LOGISTICS
IN LATIN AMERICA AND THE CARIBBEAN:

OPPORTUNITIES, CHALLENGES, AND COURSES OF ACTION

Agustina Calatayud and Laureen Montes (Eds.)

TRANSPORT DIVISION

IDB

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EXECUTIVE SUMMARY

In modern economy, productive activities are organized in supply chains. They cover a range of activities starting from the design of a product or service to its delivery or provision to final consumers. **Logistics —understood as the processes of management, storage and transportation of inputs and goods— plays a key role in the proper functioning of a supply chain.** Given the spatial distribution of supplies, production nodes and consumption markets, logistics allows us to overcome the friction of distance and create spatial convergence between supply and demand (Barbero, 2010). Thus, logistics influences **the level of competitiveness of both companies and economies, while providing employment opportunities and access to goods.** Because transportation is one of the main contributors to pollutant gas emissions, logistics also plays an important role in slowing down climate change.

From a **public policy point of view, logistics efficiency depends on three main components** (IDB, 2020b): (i) infrastructure (road, port, airport and railroad infrastructure, logistics platforms, warehouses, distribution centers and border crossings); (ii) services (road, maritime, river, air, rail transportation, and logistics services); and (iii) regulatory and institutional framework. According to international indices, **Latin America and the Caribbean (LAC) lags significantly in the performance of all of these components.** According to the latest edition of the Logistics Performance Index, in 2018 the region's overall logistics performance reached just 2.66 points out of 5, ranking well below the levels of Europe (3.40), East Asia and Pacific (3.13), and only close to the Middle East and North Africa (2.78) (World Bank, 2018a). In addition, this score was lower than the one achieved four years earlier, in 2014, when the region scored 2.79 points. In all components of the Index, the region obtained average scores closer to those of South Asia and Sub-Saharan Africa, with transportation infrastructure quality and customs efficiency being the components with the lowest relative scores.

LAC countries could reap significant benefits by improving their logistics performance. Logistics costs, for example, influence trade costs, which can result in greater or lesser access to markets. Our estimates predict that, if the quality of a country's logistics services improved by one unit (in a scale from 1 to 5), its exports (in US$) would increase by about 7%. Likewise, a 5% increase could be achieved if the quality of its transportation infrastructure were improved by a similar magnitude. Benefits are even greater when exports are considered by economic sector. Exports of manufactured goods would increase by 18% with a one-unit improvement in the quality of logistics services, and by 12% if such an improvement were made in the country's transportation infrastructure. In the case of highly technology-intensive products, a one-unit improvement in the quality of logistics services would increase exports of such products by 25% and imports by 17%. This increase would be about 17% if improvements in the quality of transportation infrastructure were made by the exporting country. In particular, new developments in the field of logistics would allow LAC countries **to benefit from the reconfiguration that global supply chains are undergoing** as a result of the current context in which large companies and consumer markets are seeking to diversify their supplier schemes in order to ensure greater resilience and better risk management in the event of potential shocks such as those caused by the COVID-19 pandemic.

LAC's logistics matrix is characterized by the predominance of inland freight transportation. More than 85% of domestic freight movement (by weight) in the countries of the region is by road (IDB, 2020a). This mode accounts for 30% of intra-regional trade in South America while in Central America cargo is transported almost entirely by road. The performance of road transportation companies is heterogeneous. On the one hand, there is a small group of large companies with high levels of operating efficiency and service quality, comparable to international standards; on the other hand, there is a large number of micro and small companies that **face challenges in several areas,** such as the low occupancy and use —in terms of distance traveled— of their transportation fleet, which are two of the factors that reduce their productivity. This, combined with the high average age of the fleet, causes losses in operational and energy efficiency and has been associated with poor service quality and high levels of emissions. In addition, there is evidence of high levels of informality and limited human and financial resources. The sector's regulatory framework also needs to be updated to encourage greater efficiency and reduce informality. Finally, regarding road infrastructure, improving its performance requires investments to be made to increase its quantity, capacity, and quality and to improve asset management and its interoperability with other modes of transportation.

The development of rail freight transportation has remained a constant item on the agenda to enhance LAC's logistics performance. However, its share in the region's cargo matrix is still very limited, as it is mainly used only for bulk transportation and mining in a few countries. In most countries, rail infrastructure is either almost non-existent or of poor quality. The topographical features, the particular characteristics of the production matrix (i.e., volume, type of product), and the small size of many countries are detrimental to the cost-benefit ratio of this type of transportation (which can compete with road transportation for distances usually greater than 500 km). This, combined with the high construction costs and the rigidity of this mode in comparison to the flexibility of road transportation, means that, unlike in advanced economies and except for Mexico and Brazil, the share of rail transportation in LAC is marginal (less than 3%). For countries where this mode can indeed be a competitive option, **challenges** are evident particularly **in three areas** when compared to international best performers: lower technical efficiency, higher costs, and weak institutional and regulatory frameworks.

