Evolution of the Latin American Digital Ecosystem in COVID-19

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Abstract

The relevance of digital technology to fight isolation, distribute preventive measures and assist economic systems began to build as early as the installation of the first health measures for covid 19. This study's goal is to analyze Latin America's ability to fulfill this challenge. The following are the conclusions: Latin America's digital ecosystem is at an intermediate degree of development, allowing it to somewhat alleviate the consequences of the epidemic. Also, the rural/urban contrast shows a significant amount of digital marginalization. The digital divide prevents key segments of the population from receiving health information, downloading instructional resources to improve school performance, or purchasing things online. The digital gap is compounded by the fact that most Latin American homes only use

the internet for communication and social networking. A home digital resilience index (calculated on the use of the Internet to download health apps, educational apps, perform e-commerce operations and use fintech). It also suggests a lack of technology adoption, but rather a lack of technological integration in manufacturing processes, notably supply networks. The share of the workforce that can telework adds to the labor market disruption in COVID-19.

Keywords

Economic Resilience, Digital Ecosystem, Digital Infrastructure, Digital Home, Production Resilience, Work Office.

Introduction

This research has been carried out to lead to reflection on the effects of the coronavirus pandemic in Latin America and the Caribbean (LAC). This phenomenon affects advanced economies and emerging countries equally to the extent that, both because of their effects and by the public policies implemented, it represents a rethinking of social practices and productive systems that until the end of the year were normal (ECLAC, 2020). Numerous analysts anticipate a global stagnation or recession this year due to the coronavirus crisis. Credit rating agency Fitch has cut its forecasts and estimates that the global GDP of 2021 will be $8.65 billion lower than the data forecast in December 2020, yet it maintains an overall growth outlook of 1.3% (up from the 2.5% it forecasts in December). However, its recent forecast warns that the outlook may be revised down depending on events. In the case of China, the company anticipates a 5% drop at the beginning of the year. For Italy and Spain, an annual GDP contraction of 2% and 1% is expected, respectively (CAF, 2020). For its part, the International Monetary Fund makes more pessimistic forecasts, anticipating that the pandemic will cause a global recession in 2021 that may even be worse than that caused by the 2008-2009 financial crisis.

From the implementation of the first health measures, coupled with fear of contagion, anecdotal evidence began to accumulate that accounted for the importance of digital technologies in countering isolation, disseminating prophylactic measures, and facilitating the functioning of economic systems (Hacievliyagil & Gümüş, 2020). Clearer metrics include the exponential rise in Internet usage (consequent obstacle for distributors to maintain acceptable service standards), the importance of telework (Lobo et al., 2020), and the need to manage successful supply chains of goods. In this sense, it is important to question Latin America's position in terms of the degree of readiness of its digital infrastructure and the level of digitization to meet these challenges. Needless to say, over

the past three decades, the region has made considerable strides in terms of the growth of its network technologies (Katz & Callorda, 2019). However, the questions we must ask ourselves are whether the region's digital ecosystem is prepared to meet the challenge of the pandemic:

- Can digitization act as a mitigating factor, reducing the disruptive impact of the pandemic?
- What is the degree of deployment of digital platforms to address the need to disseminate health control measures, facilitate consumer transactions, and continue to educate children?
- In the same way, can the Latin American production system migrate to a context where supply chains are supported by the efficient flow of digital information?
- To what extent can telecommunications networks respond to the challenge of mass migration to telework?
- The answer to these questions should be based on four types of evidence:
- Empirically justify the argument that at the highest level the development of the digital ecosystem, the more prepared society is to face COVID-19;

Based on these major problems, the first portion of this paper analyzes the link between digital service standards and economic stability in the face of a health crisis of this size (Fan, 2003). From this analysis, the impact of COVID-19 is studied at four levels (infrastructure, households, production systems, labor structure). This analysis is presented not only in aggregate terms but also discriminates results by country based on their progress.

Digital Infrastructure and Economic Resilience

This segment explores the role of automation in reducing the social and economic effects associated with pandemics such as that of the new Coronavirus. To this end, it analyses the case of the SARS outbreak in 2003, for which an econometric model is estimated seeking to examine the extent to which internet infrastructures have allowed to mitigate the negative effects on the economy of the affected countries.

The SARS-CoV virus advanced from China in 2003, entered 27 countries, and caused almost 950 deaths. (Wilder et al., 2020). Efforts were made in the affected countries to segregate people who might be infected with the disease, quarantine and social estating modalities were established. While the measures taken were narrower and less stringent

than many countries are currently following to address COVID-19, face-to-face interactions between people were also sought.

Keogh & Smith (2008) notes that between the first and third quarters of 2003, SARS has a negative economic effect, with particular intensity in the second, when the disease peaks. In short, there was a marked decline in economic activity in the affected countries during the duration of the outbreak. Economic losses have been estimated to range from US$ 30–100 billion according to specialized literature (Fan, 2003; McKibben, 2004 Knapp et al, 2004). The potentially affected sectors were health, tourism, hospitality, airlines, retailers, restaurants, leisure and entertainment to Keogh & Smith (2008).

In this context, back then, experts augured an important role of the internet during the epidemic due to the increase in telework in times of confinement (Ghosh, 2016). Even the period of confinement by SARS is identified as crucial for the development of the e-commerce sector in China because in this pandemic situation thousands of inhabitants began shopping over the internet (Katz, Jung & Callorda, 2020) having a similar scenario in Latin America (Zhang et al, 2021). The economic impact of the epidemic is then analyzed, to which degree the detrimental impacts of the pandemic can be alleviated by strong digital technology countries. The results reported by Agudelo et al., (2020) show that the most expanded countries with broadband have been able to partly mitigate the pandemic's detrimental effects. On this basis, it is now up to us to study how the effects of it materialize and how Latin America is positioned in terms of its digital infrastructure to address the COVID-19 pandemic.

