 million**

PROJECT SUMMARY

- The Connected Economy is a virtual business ecosystem supporting the expansions of small- and medium-sized Peruvian companies into global markets.
- The project is structured as a virtual exposition with five key components:
  - A global economic center;
  - Digital showrooms;
  - A conference hall;
  - An exhibition center; and
  - A trade center.
- A consortium of companies is sponsoring The Connected Economy. The consortium has received the endorsement of the Peruvian software association, APESOFT, and has signed a memorandum of understanding with the Ministry of Foreign Affairs.

PROJECT BACKGROUND AND DESCRIPTION

APESOFT[58], the Peruvian software association, is endorsing "The Connected Economy" (TCE), a virtual business ecosystem. TCE is aimed at micro-, small-, and medium-sized companies (MiniSMEs[59]) in Peru to facilitate their opening to new markets around the globe. TCE is an innovative model of a connected, digital, and global economy.

TCE is structured as a virtual exposition with five key components:

- ***Global Economic Center***: Meeting space with government institutions and public-private entities organized by geographic regions for economic development;
- ***Digital Solution***: Showrooms to hold one-on-one and one-to-many meetings with prospective clients, distributors, or partners, including the ability to close deals and carry out transactions in real-time;
- ***Conference Hall***: Space for seminars, workshops, or conferences;
- ***Exhibition Center***: An unlimited number of virtual pavilions; and
- ***Trade Center***: An economic matchmaking space with a search engine to facilitate the identification of potential clients or business partners within specific business sectors.

[58] APESOFT – Asociación Peruana de Software
[59] MiniSMEs – Mini-, small-, and medium-sized enterprises

One or more of TCE's components also can be structured into virtual fairs, beyond providing permanent support for global trade. The structure of TCE's five components is depicted in Figure 30.

Figure 30: TCE Structure of Five Components

TCE is an initiative of a consortium of companies known as "Perú con el Mundo[60]." Member companies of the consortium include:

- iDMR Solutions;
- Llona & Bustamonte Abogados;
- We2Video;
- WWCalls; and
- X Quadra Media.

[60] Perú con el Mundo – Peru with the World

TCE was piloted in 2019. The pilot included Peruvian MiniSMEs in key export sectors such as shoes, jewelry, and accessories. Companies participating in the pilot included:

- Alpacol Garments in Alpaca;
- Butrich Shoes;
- Claire de Luna Sleepwear;
- Curtiembre Austral Leather Goods;
- Fidenza Fantasy Jewelry;
- Lobo Black Shoes;
- Sandder TNT Safety Shoes; and
- Zoe Children's Clothing.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

TCE was piloted and demonstrated in July 2019 with the participation of Latin Magazine and other sponsors.

In February 2021, the Ministry of Foreign Affairs signed a collaboration agreement with "Perú con el Mundo" to support the internationalization of Peruvian MiniSMEs, as part of broader efforts to promote trade, investment, and tourism. This agreement also includes mechanisms and channels for:

- Disseminating business opportunities for MiniSMEs;
- Gathering essential information on economic and financial current events;
- Providing links for key tax, legal, and labor issues; and
- Facilitating participation in virtual fairs and exhibitions.

The consortium is planning series A and B financing rounds described below.

PROJECT COST AND FINANCING

ADEX, ITP, and KPMG sponsored the pilot demonstration.

The next two financing rounds contemplated by the project consortium involve:

- ***A Round:*** Raise $1,000,000 to enlist 1,000 Peruvian MiniSMEs, populate the Global Economic Center, and carry out at least 12 virtual trade fairs; and
- ***B Round:*** Raise $10,000,000 to increase the Peruvian MiniSME subscriptions to at least 25,000 companies and structure the first six virtual trade fairs as recurring events, using the entire suite of TCE components and capabilities.

U.S. EXPORT OPPORTUNITIES

Opportunities for U.S. companies related to the TCE ecosystem include:

- TCE platform expansion and solutions:
  - Custom software/applications/programming; and
  - Cloud computing solutions.
- Services for Peruvian MiniSMEs:
  - Advisory services; and
  - Distribution and logistics.
- Export opportunities resulting from participating in the TCE ecosystem.

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
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Financial Sector Cybersecurity Management	
SUBSECTOR	**Cybersecurity**
LOCATION	**Peru**
PROJECT VALUE	**$20 million**

PROJECT SUMMARY

- The Peruvian financial services regulator recently promulgated integrated regulations for the management of information security and cybersecurity.
- All regulated entities must design and implement a compliant information security and cybersecurity management system.
- The regulated entities must also implement a comprehensive cybersecurity program.
- Internal and external audits will evaluate compliance during the 2022 fiscal year audit cycle.

PROJECT BACKGROUND AND DESCRIPTION

In February 2021, the Peruvian financial services regulator SBS[61] adopted Regulation 504-2021.

Regulation for the Management of Information Security and Cybersecurity
The code entered into force on July 2, 2021, excepting a few conditions with later implementation timelines. It replaces prior instructions from the regulator published in 2009. Following are summaries of key provisions and requirements found in the regulation.

Board and Management Responsibilities
The board of directors is responsible for approving and facilitating the actions to implement an information security and cybersecurity management system (ISCMS) tailored to its needs and risk profile. Essential board functions include:

- Approve policies and guidelines for the implementation of the ISCMS and its continuous improvement,
- Allocate the technical, personnel, and financial resources required for its implementation and proper functioning, and
- Approve the organization, roles, and responsibilities for the ISCMS, including information dissemination throughout the organization and training guidelines, emphasizing a thorough understanding of the risks involved.

General management is responsible for implementing the ISCMS following the provisions of the board of directors and the provisions of the Regulations. In addition, managers of business units

[61] SBS – Superintendencia de Banca, Seguros y Administradores Privados de Fondos de Pensiones

and support functions must support the ISCMS and manage the associated risks within their responsibilities.

The regulation confers specific responsibilities to the Risk Committee relating to information security and cybersecurity:

- Approve the ISCMS strategic plan and recommend actions to be taken;
- Approve the training plan to ensure that staff, management, and the board of directors have the necessary competencies in information security and cybersecurity; and
- Foster a culture of risk awareness and the need for appropriate measures for risk prevention.

For compliance, regulated entities may assign these functions to a specialized committee in information security and cybersecurity. For smaller entities without a Risk Committee, management may take on the functions.

Information Security and Cybersecurity Management System (ISCMS)
The regulation defines an ISCMS as the set of policies, processes, procedures, roles, and responsibilities designed to:

- Identify and protect information assets;
- Detect security events; and
- Anticipate response and recovery to cybersecurity incidents.

The ISCMS establishes that all companies regulated by the SBS must implement such a management system tailored to their operations' size, nature, and complexity. The management systems must incorporate the following principles:

- *Confidentiality*: Information will only be available to authorized individuals, entities, or processes; strict measures to assure confidentiality are required.
- *Availability*: Access to and use of information must be timely.
- *Integrity*: The irrevocability of information and its authenticity must be ensured, avoiding modification or undue destruction.

Cybersecurity Program
The regulation stipulates that all entities in cyberspace must have a permanent cybersecurity program applicable to operations, processes, and other information assets. This program must include a periodic diagnosis and improvement plan for cybersecurity capabilities. The cybersecurity program must utilize a suitable international reference framework. At a minimum, the cybersecurity program must be able to:

- Identify information assets;
- Protect information assets from threats;
- Detect cybersecurity incidents;
- Respond with measures that reduce the impact of incidents; and
- Recover technological capabilities or services that may be affected.

Cybersecurity incident management provisions include:

- Implementing a methodology to classify cybersecurity incidents and provide for response and recovery protocols;
- Having an information security operations service, which includes capabilities for detection and response as well as monitoring of communications within the internal network;
- Having access to threat, vulnerability, and incident intelligence information, as well as knowledge bases of techniques and tactics used by threat agents;
- Implementing mechanisms for internal and external reporting of cybersecurity incidents;
- Identifying the possible improvements for cybersecurity incident management; and
- Preserving evidence facilitating forensic investigations following the occurrence of information security incidents.

Regulated entities must report to the SBS any cybersecurity incident that presents a significant adverse impact verified or presumed to be:

- Loss or theft of company or customer information;
- Internal or external fraud;
- Negative effect on the image and reputation of the company; or
- Interruption of operations.

After reporting any such incident, the company is required to conduct forensic analysis to determine the causes of the incident and take measures for future management and avoidance. Entities must also provide a full report to the SBS of each incident with an executive summary and technical details resulting from its forensic investigation.

Minimum Security Measures
The regulation stipulates minimum information security measures to be adopted by entities. Shall. include:

- Human resources security;
- Physical and logical access controls;
- Security in operations;
- Security in communications;
- Acquisition, development, and maintenance of systems;
- Physical and environmental protection;
- Encryption techniques; and
- Acquisition, development, and maintenance of systems.

Simplified and Strengthened Authentication for Digital Channels
The regulation also covers authentication procedures, including:

- Implementation of authentication processes;
- User enrollment in services provided by digital channels;
- Enhanced authentication for digital channel operations;

- Enhanced authentication exemptions for digital channel operations; and
- Application programming interfaces for the provision of online services.

The code also regulates the provision of digital services by third parties.

Other Regulatory Modifications
The regulation amends various other rules to integrate information security and cybersecurity within the entire financial services regulatory framework, such as:

- Internal and External Audit Regulations to include the evaluation of ISCMS compliance;
- Corporate Governance and Comprehensive Risk Management Regulations and Operational Risk Regulations;
- Credit and Debit Card Regulations; and
- Regulation of Operations with Electronic Money.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

Peru published the regulation on February 21, 2021, and entered it into force on July 1, 2021. The code stipulates that regulated entities must submit to the SBS within 60 days a board-approved implementation plan containing:

- A preliminary diagnosis of the entity's situation;
- Measures envisaged for full compliance with the regulation;
- Enumeration of the officials responsible for implementing the plan; and
- An implementation schedule.

Therefore, each regulated entity has a unique implementation timeline.

The internal and external audit requirements enter into force for the audit of the fiscal year 2022 results.

PROJECT COST AND FINANCING

The SBS did not prepare an economic impact assessment of the new regulations. Regulated entities will have increased costs related to cybersecurity measures and the design and implementation of their ISCMS.

Indicative benchmarks of cybersecurity spending of U.S. financial institutions include[62]:

- Cybersecurity represented 10.9. percent of all IT spending in 2020; and
- Cybersecurity expenditure per employee increased by $354 in 2020 to reach a value of $2,691.

[62] Deloitte - How Digitization and the COVID-19 Pandemic Are Accelerating Cybersecurity Needs at Many Large Financial Institutions, 2021

The banking association, Ausbanc, reports over 62,000 employees in the Peruvian banking sector. If the economic impact of the regulation were equivalent to only one year of increased cybersecurity effort, then the expenditure for the sector would be at least $20 million.

U.S. EXPORT OPPORTUNITIES

Export opportunities for U.S. companies in support of business entity compliance with the regulations will include:

- Cybersecurity software and solutions;
- Specialized advisory services:
  - Cybersecurity risk assessment;
  - ISCMS design and implementation;
  - Cybersecurity forensic investigation; and
  - Training and awareness.

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
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Annex A: ICT Sector Overviews

A1 Terrestrial Communications Network Infrastructure: Telephone, Internet, and Broadband

A1.1 Sector Overview

The vast majority of ICT network infrastructure resides on land. Nonetheless, key transmission infrastructure also exists in space (satellites) and on the ocean floor (see *Subsea Communications Infrastructure*).

Communications networks may be wired, wireless, or a combination of the two and may be as simple as the connection of devices within a home or as complex as serving millions of subscribers throughout a country or across the globe. Although modern technology has blurred the lines in terms of ICT networks and service crossovers, three key areas represent the majority of global communications:

- Telephony;
- Broadband; and
- Internet.

Terrestrial communications network infrastructure spans:

- Hardware and devices;
- Software and firmware;
- Network equipment;
- Supporting systems such as power, cooling, security, and dedicated facilities,
- Computing, application, and content platforms; and
- Related services, including telecommunications, broadband, and internet access, as well as service delivery.

A1.1.1 Telephony

For many decades, telephony was the principal mode of remote human communications. First introduced conceptually by Antonio Meucci, in 1871, Alexander Graham Bell is more generally recognized as the inventor of the telephone. Telephony remained primarily analog/wired until the 1970s, when Martin Cooper, a Motorola engineer, developed the first-generation mobile telephone. In 1979, Nippon Telephone and Telegraph (NTT) deployed the first mobile network (using analog signals). In 1987, various European nations agreed to the use of GSM, or the second generation of mobile telephony -- digital, cellular, and with uniform standards. The adoption of mobile telephony was rapid thereafter, as shown in Table 25.

Table 25: Evolution of Mobile Telephony[63]

Generation	Speed	Technology	Key Features
1G (1970-1980s)	14.4 Kbps	AMPS, NMT, TACS	Voice only
2G (1990-2000)	9.6/14.4 Kbps	TDMA, CDMA	Voice and data
2.5-2.75G (2001-2004)	171.2 Kbps 20-40 Kbps	GPRS	Voice, data and web mobile internet, low-speed streaming services, and e-mail services
3G (2004-2005)	3.1Mbps 500-700 Kbps	CDMA2000 (1xRTT, EVDO) UMTS and EDGE	Voice, data, multimedia, support for smartphone applications, faster web browsing, video calling, and TV streaming
3.5G (2006-2010)	14.4 Mbps 1-3Mbps	HSPA	All 3G capabilities with enhanced speed and mobility
4G (2010-present)	100-300 Mbps 3-5 Mbps 100 Mbps WiFi	WiMAX LTE WiFi	High speed, high-quality voice over IP, HD multimedia streaming, 3D gaming, HD videoconferencing, and worldwide roaming
5G (2019 forward)	1-10 Gbps	LTE advanced schemes OMA and NOMA	Super-fast mobile internet, low latency network for mission-critical applications, Internet of Things, security and surveillance, HD multimedia streaming, autonomous driving, and smart healthcare applications

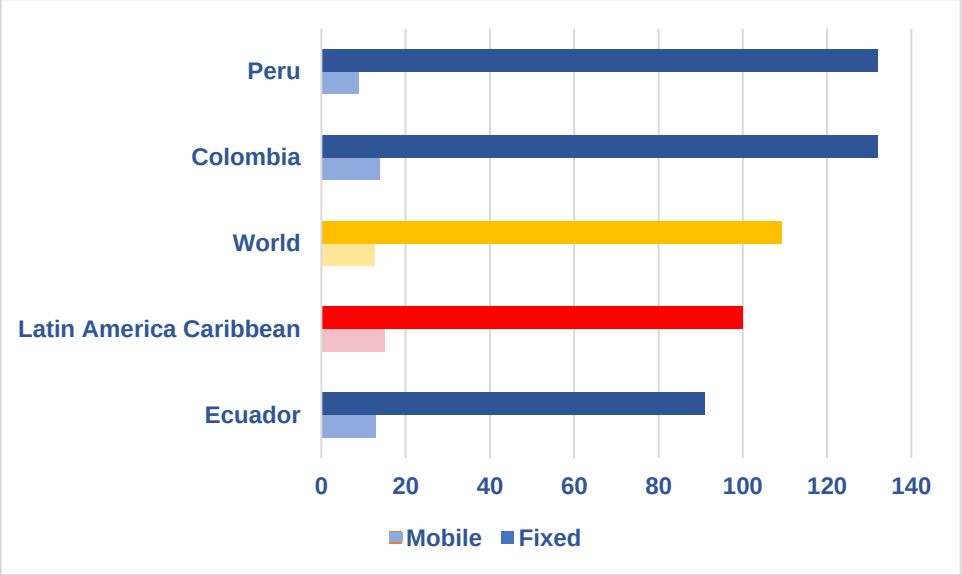
From 1987 to the present, the world has witnessed several new generations of mobile telephony. Each successive innovation provides faster speed, lower latency, and a wider range of capabilities in terms of content transmission capability. The current focus is on the successful implementation of 5G technology, which offers the ability to handle standard voice and data communications and the ability to power Internet of Things (IoT) devices, artificial intelligence (AI), and a wide array of other data-intensive applications.