Maritime transportation is key to the international integration of LAC countries. Together with river transportation, this mode is used for 95% of LAC's international trade. In addition, it provides business opportunities to countries that are considered trade hubs within the main international trade routes. Although the region has improved the technical efficiency of its port terminals and its international connectivity, there are **three main challenges that this sector must overcome to increase its performance:** (i) a greater horizontal and vertical concentration in the container market and its tendency to gigantism; (ii) the limited governance and institutional capacity of the sector; and (iii) port performance gap with respect to international and regional best performers. A fourth challenge is related to the limited intermodal and multimodal transportation systems in the region, which makes access to port terminals difficult for the growing export demand. This is particularly important in the case of bulk agricultural products, as even though many world-leading terminals specialized in this segment are found in LAC, they face serious hinterland connectivity problems due to the low quality of land infrastructure and poor rail connections. In addition, **river transportation** is poorly developed, despite the great potential for cargo movement of many of the region's river basins.

Despite its limited participation in LAC's modal matrix, **air freight transportation plays an important role as it enables the countries of this region to participate in higher value-added economic segments.** The analysis of this mode of transportation suggests **three areas for action.** First, local regulatory aspects should be updated and standardized with the aim of integrating air transportation with other dimensions of logistics operations. Likewise, process simplification and digitization should be encouraged, as well as the integration of cargo processes, such as cargo and passengers. Finally, although airport infrastructure in the region has undergone significant modernization and expansion, there are still significant imbalances between the supply and the quality of the services offered.

Due to the globalization of trade, many aspects of logistics-related processes are subject to the control and supervision of customs and sanitary authorities. Although LAC countries have made progress in trade facilitation, administrative processes, and the lack of adequate infrastructure at border crossings continue to cause delays, increasing logistics costs for international trade and limiting the benefits of the region's economic integration. LAC is particularly lagging in the implementation of explicit commitments made in the World Trade Organization's Trade Facilitation Agreement, in key areas such as risk management, single windows for foreign trade, authorized economic operators, digitization of processes, and cooperation with customs authorities and with other relevant agencies.

The growth of e-commerce has generated a boom in urban logistics. The economic and social activities that take place in cities usually require the provisioning of a diverse range of goods, which makes cities a key node for supply chains. E-commerce is one of those activities which, consequently, increases the flow of freight transportation on urban roads. In particular, the mobility restrictions implemented by countries to contain the spread of COVID-19 have given a major boost to e-commerce. Between March and April 2020, revenues from this channel increased by 130% in Brazil and Colombia, by 500% in Mexico, and by 900% in Peru (Statista, 2020). While this sales channel presents business opportunities for different types of companies, particularly for distribution companies, from a public sector perspective there are **four main issues that deserve particular focus:** high urban congestion, restricted spaces, and challenges related to safety and sustainability.

This technological revolution presents unprecedented opportunities to improve LAC's logistics performance. Globally, the logistics industry stands among one of the most prone sectors to the adoption of new technologies such as blockchain, the Internet of Things, artificial intelligence, robotization and digitization. Furthermore, the COVID-19 pandemic is accelerating the pace of technological transformation in the industry, especially in terms of obtaining real-time information for better operational risk management. However, the countries of the region are lagging considerably behind in technological modernization. Some of the **main barriers** include uncertainty of the macroeconomic context, limited local availability of technology, lack of knowledge at managerial level, resistance to change, limited human and financial resources, and lack of telecommunications infrastructure. Two different speeds can be observed among logistics players: while a small number of international firms are accelerating their digital transformation, most micro and small enterprises still operate with obsolete technologies and face barriers to transformation.

One of the most urgent challenges for this sector is to reduce its contribution to climate change. To achieve the global target set in the Paris Agreement with the aim of keeping the average temperature increase below 2ºC, a transition to a low-carbon transportation model is necessary. Even considering the impacts of the COVID-19 pandemic on freight demand, emissions reductions by 2020 will have minimal long-term impact. However, the implementation of decarbonization measures as part of economic recovery plans, such as the adoption of cleaner technologies or tax reforms on fossil fuel subsidies, can contribute to job creation and accelerate the recovery of economies. Such a decarbonization strategy should be integrally structured around objectives not only regarding energy efficiency, but also efficiency in freight transport operations, encouraging a modal shift towards less polluting modes of transportation.