Latin America's Digital Ecosystem

Latin America is at the center of the growth of its digital ecosystem in contrast to other regions worldwide. With an index of 49,9215 (on a scale of 0 to 100), Latin America is better developed than Africa and Asia-Pacific with an index of 49,9215. But Latin America and the Caribbean still show a lag toward Western Europe, North America, Eastern Europe, and the Arab States, despite considerable improvement over the past fifteen years in its digital environment. Latin America is, in particular, one of the communities of emerging countries that display a modest annual digitization growth (see Figure 1).

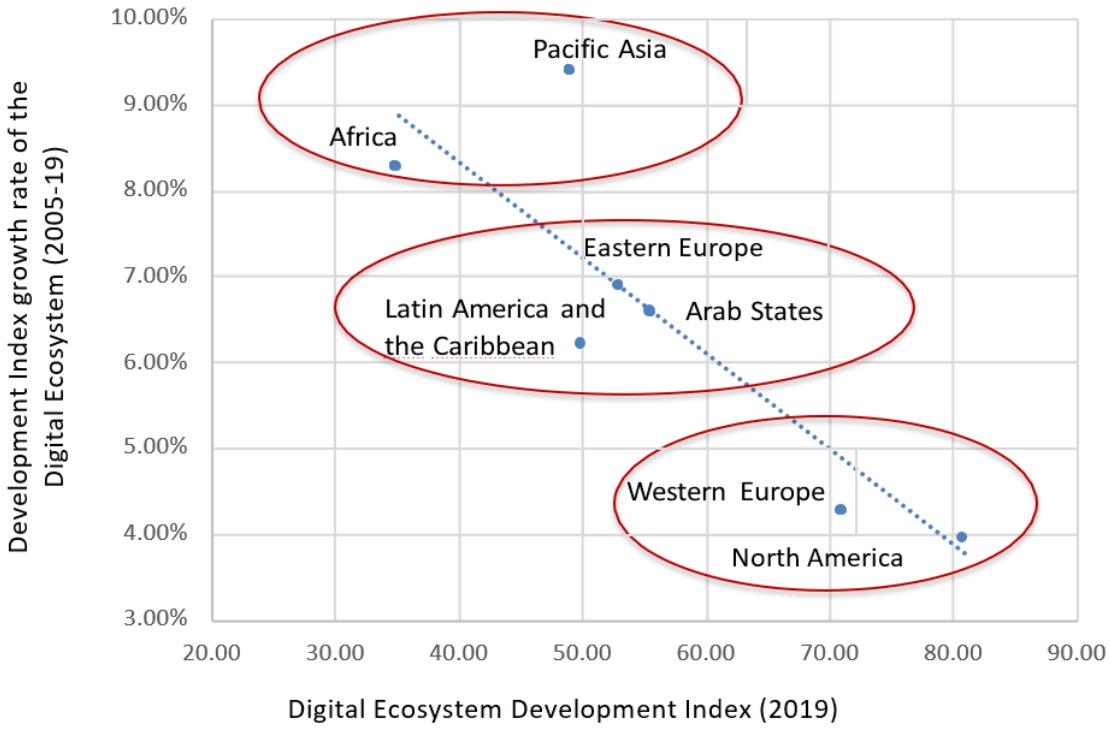

Figure 1. Digital Ecosystem Development Index (2019) vs. Growth rate (2005-19)
Source: Telecom Advisory Services analysis

As shown in Figure 1, the development rate of the digital ecosystem in LAC has an annual compound growth rate between 2005 and 2019 of 6.21%. It is the lowest among emerging countries: Asia-Pacific: 9.39%, Africa: 8.27%, and Eastern Europe: 6.89%. In fact, according to their level of development of the digital ecosystem, as projected, Latin America's growth rate should be quicker; industrialized nations' yearly growth rates are lower than those of the developing world, which correlates to an advanced stage of ecosystem development: Western Europe's digitalization rate increases to 4.28 percent.

North America does so at 3.94%. The disaggregation of the index by the pillars that make up it allows us to identify the great challenges facing the region to deal with the disruption of the pandemic.

Digital Infrastructure in COVID-19

The imposition of health measures to address COVID-19 such as workplace closures and home quarantine has generated a jump in the use of telecommunications networks to address issues of supply of goods, social connectivity, and access to information. There is already large evidence of the increase in the use of telecommunications networks16 from the triggering of the pandemic, and as a result of natural erosion of quality indices. For

example, the average speed and Internet latency rates of four countries underwent significant changes in March (Table 1).

Table 1 Latin America: Performance of Internet Networks Vs. COVID-19

		Brazil	Chile	Ecuador	Mexico
Average fixed broadband speed (Mbps)	February 2020	52,57	92,96	27,35	36,55
	Week 1 March	57	110	23	39,5
	Week 2 March	55	89	21	39
	Week 3 March	54	90	22	39
Fixed broadband latency (ms)	Week 1 March	17	21	17	27
	Week 2 March	19	24	19	28
	Week 3 March	19	25	19	29
Average mobile broadband speed (Mbps)	February	24,11	19,51	20,65	26,99
	Week 1 March	25	20	20	29
	Week 2 March	25	17	21	29
	Week 3 March	23	16	19	29,5
Mobile broadband latency (ms)	Week 1 March	48	40	38	50
	Week 2 March	48	46	38	51
	Week 3 March	49	48	40	50

Source: Ookla/Speedtest

According to table 1, broadband speed and latency are particularly variable in March, possibly because of Internet connectivity spikes, developing behavior, and circulation movement. (From the job or studio to the residence). The examination from February through the final week of March 2020 reveals the following:

- Fixed broadband speed: constant in Brazil and Mexico, with a weekly reduction in March; significant slowdown in Chile in March; fall in Ecuador from February until the end of March.
- Fixed broadband latency: increasing gradually (and hence eroding service quality) in Chile, Brazil, Ecuador, and Mexico.
- Mobile bandwidth speed is steady in Brazil and Mexico but decreases significantly in Chile (notable) and Ecuador (gradual)
- Mobile broadband latency is consistent across all countries, although at an astronomical level.