While fixed telephony still exists worldwide, mobile telephony has been a boon to economically developing societies, giving more citizens telephone access more quickly due to less cumbersome infrastructure installation requirements. Typically, countries with earlier economic development trajectories have higher remaining use of fixed telephony, while those later-to-develop have higher levels of mobile to fixed telephone usage. Relative fixed and mobile telephony usage in Colombia,

[63] RFPage.com

Ecuador, and Peru is shown versus regional and global benchmarks in Figure 31. Peru and Colombia substantially exceed both world and regional levels for mobile telephone subscriptions on a population-adjusted basis.

Figure 31: Fixed and Mobile Telephone Usage – Subscriptions per 100 People[64]



New technology developments include:

- Deployment of 5G (fifth generation) mobile telephony -- with faster speeds, lower latency, and ability to carry vast amounts of information, 5G will make demanding IoT and AI applications more feasible.

- Expanded use of SD-WAN (software-defined wide area network) -- this cloud-based architecture will continue the path of abstracting software from hardware to provide more elastic traffic management and WAN virtualization.

- Development of a sixth-generation (6G) approach to telecommunications -- using frequencies between 100 GHz and 1 THz. Still, in the early development stages, industry experts expect 6G may require a decade of development but could offer speeds up to one terabyte (TB) per second. That is the equivalent of 142 hours of movies delivered in one second.

A1.1.2 Internet

The internet is a global computer network consisting of interconnected networks using standardized communication protocols. It links smaller computer networks, including commercial,

[64] World Bank https://data.worldbank.org/indicator/IT.CEL.SETS.P2

educational, governmental, and others, all of which use the same set of communications protocols. Also called the World Wide Web (with the terms are frequently used interchangeably), technically, the internet comprises the physical infrastructure elements. The World Wide Web is software (i.e., the large collection of webpages connected by hyperlinks) and is a service of the internet.

The internet effectively began in 1965, when Lawrence Roberts and Robert Merrill connected two computers via a low-speed telephone line, one in Massachusetts and one in California. By 1969, a better-developed version of the internet, ARPANET, was demonstrated among computers at Stanford University and the University of California at Los Angeles (UCLA). By 1995, or in just under 25 years, 16 million people had begun using the internet. By 2005, a billion users were accessing the internet, and as of 2019, over 4 billion[65]. Today, citizen internet access and usage are considered barometers of the economic development of nations.

As the internet has developed, rapid changes to hardware, software, and networking technologies have increased utility and speed. Networks have moved from telephony-based to high-speed, high-capacity fiber optic cables and wireless. Content has shifted from simple text to the ability to stream dense video, photographic, and music content worldwide. Access has moved from desktop computers to small mobile devices, especially cellular phones. Users may now connect anywhere in the world with but milliseconds of lag from anywhere else.

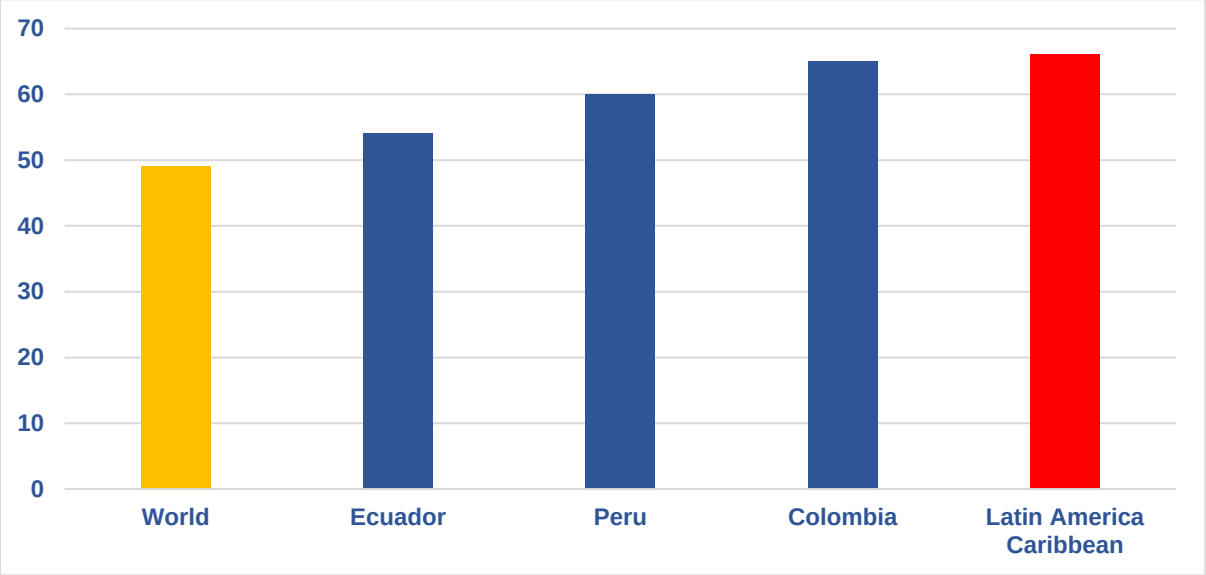
Technologies in development to extend internet utility include:

- **5G Data Networks** – super fast data networks allowing better streaming capabilities at lower latency.
- **Internet of Things (IoT)** -- increased bandwidth allows for high-data-intensity new applications such as autonomous driving vehicles, smart machines, and advances in telemedicine, including predictive diagnostics.
- **Computer Vision** – automated, digital visioning.
- **Artificial Intelligence** -- computer system ability to perform tasks previously requiring human intelligence (e.g., visual perception, speech recognition, decision-making, and translation between languages).
- **Virtual and Extended Reality** – used today primarily for entertainment but also for simulation, training, and other professional uses. The user allows the computer to create a virtual world and block out the real one.
- **Blockchain** – a digital ledger to record transactions secured via encryption and decentralized. Cryptocurrencies are the medium of exchange, including perhaps the best known Bitcoin, along with others such as Ether (Ethereum), Binance, zCash, Monero, and Facebook's Libra, which is shifting in scope due to regulatory pressure.

Internet usage (i.e., the percent of the population using the internet) varies widely globally, as shown in Figure 32. Colombia, Peru, and Ecuador all exceed global internet penetration levels, but today somewhat lag regional levels, though all are making progress on citizen connectivity.

[65] HootSuite

Figure 32: Internet Usage Penetration - 2018[66] (Percent of Population Using the Internet)



A1.1.3 Broadband

Broadband is a high-capacity transmission technique using a wide range of frequencies, enabling a large number of messages or other content to be communicated simultaneously. The term broadband commonly refers to high-speed internet access that is always on and faster than the historical dial-up access. Several high-speed transmission technologies comprise broadband, including:

- **Digital Subscriber Line (DSL)** - a wireline transmission technology over traditional copper telephone lines already installed to homes and businesses with transmission speeds ranging from several hundred kilobits per second (Kbps) to millions of bits per second (Mbps).

- **Cable Modem** - broadband provided using the same coaxial cables that deliver pictures and sound to a television. Cable modems are typically external devices with two connections, one to the cable wall outlet and a computer, and operate at transmission speeds of 1.5 Mbps or more. It is possible both to use broadband and watch television simultaneously.

- **Fiber** - converts electrical signals carrying data into light and sends the light through transparent glass fibers about a human hair's diameter. Fiber transmits data at speeds far exceeding current DSL or cable modem speeds, typically by tens or even hundreds of Mbps. Fiber may run to the customer's home or business, the curb outside, or a location somewhere between the provider's facilities and the customer.

[66] World Bank

- **Wireless** - a radio link between the customer's location and the service provider's facility, either mobile or fixed. Wireless technologies using longer-range directional equipment can provide broadband service in remote or sparsely populated areas where DSL or cable modem service would be costly. Speeds are generally comparable to DSL and cable modem. An external antenna is usually required.

- **Satellite** - satellites orbiting the earth provide vital links for telephone and television service and also create wireless links for broadband useful for serving remote or sparsely populated areas. Consumers may expect to receive (download) at 500 Kbps and send (upload) at 80 Kbps. These speeds may be slower than DSL and cable modem, but they are about ten times faster than the download speed with dial-up Internet access. Extreme weather conditions, however, may cause service to be disrupted.

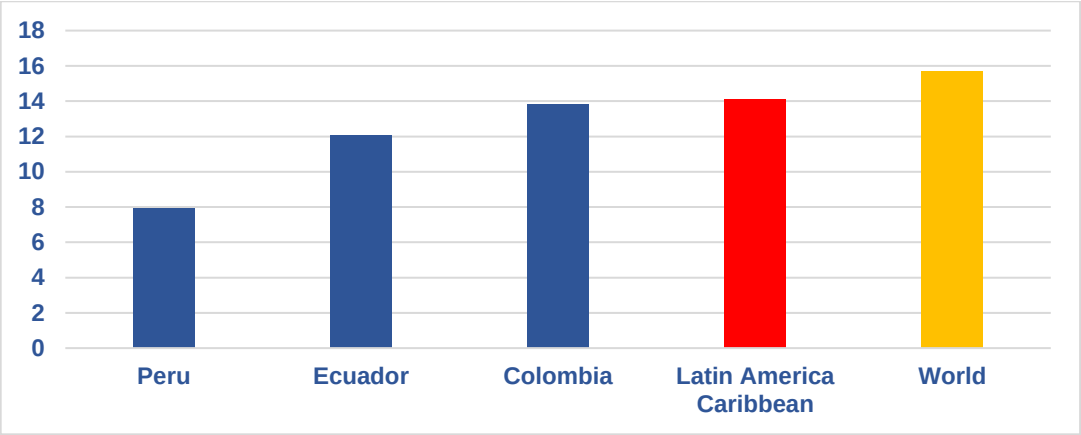
- **Broadband over Powerlines (BPL)** delivers broadband over the existing low- and medium-voltage electric power distribution network. BPL speeds are comparable to DSL and cable modem speeds. Power lines are installed virtually everywhere, thus alleviating the need to build new broadband facilities.

Broadband's origins date to the 1960s. By 1969, prestigious colleges on the U.S. east and west coasts had 50Kbps or better broadband connections. In 1984, these colleges adopted T1 (voice and data) lines, forgoing the use of the previous 50Kbps channels. In the early 1990s, businesses began to use broadband, and by 2000-2001, home use was growing rapidly. Since the dawn of the millennium, global citizen access, upload and download speeds, and service consistency and reliability have continued to improve.

The use of fixed broadband per 100 people in the Latin America and Caribbean region varies widely, as shown in Figure 33, and the region lags world usage levels. Colombia, Peru, and Ecuador are below both world and regional levels with respect to fixed broadband subscriptions per 100 people.

New broadband technologies overlap those for telephony and the internet and include implementation of the 5G network and eventual development of a 6G network. Certain futurists are beginning to ask the question as to whether fixed, even fiber-based, broadband may become obsolete in future telecommunications generations with speeds above 1Tbps, assuming wireless technologies can solve issues such as line-of-sight.

Figure 33: Fixed Broadband Subscriptions per 100 People, 2018[67]



A1.2 Terrestrial Communications Network infrastructure - Investment Outlook

The value of global telecommunications services was $1.7 trillion in 2019[68] and is expected to grow at a compound annual growth rate of 5 percent from 2020-2027. Continued increases in demand for consumer wireless telephone services, mobile access, and cloud-based technologies drive demand for high-speed telephone, internet, and broadband connectivity. Despite strong individual consumer demand, the commercial segment recently has accounted for the most growth. Commercial application foci include data reliability and quality, both for customers and internally for videoconferencing, high-security intracompany networks, and corporate calling and texting.

Global internet (web) hosting services reached $61 billion in 2018 and will grow at a compound annual growth rate of over 15 percent through 2026.[69] Growth drivers include expanding individual consumer demand for greater access to web-based shopping, household device connectivity, and mobile access.

Global broadband services were valued at $327 billion in 2019 and projected to grow at a compound annual growth rate of nine percent through 2027.[70] The digital transformation of several industry verticals, along with ever-expanding consumer demand and access, is driving growth. While the COVID-19 global pandemic has slowed growth in some sectors, broadband usage for e-learning and digital healthcare has grown rapidly.

Overall, this sector's market size in the Latin American/Caribbean region exceeded $100 billion in 2018. Growth in multichannel and fixed broadband/internet services outpaced that in fixed and mobile telephony, which are more mature technologies.[71]

Each of the countries in this Resource Guide has Terrestrial Communications Infrastructure projects profiled. Following are brief overviews of this sector in each.

[67] Ibid
[68] Grandview Research
[69] Fortune Business Insights
[70] Grandview Research
[71] S&P Global Market Intelligence

A1.3 Colombia

Although the overall terrestrial communications infrastructure growth rate declined somewhat in 2019 due to currency devaluation and again in 2020 due to the COVID-19 global pandemic, the country expects growth to return in 2021. The Colombian Ministry of Information Technologies and Communication (MinTIC) has consolidated Internet access and ICT for most Colombians in urban areas, with more than 32.8 million Internet connections reported in 2019 (12.59 million via subscriptions and 18.28 million via mobile links). MinTIC is actively planning to increase connectivity in rural areas. The most widely used technology was 4G with 11.4 million accesses, followed by 3G with 6.2 million and 2G with 0.7 million.

In March 2019, MinTIC published a draft project for Universal Sustainable Access (Acceso Universal Sostenible) to provide internet access to 10,000 rural communities in Colombia. In the same year, Colombia passed the ICT Sector Modernization Law (Law 1978 of 2019). The Law seeks to reduce the digital gap in Colombia while boosting the sector by allowing current and new companies to develop innovative projects in connection with ICT services, improve access to those services, and enable the progress, modernization, and implementation of new technologies in the country. Centros Digitales (Digital Centers) is one ambitious program to provide free Internet connectivity to nearly 10,000 rural and isolated communities throughout Colombia, as reviewed earlier in this Resource Guide.