The public sector plays an important role in overcoming the challenges faced by the different logistics modes and processes in the region. Logistics activities are developed within a business environment, where the public sector is a provider of regulations, infrastructure, financing, and public services. However, for this sector to fulfill its role efficiently and effectively, it must have a strategic vision, update its technical and technological capabilities, improve planning and spending efficiency, increase the availability of information and its transparency, and improve inter-institutional coordination as well as coordination with the private sector and academia. Although the different logistics modes and processes have their own specific challenges and therefore require the implementation of tailor-made solutions, in general, **improving logistics in the LAC region depends on three major factors:** (i) infrastructure, (ii) logistics services, and (iii) regulatory and institutional framework. In addition to these factors, there are some **general trends** such as technological modernization and the promotion of sustainability that must be considered. Regarding solutions, they may differ according to the level of performance achieved by a country. It is also important to consider the cost and time to reap the full benefits of the actions that need to be implemented. In any case, **improving logistics performance requires a systemic vision** which combines relevant investments —in many cases supported by public financing— and "soft" measures, such as supporting the professionalization of micro and small enterprises in the sector. From this perspective, the National Logistics Plans, which are currently being implemented in several LAC countries with the support of the Inter-American Development Bank (IDB) are key tools for guiding, prioritizing, and systematizing public policy actions, in support of a country's development objectives and with a systemic vision of the multiple areas involved in improving logistics performance.

INTRODUCTION

Logistics, understood as the planning, implementation and control processes that ensure an efficient flow of goods, services, and information along the supply chain, plays a key role in today's economy. Given the spatial distribution of inputs, production nodes and consumption markets, logistics can overcome the friction of distance and create spatial convergence between supply and demand (Barbero, 2010). Thus, logistics influences a country's level of competitiveness and productivity, while providing employment opportunities and access to goods for its inhabitants.

In aggregate terms, the logistics performance of Latin America and the Caribbean (LAC) lags significantly behind other regions. International indicators show that LAC consistently ranks below the levels of advanced economies, while its performance has been in decline over the last years. What are the reasons for this backwardness? What impact does it have on the region's development goals? How can this trend be reversed? These will be the main questions addressed in this publication.

To this end, in the Chapter 1 we will examine the relationship between logistics and development goals and quantify the benefits of improving logistics in LAC countries. Chapters 2 to 5 will assess the current situation of road, rail, maritime and air transportation in the region. Chapter 6 will provide an overview of the status of trade facilitation, an important complement to international logistics operations. Chapters 7 to 9 will explore three new challenges in the sector: urban logistics, digital transformation, and decarbonization. Chapter 10 will address the geographic dimension of logistics and the importance of a multimodal system. And, finally, in Chapter 11 we will present a road map with actions for improvement in the short, medium,and long term, according to the sector's development in the different countries of the region.

Since its establishment 60 years ago, the Inter-American Development Bank (IDB) has supported the region in strengthening the different components of its logistics system —infrastructure, transportation services and institutional framework. In particular, the IDB has contributed to analyzing the challenges, sizing the gaps, identifying potential solutions, designing national and regional plans, and making the necessary investments and reforms to move forward with the process of improving logistics in LAC. This publication is based on the body of knowledge on this industry generated by the IDB and includes new results regarding the main challenges faced and its potential solutions, in light of both traditional and new challenges for the region.

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List of collaborators

Chapter 1: Agustina Calatayud, Felipe Bedoya-Maya, Vileydy González.

Chapter 2: Paola Rodríguez, Laureen Montes.

Chapter 3: Laureen Montes, Jorge Kohon, Julieta Abad.

Chapter 4: Agustina Calatayud, Felipe Bedoya-Maya, Vileydy González.

Chapter 5: Reinaldo Fioravanti, Eduardo Café, Rodrigo Cruvinel, Andrés Ricover.

Chapter 6: Sandra Corcuera-Santamaría, Jorge Martín García Sanjinés.

Chapter 7: Agustina Calatayud, Paola Rodríguez, Gabriela Sampedro.

Chapter 8: Agustina Calatayud.

Chapter 9: Vileydy González, Paola Rodríguez, Francisca Giraldez, Laureen Montes.

Chapter 10: Laureen Montes, Agustina Calatayud, Francisca Giraldez.

Chapter 11: Agustina Calatayud, Laureen Montes.

Julieta Abad, Argentinian citizen. She holds an MBA from the Universidad Austral. She is a leading specialist at the Transportation Division of the Inter-American Development Bank.

Felipe Bedoya-Maya, Colombian citizen. He holds a master's degree in Economics from Universidad EAFIT in Medellin. He works as a consultant at the Transportation Division of the Inter-American Development Bank.