The drop in fixed broadband speed in Chile and Ecuador, as well as the rise in latency, are a result of the extraordinary growth in traffic in the four nations. There is already a substantial body of empirical research demonstrating the effect of broadband speed on economic development. Numerous studies on the so-called "return to speed" have

established a link between gross product and broadband speed (Carew et al, 2018; Briglauer & Gugler, 2018; Rohman & Bohlin, 2012; Kongaut & Bohlin, 2014). Recently (Katz & Callorda, 2019), research was undertaken on the influence of fixed broadband speed on GDP in 159 countries from 2008 to 2019. The authors proved the effect of "return to speed" (i.e. broadband speed having an influence on GDP) by dividing the sample of nations into those with an average speed of fewer than 10 Mbps, those with speeds between 10 Mbps and 40 Mbps, and those with speeds more than 40 Mbps (see Table 2).

Table 2 Impact of Fixed Broadband Discharge Speed on GDP

Impact on GDP	**Speed < 10 Mbps**	**Speed 10 Mbps - 40 Mbps**	**Speed > 40 Mbps**
Ln Download speed-4	-0,00206 (0,00136)	0,00264 (0,00138) ***	0,00730 (0,00175) ***
Ln Employment tt	0,00664 (0,00189) ***	0,00525 (0,00168) ***	0,00458 (0,00165) ***
Fixed consequences by country	Yes	Yes	Yes
Fixed consequences per quarter	Yes	Yes	Yes
Number of countries	116	105	49
Broadband penetration control	Yes	Yes	Yes
Observations	2.113	1.792	575
Control for GDP growtht-1	Yes	Yes	Yes
R-Square	0,9516	0,9262	0,9438

Note: ***p<0.01, **p<0.05, *p<0.10, Source: Telecom Advisory Services analysis

As the results of Table 2 reveal, the economic effect coefficient of fixed broadband speeds improves with speed: from non-significant for speeds less than 10 Mbps to 0.73025 for nations with download rates equal to or greater than 40 Mbps. The converse is true: a drop in download speed will have the opposite economic consequence. While the pandemic's effect on download speeds is restricted to March, it is reasonable to consider whether, if this condition persists, the negative economic impact may materialize.

In this context, it is appropriate to ask whether it is possible to limit the negative effects of increased traffic on network quality. Of course, measures that include additional infrastructure deployment to accommodate peak traffic require a relatively long period of time. However, three initiatives can be taken with relatively short impact. The first is the deployment of more radio bases for mobile broadband. This effort is an initiative that every operator normally takes to cope with circumstantial jumps in traffic. To speed up the process, any permit requirement for antenna deployment must be flexible to allow operators to respond quickly. The second initiative is to temporarily assign additional

spectrum mobile operators. This is what the Federal Communications Commission (FCC), the US regulator, has done, providing temporary usage of such frequency bands for network carriers in predetermined regions (Srinivasan, 2020). Thirdly, video streaming service providers are expected to minimize the amount of traffic they produce. As already documented, video streaming consumes a significant portion of network traffic. Some companies have already decreased their use of video data.

The closing of the offices was one of the most visible consequences of the pandemic, places of education, and factories to prevent the spread and dramatic increase of telework. Apart from the impact on telecommunications networks, telework has had an effect on video conferencing apps (used for business communication) and data traffic within the house via Wi-Fi technology.

For example, traffic from Cisco's Webex platform to China has surged 22fold since the epidemic began, while the number of users in Japan, South Korea, and Singapore has climbed four to fivefold.

Traffic figures gathered around the world from 125 million Wi-Fi routers at the end of March reveal that cloud-based PC uploads have risen by 80 percent, as well as spikes caused by video conferencing calls. This creates a saturation of un discharged spectrum bands (usually at 2.4 GHz and 5 GHz). Regulators around the world should begin to examine the need to increase the undischarged spectrum share in the upper 5 GHz and 6 GHz bands (following ongoing consideration in the United States).

In conclusion, digital infrastructure is a key component in maintaining economic resilience. Only collective action by the operators and regulators will ensure that the networks will be able to fulfill the connectivity needs arising from COVID-19.

Coronavirus Pandemic Digital Home Scenario

Internet penetration into homes is the key lever to cope with the pandemic. Home digitization helps individuals to continue doing a variety of everyday activities that involved physical interaction before. (The dimension of telework will be analyzed below). According to the latest available statistics, Internet penetration in Latin America is 68.66%. This value reveals whether the first obstacle to coping with COVID-19 with the use of digital devices. The marginalization of 32% of the population in internet use excludes a significant share of the inhabitants from the possibility of accessing services that can replace some activities that usually require physical contact. This marginalization is country-specific. (See Table 3).