Colombia offers 2G, 3G, and 4G cellular services at present, with 5G in the early stages. Claro Movil, Movistar, Tigo-Une, and Avantel principally serve the Colombian mobile telephony market. Colombia expects to host its delayed 5G-ready spectrum tender at the end of 2021. Several local operators have expressed interest. The project is reviewed earlier in this Resource Guide.

Mobile and fixed broadband speeds in Colombia averaged 18.27 and 61.62 for download, 10.01 and 28.82 Mbps for upload, and 52 and 26 milliseconds for latency, respectively, in June 2021. These levels position Colombia at 119th and 66th globally for mobile and fixed broadband on a speed basis, respectively.[72]

A1.4 Ecuador

Ecuador reports high mobile service population coverage for 2G/3G, with somewhat lower 4G coverage as of 2021, with more than half of the population currently enjoying internet access. The Minister of Telecommunications has a stated goal of installing several thousand Wi-Fi points by year-end 2021 as part of the country's 100 percent Connectivity and Digital Government Plan.[73] Within the plan, reviewed earlier in this Resource Guide, connectivity (internet and cellular coverage for all of Ecuador) is one of the three axes, along with digital government and digital transformation with priority to telemedicine and tele-education.

[72] SpeedTest https://www.speedtest.net/global-index/colombia
[73] Ecuador Times https://www.ecuadortimes.net/vianna-maino-we-expect-to-have-4817-wi-fi-points-installed-by-the-end-of-2021-in-ecuador/

Mobile and fixed broadband speeds in Ecuador averaged 25.44 and 33.69 for download, 10.76 and 29.20 Mbps for upload, and 34 and 17 milliseconds for latency, respectively, in June 2021. These levels position Ecuador at 92nd and 106th globally for mobile and fixed broadband on a speed basis, respectively.[74]

A1.5 Peru

The Peruvian telecommunications market is among the most competitive in the Latin America and Caribbean region and grew at a rate of five-to-six percent annually through 2019. Telefónica's Movistar led the mobile market at year-end 2019, with a 33.4 percent share, followed by América Móvil's Claro at 29.7 percent, Entel at 20.2 percent, and Viettel's Bitel at 16.7 percent.[75] Telecom investments in Peru grew by 172 percent between 2000 and 2019, reaching 4.53bn soles (US$1.28bn) in 2019, according to the Peruvian government.

Nonetheless, telecom authorities noted a reduction in telecom expenditures in 2020 to the COVID-19 global pandemic. The Transport and Telecommunications Ministry (MTC) expects telecom operators to resume investments in 2021. The Ministry notes that the health crisis further exposed the digital divide that persists in Peru and other countries as well.

As profiled earlier in this Resource Guide, PROINVERSION, the Peruvian Private Investment Promotion Agency, launched a special public tender in May 2021 to select private sector partners to deploy 4G networks in the AWS-3 and 2.3 GHz radio spectrum bands to connect difficult-to-reach customers. The projects will connect at least 1,561 new rural towns with more than 300,000 inhabitants in total. The program's two contracts have a combination of required and discretionary geographic coverage.

To further reduce the country's digital divide, in February 2021, the Peruvian government, via emergency decree, approved a program spurred by the COVID-19 global pandemic. The program, known as "Todos Conectados" (All Connected), includes internet access for over 1,000 public institutions via satellite connection in remote locations in the upper Amazon river basin; implementation and operation of over 6,500 free WiFi hot spots in the town squares of rural localities; and development of at least 1,000 digital access centers equipped with computers, tablets, and other digital equipment.

Mobile and fixed broadband speeds in Peru averaged 25.04 and 55.40 for download, 13.10 and 24.63 Mbps for upload, and 37 and 25 milliseconds for latency, respectively, in June 2021. Thus, Peru ranked 93rd and 76th globally for mobile and fixed broadband on a speed basis, respectively.[76]

[74] Speedtest https://www.speedtest.net/global-index/ecuador
[75] Inside Telecom https://www.insidetelecom.com/peru-telecom-investments-to-bounce-back-in-2021/
[76] Ibid https://www.speedtest.net/global-index/peru

A2 Subsea Communications Infrastructure

A2.1 Sector Overview

Subsea (or submarine) fiber optic cables are effectively the backbone of the internet today. They permit countries and continents to share information across long geographic distances. While satellite communications are highly effective, subsea fiber optic cable today is more reliable and cost-effective. In the future, some competition from Low Earth Orbit (LEO) satellites is likely.

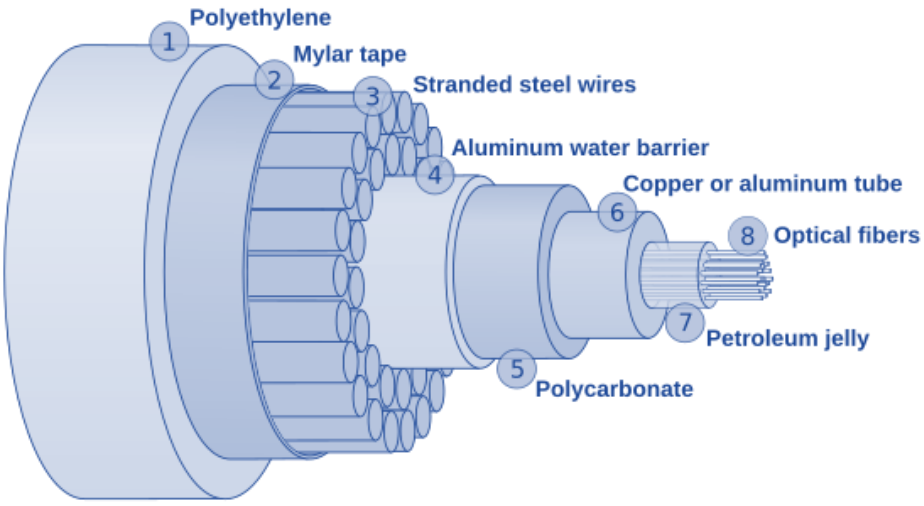
Subsea fiber optic cables are laid on the seabed to provide a high-capacity means of transferring large amounts of information and data. Using the seabed for cable laying allows for route shortening and optimization, which reduces transmission lag (latency) and also avoids terrestrial security issues such as natural disasters and human acts such as vandalism.

Subsea cables are designed and manufactured to:

- Be installed underwater and take into account:
  - Ambient temperature (both sea and land);
  - Burial/water depth and associated pressures;
  - Nature of shore approach; and
  - Cable length.
- Be laid on the rugged and rocky seabed, as well as be buried near the shore approach.
- Withstand marine animals, tsunamis, volcanic activity, and trawls used by fishermen.

A typical subsea fiber optic cable includes numerous components, of which all but the fibers themselves are protective of the glass optical strands at the center. The optical fibers carry digital data in the form of light, as shown in Figure 34.

Figure 34: Subsea Fiber Optic Communications Cable Construction[77]



[77] Fibertronics, U.S. Patent No. 4,278,835

Typical subsea fiber optic cables are just under an inch in diameter and weigh 2.5 tons per km. Manufacturers typically add extra armoring for cables and cable ends residing near a shoreline. The optical fibers themselves are about the diameter of a human hair and are fashioned of highly pure glass coated with a high-performance polymer such as a polyimide.

Installers typically bury near-the-shoreline cable sections under the seabed for extra protection. Before installation, route studies assess preferred alternatives to avoid hazards such as fault lines, anchoring zones, fishing areas, etc. The shortest cables, such as Google's Junior, connecting Rio de Janeiro and Santos, Brazil, are but a few hundred km. Transcontinental cables run lengths of as many as ten to twenty thousand km.

At one end of the cable installation, a laser transmits digital data by firing a light signal down the optical fiber. The data, in the form of the light signal, is captured on the other end by a receptor. The optical fiber performs essentially as a mirror. The laser switches on and off to send each bit. Modern fiber systems with a single laser can transmit billions of bits per second, i.e., the laser can turn on and off several billions of times per second. Newer systems use multiple lasers with different colors to fit numerous signals into the same fiber. Fibers are paired within cables, one fiber for each direction.

Fiber optic cables can carry a signal up to about 60 miles (100 km). On a long-distance line, equipment huts at intervals contain equipment to pick up and retransmit the signal, at full strength, down the next segment.

Redundancy is built into cable systems to reduce the impact of cable faults, typically by spreading network capacity over multiple cables. The function of a cable requiring downtime/repair time is managed by other cables until repairs are complete. About two-thirds of cable faults result from marine traffic (fishing and anchor dragging), with environmental issues, such as earthquakes, another major fault contributor. Occasionally underwater components fail.

At the ends of a subsea fiber-optic cable are landing points. Landing points are selected to have silty bottoms to allow the line's burial to protect it from damage, mild currents to ensure the cable's positional stability once buried, and minimal marine traffic. Multiple cables frequently share landing points. A landing station may provide power to subsea amplifiers and repeaters, as well. A cable termination station (which may or may not be the same as the landing station) provides the point at which the subsea cable connects with the high capacity, terrestrial, backhaul system, typically near an area of high communications demand such as major metropolitan areas.

The first subsea fiber optic cable, TAT-8, running between the United States (AT&T), the United Kingdom (British Telecom), and France (France Telecom), was laid in 1988. It could carry 280 megabits per second (Mbps), the equivalent of 40,000 telephone circuits.

As of 2020, roughly 400 subsea optical fiber cables are operational. The highest capacity subsea fiber optic cables operate at more than 100 terabytes per second (Tbps), more than 10 million times the typical home internet connection speed, and the equivalent of carrying 45 million high definition videos simultaneously. The Marea cable, connecting the United States (Virginia Beach,

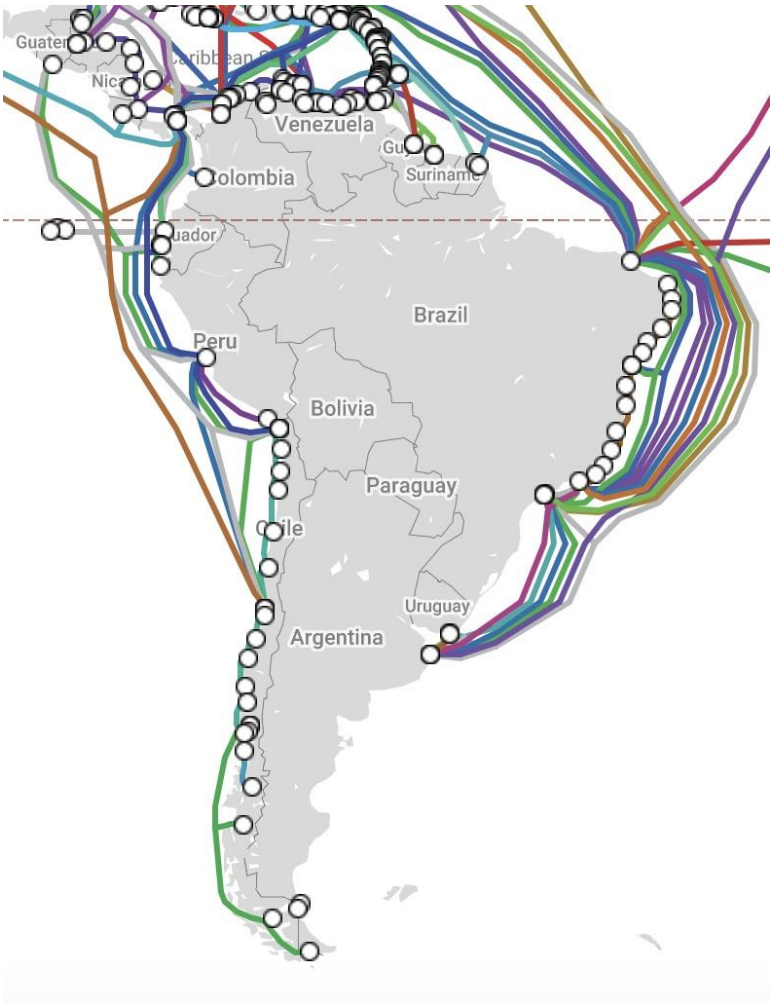
VA) and Bilbao, Spain, has a design capacity of 160Tbps but has demonstrated the ability to run at up to 200Tbps.

Recent technology developments include capacity-enhancing spatial digital multiplexing (SDM) and twisted light spirals. Google Global Networking has recently reported adapting the use of existing subsea fiber optic cable technology to detect and provide early warnings for earthquakes and tsunamis.

A2.2 Subsea Communications Infrastructure - Investment Outlook

The Latin American/Caribbean region hosts and has under construction a total of 68 cable systems and 217 landing stations. The Andean sub-region likewise hosts numerous cables and landing stations, as shown in Figure 35. All three Andean countries profiled in this Resource Guide have at least one connection to subsea fiber optic telecommunications cables.

Figure 35: Andean Region Subsea Fiber Optic Cable Map[78]



[78] Submarine Cable Map https://www.submarinecablemap.com

The global subsea fiber optic cable market is approximately $14 billion, with a projected growth rate of 13 percent through 2025[79]. Today, the U.S. and China represent a combined 42 percent of the global market, with the Latin American/Caribbean market estimated to represent a 10 percent share, or about $1.4 billion.

While historically, telephony and telecommunications companies owned subsea fiber optic cable systems increasingly, content providers such as Amazon, Facebook, Google, and Microsoft are emerging as owners and co-developers of new cables. In addition to the numerous ongoing subsea fiber optic cable projects in South America, this creates unique opportunities for U.S. companies to align with U.S. content providers for new cable development in the northern Latin America and Caribbean region, as the Ocean Networks Caribbean Express and Seaborn CARICOM cables will do.

This Resource Guide profiles two subsea cable projects, one landing in Colombia and one serving the Galapagos Islands of Ecuador.

A2.3 Colombia

Colombia has a single subsea, fiber-optic-cable landing point near Cali, its second-largest city. The 20,000 km South American Crossing (SAC)/ Latin American Nautilus (LAN) subsea cable lands at the site. This cable rings South America and offers landing points with onward connectivity to international cables.

The Ocean Networks Caribbean Express cable project, profiled in this Resource Guide, will offer additional service via a connection at Cartagena, creating a Caribbean Sea-side connection in addition to Colombia's existing Pacific Ocean-based subsea cable access. The cable's endpoints will be in the United States and Panama, offering direct regional connectivity to Caribbean neighbors and onward international service.

A2.4 Ecuador

Ecuador is a landing point for three subsea telecommunications cables.[80] Service is available from the 6,000 km Pacific Caribbean Cable System (PCCS), landing near Manta, and the 25,000 km South America 1 (SAm-1) and 7,050 km Pan American (PAN-AM) cables, landing near Salinas. All of these cables ring the region and offer landing points with onward international connectivity.

While Ecuadorian urban connectivity via subsea cable is available, telecommunications services on the Galápagos Islands today are provided by a satellite connection, resulting in relatively slow speeds and high costs. As profiled in this Resource Guide, a new subsea cable will establish a fiber-optic connection from the Islands to mainland Ecuador, increasing bandwidth by a factor of 2,500 while retaining costs similar to the existing satellite service. The project will provide fixed and mobile, national, and international telecommunications services (4G with the potential for future 5G) and wideband internet.