Eduardo Café, Brazilian citizen. He holds a master´s degree in International Economic Development from the Fletcher School in the United States. He is an independent consultant on air transportation and road safety issues.

Agustina Calatayud, Argentinean citizen. She holds a PhD in Mechanical Engineering and Systems from Newcastle University. She is a Senior Transportation Specialist at the Transportation Division of the Inter-American Development Bank.

Sandra Corcuera-Santamaría, Spanish citizen. She holds a master´s degree in Public Administration from the Katholieke Universiteit Leuven. She is a senior integration and trade specialist at the Trade and Investment Division of the Inter-American Development Bank.

Rodrigo Cruvinel, Brazilian citizen. He holds a master's degree in Transportation from the University of Brasilia, Brazil. He works as a consultant at the Transportation Division of the Inter-American Development Bank.

Reinaldo Fioravanti, Brazilian citizen. He holds a PhD in Transportation Engineering from the Universidad de Campinas, Brazil. He is a leading transportation specialist at the Transportation Division of the Inter-American Development Bank.

José Martín García Sanjinés, Mexican citizen. He holds a master's degree in Administration from Monterrey Institute of Technology and Higher Education. He works as a consultant on customs and foreign trade issues at the Trade and Investment Division of the Inter-American Development Bank.

Francisca Giraldez, Chilean citizen. She holds a degree in Transportation Systems Engineering from the Pontificia Universidad Católica de Chile. She works as a consultant at the Transportation Division of the Inter-American Development Bank.

Vileydy González, Colombian citizen. She holds a master's degree in Economics from Universidad EAFIT in Medellín. She is a consultant for the Transportation Division of the Inter-American Development Bank.

Jorge Kohon, Argentinean citizen. He holds a Civil Engineering degree at Transportation from the University of Buenos Aires. Specialized in rail transportation, he is a consultant for the Inter-American Development Bank and the World Bank.

Laureen Montes, Nicaraguan citizen. She holds a master's degree in Globalization and Development from the University of Antwerp in Belgium. She works as a transportation specialist at the Transportation Division of the Inter-American Development Bank.

Andrés Ricover, Argentinean citizen. He holds a master's degree in Business Administration with a concentration in Finance. He is an independent consultant on air transportation issues.

Paola Rodríguez, Colombian citizen. She holds a master's degree in Transportation and Planning from the Delft University of Technology in the Netherlands. She works as a transportation consultant at the Transportation Division of the Inter-American Development Bank.

Gabriela Sampedro, Mexican citizen. She holds a degree in International Trade from the Benemérita Universidad Autónoma de Puebla. She works as a consultant at the Transportation Division of the Inter-American Development Bank.

CHAPTER 1

THE IMPORTANCE OF LOGISTICS FOR LAC COUNTRIES

What is logistics? Why is it interesting from a public policy point of view? What are the potential benefits for a country's development? These are the questions that drive the first chapter of this publication. To answer these questions, we have started by reviewing the wide literature available in fields such as: Transportation Economics, International Economics, Industrial Engineering, Transportation Engineering, and Economic Geography. We have also gathered information from internationally available indicators and have used a gravity model to evaluate the importance of logistics in one of the key variables of development: a country's integration into international trade.

1.1 What is logistics?

In modern economies, productive activities are organized in **supply chains**. They cover a range of activities starting from the design of a product or service to its delivery or provision to final consumers. To illustrate the supply chain concept, a simple example can be used, such as that of a package of coffee purchased at a supermarket. In order for that package of coffee to reach the supermarket shelf, a number of processes are necessary, including, among others, coffee growing, its harvesting, roasting and grinding, its packaging and storage, various domestic and international transportation routes, and its distribution to the trader (wholesaler and/or retailer) which, in this case, is the supermarket. This example shows that supply chains involve a complex network of actors whose coordination is key to ensuring that a product reaches consumers at the time and place they require (Calatayud & Katz, 2019).