Table 3 Internet Penetration (2018-2020)

	2018	2019	2020
Argentina	77,78 %	81,42 %	85,24 %
Honduras	34,06 %	36,60 %	39,33 %
Bolivia	48,22 %	53,04 %	58,34 %
Jamaica	60,58 %	66,64 %	73,30 %
Brazil	74,22 %	81,64 %	89,80 %
Mexico	65,77 %	67,75 %	69,79 %
Chile	82,33 %	82,33 %	82,33 %
Panama	62,01 %	66,45 %	71,20 %
Colombia	66,68 %	71,40 %	76,47 %
Paraguay	64,99 %	69,16 %	73,60 %
Costa Rica	74,09 %	76,88 %	79,79 %
Peru	52,54 %	56,65 %	61,08 %
Dominican Republic	74,82 %	82,31 %	90,54 %
Uruguay	70,21 %	72,20 %	74,24 %
Ecuador	60,67 %	64,27 %	68,09 %
Venezuela	79,20 %	87,12 %	95,83 %
El Salvador	37,20 %	40,92 %	45,02 %
Latin America (weighted average)	68,66 %	73,52 %	78,78%
OECD (weighted average)	83,93 %	86,07 %	88,33 %

Source: Agudelo, et al., (2020)

The region's weighted average demonstrates Latin America's recent development in terms of Internet adoption. It should be remembered, however, that national averages hide significant differences within each country. For example, with regard to rural/urban duality, the adoption of the internet shows much higher levels of adoption in urban areas as shown by Bolivia that by 2014 the level of adoption was 20.6% in urban areas and only 1.7% in rural areas; Brazil that in 2017 the level of adoption was 65.1% in urban areas and only 33.6% in rural areas or Ecuador that by 2017 the level of adoption was 46.1% in urban areas and only 16.6% in rural areas.

One aspect to consider in addition to internet penetration is the number of home access devices. While computer tenure in Latin America reaches 44.89%, in much of households this would not be enough to accommodate simultaneous access by multiple family members.

While the adoption of the Internet at the aggregate level shows an important degree of progress, the analysis of its use reveals a behavior of use that reduces the contribution of it to the resilience of the digital home to face the pandemic (Czernich et al., 2011).

Generally speaking, broadband is used as a means of communication and social linkage (Suarez et al. 2016).

Beyond communication resulting from the use of social networks (via Whatsapp, or Facebook Messenger), one factor that reduces the resilience power of home digitization to cope with the pandemic is the fact that even among Internet users, the ability to adapt services that allow virtualizing physical activities is limited. We also developed a digital resilience index to assess the capacity of digital households to participate in internet-based activities (Chen & Leandro, 2019) taking into account the following indicators:

- Number of educational apps down per year per capita: We assume that downloading educational apps provides an indication of the ability to continue providing education to children at home.
- Range of websites for Fintech per million people: it is assumed that a country's fintech platform density is naturally aligned with a demand for monetary transactions
- Percentage of e-commerce of all retail: an indicator of the use of e-commerce to carry out e-commerce operations to purchase food and consumer goods at home (Ambrosino et al., 2018).

The higher the adoption indicators for each of these four components, the better the ability of the nation to confront loneliness and quarantine (see Table 4).

Table 4 Digital Platform Usage Indicators (2020)

	Use of Internet for Health Apps (1)	**Internet use for applications Educational institutions (2)**	**Density of Platforms fintech (3)**	**Intensity of Trade Electronic (4)**
Argentina	9,27	52,62	0,87	6,73%
Honduras	3,56	10,83	0,57	2,42%
Bolivia	3,41	7,11	1,33	0,94%
Mexico	4,44	48,19	0,57	4,57%
Brazil	10,59	65,22	1,07	7,84%
Panama	10,41	24,75	0,91	8,03%
Chile	12,08	87,35	2,98	3,70%
Paraguay	5,94	12,59	1,22	4,97%
Colombia	6,79	50,73	2,36	6,15%
Ecuador	3,97	9,09	1,14	3,29%
Peru	5,56	52,35	2,46	1,86%
El Salvador	5,50	13,34	0,57	3,03%
Latin America (weighted average)	**7,59**	**51,02**	**1,16**	**5,70 %**
OECD (average weighted)	**15,19**	**76,07**	**5,05**	**11,52 %**

Source: Agudelo, et al., (2020)

Note: Certain countries were excluded from this list for lack of reliability in source data

By combining these four indicators into a "digital home resilience" index, you can visualize which countries are most prepared to deal with health quarantine by digitizing households (see table 5).

Table 5 Digital Home Resilience Index

Country	Index
Argentina	33,87
Brazil	40,59
Bolivia	6,23
Colombia	31,69
Chile	41,14
Dominican Republic	16,38
El Salvador	12,78
Ecuador	11,53
Honduras	9,83
Guatemala	8,70
Paraguay	16,90
Peru	23,33
Mexico	25,63
Latin America (weighted average)	30,70
OECD (weighted average)	53,78

Source: Agudelo, et al., (2020)

The first observation drawn from the indices in Table 5 is as follows: This disparity between Latin America and the OECD countries indicates that the latter are more equipped digitally to cope with a pandemic. Due to the index's variability within the area, Argentina, Brazil, and Chile demonstrate a higher degree of preparation than other countries. This means that, in aggregate, the ability of households to access health information, conduct monetary transactions, acquire benefits by e-commerce, and contribute to the education of children in countries below 30 is more limited. Unsurprisingly, if the social community will breach this index, it could be seen how this mainly affects the vulnerable populations of each country.

Production Resilience

Digitization of production is critical for the economy to continue running despite the interruptions caused by COVID-19. To assess productive resilience, we evaluate two dimensions: I the degree of digitalization of manufacturing processes, and (ii) the degree of digitization of labor. In the first example, we assess the production system's ability to continue operating under existing conditions, with a particular emphasis on supply

networks, processing, and distribution channels. In the second instance, the degree to which an economy is equipped to deal with telework migration is examined.