[79] ReportLinker
[80] Fiber Atlantic http://www.fiberatlantic.com/submarinecablemap/

A3 Smart Cities and e-Government

A3.1 Sector Overview

A smart city is a municipality incorporating information and communications technologies (ICT) to improve efficiency, quality, and urban services performance. The ICT tools aid in reducing resource consumption, waste, and overall costs, as well as improving service quality, responsiveness, and transparency. Frequently, ICT smart-city tools also provide direct service access and government and community participation to residents.

Typically, more than half of smart-city services are delivered through the public sector. Smart cities and e-Government are closely related. e-Government (short for electronic government) is the use of ICT networks and devices to provide public services to citizens and other persons residing in a country, region, or municipality. e-Government offers opportunities for more direct and convenient citizen access to government overall, government transparency, and direct provision of government services.

A3.1.1 Smart Cities

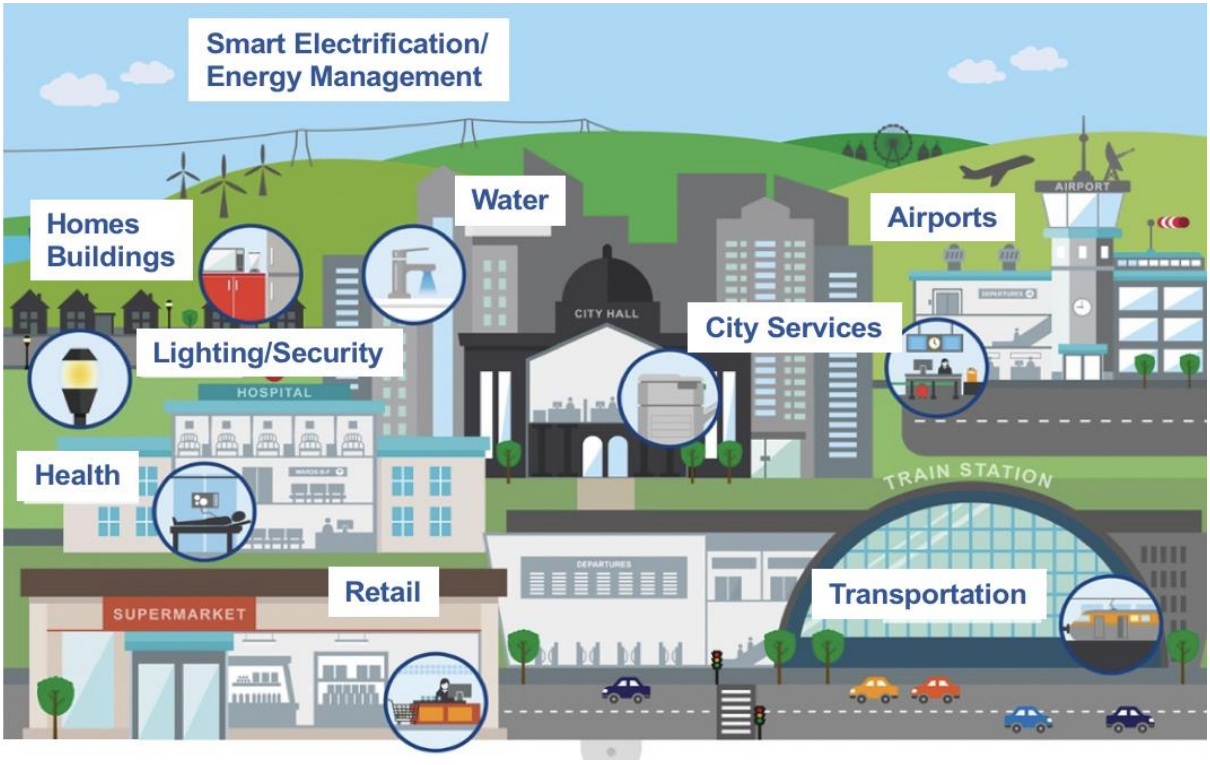
A smart city is a highly digitally connected municipality using information and communications technologies to increase operational efficiency, share information with the public, and improve both the quality of government services and associated citizen welfare. Initiatives typically focus first on infrastructure development, such as reliable electric supply, robust IT digitization and connectivity, and efficient public transportation. Efforts surrounding citizen safety and security, public housing, healthcare, education, and traffic and transportation management, as well as government efficiency and transparency, may be added, as shown in Figure 36.

Today, cities are home to more than half the world's population.[81] The United Nations projects that by 2050, 68 percent of the global population will reside in cities. By 2035, 600 cities will account for approximately 65 percent of global GDP.[82] The continued migration to cities will require new, personalized, and interactive municipal services, many delivered under the smart cities umbrella. For example, in a pilot of three cities, McKinsey and Company found smart cities tools could produce the following results:

- Reduce fatalities by 8–10 percent;
- Accelerate emergency response times by 20–35 percent;
- Reduce the average commute by 15–20 percent;
- Reduce disease burden by 8–15 percent;
- Reduce greenhouse gas emissions by 10–15 percent; and
- Reduce water consumption per citizen by 25-80 liters per day.

[81] McKinsey & Company
[82] Ibid

Figure 36: Smart City ICT Applications[83]



Numerous entities rank smart cities annually. Today, top-ranked global smart cities are located in North America and Western Europe primarily, with Singapore routinely included. In general, wealthier urban areas are faster to transform, though Asia, with large populations of younger citizens, has also rapidly embraced the smart cities concept, as shown in Table 26.

Lack of sufficient ICT infrastructure has posed challenges to smart city development in certain geographies. In some, such as Asia and the Middle East, initiatives are developing to create new cities that will be smart from the start.

As shown in Figure 37, the National Autonomous University of Mexico, with its over 350,000 students, is developing a smart education and local services support hub in the Latin America and Caribbean region. São Paulo has been at the forefront of adopting smart city practices in Brazil. Several additional examples in Colombia and Peru are provided in the project reviews in this Resource Guide.

[83] International Electrotechnical Commission

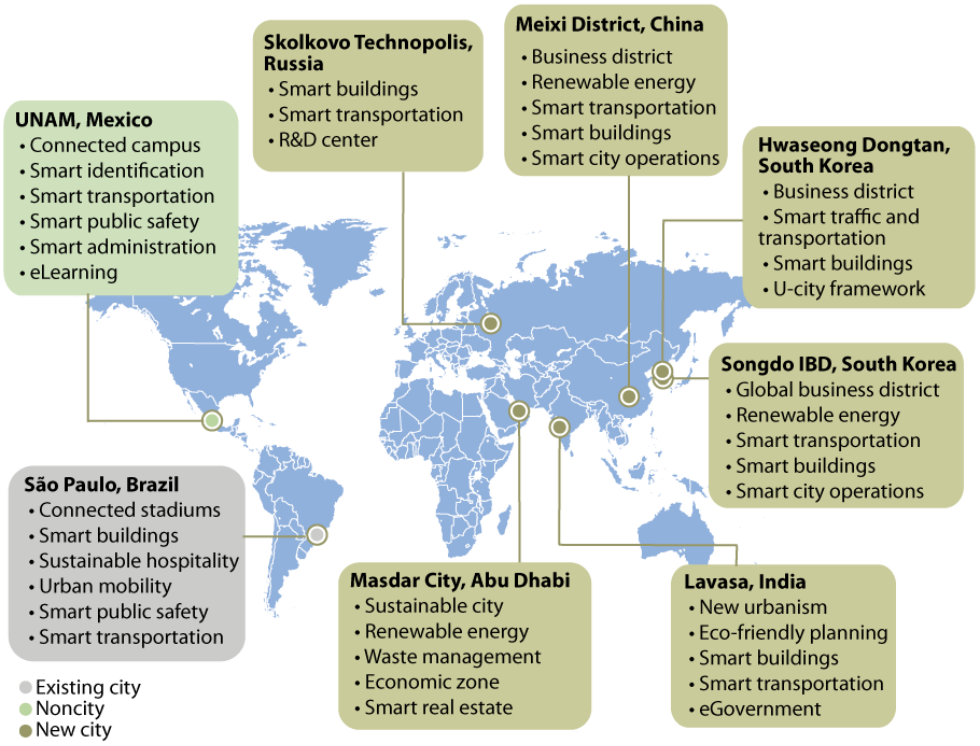
Table 26: Top 40 Global Smart Cities, 2019[84]

Rank	City	Comment
1	London	#1 – Human Capital, #3 – Transportation (behind Shanghai and Beijing – outside top 50), #1 – International Outreach
2	New York	#3 – Human Capital, #1 – Economy, #2 – Urban Planning
3	Amsterdam	#2 – International Outreach
4	Paris	#3 – International Outreach
5	Reykjavik	#1 – Environment
6	Tokyo	#3 – Economy
7	Singapore	#1 – Technology
8	Copenhagen	#3 – Environment
9	Berlin	
10	Vienna	
11	Hong Kong	#2 – Technology
12	Seoul	
13	Stockholm	
14	Oslo	
15	Zurich	#1 – Social Cohesion
16	Los Angeles	#2 – Human Capital, #2 – Economy
17	Chicago	
18	Sydney	
19	Melbourne	
20	San Francisco	#3 – Technology
21	Helsinki	
22	Washington D.C.	
23	Madrid	
24	Boston	
25	Wellington	#2 – Environment
26	Munich	
27	Barcelona	
28	Basel	
29	Taipei	#3 – Social Cohesion, #3 – Governance
30	Berne	#2 – Social Cohesion, #1 – Governance
31	Barcelona	
32	Geneva	#2 – Governance
33	Frankfurt	
34	Hamburg	
35	Auckland	
36	Gothenburg	
37	Dublin	
38	Montreal	
39	Ottawa	
40	Miami	

Americas Europe Asia

[84] IESE Cities in Motion Index

Figure 37: Smart City Development Examples Outside North America and Western Europe[85]



Three technology-related layers combine to create a functioning smart city:

1. **Technology base** – including a mass of cell phones and other sensors connected by a high-speed, high-capacity communications network with open data portals;
2. **Applications** – specific programs and digital tools for key functions including economic development, energy, health, housing, mobility, security, waste, water, and engagement/community; and
3. **Public usage** – applications, and the smart city as a whole, rely on broad adoption and resulting changes in citizen behaviors. Applications giving citizens greater transparency and allowing them to optimize their choices generate wide adoption.

More than 80 percent of the Latin American and Caribbean region population lives in cities; however, 27 percent of the urban population lives in informal settlements without access to basic services.[86] As a result, digitization is not yet uniformly distributed.

Nonetheless, in the Latin America and Caribbean region, numerous municipalities are already implementing smart city initiatives, and several rank among high and medium performers in the IESE Cities in Motion (Smart Cities) Index of 174 global cities:

[85] Forrester Research
[86] Inter-American Development Bank

- Santiago, Chile (66 - High);
- Buenos Aires, Argentina (77 - Medium);
- Montevideo, Uruguay (92 - Medium);
- San José, Costa. Rica (112 - Medium);
- Panama City, Panama (114 – Medium); and
- Bogotá, Colombia (117 - Medium).

Latin America and Caribbean cities considered in the IESE rankings are highlighted below in Figure 38. Of the countries reviewed in this Resource Guide, three Colombian, two Ecuadorian, and one Peruvian cities are included in the IESE index.

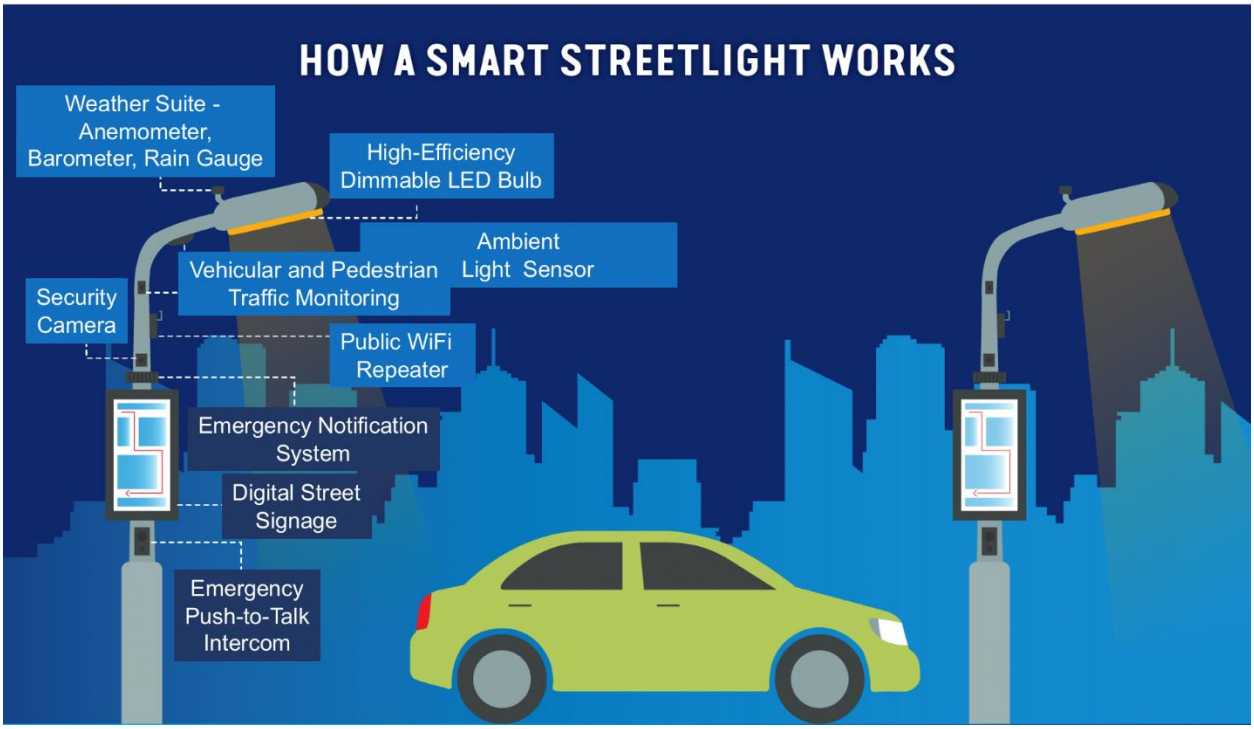
Figure 38: Latin American and Caribbean Cities in IESE Cities in Motion (Smart Cities) Index[87]

[87] IESE

A3.1.2 Smart Street Lighting

One of the early programs typically undertaken on the path toward creating a smart city is smart street lighting. Smart streetlights are networked, intelligent lighting systems consisting of smart lamp posts, LED luminaires, sensors, communication modules, and other peripheral devices. Smart streetlights improve safety, manage municipal energy consumption, and frequently provide both citizen and municipal access to warning and communication features highlighting crimes in progress, as well as impending weather events and natural disasters. Smart street lighting poles may provide public Wi-Fi access and device charging, as shown in Figure 39.

Figure 39: Smart Street Lighting Features[88]



A3.1.3 e-Government

e-Government applies information and communications technologies, like high speed/high volume communications networks, the internet, and various apps, to enhance government activities, streamline processes, and generate citizen use and interest. These changes serve to increase government efficiency, transparency, and citizen involvement.