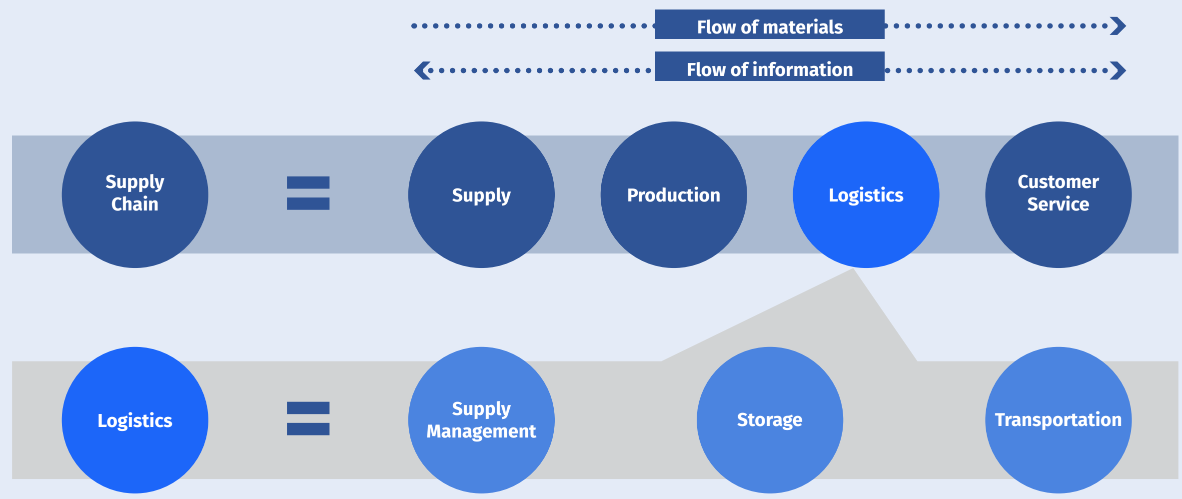
Logistics is one of the key processes for **supply chains** to work. The term "**logistics**" refers to the planning, implementation, and control processes that ensure an efficient flow of goods, services and information along the supply chain, from raw material suppliers to the final consumer, in order to meet the latter's requirements (CSCMP, 2020; Mangan et al., 2020). Given the spatial distribution of inputs, production nodes and consumption markets, logistics —the flow of goods in particular— allows us to overcome the friction of distance and create spatial convergence between supply and demand (Barbero, 2010). For logistics to be efficient, the following "5R's" need to be satisfied (Mangan et al., 2020):

1. to carry the right product,
2. in the right manner,

3. in the right quantity and condition,
4. and at the right time and price
5. to the right place and consumer.

Figure 1.1 illustrates the relationship between supply chain and logistics:

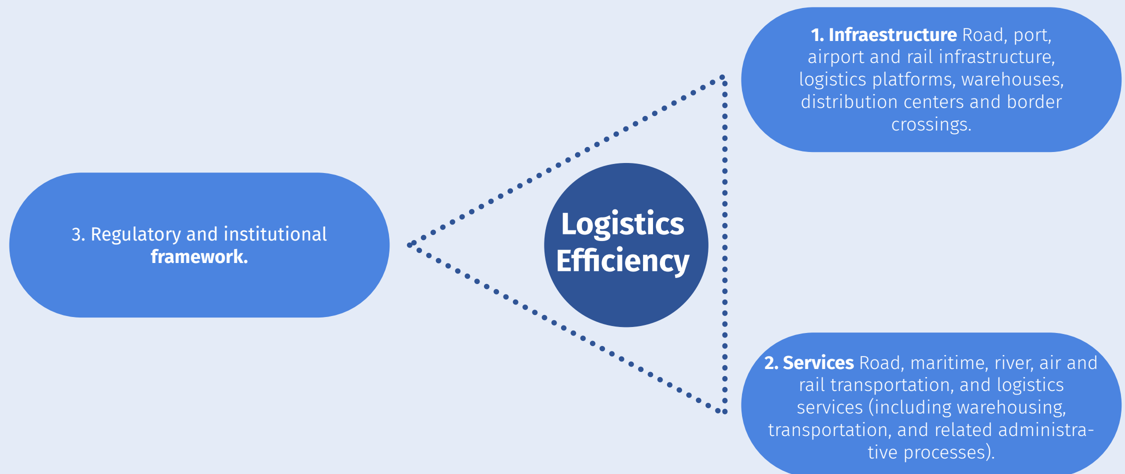
Figure 1.1 Relationship between supply chain and logistics



Source: Own production based on data provided by the Ministry of Transport New Zealand (2010).

From a public policy point of view[1], logistics efficiency depends on three main components (IDB, 2020b):

Figure 1.2 Logistics efficiency components



Source: Own elaboration.

1. From the point of view of the private sector, logistics focuses on the planning, implementation and management of transportation and storage processes of intermediate supplies and final products, as well as the related information flow, in order to optimize these processes and maximize the present and future profitability of the company that carries them out (Christopher, 2016).

In general, the private sector has a large share in the first two components. For example, most port and air cargo terminals are managed by private companies. Transportation and logistics services are also usually provided by the private sector. For this reason, public-private collaboration is critical to identify opportunities for improvement in a country's infrastructure, services, and regulatory and institutional framework in order to achieve efficient logistics performance. In this regard, as will be seen in the last chapter of this publication, several LAC countries have established mechanisms for dialog, in the form of roundtables, councils, etc., in order to foster collaboration.

