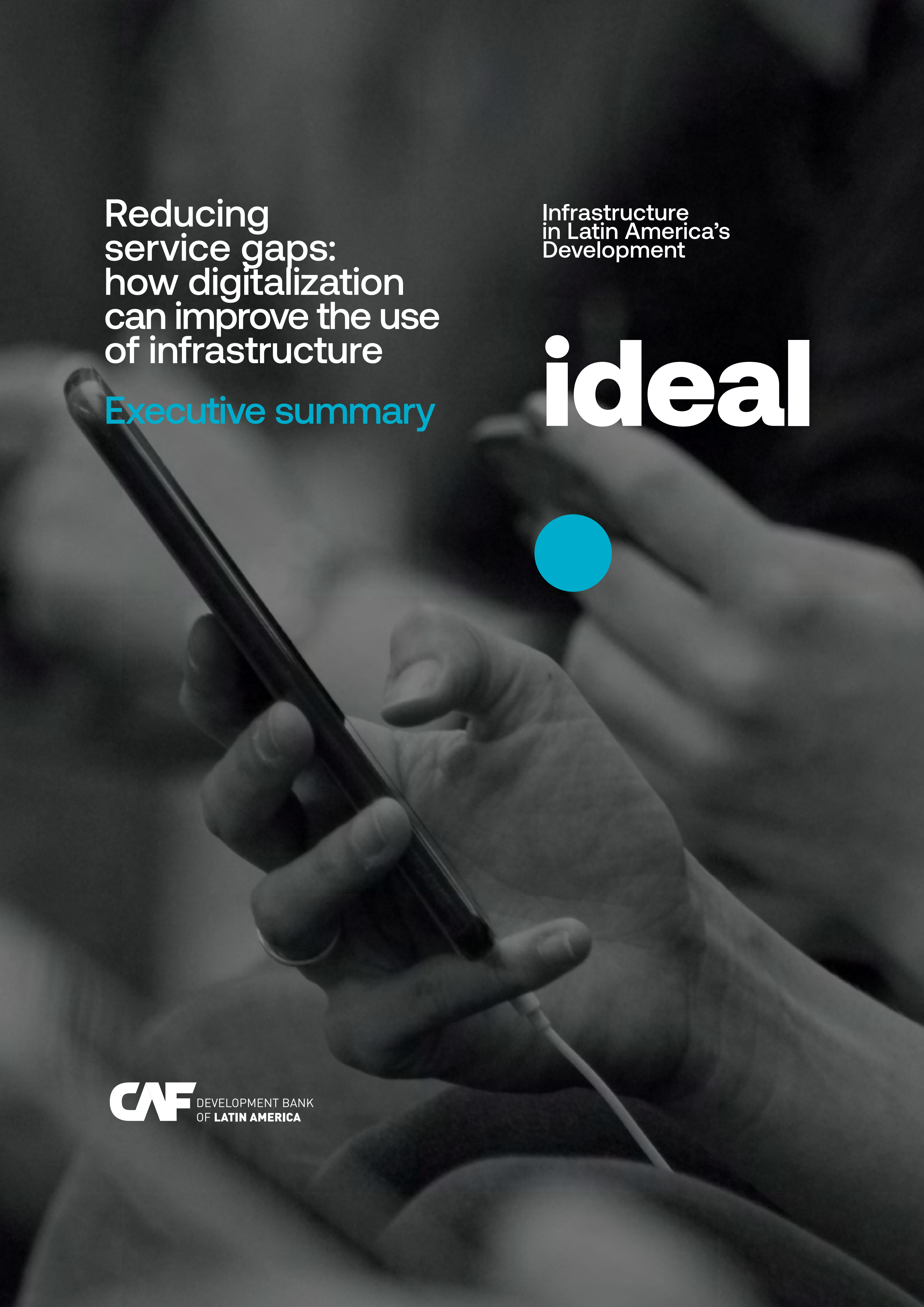
Reducing service gaps: how digitalization can improve the use of infrastructure

Executive summary

Infrastructure in Latin America's Development

ideal



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IDEAL 2021:
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Legal Deposit: DC2021000560
ISBN: 978-980-422-222-1

Publisher:
CAF
Vice Presidency of Knowledge, Pablo Sanguinetti

Study coordinator:
Walter Cont

Graphic design:
Estudio Bilder

Photographs:
Robin Worrall (cover), Clem Onojeghuo (p. 8), Chapman Chow (p. 13),
American Public Power Association (p. 16)

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Executive summary

Infrastructure is a crucial factor for sustainable development and contributes to it on several levels. Infrastructure fosters economic growth. It also improves firm competitiveness, promotes integration among national and regional spheres, and diversifies productive systems. Infrastructure further supports social inclusion and environmental protection, which improve the quality of life of current and future generations.

For years, sector-specific departments and research units within international organizations, academics, consultants, and other agents in the public and private sectors have conducted applied sectoral research in this area. Topics have evolved, from an analysis of the requirements for investment in infrastructure to attain development goals to the need for efficiency to execute and target investment and, more recently, to the adoption of a more comprehensive approach that takes into consideration the services provided by this infrastructure.