At the national/federal level, the Division of Public Administration and Development Management (DPAPM) of the United Nations Department of Economic and Social Affairs (UN-DESA)

[88] Coolfire Solutions

conducts a bi-annual e-Government survey including an *e-Government Development Index (EGDI)*. It is a comparative ranking of 193 countries of the world using three indicators:

1. An Online Service Index (OSI) measuring the online presence of the government in terms of service delivery;
2. A Telecommunication Infrastructure Index (TII); and
3. A Human Capital Index (HCI).

The Survey assesses the UN's 193 member states according to a quantitative composite e-Government readiness index based on website assessment, telecommunications infrastructure, and human resources capabilities. The TII, which focuses on ICT availability, considers internet access, fixed and mobile telephone subscriptions, and fixed and wireless broadband availability.

As is the case for smart cities, the top scorers in the EGDI are typically high-income-level countries, including West European nations, the United States, Singapore, and South Korea, Australia, and New Zealand.

Uruguay is the only Latin American country with a "very high" EGDI score (34th globally), though Chile, Argentina, and Brazil fall just shy of this level, as shown in Table 27. Colombia ranks ninth in the Americas. As a whole, Latin America and the Caribbean showed the largest regional improvement globally between the UN's 2016 and 2018 surveys. Across the Americas, the United States stands at 11th in the world, with Canada ranking as 23rd.

Table 27: The United Nations EGDI Top Ten Americas Countries in e-Government[89]

2018 Americas Rank	Country	EGDI	EGDI Level	2018 Global Rank
1	United States of America	0.8769	Very High	11
2	Canada	0.8258	Very High	23
3	Uruguay	0.7858	Very High	34
4	Chile	0.7350	High	42
5	Argentina	0.7335	High	43
6	Brazil	0.7327	High	44
7	Barbados	0.7229	High	46
8	Costa Rica	0.7004	High	56
9	Colombia	0.6871	High	61
10	Mexico	0.6818	High	64

A3.1.3 Payment Systems

Digital payment systems are used by all government levels (national, state, and municipal) to increase revenue collection, exceed constituent expectations, and improve cash flow. Not only do

[89] United Nations

these ICT systems improve payment and collections efficiency and accuracy in normal times, but during the COVID-19 global pandemic, they allowed citizens to access government services while in quarantine or social distancing. Contactless digital payments at the point of collection, powered by facial recognition, Quick Response (QR) codes, or near-field communications (NFC), can make it less likely for the virus to spread to others through cash exchanges. Online payments have helped to put government stimulus funds into consumers' hands more rapidly across the globe.

In the Latin American and Caribbean region overall, while online identification and authentication systems are fairly robust several challenges exist to broader deployment of digital financial systems (DFS):[90]

- Boosting financial inclusion across populations regardless of income levels and geographic location;
- The ability of regulatory agencies to respond to evolving DFS deployment;
- Infrastructure development;
- Management of the rural/urban population divide; and
- Population readiness in areas where digital literacy is low and trust is high in cash-based transactions.

In terms of usage levels, e-commerce and the DFS ecosystem still reach a relatively small portion of the population in the Andean countries covered in this Resource Guide, and digital wallets today are a small market niche. Limited levels of physical infrastructure, needed regulatory reforms, and the high percentage of people outside the formal labor market remain barriers to the more widespread adoption of DFS. In many markets, there are disconnects between comparatively high levels of smartphone ownership and low levels of m-commerce and between increasingly mature identification and authentication systems and remaining issues with security and safety. Nonetheless, the region is showing strong evidence of innovation and adoption.

A3.2 Smart Cities and e-Government - Investment Outlook

The global Smart Cities business opportunity is estimated at $2 trillion by 2025[91], with the Latin American/Caribbean region representing roughly 10 percent of the total. Growth will arise from a global base of about $1 trillion today, although estimates vary widely. The anticipated compound annual growth (CAGR) is 15 percent. The development of Latin American/Caribbean smart cities currently lags behind other regions such as Asia, North America, and Europe, but numerous programs are either in process or planned. Estimates suggest that globally, the public sector has around 70 percent ownership of smart-cities applications, with 60 percent of the required initial investment arising from the private sector.[92] In addition to the bricks and mortar and associated services required for developing new buildings and housing developments, a wide range of ICTs will be critical to smart city development and e-Government, including:

- 5G and other telecommunications infrastructure and services;
- Voice assistants;

[90] AFI Global https://www.afi-global.org/sites/default/files/publications/2019-07/AFI_FILAC_SP_AW_digital.pdf
[91] Frost & Sullivan
[92] McKinsey and Company

- Artificial Intelligence (AI);
- Internet of Things (IoT);
- Building automation;
- Sensors;
- Big data;
- Cloud computing;
- Cleantech;
- Distributed energy generation;
- Cybersecurity;
- Surveillance;
- Electric and autonomous vehicles (EV and AV) sensors; and
- Advanced driver assistance systems (ADAS).

The global ICT investment in e-Government was approximately $600 to 700 billion in 2019.[93] Communication and IT services represent about two-thirds of investments, while software, devices, and data centers comprise the remaining third. Big Data, the Internet of Things (IoT), and customized apps continue to be new focal points for investment technology.

Following are profiles of the Smart Cities and e-Government projects reviewed in this Resource Guide spanning Colombia, Ecuador, and Peru.

A3.3 Colombia

Colombia ranks 67th globally on the United Nations e-Government Development Index (EGDI) and 27th globally in e-participation. IESE recognizes Bogotá (120th globally), Medellin (126th), and Cali (145th) in its Cities in Motion (Smart Cities) Index. Aiding Colombia's smart cities and e-Government development are its large economy relative to many Latin American and Caribbean nations (fourth in the region) and high levels of urban mobile telephone, internet, and broadband access.

Colombian federal e-Government projects are numerous. Six are profiled in this Resource Guide:

- *Digital Transformation of News Media*: Colombia has issued a request for proposals from news media organizations to support their digital transformation. Over 2,000 news media groups are eligible, spanning television, radio, newspapers, magazines, and digital media. Eligible project activities include business culture transformation, business process transformation (both operational and support), and development and implementation of technologies for digital transformation. Qualifying opportunities include acquiring IT infrastructure, implementing emerging technologies, and migrating to digital product delivery.

- *Multipurpose Cadaster in Protected Areas:* This project will develop and implement a multipurpose cadaster in municipalities with national environmentally-protected areas,

[93] Grandview Research

deforestation hotspots, and other national environmentally significant and strategic areas. The project seeks to strengthen environmental authorities, develop and strengthen the Colombian Environmental Information System, and implement and maintain the multipurpose cadaster in environmentally sensitive areas.

- *Digital Transformation of the Justice System:* Colombia's constitution guarantees access to the administration of justice promptly. The duration of most cases in the judicial system currently exceeds stipulated maximum time frames, and citizen satisfaction with the judiciary is low. Thus, this project aims to support the digital transformation of the judicial system to improve judicial processing times and increase transparency and coordination. ICT components of the project include using digital services and Technology for Justice and creating a digital environment and culture.

- *Digital Transformation of the Comptroller General:* The Comptroller General carries out financial control and auditing over 5,000 public entities in Colombia. Digital transformation of the office has three objectives:

    - Improve productivity to audit a total of 5,677 control subjects effectively;
    - Increase efficiency to engage in preventive functions before contract disbursements; and
    - Enhance citizen participation.

    Expected outcomes of the effort include enhanced comptroller productivity and effectiveness and greater citizen participation.

- *DIAN Modernization Project:* The National Tax and Customs Directorate (DIAN) administers and controls Colombian tax and customs requirements. The Directorate is undertaking a tax and customs management effectiveness program to improve both institutional governance and technology management. The project spans three initiatives:

    - Institutional organization and human resources;
    - Tax and customs control and compliance; and
    - Technology platform, data, and information security.

- *Smart Cities Initiative:* The Ministry of Information Technologies and Communications supports 61 municipalities in a voluntary program to foster smart city technologies and projects throughout Colombia. The program's first step was developing and applying a smart city maturity model, offering benchmarking and gap analysis along six smart city dimensions and five horizontal enabling factors. Following the benchmarking, each municipality will develop and administer its own implementation plan.

In addition, one Colombian municipal Smart Cities and e-Government project is reviewed. In November 2020, the city of Bogotá announced an ambitious Digital Transformation (DT) Plan, organizing 100 initiatives under nine digital transformation agendas:

- Green Transformation;
- District Care System;

- Open Government;
- Cultural Agenda;
- Networked, Preventive and Territorial Health;
- Education;
- Reactivation and Economic Well-Being;
- Simplify Day-to-Day Life; and
- Territory in Peace and Security.

The main objective of the nine Bogotá DT agendas is to use technology to strategically transform Bogotá into a more sustainable city while generating new opportunities and empowering citizens to take part in the most critical municipal decisions. The agendas will also result in deploying technology, data, and innovation to improve the quality of life of Bogotá citizens.

A3.4 Ecuador

Ecuador ranks 74th globally on the United Nations e-Government Development Index (EGDI) and 49th in e-participation. The IESE recognizes Quito (142nd globally) and Guayaquil (164th) in its 2020 Cities in Motion (Smart Cities) Index. Aiding Ecuador's smart cities and e-Government development are its relatively high urban mobile telephone, internet, and broadband access levels. Connectivity to smaller and more remote municipalities, however, is still developing.

To address both remote population connectivity and access to e-Government services, the Ecuadorian connectivity and e-Government plan, profiled in this Resource Guide has three focal points:

- Connecting 100 percent of the country's population;
- Expanding e-Education and e-Healthcare; and
- Implementing e-Government approaches to streamline public sector procedures and reduce corruption.

The e-Government initiative will promote the harmonization of procedures at all levels to reduce the administrative and financial burden currently falling on citizens and companies in Ecuador. Digital paperwork and services will solve many bureaucratic problems, as they are faster, cost less, and reduce corruption. In the e-Education segment, the project will provide tablets to students; since much of the Ecuadorian population has cellular telephone access, home access to computers is more limited. In e-Healthcare, digital transformation will improve the quality and efficiency of medical care, reduce waiting times, exchange of patient health information, and expand medical care to difficult to access rural areas.

A3.5 Peru

Peru ranks 71st globally on the United Nations e-Government Development Index (EGDI) and 55th in e-participation. The IESE recognizes Lima (155th globally) in its 2020 Cities in Motion (Smart Cities) Index. Aiding Peru's smart cities and e-Government development are its large economy relative to many Latin American and Caribbean nations (sixth in the region) and relatively high levels of urban mobile telephone, internet, and broadband access.

Peruvian e-Government projects profiled in this Resource Guide include:

- *Centralized Emergency Response System*: Peru will integrate, into a single 911 center, its three principal existing emergency response systems, those of the national police, the mobile emergency care system, and the corps of voluntary firefighters. Covering the greater Lima area, the project seeks to reduce dispatch times from a current baseline of 17 minutes to 3.5 minutes. ICT developments associated with the project include a digitally integrated platform, 911 response protocols, interconnection of police cameras, and a use and awareness campaign for the new 911 platform.

- *National Urban Cadaster Project*: Today, only eight of Peru´s 522 urban municipalities have complete and updated cadasters. Peru is undertaking a project to improve urban cadaster services in 22 municipalities to enhance revenue generation and urban management. The project includes strengthening both municipal systems and the national institutional framework.

- *Digital Transformation of Financial Administration:* The Peruvian Ministry of Economy and Finance recently approved a digital transformation master plan to transform. Financial administration across the country. The project spans three ICT objectives:
  - Improvement of the functional processes for financial administration;
  - Modernization of the Ministry's computer systems; and
  - Expansion of the associated technology infrastructure.

After piloting a program to provide international trade support, a private consortium will be expanding the effort. *The Connected Economy* is a virtual business ecosystem supporting the expansions of small- and medium-sized Peruvian companies into global markets. The project includes a virtual exposition center with a global economic center, digital showrooms, a conference hall, and exhibition and trade centers.

Peru's *Todos Conectados* project, reviewed under the Terrestrial Communications Infrastructure: Telephone, Internet, and Broadband sector, also provides e-Government support capability to the country's currently underserved eastern Amazonian region.

A4 Internet of Things (IoT) and Artificial Intelligence (AI)

A4.1 Sector Overview

The Internet of Things (IoT) and Artificial Intelligence (AI) are closely related. IoT is the networking capability allowing information to be sent to and received from objects and devices (such as home appliances, industrial systems, and modes of transportation) using the Internet. AI is the capability of a machine to imitate intelligent human behavior. AI is often incorporated in IoT applications to enhance performance and better predict user needs.

A4.1.1 The Internet of Things (IoT)

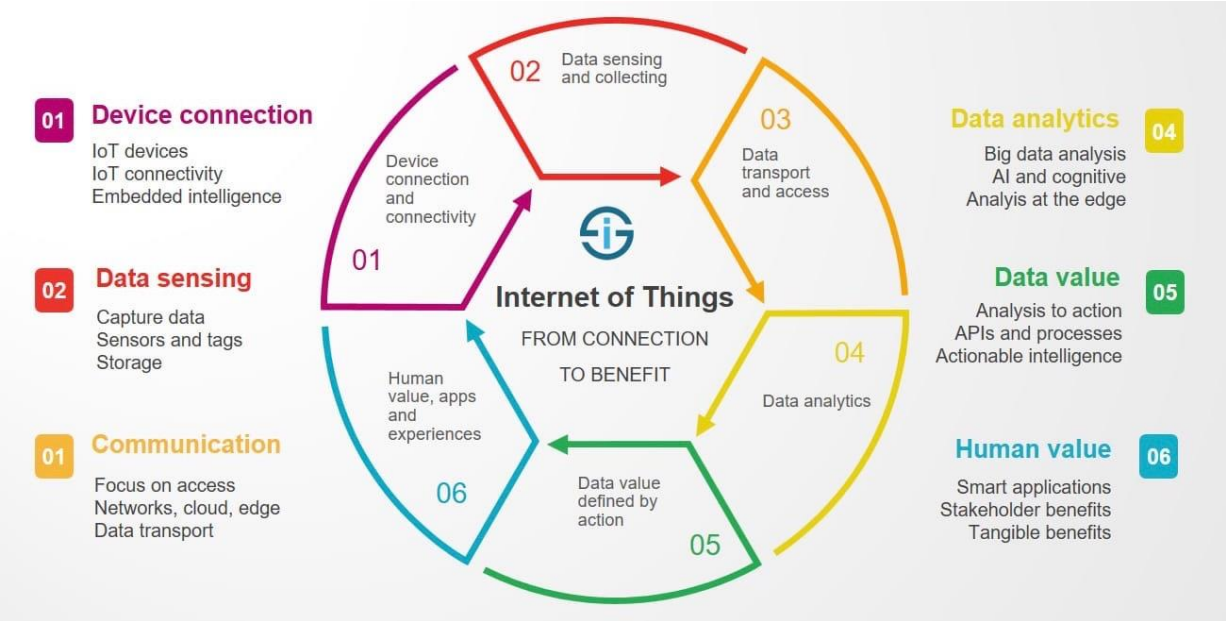
The IoT is a system of interrelated computing devices, mechanical and digital machines, objects, animals, or people provided with unique identifiers (UIDs) and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction. A *"Thing"* may be an automobile with sensors monitoring/adjusting performance systems; a person with an electronic implant such as a pacemaker; livestock/individual animals with biochip transponders; a manufacturing plant or piece of equipment with smart sensors; or any other natural or human-made object which may be assigned an Internet Protocol (IP) address and can transfer data over a network.