Together with infrastructure and services components, a country's regulatory and institutional framework can play a decisive role in influencing its logistics performance. Indeed, the available literature shows a correlation of near 0.75 between logistics performance and the quality of institutions (OECD/UN & ECLAC/CAF, 2014). Given the broad scope of logistics, the institutions involved in logistics include both sectoral agencies, such as Ministries of Transportation or Public Works, and the Authorities related to the different modes of transportation, as well as other institutions outside the sector, including trade, tax, and safety institutions, among others. In addition, regulations refer to a set of legal and policy instruments that establish guidelines for the operation of the sector. These range from specific aspects, such as technical regulations on weights and dimensions of freight vehicles, to broader policies such as national logistics programs. Due to the multiplicity of institutions and regulations that directly or indirectly relate to logistics performance, inter-institutional coordination is key at all levels —national, state and, city level— to generate synergies and simplify requirements for greater efficiency. We will address this matter in the last chapter of this document.

As defined above, logistics involves managing not only the flow of inputs and outputs, but also the information generated in multiple processes and by different players in the supply chain. In the context of the Fourth Industrial Revolution (see Chapter 8), technologies such as artificial intelligence, automation and digitization allow us to have timely, complete, traceable, and quality information to make unprecedented improvements in the performance of all three components of logistics. For example, the use of logistics infrastructure and assets may be planned and monitored more accurately, avoiding both underutilization and congestion; logistics services may be organized better to reduce waiting times; and requirements and procedures may be simplified, digitized, and automated to reduce administrative cost. Thus, as will be seen in Chapter 8, technology adoption is a key competitive variable in 21st-century logistics.

1.2 The contribution of logistics to development variables

Why should logistics be of interest to the public sector? The available international economic literature has shown the positive impact that good logistics performance can have on a country's development variables. In the case of infrastructure investment, for example, the literature reports the following benefit transmission mechanism: improved infrastructure reduces transportation costs and times which, in turn, reduces trade costs and, consequently, increases the country's potential for access to markets (Rietveld, 1994; Banister & Berechman, 2001; Jacobs & Greaves, 2003; McCann, 2005). This leads to an increase in sales and employment opportunities in areas with improved market connectivity through the provision of infrastructure (Limão & Venables, 2001). With lower trade costs, the country's exports grow and diversify. In the medium term, infrastructure investments reduce companies' inventory and warehousing costs, and facilitates higher inventory turnover, as well as greater reliability and less variability in transportation times (Gonzalez et al., 2008). All of this has an impact on reducing total costs for companies. At the same time, access to supplies and labor increases, and this contributes to improving company productivity (Dorosh & Hyoung Gun Wang, 2011; Rietveld, 1994). Finally, infrastructure investments encourage the attraction of investment from the now better connected area, helping promote industrialization and the positive effects of economic agglomeration, thus fostering the economic growth of the area (Vickerman et al., 1999 ; Suk Park et al., 2019).

Table 1.1 presents a summary of the selected literature on the subject. Most of the available studies focus on analyzing the impact of logistics on three main development variables[2]: **market access, productivity, and environmental sustainability**. These variables have been used in the following table to classify the selected literature. It should also be noted that available studies tend to focus on certain components of logistics, such as road infrastructure and maritime transportation services, while evidence on general logistics performance is scarce, largely due to the absence of aggregate data for the sector (see section 1.3). Finally, with the exception of studies analyzing the impact of administrative and control procedures on foreign trade (see Chapter 7), there is little evidence on the effect of other regulatory changes related to the logistics sector, which is why more attention should be paid to impact evaluations of programs implemented in this sector.

Table 1.1 Selected empirical evidence on the impact of logistics on development variables