1. Digitalization of the Supply Chain

In this analysis, we define the supply chain more widespread than the mere acquisition of inputs by firms (Calatayud & Katz, 2019). In this sense, our analysis includes the multiplicity of actors occupying specific functions throughout the supply chain, with the participation of not only input suppliers, manufacturing companies and marketing channels, but also actors which encourage the flow along the chain of products and knowledge. For their harmonious operation, these chains require both logistics, Providers of financial markets and infrastructure, as well as government agencies that promote infrastructure growth and the building of a functional market environment for these chains' strong success (Katz & Callorda, 2019).

Key players participating in a logistics chain include:

- Providers of primary and secondary inputs. The world's best suppliers provide raw materials directly to huge industrial firms. Second-tier manufacturers provide inputs to world-class manufacturers, so becoming indirect suppliers to huge manufacturing firms.
- Manufacturing firms. They are often major corporations that operate in a variety of industries, such as automotive, food, or textiles. To create a finished product, these businesses convert a variety of inputs given by top-tier suppliers.
- Distributors and retailers. These are marketing-related businesses that function as a conduit between manufacturers and end consumers.
- Providers of logistics services, transportation businesses, and infrastructure operators. This category comprises businesses that assist the physical transfer of inputs and finished goods by various means of transport (road, sea, air, and railway), as well as those that offer storage, packing, and inventory management services.
- Regulatory bodies. It refers to public sector institutions that are involved in the movement of commodities, particularly import and export, in order to assure compliance with applicable national and international tariff, safety, sanitary, and phytosanitary standards.
- Technology vendors. It comprises businesses that provide systems and solutions for the administration and automation of digital processes.

- Providers of financial services It consists of banks and financial institutions that assist supply chain firms' access to investment and working capital finance through instruments such as loans, factoring, guarantees, and leasing.

The implication of this analytical framework is that for a productive system to operate with some resilience within the framework of the pandemic, all actors participating in a supply chain must have an advanced degree of digitization. Input procurement orders must not be digitally handled just for production firms enough, but to provide enough traceability knowledge on transiting goods they need to be able to communicate with logistics undertakings or to be prepared to interact with port operators and customs to office the transport of products (Casalet, 2018).

As we have already discussed in other studies, although Latin American companies present to date a high degree of internet connection, the proportion of them that use the platform in their supply chain is smaller (see table 6).

Table 6 Latin America, Digitalization of the Supply Chain (2019)

	Percentage of Companies connected to the Internet	**Percentage of companies that use electronic banking**	**Percentage of companies who use the Internet to acquisition of inputs**
Brazil	96,40 %	88,00 %	66,00 %
Argentina	94,93 %	79,60 %	45,80 %
Chile	86,16 %	84,37 %	28,80 %
Ecuador	93,89 %	47,06 %	13,90 %
Peru	94,00 %	34,20 %	15,20 %
Colombia	92,81 %	95,39 %	37,00 %
Uruguay	93,39 %	68,35 %	38,43 %

Source: Agudelo, et al., (2020)

Note: It's largely due to the degree to which SMEs are used in the survey.

The statistics in Table 6 indicate that, regardless of the degree of adoption of the Internet, a significant share of enterprises (mainly SMEs) has not incorporated the technology into their supply chain. In addition to the difference in the digitization of the supply chain according to the size of the company, there is a significant variation between industrial sectors and between countries. For example, in general, the automotive sector has a more advanced degree of preparation than the rest of the sectors. Still, within the sector, there are differences between countries. In analyzing the situation of the automotive sector by country, it is noted that Mexico is the most advanced country in the design of technological strategies and the adoption of new technologies (partly due to vertical integration with U.S. companies), followed by Brazil. Behind them are Argentina (where the digital transformation of the sector lags behind, in large part, the volatility of the

country's macroeconomic context) and Colombia (due to lower demands for transformation into a smaller local market).

Even for those companies that have digitized their supply chain internally, barriers exist for inter-organizational communication between all supply chain participants. Over the past decade, most countries in the region have improved the performance of some of the supply chain facilitators, such as port infrastructure, intercity roads and airports. This is reflected in a better position in the region in international logistics rankings (Bertschek et al, 2013).

However, the region is still a long way from the performance levels of advanced economies. For example, the low level of digitization of the region's land transport industry represents a significant bottleneck for supply chain eficientization. The Latin American land transport industry is overly fragmented, made up of a majority of small businesses, which present the typical barriers to the digitization of an SME: low investment capacity, limitations in technological implementation capacity, and limited access to financial resources. As an example, of the approximately 150,000 land transport companies in Mexico, only 10 have enough scale to carry out a digital transformation. In Colombia, of the 3,500 land transport providers (Government of Colombia, 2017), government experts estimate that only 100 companies can adopt digital technologies. In this context, technology companies with the digital linking platform profile (matching platforms) are being developed to provide a more efficient relationship between logistics providers and transport services. These firms provide digital services to resolve coordination failures between logistics service providers and ground conveyors.

With regard to the management of customs processes, some progress has been made in the simplification and digitization of processes in recent years, including the development in many countries of the single window of foreign trade. Still, Latin American countries are still lagging behind international best practices (see Table 7).

Table 7 Time to process reports on international exchange (2019, in hours)

	Export	**Import**
Colombia	60	64
Brazil	12	48
Paraguay	24	36
Argentina	30	192
BENCHMARKS		
Netherlands	1	1
Singapore	2	3

Source: World Bank. Doing Business 2019

In short, the restricted digitization of supply chains within businesses, particularly SMEs, and logistics chains bottlenecks are barriers to the growth of COVID-19 capable of addressing resilient chains.