At the same time, a whole set of trends has emerged that affects and interacts with various elements of infrastructure. Without meaning to draw up an exhaustive list, one major trend over the past two decades has involved technological progress triggered by digitalization. These changes have supplemented other trends addressed in this report, which include adapting the sustainability agenda, decentralizing processes and activities, and urban population growth. More recently, economies as well as specific sectors have been shaken by the COVID-19 pandemic and have had to adapt to a new reality ushered in by the spread of the virus.

This edition of the report *Infrastructure in Latin America's Development* (IDEAL) focuses on the services provided by infrastructure, with digitalization as a crosscutting topic. The report prioritizes electricity and urban passenger transportation, the two sectors that are most exposed to this form of technological progress. In turn, these sectors present many varied challenges. The electricity sector has traditionally been considered a basic utility, while the passenger transportation system has often not been granted that status. Digitalization and the hurdles it poses —in terms of innovation and safe provision, price-setting, and subsidy policies— have therefore been very different in both sectors. And yet both sectors have to some extent played similarly important roles during the COVID-19 pandemic.

Service gaps in infrastructure

Infrastructure gap analyses have changed their approach over time. Initially, gaps were defined as investment required at a global, regional, or country level to attain infrastructure levels that met certain coverage goals or desired targets (through comparisons with specific countries or groups of countries). Later, the need to also ensure efficient execution and results was acknowledged regarding investment.

Beyond this change, several limitations have been identified in these approaches in recent years (Barbero, 2019). On the one hand, infrastructure gap definitions incorporate purely monetary measurements. On the other hand, efforts to reduce infrastructure gaps seek to meet people's needs in terms of service coverage and relegate other important dimensions, including quality and cost. The global agenda and multilateral banks, along with many specialized research studies and reports, have already adopted a more comprehensive outlook, one that takes into consideration the services provided by infrastructure.

This report starts off with service gap levels in Latin America and the Caribbean (LAC) and goes on to address these gaps through various proposed interventions, particularly investment, regulation, and other public policies.

Starting off with the premise that infrastructure services aim to meet user needs, gaps in the provision of these services can emerge in different dimensions. The first relevant dimension within this general framework is access, which defines individuals' ability to use a given service. Once these conditions are met, the remaining factors affecting user satisfaction can be assessed: service quality and cost. Cost is defined not only in terms of service provision (that is, the actual monetary resources involved in providing a given service), but also in terms of the tariffs paid by users and their weight relative to family income (affordability).

In the first sector addressed in this IDEAL report, electricity, access requires, by definition, connection to a power grid. The cost of provision reflects the sector's efficiency in service provision. This cost is determined by various factors (for instance, generation technology, seasonality of demand, and system efficiency, among others), which affects the tariffs paid by end users and their weight in family (and company) budgets. However, tariffs also depend on social and distributive considerations, which define subsidy policies. Leaks (whether technical or non-technical) in different segments are another factor that is crucial for this sector's efficiency. Finally, a good-quality electricity service supplies power with minimal interruptions, in terms of both intensity and frequency.

Table
Elements that determine service gap dimensions in selected sectors
Source: Compiled by the authors.

Sector	Access	Cost	Quality
Electricity	Power grid coverage	Average/Marginal cost of service provision, prices (affordability)	System reliability (number and duration of interrup-tions)
Urban transporta-tion	Service coverage	Average cost of service provision, fares (affordabil-ity)	Travel time (total, wait, vehicle changes), frequen-cy, comfort, reliability, safety
National and in-ternational logis-tics	Access to logistics services	Average cost of service provision, prices (afforda-bility)	Service reliability and cus-tomization
Urban logistics	Access to urban logistics services	Cost for the user	Average time/speed in freight corridors
Water and sanita-tion	Availability of drinking water (and safely managed water) nearby and safe wastewater management systems	Average cost of service provision, prices (afforda-bility)	Continuity, pollution, pres-sure
ICTs	Connection to the network (usually measured in terms of coverage) and availability of individual or nearby common equipment	Average cost of service provision, prices (afforda-bility)	Connection speed, network availability, interruptions, latency

Note: Indicators are developed in this report based on the available data.