Development variable	Component of logistics analyzed	Evidence
Access to markets	Multiple	• Each additional day of transport reduces a country's chances of exporting to the United States by 1 to 1.5% (Hummels, 2001; Hummels & Schaur, 2013). • Each day of delay in the shipment of a product reduces trade by at least 1% (6% in the case of perishable products) (Djankov et al., 2010). • A 10% decrease in transportation costs could increase exports by 30% and increase employment in exporting companies (IDB, 2013; IDB, 2018) • An improvement in port efficiency from the 25th to the 75th percentile reduces transportation costs by 12%. In addition to infrastructure, this efficiency depends on the prevalence of organized crime and the regulatory framework (Clark et al., 2004). • Improving the efficiency of ports and other transportation infrastructure, customs management and the regulatory framework has a favorable impact on a country's international trade, creating greater benefits for exports (Wilson et al., 2005). • A one standard deviation improvement in a country's logistics performance is associated with an increase in exports of 46% (Behar et al., 2009).
	Infrastructure	• A deterioration of infrastructure from the 25th percentile to the median would increase transportation costs by 12% and reduce traded volumes by 28% (Limão & Venables, 2001). • An improvement in Colombia's infrastructure that would bring its transportation costs to the 25th percentile level would increase exports from its regions by 10% to 45% (IDB, 2013). • Doubling port efficiency has an effect on transportation costs that is similar to reducing the distance between two ports by half (Wilmsmeier et al., 2006).
	Maritime transportation services	• The level of maritime connectivity (maritime services) of a country has a greater effect on transportation costs than geographical distance and port infrastructure (Martínez-Zarzoso & Wilmsmeier, 2010). • The centrality of a country on shipping routes reduces transport costs and increases trade flows (Márquez-Ramos et al., 2011). • The non-existence of a direct maritime connection with a trading partner is associated with a lower value of exports, while each additional transshipment would reduce by 40% the value of exports (Fugazza & Hoffmann, 2017).

2. The concept of development is multidimensional, encompassing economic, social, and environmental aspects, with the aim of providing a better quality of life for all individuals (UN, 1997). Within the economic aspects, the literature surveyed relates to the variables of access to markets and productivity. Within the environmental aspects, it is linked to environmental sustainability.

Table 1.1 Selected empirical evidence on the impact of logistics on development variables		
Development variable	**Component of logistics analyzed**	**Evidence**
Productivity	**Road infrastructure**	• Increased rural connectivity via infrastructure improves access to technology, increasing agricultural productivity (Dorosh & Hyoung Gun Wang, 2011; Kiprono & Matsumoto, 2018; Aggarwal, 2018). • Investments in rural roads in Colombia increased productivity by 62% due to access to inputs for agricultural production, the probability of sales by 5% and the value of production by 15% (Ortega, 2018).
Environmental sustainability	**Transportation services**	• Freight transportation is responsible for 12% of global emissions. These emissions could more than double by 2050, negatively impacting climate change and the likelihood of meeting the goal of keeping global temperature rise below 2 degrees Celsius (ITF, 2019b). • The level of emissions in logistics can vary by up to 80% depending on transportation and storage (Liotta et al., 2015). • Modal shift and the optimization of routes and operations reduce CO_2 emissions in transportation. In the long run, this reduction increases the competitive advantage of companies (Herold & Lee, 2017). • Urban logistics regulations such as night-time delivery of goods and the implementation of low-emission zones can generate significant savings for cities in terms of CO_2 emissions (Holguín-Veras, Hodge, et al., 2018).

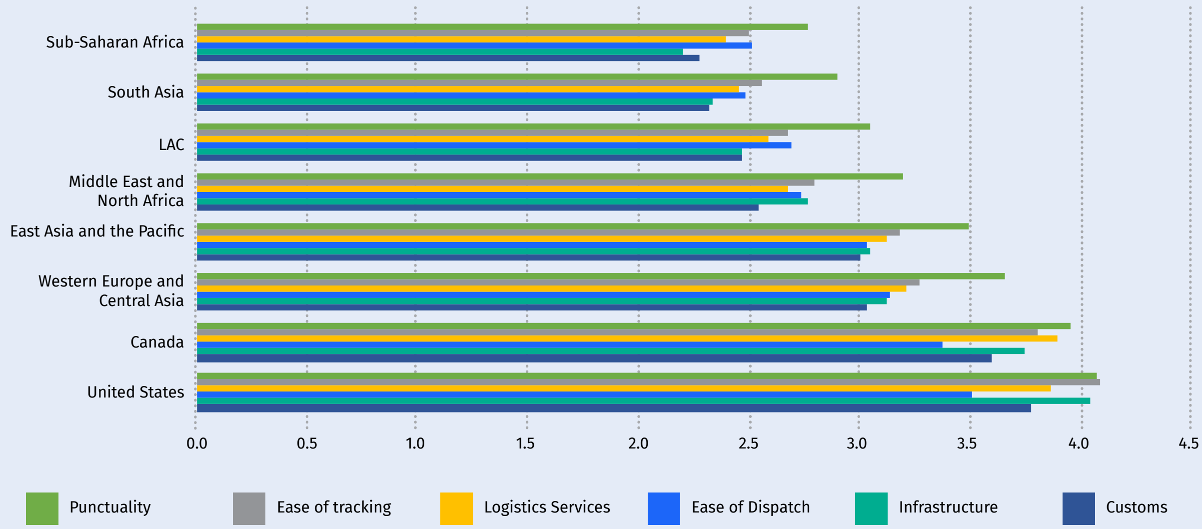
Source: Own production.