2. Scanning Distribution Channels

Barriers to digitization in the region's supply chain extend to distribution channels. Table 8 presents a compilation of statistics on the percentage of Latin American companies that have deployed digital sales channels or developed websites.

Table 8 Latin America, Digitalization of Distribution Channels 2019)

	Percentage of companies that have a website	**Percentage of companies have deployed digital sales channels**
Chile	78,80 %	10,60 %
Argentina	63,60 %	18,52 %
Peru	5.30 %	7,20 %
Brazil	59,52 %	22,00 %
Colombia	67,21 %	38,00 %
Uruguay	52,75 %	35,41 %
Mexico	49,79 %	8,68 %

Source: Agudelo, et al., (2020)

Note: Information for some countries has been estimated based on their correlation with the level of internet adoption.

As can be seen, while many businesses have created websites in order to boost their presence in the market, only a small number of them have the capability of accepting electronic purchase order requests. When it comes to solving this problem, the most efficient method is to leverage and accelerate the growth of e-commerce platforms, which act as intermediates and allow for the introduction of a higher degree of efficacy in the distribution of goods.

3. La Transformation of the Workforce

The massive emergence of telework has already been alluded to in terms of increased Wi-Fi traffic and its impact on networks. Another approach to the issue concerns the consequences of telework on the job market and its social ramifications. In principle, Staff of information could be considered to be the most likely to adopt new ways of working (Tapia & Salazar, 2019; Fuster-Guillen et al., 2020). A fundamental question to ask is what are the number of workers who, by the nature of their occupation, cannot work from

home? In March alone, 6,650,000 unemployed people showed up to collect unemployment insurance in the United States.

To get a rough idea, we examined data from Chile's Ministry of Social Development's 2018 National Socioeconomic Characterization Survey (CASEN). The survey, conducted every two years, has information for more than 200,000 individuals in each survey. These represent (using expansion codes) the entire population of Chile. To the extent that each respondent first responds to whether or not they are employed, the observations considered include only those individuals who are in the workforce and occupied during the survey (implying that the unemployed are excluded). The objective of the analysis is to apply for each of the 387 occupations compiled in the CASEN database the likelihood that the occupation should continue to operate in the physical place (for example, health professionals must continue working in hospitals), as well as the likelihood of migration to telework (the latter based on the type of occupation; for example, cannot resume work at home on a factory operator). probabilities were established on the basis of official decrees indicating which workers should attend the workplace and who should not supplemented by our subjective analysis.

The set of odds shows us the number of people who will choose to work at home (Guaca et al, 2018), the percentage that should continue to occur in your workplace, and the percentage that cannot resort to telework or is obliged to continue working. In addition, the CASEN base allows analyzing each category in terms of educational level, gender, and origin (Chilean, foreign, Chilean of indigenous origin).

Table 9 Peru: Impact of COVID-19 on the workforce

	Total Population: Possibility to perform *Home Office*		**Total Population: Obligation to go to quarantine work**		**Population in Quarantine: Possibility to perform *Home Office***	
Statistics Peru 2019	**Universe**	**Probability**	**Universe**	**Probability**	**Universe**	**Probability**
All the Population	7.830.958	23,44%	7.830.958	20,56%	6.220.717	28,95%
Uned education Basic	715.636	4,18%	715.636	23,70%	546.022	5,46%
Education Basic	1.582.376	6,29%	1.582.376	24,31%	1.197.777	8,25%
Education media	2.925.729	14,74%	2.925.729	23,14%	2.248.804	19,09%
Education superior	2.560.806	49,40%	2.560.806	14,44%	2.191.105	56,32%
1st quintile of Income	859.226	7,27%	859.226	22,40%	666.731	9,26%
2nd quintile of Income	1.477.662	10,20%	1.477.662	23,20%	1.134.,800	13,20%
3rd quintile income	1.739.900	15,43%	1.739.900	22,56%	1.347.441	19,83%
4th quintile income	1.900.947	23,14%	1.900.947	21,44%	1.493.412	29,26%
5th quintile income	1.833.716	49,83%	1.833.716	14,97%	1.559.130	56,80%

Source: INEI, 2019; Telecom Advisory Services analysis

The analysis shows the following results:

- Out of the total of 7,830,958, 1,610,241 (or 20.56%) You should keep returning to your place of work (security forces).
- Of the total again, 6,220,717 (79.44%) you can't go to your workplace.
- From the universe of 6,220,717 who cannot attend their workplace, 1,801,187 (or 28.95%) they can perform their duties by teleworking at home (Government of Peru, 2019).
- Finally, from the universe of 6,220,717, 4,419,530 (or 71.05%) they can't work remotely from home.
- Of the universe of 7,830,958, workers who do not attend the workplace and who cannot perform their duties by telework represent 56.44%.

These values are of a significant magnitude in terms of their social involvement. Of this workforce, one proportion will lose employment as the company in which they work ceased operations (Nithya et al., 2022), while others will be able to continue on staff, although companies will be able to determine (if allowed by labor law) whether a salary continues to be paid or not.

When the number of employees in a job risk is evaluated, the social effects are much more severe, that is, they cannot attend the workplace and cannot work remotely (see Table 10).