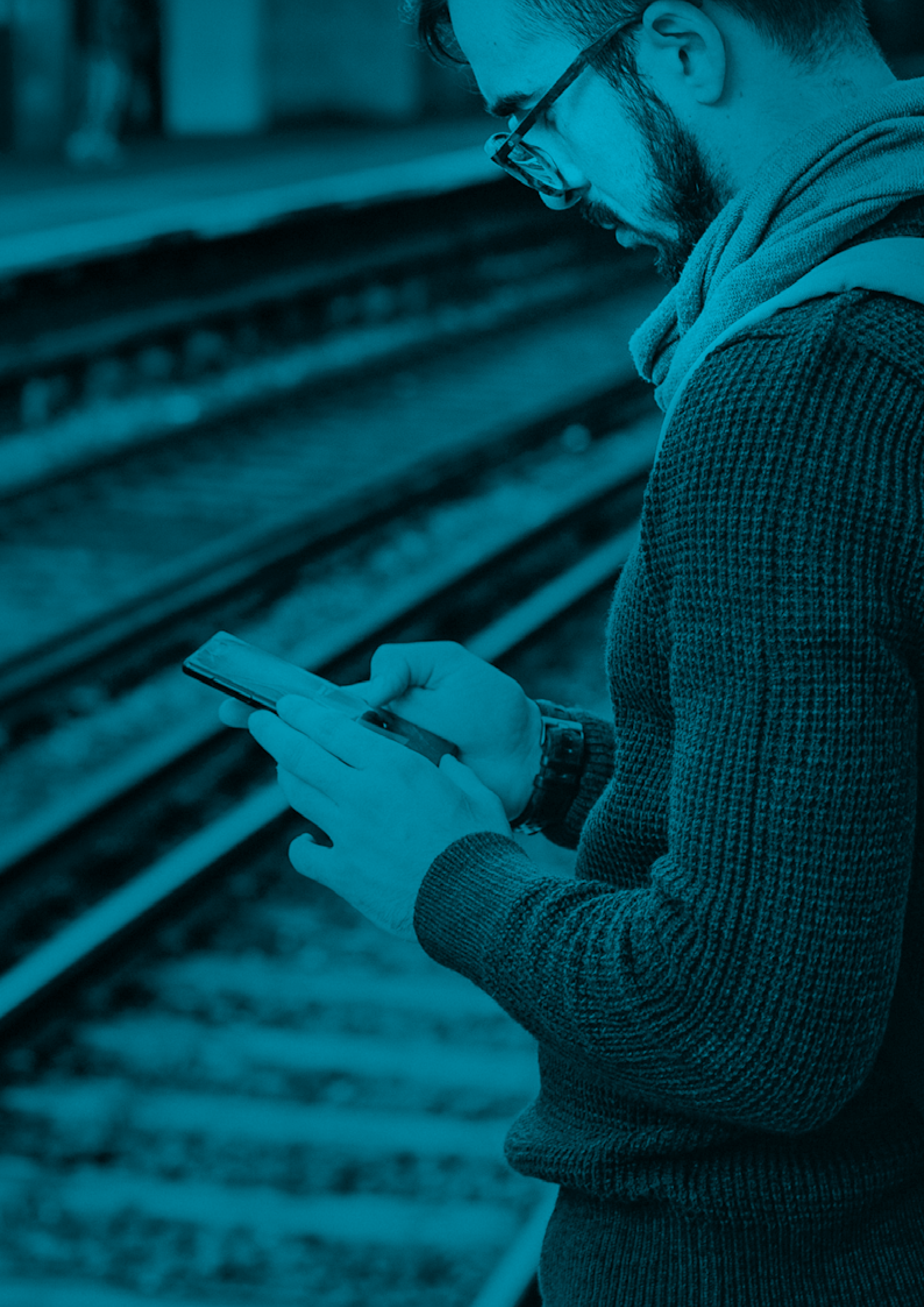
In urban passenger transportation, the second sector that is prioritized in this report, access is not a binary feature, as it is in electricity. It is measured as the ability to use services. The cost dimension captures system efficiency in taking people from one place to another using different modes of transport, whether public or private, and it also includes the fares that users need to pay based on their service use and the share of spending on transportation relative to family income. Finally, service quality takes into consideration a trip's non-monetary value for the user, including travel time, comfort, reliability, and safety.

In other sectors, such as logistics, water and sanitation, and information and communications technologies (ICTs), the approach to service gaps has changed in similar ways. The following table sums up the factors that determine the extent of each service gap dimension in the sectors that are prioritized in this report and in other sectors that are also mentioned here.

Service gap diagnosis for LAC

In the electricity sector, LAC's main problems are found in the quality dimension, with interruption indices (whether in terms of frequency or of duration) that are three times as high as they are in Europe and twice as high as they are in the United States. Within LAC, however, there are significant variations between countries. Mexico performs best, with less than one interruption per year lasting less than half an hour, and Argentina performs worst, with an interruption every 1.6 months lasting on average more than 25 hours. Deficiencies are also common in the form of leaks (twice as significant as they are in the United States, the European Union, and Australia), although the energy mix that prevails in Latin American countries, where hydroelectric power has a major share, means the cost remains low. Beyond production costs, it is worth noting that tariffs are in many cases distorted by subsidized components, and that, even with subsidies, they amount to a much higher percentage of income in LAC than in the United States or Europe. Finally, access is virtually universal, although there are some lags in rural areas (as in Peru and Bolivia, for instance).

In the urban passenger transportation sector, we can identify various aspects that mean access issues are significant for service gaps. In some cities, like Bogotá and La Paz, users need to walk long distances (more than 10 minutes) to get to a bus stop, which makes them (particularly women) more vulnerable to crime. In almost all the cities that were assessed, informal services ensure a capillarity that the formal system is unable to offer, although informal transportation is sometimes more expensive and unsafe than formal services. The share of public bicycles (available in many of the cities that were examined) has increased among modes of transport, but not enough to ensure accessibility within short distances. Further, in quality terms, travel times are greater on public transportation than on private transportation (with differences of over one hour in Bogotá, Mexico City, or São Paulo), and users find service deficiencies in other dimensions too (high rates of occupancy and, in cases like Bogotá and Santiago, low vehicle frequency). These users tend to be the individuals who live the farthest from their places of work and study (and, in the case of women, also the places where they engage in household chores and childcare tasks). They may therefore have less time available to do other activities. Public transportation systems in cities of similar sizes (like Mexico City and São Paulo) evidence different provision costs, with the resulting relative cost gap increases. Finally, after taking into consideration specific subsidy policies, we find differences in service affordability. For example, São Paulo and Santiago have similar subsidy components, but low-income users pay much more in the former than they do in the latter. In Cali and Recife, on the other hand, affordability is quite similar for low-income users, but Recife subsidizes trips (at approximately 25% of their cost) and Cali does not.