IoT ecosystems comprise web-capable smart devices using embedded processors, sensors, cameras, and communication hardware to collect, send, and act on data acquired from their environments. IoT devices share the sensor data collected by connecting to an IoT gateway or other edge device and send it to the cloud for processing (or sometimes local analysis). IoT devices generally operate without human intervention. However, humans do interact with the devices for setup, instruction, and access to information resulting from machine data analysis, as shown in Figure 40. IoT devices frequently communicate with other related devices and act on the information obtained from one another. IoT devices can also use artificial intelligence (AI) and machine learning to make data collection and analysis processes easier and more dynamic.

IoT benefits include:

- Access to information from anywhere at any time on any device;
- Improved communication among connected devices; and
- Task automation, improving business, consumer, and production process efficiency, while also reducing human intervention and required labor.

Figure 40: Internet of Things (IoT) Data and Benefit Cycle [94]



Challenges to wide IoT adoption include:

- The need for a uniform international standard of compatibility for IoT, lack of which currently limits the abilities of devices from different manufacturers and regions to communicate with each other;
- The ability of enterprises to manage with massive numbers of interconnected IoT devices (up to and. including in the millions) and the associated challenges in collecting and managing extensive quantities of data;
- The possibility all interconnected devices will become corrupted if a bug manifests in one; and
- The potential is that hackers may steal confidential information, particularly as the number of connected devices increases and more information is shared among devices.

IoT uses span numerous markets and applications, including but not limited to:

- Home (security, appliances, automation);
- Industrial and utilities (process control, machine-to-machine automation, logistics);
- Transportation (aircraft, railroad and light rail, vehicular);
- Agriculture (soil and crop management, livestock care);
- Government and military (smart cities, aerospace and defense, and e-Government);
- Healthcare (telemedicine, predictive diagnostics, robotic and image-guided surgery);
- Environmental (weather and climate management and prediction, fire and flood detection, wildlife management);
- Retail (logistics, inventory control, security); and

[94] I-Scoop.eu

- Building and construction (fault prediction, energy management, and heavy machinery control).

Today, in the Latin American/Caribbean region, Brazil hosts just under half of regional IoT devices, with Mexico and Colombia representing the next two largest users. The rest of Latin America and the Caribbean, in total, comprises 20 to 25 percent of current IoT device usage. IoT adoption in Ecuador and Peru is somewhat limited but poised for rapid growth, particularly as cellular technologies and cost-effective broadband access continue to evolve.

A4.1.2 Artificial Intelligence

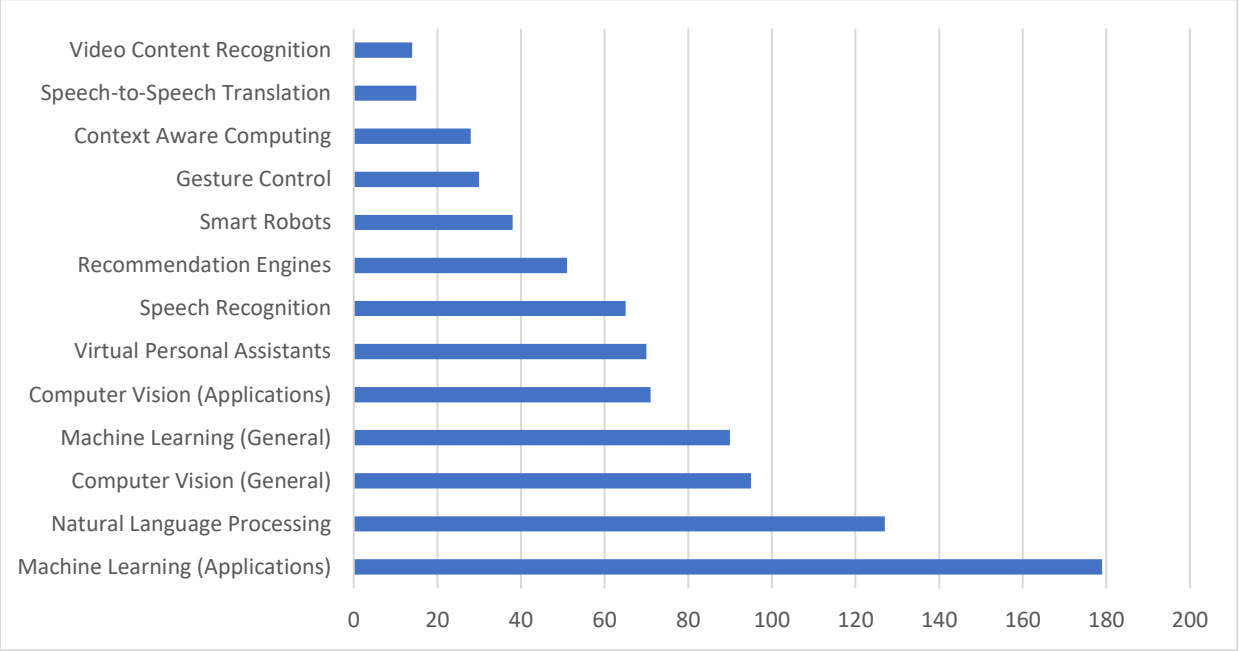
Artificial Intelligence (AI) is the simulation of human cognitive capabilities in machines programmed to think and mimic the actions of people. Any machine exhibiting traits associated with a human mind, such as learning and problem-solving, may be described as using artificial intelligence. The key characteristic of AI is its ability to rationalize and take actions having an optimized chance of achieving a specific goal.

Artificial intelligence divides into two categories:

- **Weak:** a system designed to carry out one particular job (e.g., playing chess or personal assistants such as Amazon's Alexa or Apple's Siri where the assistant is asked a question and answers it); and
- **Strong:** typically complex systems performing multiple tasks considered human-like, programmed to handle situations requiring problem solutions without human intervention. (e.g., self-driving cars or robotic and image-guided surgery).

AI technologies are evolving rapidly. Over 800 companies are developing AI technologies and solutions spanning: machine learning; computer visioning; language processing, recognition and translation; and movement and context recognition and interpretation, as described in Figure 41.

Figure 41: Artificial Intelligence Innovation Areas, 2020 (Number of Companies Developing Solutions)[95]



AI solutions offer benefits including:

- Labor and home/personal management cost reduction;
- Worker safety (e.g., allowing machines to replace humans in risky environments);
- Ability to perform tasks more quickly and effectively than the average human (e.g., reading digital medical images and performing complex surgeries); and
- Scalability and 24/7/365 service availability and access from any location.

A challenge facing AI is concern about the potential replacement of human labor by machines, leading to possible unemployment. Another concern is that machines may become so highly developed that humans will not be able to keep up with machine learning, creating a prospect that machines could evolve themselves to take over society. Yet another is that AI devices may have the ability to hack into human privacy or be weaponized. Many debate the ethics of artificial intelligence and how intelligent systems should be treated legally vis-à-vis human rights.

For the Latin America and Caribbean region, which has historically lagged larger economy regions in worker productivity, AI offers an opportunity to leapfrog to greater innovation and economic progress. Research suggests AI can add a full percentage of GDP to five of South America's largest economies (Argentina, Brazil, Chile, Colombia, and Peru) by 2035.[96] By year-end 2019, 79 percent of Latin American companies had launched AI initiatives, with fewer than two percent reporting lower than expected investment returns.[97]

[95] Venture Scanner
[96] Inter-American Development Bank
[97] Massachusetts Institute of Technology (MIT)

A4.1.2 Digital Payment Systems

Electronic payments allow customers to pay for products or services online. An e-commerce payment system facilitates transactions seamlessly among several parties:

- The account holder, or consumer**,** who purchases a product or service online;
- The merchant who sells goods and services to the consumer;
- The issuer (the financial institution providing the consumer with a payment account and/or card);
- The acquirer (the merchant account provider, the financial institution that establishes an account with the merchant). The acquirer authorizes the legitimacy of the consumer account;
- The payments processor, who handles the official transaction between the consumer and the merchant; and
- The payment gateway (processes merchant payment messages and uses security protocols and encryptions to ensure transaction safety).

Artificial Intelligence is gaining momentum in the digital payments market, both in backend operations and customer-facing payment systems. AI digital payment applications include:

- Fraud protection facial recognition;
- Smarter Stan-In Processing (Smarter STIP) and other technologies to ensure fast interruption-free transaction; and
- Fraud-resilient settlement technology with transaction pattern recognition, human error reduction, and AI-enhanced cybersecurity.

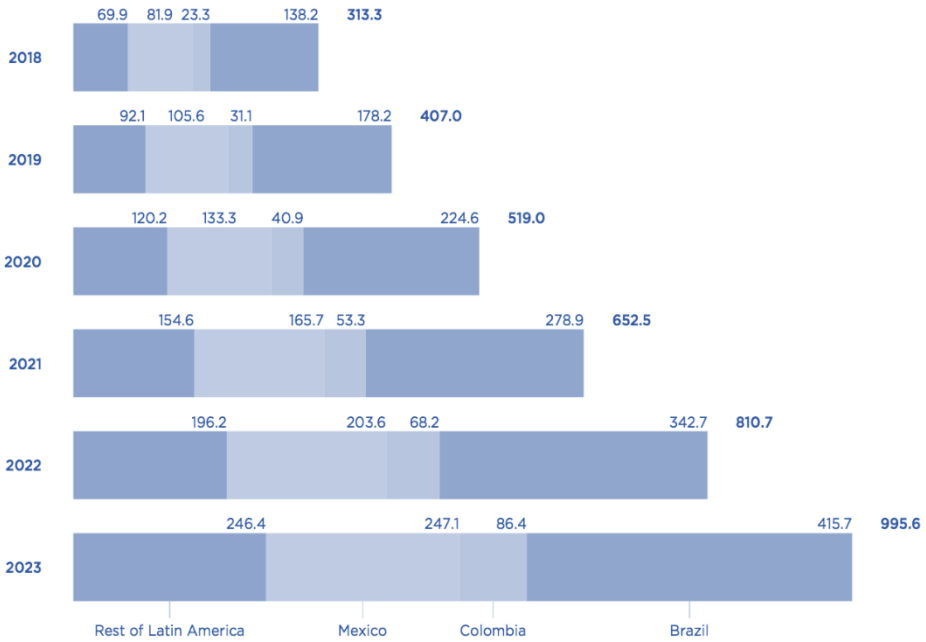
A4.2 Internet of Things (IoT) and Artificial Intelligence (AI) Investment Outlook

In 2019, the global market for IoT was approximately $745 billion.[98] By 2025, projections suggest 41.6 billion IoT devices will be connected globally, generating 79.4 zettabytes of data. Global spending will exceed $1 trillion by 2022.[99]

In 2017, the Latin American/Caribbean region hosted 400 million connected devices. By 2023, MIT forecasts that the number will reach over one billion connected IoT devices. The region will represent the fastest growth in IoT spending through 2025. While Brazil is and will remain the largest IoT device consumer, Mexico (28.3 percent compound annual growth rate (CAGR)), Colombia (24.9 percent CAGR), and Chile (23.3 percent CAGR) are projected to lead growth in the region, as shown in Figure. 42.

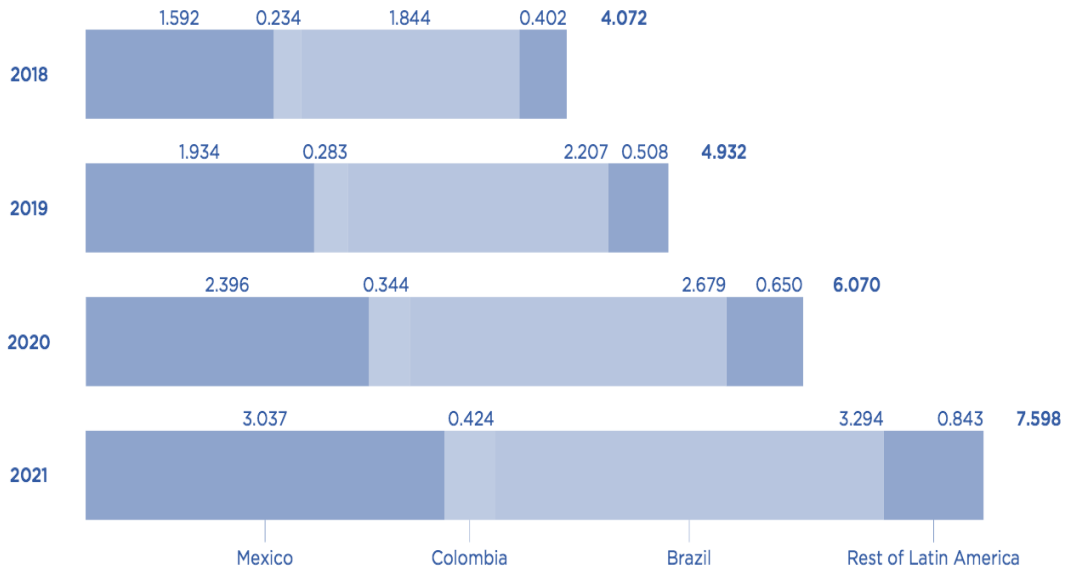
[98] Ibid
[99] Ibid

Figure 42: Latin America and Caribbean Internet of Things (IoT) Device Forecast, 2018-2023 (million units)[100]



The foregoing device numbers translate to a regional market of almost $5 billion in 2019. The Latin American/Caribbean region IoT market will grow to $7.6 billion by 2022, or at a compound annual growth rate of above 20 percent, as shown in Figure 43.

Figure 43: Latin American and Caribbean Internet of Things (IoT) Revenue Forecast, 2018-2023 ($ billion)[101]



[100] Ibid
[101] Inter-American Development Bank

Although the Latin America and Caribbean region AI market is small today (various estimates suggest under $1 billion in 2019), the geography is already seeing substantial economic benefits from artificial intelligence. Several factors will drive growth, with big data providing traction and image processing being a critical application area. The large amount of data required to train AI systems for character and image recognition has, to date, constrained growth. Visa, for example, reported that artificial intelligence allowed regional financial institutions to avoid $2 billion in credit card fraud in 2019 on a payment volume of $430 billion.

Three Colombian IoT/AI projects are profiled in this Resource Guide.

A4.3 Colombia

Colombia has undertaken a variety of IoT and AI implementations through its various smart cities efforts and in the private sector. As one example, recently (February 2021), the South African Council for Scientific and Industrial Research (CSIR), a part of its Department of Science & Innovation, signed an agreement with the Colombian Center for the Fourth Industrial Revolution (C4IR.CO). The parties intend the cooperation to unlock the potential of artificial intelligence (AI) and Internet of things (IoT) technologies and bolster research capacities in both Colombia and South Africa. C4IR.CO is a Colombian corporation and an operator of the Centre for the Fourth Industrial Revolution of Colombia, arising from an alliance between the Mayor's Office of Medellín and the National Government of Colombia.