Table 10 Peru: CoVID-19 impact discrimination on employment

Statistics Peru 2019	Percentage that keeps the job	They have to continue to attend work	Work remote	No they can work
The entire population	43,56%	1.610.241	1.,801.187	4.419.530
No basic education	27,87%	169.614	29.828	516.194
Basic education	30,55%	384.599	98.872	1.098.905
Middle education	37,81%	676.925	429.245	1.819.559
Higher education	62,63%	369.701	1.234.063	957.042
1st quintile of income	29,59%	192.495	61.732	604.999
2nd quintile income	33,34%	342.862	149.758	985.042
3rd quintile income	37,91%	392.459	267.170	1.080.271
4th quintile income	44,42%	407.535	436.918	1.056.494
5th quintile income	63,27%	274.586	885.610	673.520

Source: INEI 2019; Telecom Advisory Services analysis

- Of Chile's entire workforce 7,830,958, 43.56% retain employment because they either have to continue to attend the workplace (20.56%) or they can work remotely (23%); logically, due to the difficulty in maintaining social estating, the 20.56% who continue to attend the workplace is at increased risk of contagion.
- These results imply that, according to our analysis, more than 56% of the workforce faces disruption conditions. This percentage is similar to that calculated by Hevia & Neumeyer (2020), which from data from the International Assessment of Adult Skills Programme (PIAAC) on the number of employees per company indicate that 53% of the workforce is at potential risk in Latin America and the Caribbean as they work in companies of up to 5 employees with limited access to financial institutions.
- Of the 4,419,530 who are unable to attend work and cannot work remotely, 1,615,099 have a maximum level of basic education; from the same universe, 1,590,041 belong to the 1st or 2nd quintile of income.

Beyond the immediate social implications of this situation, restructuring of the profitable sector's organizational processes is necessary in order to raise the number of people who can operate remotely, and the recruitment of the most disadvantaged sectors of society.

Conclusions

Since the socio-economic global environment is endangered, coronavirus pandemics are uncommon. Since the implementation of sanitary measures, coupled with fear of transmission, anecdotal evidence has accumulated demonstrating the critical role of digital technology in combating isolation, distributing preventive measures, and enabling economic system functioning. The goal of this study was to determine the significance of digitalization as a mitigating element in the pandemic's disruption, as well as how Latin America is positioned to tackle this issue. The following are the conclusions of the same:

- It has been demonstrated that nations with improved connectivity infrastructure were able to avoid 75% of the economic losses associated with the SARS outbreak and its influence on health measures implemented to combat it. (containment, social shaming, disruption of air traffic, mask use, and so forth).
- Much like the rest of the world, Latin American networks are being impacted by the exponential growth in traffic. In particular, a drop in fixed broadband speed is detected in Chile (-3%), Ecuador (-19.6%), and Mexico (-19.6%), when combined with an increase in latency in the same technology in Brazil (11.7%), Ecuador (11.8%), and Mexico (-19.6%). (7.4 %). Given that our estimates indicate that a

certain speed of broadband has a 0.73 percent effect on GDP when increased by 100%, the negative economic impact might occur if this slowdown continues.

- Additionally, widespread adoption of telework is overwhelming the bandwidth of home Wi-Fi routers, owing to greater cloud work (a rise of 80 percent in upload traffic) and video conferencing.
- The digital divide is a hindrance for significant segments of the Latin American population that rely on an Internet connection to obtain health information, download instructional resources to aid in school progress or make electronic purchases.
- Additionally, the digital gap is exacerbated, as Internet use in big homes is restricted to communication tools and social media. In other words, Internet penetration does not always imply that Latin American households are digitally resilient.
- The industrial apparatus's resilience also demonstrates clearly, not in terms of technological adoption, but in terms of technology integration into production processes, most notably supply chains. As a result, the ability to respond to pandemic disruptions is significantly compromised.
- COVID-19 creates an extra disturbance in the labor market as a result of the percentage of the workforce that is teleworkable. According to a study of the CASEN survey for Chile, which assigns migration probabilities for telework to the 7,830,950 census workers, only 20.56 percent of workers remain on the job (health care providers, security forces), while 23 percent can work remotely using digital technology. This indicates that 4,419,530 workers are in the precarious situation of being unable to report to work and unable to transfer to telework under existing conditions. Apart from the immediate social repercussions of this predicament, changing the lucrative sector's organizational procedures is important to increase the number of individuals who can work remotely and to demonstrate the emergence of the most disadvantaged social sectors.

Short, in short, the fact that the consequences of the pandemic are mitigated by digitalization is important, it is important that Latin American governments and civil society enter into a collaboration and joint work agreement that allows in the very short term to identify those areas of work that improve the performance of certain components of the digital ecosystem.

References

Agudelo, M., Chomali, E., Suniaga, J., Núñez, G., Jordán, V., Rojas, F., & Jung, J. (2020). The opportunities of digitization in Latin America vis-à-vis COVID-19.

Ambrosino, C., Rose, R., Pariyar, M., Bui, T., Kothari, R., Phillips, S., Hernandez, M. & Savino, L. (2018) Effect of market system interventions on household resilience: comparison of two methodologies. *Resilience Measurement, Evidence and Learning Conference - New Orleans.* 1-13.

Bertschek, I., Cerquera, D., & Klein, G.J. (2013). More bits–more bucks? Measuring the impact of broadband internet on firm performance. *Information Economics and Policy, 25*(3), 190- 203. https://doi.org/10.1016/j.infoecopol.2012.11.002

Briglauer, W. & Gugler, K. P. (2018) Go for Gigabit? First Evidence on Economic Benefits of (Ultra-)Fast Broadband Technologies in Europe. *ZEW - Centre for European Economic Research Discussion Paper No. 18-020.* http://dx.doi.org/10.2139/ssrn.3165417

Carew, D., Martin, N., Blumenthal, M., Armour, P., & Lastunen, J. (2018). The potential economic value of unlicensed spectrum in the 5.9 GHz Frequency band: insights for allocation policy. *RAND Corporation.*

Calatayud, A., & Katz, R. (2019). *Supply Chain 4.0: International best practices and roadmap for Latin America* (Vol. 744). Inter-American Development Bank.