Digital technology and its impact on infrastructure services

Chapter 2 looks at progress made in digital technologies and other improvements that specifically affect the infrastructure sectors that are prioritized in this report.

Changes in the ICT sector and other trends

Convergence among the telecommunications, electronics, and computer industries has consolidated over the past two decades. This change has been favored by the growing geographic availability of broadband wireless access, by the widespread penetration of mobile terminals with considerable processing power, and by the decreasing costs of transmitting, storing, and processing large volumes of data. More recently, convergence among sectors has increased (particularly in developed countries) based on improvements like 5G communications networks and what is known as the Internet of Things (IoT). These technologies have become inputs or sources of support for other economic activities, including infrastructure sectors.

A high degree of ICT coverage and growth is necessary for digital innovations to start becoming widespread in LAC, to enable provision of the necessary infrastructure for other sectors to benefit from technological progress. A set of selected indicators shows a clear difference (relative gap) between groups of developing and developed countries. Individually, Chile performs well in all dimensions (penetration, coverage, quality, and affordability). Uruguay performs well in terms of penetration and coverage, while Argentina performs well in terms of access and quality (but services are considered costly for users), and Panama has good quality indicators. At the other extreme, Bolivia and Paraguay have poor indicators in all dimensions, and they are joined by Peru for coverage and by Colombia for quality. While direct cost indicators are not comparable, spending on data as a share of income is 50–75% higher in Latin America and the Caribbean than in developed countries. Further, disruptive technological developments linked to the digitalization of productive processes (like data centers or investment in big data) have evolved as in advanced countries, but other developments—including machine-to-machine communication (M2M)—have changed much more slowly in LAC. Finally, the report highlights the role of the state in the adoption of digitalization, by helping to reduce both the absolute and the relative divides.

In this context, three trends have been found to converge in the electricity sector in recent years: digitalization, electrification, and decentralization. Electrifying specific sectors (like public and private transportation) can be crucial to meet the climate targets held in the Sustainable Development Goals (SDGs). Further, the trend to decentralize activities at the end-user level includes small-scale generation of non-conventional renewable energy (NCRE). This type of generation is becoming increasingly significant as its cost falls (although it is yet to reach competitive levels, since it still costs four times as much as large-scale solar power) and the use of batteries to store energy increases (which could change significantly as electric vehicles that can both take and inject energy into the grid become widespread). These activities will give the renewable energy sector a more active role, with innovations in the fields of distributed generation and storage, and in response to demand.

Trends that complement digitalization in urban transportation include urbanization and population growth in cities, and climate change. City growth leads to increased use of transportation services and to more related externalities (congestion) and service gaps (particularly travel times and coverage, especially in cases of urban sprawl). Transportation has a major effect on greenhouse gas emissions. It has amounted to 25–35% of total emissions in recent years, depending on the country. This is why measures aimed at reducing traffic (such as encouraging the use of public transportation and promoting shared travel, micromobility, and walking) and at fostering cleaner technologies (like electric vehicles) are increasingly relevant. These sustainable transportation measures clash with restricted mobility and social distancing measures imposed on a large scale in the context of the COVID-19 pandemic. Micromobility modes can be encouraged, but the return to mass transit will depend on biosecurity measures and on vaccine administration. In any case, these changes pose challenges for planning and for the provision of transportation services, whether public or private. The net environmental impact of electrification in transportation will depend on the actual consumption of energy and on a given country's energy mix.

Digitalization in electricity: Smart grids

The emergence of a new digital economy paves the way for smart grids. A smart grid is basically the combination of a physical electrical grid with an information system that connects the network's traditional equipment and components with advanced metering infrastructure. This improves the reliability, safety, and efficiency (in terms of both cost and energy) of the electricity system. It also makes it easier to manage network assets, integrate renewable energy sources into the system, and develop real-time communications between consumers and providers.

The structure of smart grids can be divided into four types of agents: internal data collectors (network sensors and smart meters); companies that provide electricity and control centers; electricity generators; and external data sources. Bidirectional meters are essential for smart grid deployment, because they enable consumers to be both producers and consumers (*prosumers*). Using advanced metering infrastructure (AMI) systems enables the collection of instant data on individual and aggregate demand. This information can be useful for consumers, who can make decisions in real time about their electricity consumption. And it can also be useful for distribution and commercialization firms, who can use it to find the origins of non-technical leaks (Donato, Carugati, and Strack, 2017).

A substantial portion of investment in digital infrastructure on a global scale has focused on smart meters (with 56.6% penetration in the United States, 32.5% in Australia, and 33.8% in Europe). However, this has so far not happened in LAC (with 3.2% penetration), with a few exceptions like Asunción, Montevideo, and Santiago. Distributed storage and demand management are even more limited. Smart grid development varies among different regions, depending on sociopolitical factors, regulatory aspects, technological progress, and access to funds, among other aspects.

The most important hurdles for smart grid deployment involve the following requirements: (i) major investment (including ICT infrastructure); (ii) a legal and regulatory framework that provides incentives, defines roles and property rights for various stakeholders, regulates interactions among these stakeholders, and enables communications among different components; (iii) unified technical standards for various smart grid components; and (iv) cybersecurity protocols. The transition to a new electricity system faces four further challenges: (i) electricity is still considered a commodity; (ii) current regulatory paradigms do not do enough to encourage distributed resources; (iii) uncertainty concerning the rules does not provide incentives for stakeholders to make decisions on complementary grid infrastructure; and (iv) some segments culturally resist change.