Three Colombian IoT/AI projects featured in this Resource Guide also focus on IoT and AI technologies:

- *Ecopetrol Digital Transformation*: Ecopetrol recently announced the second phase of its digital transformation, spanning 2021 to 2023, with a budget between $100 and 150 million. Ecopetrol has focused the digital transformation on three pillars: value creation, innovation, and business transformation. Digital transformation technologies for the project include elastic cloud computing, big data, AI, IoT, robotics, blockchain, and advanced analytics.
- *Digital Transformation for Small-Scale Farmers:* The Colombian Center for the Fourth Industrial Revolution, affiliated with the World Economic Forum, is working in eight project areas, one of which is the digital transformation of agriculture. The strategic use of data and 4.0 technologies will be critical to reinforcing agriculture as a fundamental pillar of the country's economy. Project implementation will involve optimal data gathering using techniques ranging from IoT sensors to third-party data providers. The project uses an economic valuation model of data developed with experts for three crops: cocoa, Haas avocados, and coffee.
- *Procolombia FinTech Portfolio*: PROCOLOMBIA is promoting a portfolio of fintech opportunities, including a mobile wallet targeting banked and unbanked (65 percent of the Colombian population) consumers, a fintech boutique focused on lending and other financial services for small and medium enterprises (SMEs), and a crowdfunding platform focused on developing countries with specialized solutions including rewards-plus-donation, pre-sales, subscription, political, and personal/friends. The portfolio encompasses various ICT technologies, particularly IoT and AI, such as chatbot and virtual assistants, robo-advisors, blockchain, and AI and robotic process automation.

A5 Cybersecurity

A5.1 Sector Overview

Cybersecurity emphasizes the safeguarding of computers, programs, networks, and data from unlicensed and spontaneous access. The sector includes:

- Network security;
- Application security;
- Endpoint security;
- Identity management;
- Data security;
- Cloud security; and
- Infrastructure security.

As for many other ICT segments, providers typically supply articles of commerce in the forms of hardware, software, and services.

Cybersecurity threats, commonly known as malware, can infiltrate the software of any device. These threats take many forms, including[102]:

- ***Viruses:*** malware that propagates by inserting a copy of itself into and becoming part of another program. It spreads from one computer to another, leaving infections as it travels. Almost all viruses are attached to an executable file, so the virus may exist on a system but not spread until a user runs or opens the malicious host file or program. Viruses spread when the software or document attached to is transferred from one computer to another using the network, a disk, file sharing, or infected e-mail attachments.
- ***Worms are similar to viruses in replicating functional copies of themselves; however, viruses require spreading*** an infected host file, while worms are standalone software and do not require a host program or human help to propagate.
- ***Trojans:*** malware named after the wooden horse that the Greeks used to infiltrate Troy. A Trojan is a harmful piece of software that looks legitimate. A Trojan can achieve any number of attacks on the host, from irritating the user (popping up windows or changing desktops) to damaging the host (deleting files, stealing data, or activating and spreading other malware, such as viruses). Trojans are also known to create backdoors to give malicious users access to the system. Unlike viruses and worms, Trojans do not infect other files or self-replicate. Trojans spread through user interactions like opening an email attachment or downloading and running a file from the internet.
- ***Spyware:*** software that "spies" on a device, capturing information including web browsing habits, e-mail messages, usernames and passwords, and credit card information. If left unchecked, spyware can transmit this data to another person's computer over the Internet. Users typically install spyware by opening an e-mail attachment containing the malicious software.

[102] Cisco

- ***Ransomware:*** threatens to publish the victim's data or perpetually block access unless a ransom is paid. Advanced ransomware uses *cryptoviral extortion*, encrypting the victim's files, making them inaccessible, and demanding a ransom payment to decrypt them.
- ***Bots*:** from the word "robot," an automated process interacting with other network services. A typical use of bots is to gather information (e.g., web crawlers or interact automatically with messaging and chat software or other web interfaces. Bots may be used for either legitimate or malicious intent. A malicious bot is self-propagating malware designed to infect a host and connect back to a central server or servers that act as a command and control (C&C) center for an entire network of compromised devices, or "botnet." With a botnet, attackers can launch broad-based, "remote-control" flood-type attacks against their target(s). Bots can include the ability to log keystrokes, gather passwords, capture and analyze packets, gather financial information, launch Denial of Service attacks, relay spam, and open backdoors on the infected host. Advanced botnets can take advantage of internet of things (IoT) devices, like home electronics or appliances. Crypto mining is a common malicious use of bots.

Recent history suggests the following concerning cybersecurity threats[103]:

- Eighty-eight percent of organizations worldwide experienced spear-phishing attempts in 2019.
- Sixty-eight percent of business leaders feel their cybersecurity risks are increasing.
- On average, only five percent of companies' folders are adequately protected.
- Data breaches exposed 36 billion records in the first half of 2020.
- Eighty-six percent of breaches were financially motivated, and 10 percent were motivated by espionage.
- Forty-five percent of breaches featured hacking, 17 percent involved malware, and 22 percent involved phishing.
- Between January 1, 2005, and May 31, 2020, there were 11,762 recorded breaches.
- The top malicious email attachment types are .doc and .dot, which make up 37 percent; the next most experienced file type is .exe, at 19.5 percent.
- An estimated 300 billion passwords are used by humans and machines worldwide.

As cyber threats have increased in sophistication and at rapid rates, security solutions have gained traction globally. Offerings such as antivirus software and firewalls have grown in complexity and proven to be effective at preventing threats, including malware, Trojans, and phishing. The success of early solutions led to the rapid development of the cybersecurity industry. Implementing technical defenses has become a standard best practice in every enterprise.

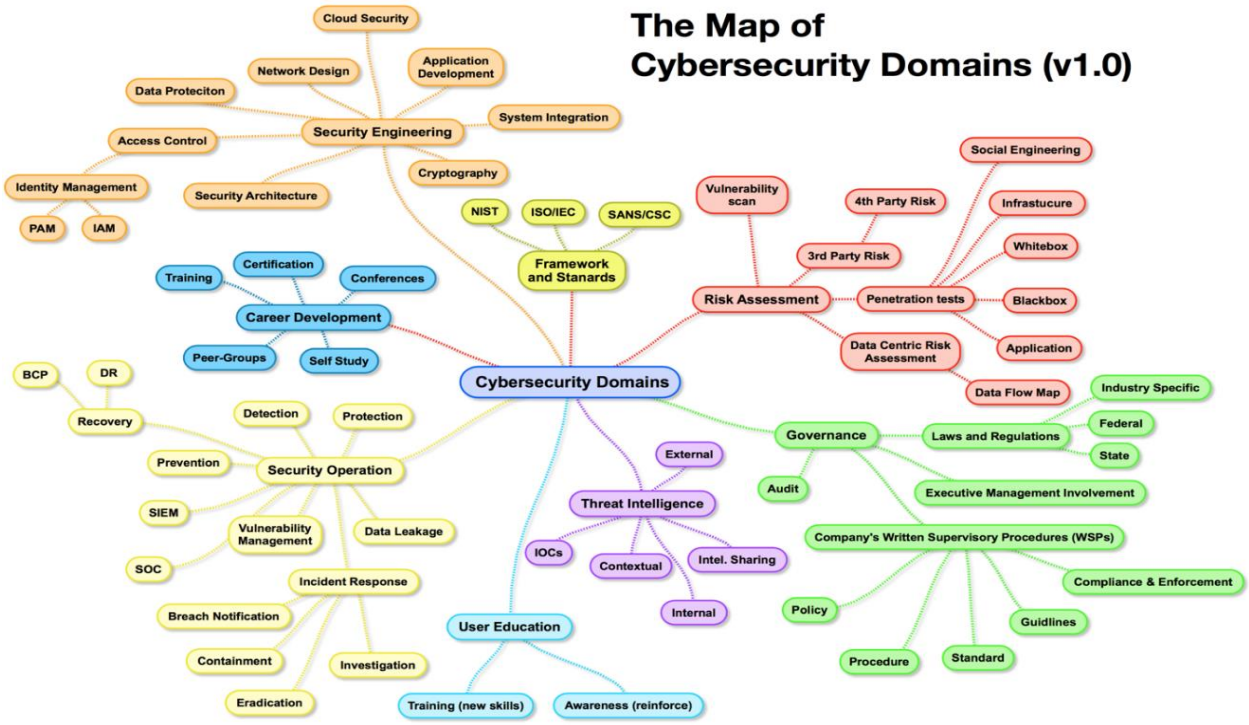
The breadth of cybersecurity considerations is described in Figure 44. Focal areas include:

- Risk assessment;
- Governance;
- Threat intelligence;
- Security operations;
- Security engineering;
- User education; and

[103] Varonis https://www.varonis.com/blog/cybersecurity-statistics/

- Career development.

Figure 44: Cybersecurity Domains[104]



Future considerations for managing cybersecurity include:

- Remote workers will continue to be a target for cybercriminals.
- As a side effect of remote workforces, cloud breaches are likely to increase.
- As a result of 5G increasing the bandwidth of connected devices, IoT devices will become more vulnerable to cyberattacks.
- DNS over HTTPS is likely to become a common attack vector given the ability to encrypt malicious requests, so they are masked from security controls.
- Disinformation campaigns are likely to continue and grow.
- Attacks on cars and operational technologies will continue to proliferate due to less mature security controls.
- There is a widening talent gap, with demand outstripping the supply of needed personnel.

By 2019, eighteen Latin America and Caribbean region countries had made efforts to frame cybersecurity strategies, with twelve in place and operational.

In Latin America, Argentina, Mexico, and Brazil were among the countries with the highest percentages of internet users and mobile devices affected by malware. In 2019, Ecuador

[104] Tao Security https://taosecurity.blogspot.com/2017/03/cybersecurity-domains-mind-map.html

and Paraguay suffered the most significant number of cybersecurity incidents. Seventy percent of IT managers of companies in these two countries indicated addressing incidents including malware infections, unauthorized access to applications, and unauthorized access to databases. In Brazil, 65 percent of organizations reported suffering ransomware attacks in 2020, compared to 44 percent in each of Mexico and Colombia.[105]

Important cybersecurity challenges in the Andean countries covered in this Resource Guide include:

- The sophistication of ICT technologies and broadband speeds;
- The ability to defend against foreign interests targeting the region; and
- The availability of cybersecurity talent.

A6.2 Cybersecurity Investment Outlook

In 2019, the global market for Cybersecurity solutions was approximately $150 billion, according to various sources.[106] Estimates project market growth at an annual rate of at least 10 percent over the next five years.

Cybercrime costs have quadrupled since 2015, reaching $2.1 trillion by the end of 2019 and outpacing spending on cybersecurity by over 16 times. The COVID-19 global pandemic posed challenges to the already rapid growth of the sector by requiring the swift adoption of remote working technologies with concomitant needs for safeguarding business data, preventing losses from cyberattacks, and managing the spike in demand for robust authentication methods over vastly more workplaces.

The Latin America and Caribbean cybersecurity market was approximately $5 billion in 2020 and is projected to double by 2026.[107] In 2017, the Latin American/Caribbean region hosted 400 million connected devices. By 2023, MIT forecasts that the number will reach over one billion. The region will represent the fastest growth in IoT spending through 2025, posing rapidly expanding cybersecurity risks. While Brazil will remain the largest device consumer, Mexico, Colombia, and Chile will lead growth in the region.

A5.3 Peru

With the growth of connectivity, the dependence on Internet-based platforms has also grown and increased exposure to cyber-related crimes in Peru. Cybersecurity challenges in Peru include:[108]

- The Government of Peru is establishing a Digital Security Center, but resources/staffing are limited.
- Peru is early on in understanding and managing issues of data localization and cross-border data flow.

[105] Statista
[106] Ibid
[107] Mordor Intelligence
[108] Global Atlanta https://www.globalatlanta.com/event/opportunities-in-the-cybersecurity-sector-in-peru/

- According to statistical reports, Peru occupies 4th place in cyber-attacks in Latin America after Brazil, Mexico, and Colombia.
- During 2019, at least 57 percent of Peruvian companies suffered a ransomware attack, with Peru being the most attacked country in Latin America. Vulnerability and malware attacks have also been detected.
- Among the most affected Peruvian sectors are technology, education, and health.

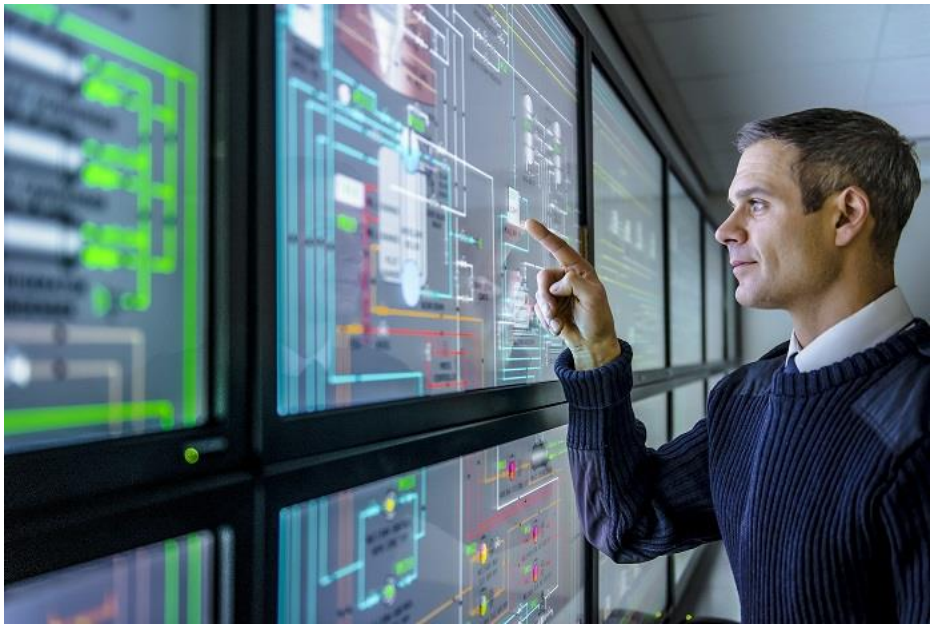
Another area of concern, as profiled earlier in this Resource Guide, is the Peruvian financial services sector. The Peruvian regulator is active in ensuring better management of information security and cybersecurity in financial services and has recently promulgated regulations to require all regulated entities to design and implement compliant information security and cybersecurity management systems. In addition, the regulated entities must also implement a comprehensive cybersecurity program. Internal and external audits will evaluate compliance during the 2022 fiscal year audit cycle.

A6 Utilities Automation

A6.1 Sector Overview

Utilities are increasingly applying ICT technologies to manage the electric power process generation and transmission processes, respond to system and weather disruptions, and manage back-office functions more efficiently and effectively, as shown in Figure 45.