Casalet, M. (2018). Industrial digitization: a path to collaborative governance. *Case studies.* https://repositorio.cepal.org/handle/11362/44266

Czernich, N., Falck, O., Kretschmer, T., & Woessmann, L. (2011). Broadband infrastructure and economic growth. *The Economic Journal, 121*(552), 505-532. https://doi.org/10.1111/j.1468-0297.2011.02420.x

CAF (2020). *The opportunities of digitalization in Latin America in the face of Covid-19.* Caracas: CAF. https://scioteca.caf.com/handle/123456789/1541

ECLAC, N. (2020). *The opportunities of digitization in Latin America vis-à-vis Covid-19.* Economic Commission for Latin America and the Caribbean.

Chen, K.F., & Leandro, J. (2019). A conceptual time-varying flood resilience index for urban areas: Munich city. *Water, 11*(4). https://doi.org/10.3390/w11040830

Fan X. (2003). SARS: economic impacts and implications in policy brief 15. *Asian Development Bank Economics and Research Department.*

Government of Colombia (2017), Technical Document, Logistics, and Foreign Trade Mission, *National Planning Department, 35.*

Government of Perú (2019) National Institute of Statistics and Informatics. *Annual Economic Survey on Information and Communication Technology in Companies; analysis Telecom Advisory Services.*

Ghosh, B. (2016). *China's Internet got a strange and lasting boost from the SARS epidemic.* Quartz (April 14th).

Guaca, N.A., Caicedo, Y., & Díaz, J.C. (2018). State of the art of Telework. *Documentos De Trabajo ECACEN*, (1). https://doi.org/10.22490/ECACEN.2568

Fuster-Guillén, D., Ocaña-Fernández, Y., Salazar, D.E. & Ramirez, E.H. (2020). Human development and family integration: Study from the comprehensive service of the elderly in Peru. *Revista Venezolana de Gerencia, 25*(90), 477 – 490. https://doi.org/10.37960/rvg.v25i90.32392

Hacievliyagil, N., & Gümüş, A. (2020) The Epidemic-Exchange Relationship in the Countries where Covid-19 is Most Effective. *Journal of Social Sciences of the University of Gaziantep*, 19 (COVID-19 Special Issue), 354-364. https://doi.org/10.21547/jss.742893

Hevia, C., & Neumeyer, A. (2020). A conceptual framework for analyzing the economic impact of COVID-19 and its policy implications. *UNDP Latin America and the Caribbean, UNDP LAC C19 PDS N.1*.

Knapp S., Rossi V., & Walker J. (2004). *Assessing the impact and costs of public health risks: the example of SARS*. Oxford Economic Forecasting Group.

Katz, R. & Callorda, F. (2019). *Assessment of the economic value of 10G networks*. New York: Telecom Advisory Services.

Katz, R., Jung, J., & Callorda, F. (2020). Can digitization mitigate the economic damage of a pandemic? Evidence from SARS. *Telecommunications Policy, 44*(10). https://doi.org/10.1016/j.telpol.2020.102044

Keogh, M.R., & Smith, R.D. (2008). The economic impact of SARS: how does the reality match the predictions? *Health policy*, *88*(1), 110-120. https://doi.org/10.1016/j.healthpol.2008.03.003

Lobo, B.J., Alam, M.R., & Whitacre, B.E. (2020). Broadband speed and unemployment rates: Data and measurement issues. *Telecommunications Policy*, *44*(1). https://doi.org/10.1016/j.telpol.2019.101829

McKibben W.J. (2004). *Economic modelling of SARS: The G-Cubed approach. In: Prepared for handbook on the rapid assessment of the economic impact of public health emergencies of international concern.* World Health Organization.

Nithya, R., Amudha, K., Musthafa, A.S., Sharma, D.K., Ramirez-Asis, E.H., Velayutham, P., & Sengan, S. (2022). An Optimized Fuzzy Based Ant Colony Algorithm for 5G-MANET. *CMC-Computers Materials & Continua*, *70*(1), 1069-1087. https://doi.org/10.32604/cmc.2022.019221

Rohman, B.E., & Bohlin, E. (2012). Socio-economic effects of broadband speed. *Ericsson, 3*.

Srinivasan, S. (2020). Cisco Webex. *Supporting customers during this unprecedented time.*

Suárez, M., Gómez-Baggethun, E., Benayas, J., & Tilbury, D. (2016). Towards an urban resilience Index: a case study in 50 Spanish cities. *Sustainability*, *8*(8). https://doi.org/10.3390/su8080774

Tapia, J.F., & Salazar, R.G.B. (2019). Telework in Latin America: second and fourth generation rights and digital citizenship. *Criticism and Resistance: Revista de conflictos sociales latinoamericanos*, (9), 17-38. https://www.criticayresistencias.com.ar/revista/article/view/118

Wilder, A., Chiew, C.J., & Lee, V.J. (2020). Can we contain the COVID-19 outbreak with the same measures as for SARS? *The Lancet Infectious Diseases*, *20*(5), e102-e107. https://doi.org/10.1016/S1473-3099(20)30129-8

Zhang, J., Raza, M., Khalid, R., Parveen, R., & Ramírez-Asís, E.H. (2021). Impact of team knowledge management, problem solving competence, interpersonal conflicts, organizational trust on project performance, a mediating role of psychological capital. *Annals of Operations Research*, 1-21. https://doi.org/10.1007/s10479-021-04334-3