Smart grid deployment is expected to have positive impacts. For example, higher restoration speed following failures helps to ensure better-quality service (by reducing the duration of service interruptions), but also lowers system costs. More efficient generation and transmission have a direct impact on the quality and cost dimensions and lead to lower end prices. Reduced supply costs directly affect affordability, if we assume automatic pass-through of production costs to the prices paid by consumers. Integrating consumers and renewable energy may affect access, through the operations of isolated smart systems. While there is little evidence to date, the case of Chattanooga, in the US state of Tennessee, shows potential smart grid impact on quality. Following a failure caused by a wind storm in June 2012, automated distribution systems prevented power outages for 55% of all customers and led to faster service restoration.

Digitalization in urban passenger transportation: Travel apps, new services and modes of payment, and system integration

Digitalization is an opportunity to optimize and make the most of existing assets (including infrastructure, vehicles, and data) to enable improved urban passenger transportation services. The main innovations in this sector are highlighted below.

App development to optimize data use. Using systems that collect real-time information on the state of the transportation system, apps have emerged that provide data for users to plan trips or for sector authorities to plan transportation. The data (on the state of traffic and routes and the operations of some modes of transport, in particular) are obtained using georeferencing and general transit feed specification systems. These apps may serve various purposes: recommending routes for private transportation users (like Waze), reporting on the state of public transportation (like Cuando Subo in Buenos Aires, TransMiSITP in Bogotá, and Moovit in several cities), or even integrating both services (like Google Maps). These data increase service quality for users and improve system efficiency. In the medium run, they are useful to optimize operations and the fleet they require, adapt service to demand, and plan investment in transport infrastructure.

Apps that create new services. This category brings together, first, apps that enable travel using new transportation services. Digital sharing economy platforms involve a business model that mediates between the supply of drivers and the demand for travel (for instance, Uber and Cabify) and enables the supply of local transportation services for individuals and small groups of users. These functionalities expanded to capillary freight transportation (Uber Eats and Cabify Envíos). The main aspects that differentiate these platforms from certain traditional transportation services are the use of dynamic pricing, the option of booking trips in advance, and flexible supply. There are differences in the use of these apps in different cities in LAC. On one end of the spectrum, São Paulo and Bogotá feature abundant use (respectively 47% and 39% of all ECAF 2019 respondents said they had used them), while La Paz and Panama City are at the other extreme (3% and 14 %, respectively).

Second, ride-sharing apps provide a mediation service among individuals who wish to travel along the same route at the same time, to give these individuals the opportunity to share a vehicle and travel costs. Steer (2020) looked at shared travel characteristics (in terms of time and space) in selected cities in LAC and identified potential demand for ride-sharing (particularly in Santiago and São Paulo, followed by Buenos Aires, Mexico City, and Bogotá). Approximately 50% of all individuals are willing to share a ride with someone they know (Estupiñán, 2018).

Third, a more recent version of the apps mentioned above involves platforms that enable temporary vehicle use (carsharing). This service allows subscribers to use a car when someone else has stopped using it, enabling them to rent the vehicle by the hour or for specific trips. However, social distancing, if it becomes permanent, may affect the availability and cost of ride- or carsharing, or it may delay the prospects for these new services around the region. Apps that enable travel using bicycles and electric scooters (for instance, Movo or Grin) work in a similar way, but they focus on micromobility. These apps are used relatively little in Latin America and the Caribbean, because they are new. With Asunción as the single exception, the highest rate of use is only 5% (Bogotá).

Innovations in travel-payment options. Digitalization led to the emergence of new modes of payment, introducing changes in the collection and pricing systems used by transportation service providers, whether public or private. These new modes of payment may involve the use of cell phones or credit cards, or a dedicated transport card.

Transportation service integration. Innovative models are currently emerging to provide several public and private modes of transport together, to enable integration on three levels: physical, digital, and price-related. There are two different models, mobility as a service and mobility on demand. Mobility as a service involves service provision using digital apps that enable users to purchase subscription plans, and focuses on aggregating various modes of transport. Mobility on demand, in turn, integrates passenger and freight transportation: It acknowledges that courier services reduce individuals' need to travel and sets prices per trip (knowing that each trip can have one or several stages). There are various public transportation services on offer in Latin America and the Caribbean, and progress has been made to unify payments. This means adopting a single fare (or an alternative with discounts per stretch) for multimodal trips. Some examples are Santiago's Bip! card and Buenos Aires' Sube, which enable payment for bus, subway, and train trips. In some cities, major steps have also been taken toward multimodal integration in public transportation. However, full integration—which in developed countries converges toward monthly plans or subscriptions—has not been attained.

The emergence and adoption of new digital technologies poses various challenges for this sector: (i) the need for major investment (in ICT and traditional infrastructure); (ii) the need to set data standards and design urban planning policies; (iii) an unequal distribution of the benefits of digitalization among users (with higher-income social groups most likely the main beneficiaries); and (iv) exposure to cybersecurity risks.