Figure 45: Utilities Automation ICT Control Center[109]

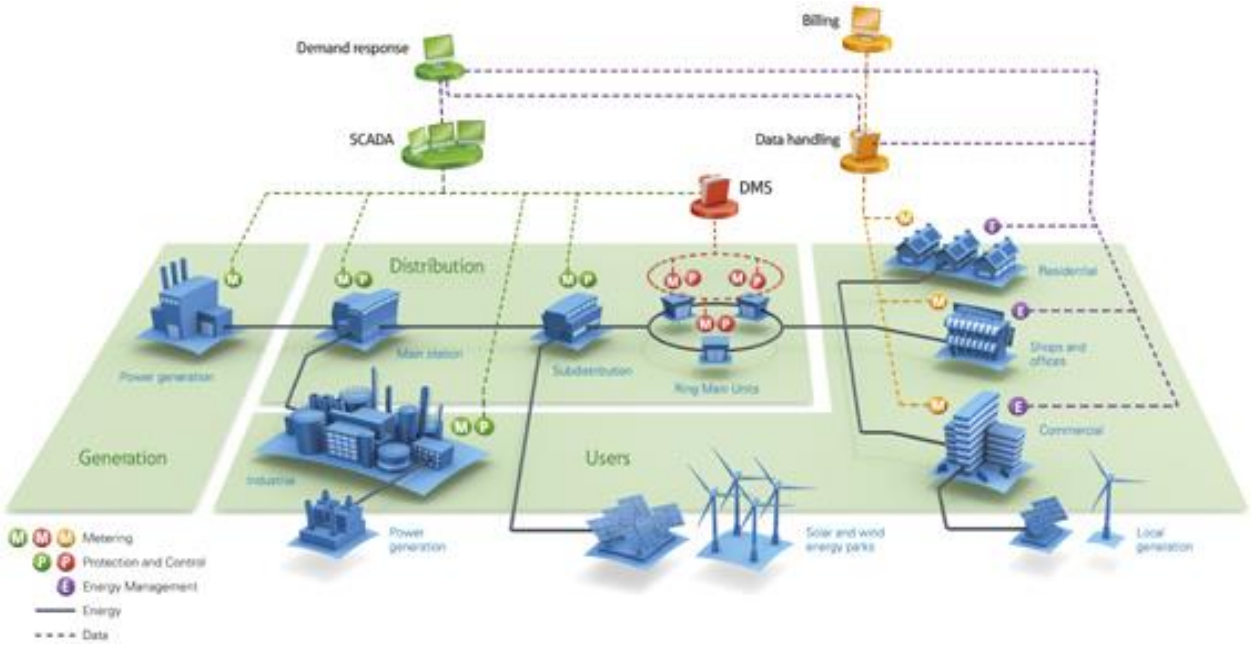


A "smart grid" deploys a wide variety of technologies and services, as shown in Figure 46. ICT tools typically used include:

- Advanced Metering Infrastructure
- Automatic Vehicle Location
- Customer and Financial Information Systems
- Demand-side Management
- Demand Response
- Distribution Automation
- Geographic Information Systems
- Mobile Work Management
- Motor Controls and Automation Outage Management Systems;
- Supervisory Control and Data Acquisition (SCADA) systems; and
- Substation Automation.

[109] Schneider Electric

Figure 46: Smart Grid Schematic[110]



Hardware, software, and advisory services specific to generation and transmission include:

- **Relay Settings**
  - Transmission line protection;
  - Communication-aided protection schemes;
  - Unit protection for generators, transformers, capacitor banks, and shunt reactors;
  - Substation protection and control for busses and breakers;
  - Distribution system protection; and
  - Wide Area Protection and Remedy Action schemes.

- **Digital Substation Design**
  - IEC- and other industry-standard specification compatible system design;
  - Substation communication network design;
  - Remote terminal unit (RTU) and station human-machine interface (HMI) configuration;
  - Substation automation systems; and
  - Asset health monitors.

- **Power System Automation**
  - Fault analysis and remediation;
  - Short circuit and relay coordination;
  - Transient simulations;
  - Area coordination; and
  - Protection systems reliability.

[110] Eaton http://www.eaton.nl/ecm/groups/public/@pub/@europe/documents/content/pct_314533.jpg

- **Power and Communications Applications**
    - Protection schemes (line, transformer, bus, breaker, capacitor bank, and reactor);
    - Auto-reclosing;
    - System integrity protection; and
    - Volt/VAr (volt amp reactive) control.

- **Real-Time Digital Simulation (RTDS) testing**
    - Protection and control schemes/settings verification for complex power-system or critical assets;
    - Power system transient studies; and
    - Secondary injection testing.

Robotic process automation, cited by Ernst and Young as one of the four basic digital technologies for the future of the energy sector, focuses on:

- **Energy Trading**
    - Data entry;
    - Purchase order issuance;
    - Submission of compliance documents; and
    - Management of information from legacy systems.
- **Back Office**
    - Meter reading and validation;
    - Misread correction;
    - Billing and statement management;
    - New account creation;
    - Complaint management;
    - Finance and accounting;
    - Procurement; and
    - Human resource management.

The other critical ICT utility automation technologies cited by Ernst and Young include blockchain, IoT, and smart metering. The AI, IoT, and Smart Cities and e-Government sectors of this Resource Guide, respectively, describe these tools.

A6.2 Utilities Investment Outlook

Due to the breath of the utility automation sector, precise market size is difficult to estimate accurately but is likely in the range of $15-20 billion globally.[111] The United States accounts for the largest share of global investment, with the Asia Pacific region growing most rapidly. In the Latin America and Caribbean region, energy and utility companies in Argentina and Ecuador have been public regarding ongoing initiatives for digital automation, as reviewed in this Resource Guide and its companion volume covering the Southern Cone countries of Argentina, Brazil, and Paraguay.

[111] Grandview Market Research https://www.grandviewresearch.com/industry-analysis/electric-power-distribution-automation-systems-market, et al

Available cost savings for utility automation were nearly $3 billion in 2019, according to Capgemini. In general, the sector has enjoyed customer (revenue)- and expense-related automation benefits in excess of other industrial sectors, along with higher executive and customer satisfaction. In parts of the Latin America and Caribbean region, transmission losses may reach 15 percent or more, making process automation and management tools of particular interest.

This Resource Guide reviews two Ecuadorian utility automation projects.

A6.3 Ecuador

Over the past two decades, Ecuador has added considerable hydroelectric power to its mix, somewhat reducing its level of dependency on oil. Moving forward, natural gas generation will play a more important role in maintaining reliability and adding flexibility. As additional, intermittent renewable resources are incorporated, reactive power assets will also become important.

A change in government policy in 2019 allowing foreign investment in the energy sector suggests another 5 GW will be added over the next few years. This includes a 1-GW combined cycle plant for the Guayaquil area, two large hydroelectric plants, and major transmission upgrades.

To manage the increasingly complex power generation and distribution networks and to modernize systems approaching obsolescence, Ecuador is undertaking two important utilities automation projects:

- ***CENACE Control Center Upgrade:*** The control center of Ecuador's national power grid system operator, CENACE, carries out automatic and manual control of electricity generation and transmission assets and manages international energy transactions. The technology at the core of the current control center is becoming obsolete and requires upgrading. CENACE's principal hardware and software comprise four Operational Technologies (OT): the SCADA/EMS (Supervisory Control and Data Acquisition / Energy Management System), the WAMS (Wide Area Monitoring System), the SPS (Special Protection Scheme / System Injury Protection Scheme), and the AMI (Advanced Measurement Infrastructure) for commercial purposes. The upgrade focuses on the Andean regional power market (Colombia, Ecuador, Peru, Bolivia, and Chile) and demand growth and new requirements for the national grid from developing generation and power user technologies.

- ***Transelectric Digital Transformation:*** Transelectric, a business unit of the national utility CELEC, owns and maintains all of Ecuador's transmission assets. The company is initiating a digital transformation spanning substation automation, digital protective relays, advanced asset management and applications, and new smart grid functions. Transelectric expects material business and performance benefits from its digital transformation.

Annex B: List of Acronyms

ACRONYM	DEFINITION
3D	Three Dimensional
2G	Second Generation Cellular Network
3G	Third Generation Cellular Network
4G	Fourth Generation Cellular Network
5G	Fifth Generation Cellular Network
6G	Sixth Generation Cellular Network
ADAS	Advanced Driver Assistance Systems
AGC	Automatic Generation Control
AI	Artificial Intelligence
AMI	Advanced Metering Infrastructure
AMPS	Advanced Mobile Phone Service
ANDICOM	International ICT Congress
APESOFT	Asociación Peruana de Software
ARCOTEL	Agencia de Regulacion y Control de las Telecomunicaciones
ATM	Automatic Telling Machine
ATMS	Advanced Traffic Management System
AMX-1	America Movil Submarine Cable System-1
BPL	Broadband over Powerlines
C4IR.CO	Colombian Center for the Fourth Industrial Revolution
C-RAN	Centralized Radio Network
C&C	Command and Control
CAGR	Compound Annual Growth Rate
CARICOM	Caribbean Community
CCLIP	Conditional Credit Line for Investment Projects
CCS	Coca Codo Sinclair
CDMA	Code Division Multiple Access
CELEC EP	Corporación Eléctrica del Ecuador
CENACE	Centro Nacional de Control de Energía de la República del Ecuador
CGR	Comptroller General of the Republic
CIF	Contracts in Force
COFOPRI	Agency for Informal Property Formalization
CONPES	Colombian National Council of Economic Policy
CRC	Comisión de Regulación de Comunicaciones

CSIR	Council for Industrial Research
CSIRT	Computer Security Incident Response Team
CSJ	Consejo Superior de la Judicatura
CX	Caribbean Express
DFS	Digital Financing Systems
DIAN	Dirección de Impuestos y Aduanas Nacionales
DIARI	Dirección de Información, Análisis y Reacción Inmediata
DNS	Domain Name System
DNP	National Planning Department
DPAPM	Division of Public Administration and Development Management
DSL	Digital Subscriber Line
DT	Digital Transformation
EDGE	Enhanced Data Rates for GSM Technology
EGDI	e-Government Development Index
EPAD	Espacios Públicos de Acceso Digital
ERP	Enterprise Resource Planning
EV	Electric Vehicle
EVDO	Evolution Data Optimized
FACTS	Flexible AC Transmission
FITEL	Fondo de Inversión en Telecomunicaciones
FUTIC	National Fund for Information Technologies and Communications
GDP	Gross Domestic Product
GHz	Gigahertz
GIS	Grenada Information Service
GMS	Generation Management System
GPS	Global Positioning System
GPRS	General Packet Radio Service
GSM	Global System for Mobile Communications
GSMA	The GSM Association
HCI	Human Capital Index
HSPA	High-Speed Packet Access
HTTPS	Hypertext Transfer Protocol Secure
HVAC	Heating Ventilation and Air Conditioning
IaaS	Infrastructure as a Service
IADB	Inter-American Development Bank
IBRD	International Bank for Reconstruction and Development, World Bank Group
IBRD	International Bank for Redevelopment
ICDE	Colombian Spatial Data Infrastructure

ICT	Information and Communication Technology
IED	Intelligent Electronic Devices
IESE	Graduate Business School of the University of Navarra, Barcelona, Spain
IoT	Internet of Things
IP	Internet Protocol
IPS	Intrusion Prevention System
IRU	Indefeasible Rights of Use
IS	Information Systems
ISCMS	Information Security and Cybersecurity Management System
IT	Information Technology
ITU	International Telecommunication Union
Kbps	Kilobits per Second
km	Kilometer
kV	Kilovolt
LAC	Latin America and the Caribbean
LED	Light-Emitting Diode
LEO	Low Earth Orbit
LTE	Long-Term Evolution
M&D	Monitoring and Diagnostic
Mbps	Millions of Bits per Second
MEF	Ministry of Economy and Finance
MHz	Megahertz
MIMO	Multiple-Input/Multiple-Output
MiniSMEs	Mini-, small-, and medium-sized enterprises
MinTIC	Ministerio de Tecnologías de la Información y las Comunicaciones
MoH	Ministry of Health
MoI	Ministry of Interior
MTC	Ministerio de Transportes y Comunicaciones
MVA	Megavolt Amperes
MVCS	Ministry of Housing Construction and Sanitation
NAP	Network Access Points
NFC	Near-Field Communications
NGO	Non-Governmental Organization
NMT	Nordic Mobile Telephony
NOMA	Non-Orthogonal Multiple Access
NSA	Non-Standalone Standard
NTT	Nippon Telephone and Telegraph
NUC	National Urban Cadaster

OECD	Organisation for Economic Co-operation and Development
OMA	Orthogonal Multiple Access
ONI	Ocean Networks Inc.
OOS	Out-of-Service
OSI	Online Service Index
OSIPTEL	Organismo Supervisor de Inversión Privada en Telecomunicaciones
OT	Operational Technologies
PaaS	Platform as a Service
PAN-AM	Pan American Cable
PLC	Programmable Logic Controllers
PoP	Point of Presence
PND	National Development Plan
PNN	Parques Nacionales Naturales de Colombia
PPP	Public Private Partnership
PRONATEL	Programa Nacional de Telecomunicaciones
PSTN	Public Switched Telephone Network
PUC	Public Utilities Commission
QR	Quick Response
RFS	Ready for Service
RFP	Request for Proposal
RTT	Real-Time Text
SA	Substation Automation
SaaS	Software as a Service
SAC	South American Crossing
SADS	Environment sector and Sustainable Development
SAm-1	South America 1 Cable
SBS	Superintendencia de Banca, Seguros y Administradores Privados de Fondos de Pensiones
SCADA	Supervisory Control and Data Acquisition
SCADA/EMS	Supervisory Control and Data Acquisition/Energy Management System
SD-WAN	Software-Defined Wide Area Network
SDM	Spatial Digital Multiplexing
SEGDI	Secretary of Digital Government
SIAC	Colombian Environmental Information System
Smarter STIP	Smarter Stan-In Processing
SME	Small and Medium Enterprises
SNI	Sistema Nacional Interconectado
SOC	Security Operations Center

SNR	Superintendencia de Notariado y Registro (Superintendency of Notary and Registration)
SPS	Special Protection Scheme
sq km	Square Kilometer
TA	Technical Assistance
TACS	Total Access Communication System
TB	Terabyte
Tbps	Terabytes per Second
TCE	The Connected Economy
TDMA	Time Division Multiple Access
TII	Telecommunication Infrastructure Index
TV	Television
UAV	Unmanned Aerial Vehicle
UID	Unique Identifiers
UCLA	University of California at Los Angeles
UMTS	Universal Mobile Telecommunications System
UN-DESA	United Nations Department of Economic and Social Affairs
US	United States
USD	United States Dollar
USTDA	United States Trade and Development Agency
VoIP	Voice over IP
VR	Virtual Reality
VUC	Ventanilla Única de la Construcción
WAMS	Wide Area Management System
WAN	Wide Area Network
WEF	World Economic Forum
WiFi	Wireless Fidelity
WiMAX	Worldwide Interoperability for Microwave Access