Digitalization enables a reduction in urban transportation service gaps. Travel-planning apps have a direct impact on the service quality dimension, because they enable substantial reductions in travel times, more predictability, and shorter periods of exposure to personal safety risks (especially for women). These apps affect various service gap dimensions. They enable easier access to the core public transportation network in remote areas, they allow users to move without having their own vehicles, and they shorten travel times for the transportation system as a whole (when shared travel replaces individual private trips, which reduces congestion). Finally, in the case of transportation service integration, it is likely that access will be improved and travel times will be reduced as multimodal travel becomes easier.

Granularity and market formation

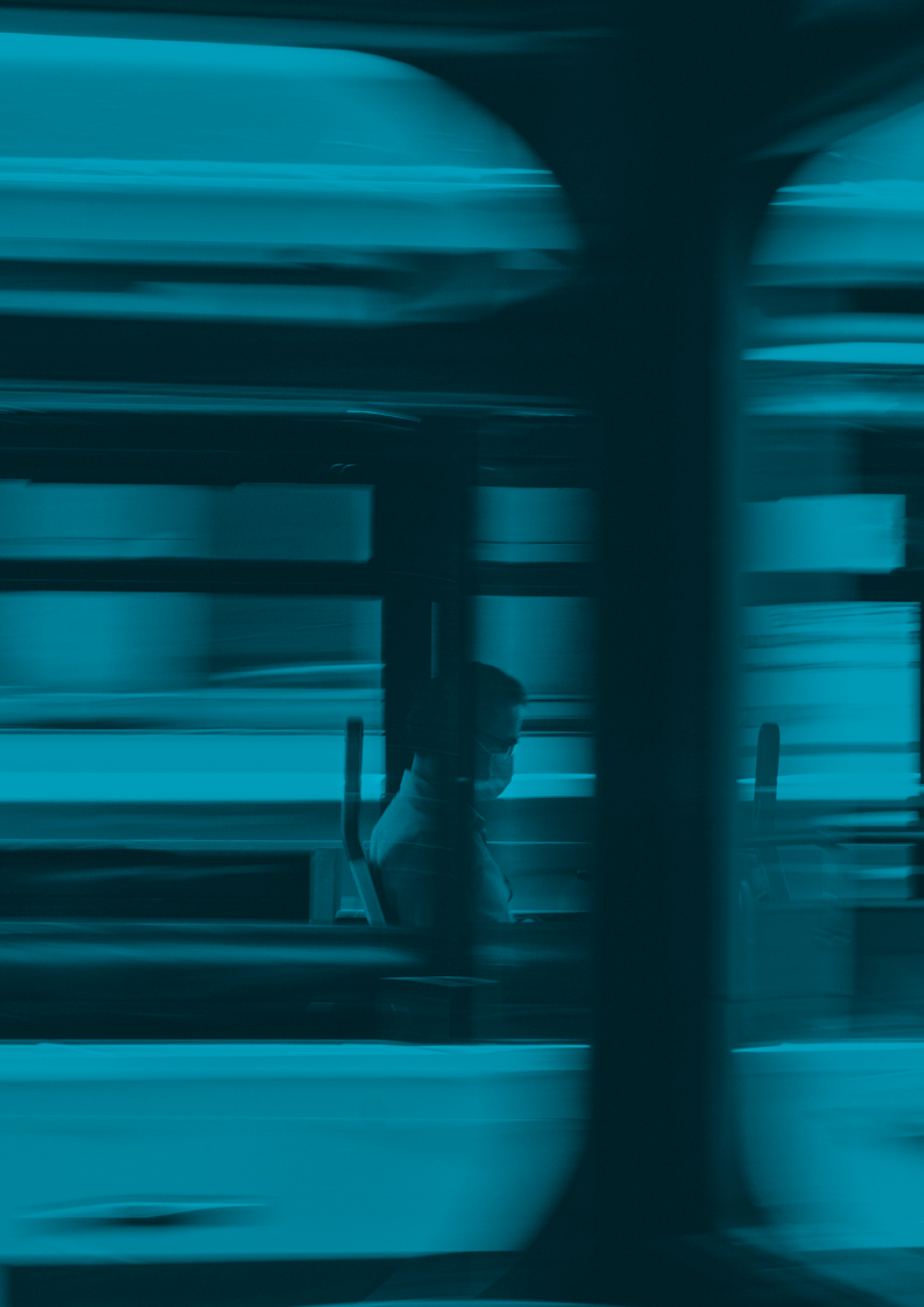
Progress in terms of connectivity and the proliferation of digital platforms enable a more granular supply of various services. This in turn reduces the number of inefficiencies associated with a combination of inelastic demand, volatile demand, and static prices. These deficiencies are very common in the electricity and urban transportation sectors.

In electricity, deploying smart residential meters enables users to dynamically adjust their demand and allows for the implementation of distributed generation using bidirectional connections. This enables a more granular supply. In the urban transportation sector, sharing economy platforms involve a new business model that mediates between the demand for travel and a flexible supply that adapts to relative scarcity through price signals.

COVID-19: Faster digitalization and its implications for services

Faster digitalization

There is a dedicated chapter to address the effect that the COVID-19 pandemic has had on various dimensions, whether personal, economic, or social. Mass spread of the virus meant varying degrees of stress for countries around the region and caused major losses, in terms of both life and the economy. The report highlights the role of ICTs to mitigate the negative effects of the crisis. These technologies have assisted the healthcare, education, and employment sectors and other areas in the economy, as digital activity stepped in to replace physical activity. However, not all people in Latin America and the Caribbean have been able to benefit from these technologies or to mitigate negative impacts, given the existence of digital divides. These divides can be both absolute (in terms of physical access or the ability to pay for these technologies, quality, repurposing, use of innovations, and so on) or relative (with greater deficiencies in low-income households and rural areas, among specific users like children and older persons, and among workers whose economic activities make remote working unlikely).



Impact on infrastructure sectors

Infrastructure sectors face specific challenges in certain dimensions and common challenges in others. For example, the public passenger transportation system needs to solve the problem of increasing intensity of use (and remaining sustainable) in a context with increasing biosecurity-related restrictions. The authorities will face the challenge of ensuring that this form of transport remains a competitive and safe option to carry passengers. In the medium run, changes—mainly in the labor market (especially in the form of remote working), but also in other markets and activities (like retail and education)—may foster new mobility patterns. The supply of transportation will need to adapt to these new patterns, for instance by promoting active modes of transport like bicycles and scooters and ensuring urban planning in terms of mobility and logistics. Urban logistics have also been affected by changes in distribution patterns (from deliveries to large companies to many smaller deliveries to small businesses and homes), which implies higher occupancy in public spaces, more road accidents, and more pollution. Further, changes in individual and freight movements will contribute to greater congestion in the new normal. It is therefore worth considering early adoption of tools to plan and regulate mobility and the use of public space in Latin America and the Caribbean. The drinking water sector has played an essential role during the pandemic, given how important water is for hygiene (with frequent handwashing using soap and water, for instance). The existence of a basic utility gap, particularly among people who cannot access good-quality services, makes it harder to comply with public health measures. In the electricity sector, on the other hand, the COVID-19 pandemic led to a drop in power consumption, and to redistribution based on geographic and user-group criteria (moving from industry and retail to residential areas).

A problem shared by the electricity, drinking water, and urban passenger transportation sectors is the fact that operators are currently facing challenges to provide public services in a context of major financial difficulties. Governments help to ensure service provision in different ways (financial support, transfers, input subsidies, and so on), but these measures are not sufficient, given the current fiscal constraints. It is likely that solutions will start to be sought to reduce costs and get closer to full capacity (with a commitment to the biosecurity measures needed in transportation and to other government decisions banning shutoffs and favoring service payment deferrals in the electricity and water and sanitation sectors). Sustainable infrastructure agendas will remain available to guide these solutions, but some initiatives (like the transition toward more decentralized, less polluting systems) may take longer in a context with major fiscal constraints.

Finally, digitalization has fostered (or may foster) collaboration among sectors, by enabling adjustments in restrictions and promoting service adaptation and, in many cases, by ensuring earlier adoption of changes that would otherwise have happened further into the future. Online retail platforms have proliferated and tracking apps have been designed to track individual health and to organize the supply of transportation, for instance. In the future, certain developments may improve the operations and commercial management of public services like drinking water, electricity, and transportation, to reduce costs and fiscal pressure for their short- and medium-run operations and to improve long-term planning.

Challenges and opportunities: Investment, regulations, and public policy

The technological changes that are expected in the near future have the potential to trigger a revolution in infrastructure sectors. In most countries in LAC, these sectors are not well developed, especially in terms of institutional quality, with a strong presence of public institutions. The current regulatory schemes require updates for the adoption of new technologies. Deeper changes will be needed in the future. They will affect infrastructure sectors and create opportunities to reduce service gaps, but also pose challenges linked to the region's ability to take these opportunities and to make the most of them. It is therefore important to make sure that any necessary interventions (in the form of regulatory changes, investment, or public policy) are implemented, to ensure fast adaptation and optimized enjoyment of the benefits of new technologies.

The main impacts and challenges are listed below.

- **Emergence of new stakeholders.** Digitalization has led to the emergence of new stakeholders who previously were not part of the market and who, with a few exceptions, have only been included in market regulations to a limited extent. In the electricity sector, we could mention prosumers (consumers–producers) as an example. In urban passenger transportation, we find new service providers, including Uber and ride- and carsharing platforms.

- **New roles.** New technologies create new roles or activities for stakeholders who were already present in the market, or they enable a redistribution of activities within the market. In electricity, the benefits of smart grids would reach their full potential with the separation of distribution and commercialization. In urban transportation, digitalization could trigger changes in fare collection and payment methods as well as fare integration among transportation systems and modes of transport, enabling new roles within this sector (for instance, payment system managers and integrated transportation system operators).

- **Data availability.** All sectors will have a larger flow of real-time data. Regulatory challenges emerge in terms of data ownership and management, user privacy, and the effects of differentiated data use on competition.

- **Convergence among sectors.** New technological developments in each of the different sectors will use the same ICT infrastructure, blurring pre-existing borders between the various sectors. These connections will pose challenges in terms of investment and regulations.

Required regulatory changes

Considering the diversity apparent in country regulators, the report highlights five aspects that are crucial to realize the potential of digitalization in different sectors:

- **Cost–benefit analysis.** Digitalization involves both costs and benefits that, before being promoted, need to be individually assessed for each of the technologies and projects examined in this report.

- **Market redesign.** The transition toward digitalized sectors in most cases requires market redesign to incorporate new stakeholders and redistributed roles. These are the required changes in the electricity sector: (i) separating distribution and commercialization tasks, with differentiated payment schemes; (ii) the emergence of demand aggregators; (iii) the emergence of distribution system operators; and (iv) the creation of the role of data aggregators.

  In urban transportation, market redesign is based on the following factors: (i) adapting regulatory frameworks to include travel apps; (ii) taking action to reduce congestion; (iii) ensuring comprehensive urban transportation service provision; and (iv) fostering micromobility and capillary logistics distribution, and their effects on the use of public spaces and on road safety.

- **New fare schemes.** The impact of digitalization and customer involvement in service provision will both affect pricing. In electricity, separating distribution and commercialization will enable commercialization companies to offer plans with different rates (including dynamic pricing options) and to compete with each other for customers. In urban transportation, sharing economy platforms have already introduced forms of granular supply adaptation and dynamic pricing.

- **Cooperation among different sectors.** Sector interconnections based on shared infrastructure use, given technological convergence, open up spaces for intersectoral regulatory cooperation and coordination.

- **New regulatory and sectoral capabilities.** Adequately implementing progress enabled by new technologies requires qualified staff who can understand, apply, communicate, and update software-based systems. The new capacities that are required call for the development of new capabilities in the institutions involved in infrastructure sectors.

Investment

Adapting new technologies to sector infrastructure requires investment that enables adjustments in current networks and systems. It also requires rules to reward new investment in physically adapting networks.

In electricity, investment will be required in smart meters and sensors, advanced switches, new software, and traditional grid improvements. Progress in distributed generation has triggered a need to set up bidirectional grids and smart metering equipment that enable customers to market their energy. These developments will be useful to incorporate electric vehicles as alternatives for the consumption, storage, and supply of electricity. NCRE intermittence affects system reliability and may require various forms of intervention. In the case of urban passenger transportation, greater investment will foreseeably be needed to adapt traditional infrastructures to new technologies. Some examples of adaptations include integrating GPS technology so vehicles can be located and the relevant data can be sent to stops or cell phone apps, as well as changes in fare collection machines so they take new modes of payment.

One aspect that is common to the electricity and urban transportation sectors and that will become increasingly important in the future involves mass use of public and private electric vehicles. This requires investment in fleet renewal and in ensuring the integration into the power grid of public as well as private vehicles.

Social policies

Redistributive effects are a consequence of differentiated impacts on users' ability to benefit from technological change. Digitalization also enables the use of tools to implement compensation policies.

In the electricity sector, two likely routes for redistributive effects can be identified. The first involves a reduction in non-technical distribution leaks through the use of advanced metering infrastructure (which affects users with illegal connections, usually lower-income users). Since users would then be identified, regulators and the relevant ministries would have tools—like the adoption of targeted social tariffs—to mitigate the negative impact that these changes would have on financially vulnerable households. A second route is to eliminate cross subsidies between high-demand and high-income users and low-demand users (since commercialization companies would find it more difficult to apply these types of subsidies). To neutralize this impact, pre-existing tariff schemes may be preserved, or new subsidies may target lower-income users.

Two potential routes were identified in urban transportation. First, appropriate conditions to adopt these technologies involve access to certain digital tools and instruments (mass use of ICTs suggests that this will not be a problem) and adequate use of these tools and instruments (which can be achieved through digital literacy programs). Second, most technologies have emerged in the private sphere, and their use and benefits are not necessarily transferrable to public transportation, which restricts benefits for public transportation users. On the other hand, digitalization could enable better-targeted public transportation subsidies, through new modes of payment.

In these and other infrastructure sectors, general and specific subsidy policies risk suffering the effects of the fiscal constraints that many countries will experience in the coming years. This instrument will need to be used more efficiently, and measures to encourage productive efficiency (cost minimization) may need to be adopted to reduce the fiscal burden without directly passing it through to consumers.

Environmental impact

The adoption of new technologies causes positive externalities that may favor the environmental agenda. In all countries, the state is in charge of aligning private incentives with social benefits. In the electricity sector, countries have had to resort to instruments that encourage investment in renewable sources of energy through subsidies (that also risk being affected by the fiscal constraints mentioned above). Further, in the transportation sector, the most common instruments tend to increase the electrification of transportation and the share of alternatives to private transportation.

Security policies

One key role for the state in infrastructure sectors involves ensuring that regulators pay adequate attention to security problems concerning personal data, cybersecurity, and the resilience of the electricity and transportation systems to attacks and other incidents.

More recently, the risk of infection with COVID-19 (especially in closed modes of transport, like buses and subways, with limited space and few tools to identify sick or unclean passengers and to ensure clean surfaces) brought to light a new security dimension: biosecurity. In the transportation sector, this implies encouraging alternative, sustainable modes of transport and reviewing policies associated with mass, intensive use of public transportation to meet social distancing requirements and restrictions on movement in various countries (with varying degrees of distancing requirements adopted in buses and subways and with less restrictive measures supplemented with prevention measures).

This report features many examples from the electricity and urban transportation sectors where digitalization provides new opportunities that, once implemented, enable reductions in the three service gap dimensions (access, quality, and cost). At the same time, the report warns that specific updates are required in terms of regulations and investment. Developments could also entail risks linked to distribution and data security, and these need to be taken into consideration. The current situation in Latin America and the Caribbean has accelerated some technological developments (particularly those that help economies adapt to new mobility conditions) and will probably relegate others, especially those that require state funding.

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