1.3 Logistics performance in LAC: potential benefits of its improvement

In view of the benefits mentioned in the previous section, it is worrying to note that LAC is lagging well behind in terms of **logistics performance**, which has been associated with higher transportation costs for the countries in the region (see **Box 1.1**). According to the latest edition of the Logistics Performance Index (LPI)[3], in 2018 the region's average score was just 2.66 points out of 5, ranking well below the levels of Europe (3.40), East Asia and Pacific (3.13), and only close to the Middle East and North Africa (2.78) (World Bank, 2018a). On top of that, this score was lower than the one achieved four years earlier, in 2014, when the region obtained 2.79 points. In all components of the Index, the region obtained average scores closer to those of South Asia and Sub-Saharan Africa, with transportation infrastructure quality and customs efficiency being the components with the lowest relative scores (**Figure 1.3**).

3. This indicator ranges from zero to five points, is constructed by the World Bank from data from surveys of professionals in the sector, and is available for 2007-2018. The general index is made up of six components: customs efficiency and border procedures, quality infrastructure for transport and trade, ease of completing international agreements at competitive prices, competition and quality of logistics services, ability to track and monitor shipments, and frequency with which shipments reach their recipient within of the expected time frame. Statistical techniques are applied to aggregate the data into a single index. The result is a comparable measure between countries over time. It comprises export or import containerized cargo, so other types of freight are out of the analysis —i. e. dry bulk, very present in the economic matrix of LAC— and domestic cargo. Finally, it is essential to note that, as the data come from surveys, it may suffer from sampling error and other derived limitations. However, it constitutes the best available approximation of an international standardized measure of logistics performance to date. All technical aspects can be consulted in Arvis et al. (2018).

Figure 1.3 Logistics Performance Index (regional average by component, 2018)



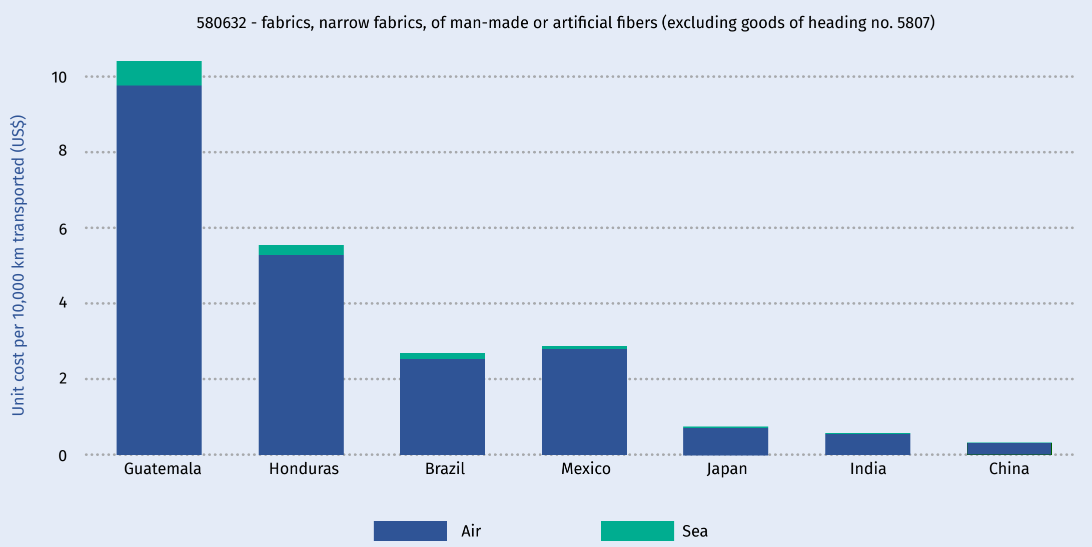
Source: Own production using data from the World Bank.

Box 1.1 Transportation costs in LAC

Higher transportation costs make companies less competitive and are a constraint for strengthening a country's export capacity, especially for its insertion in regional and global supply chains, which could benefit from comparative advantages such as geographic proximity to major world markets, with global demand. When analyzing the cost of transporting inputs for the main global supply chains, we observe that LAC countries are in a highly unfavorable position in comparison to their main competitors (UNCTAD, 2020a). For example, for China the cost of transporting a synthetic fiber fabric (HS-580632) to the United States in 2016 was US$ 0.32 per 10,000 km by air and US$ 0.01 by sea, while for the most competitive countries in the LAC region, such as Mexico and Brazil, it cost more than US$ 2 by air and more than US$ 0.05 by sea (US$ 0.15 for Brazil). As for Central America, countries have reported much higher costs: transportation cost for Honduras was US$ 5.18 by air and US$ 0.25 by sea, while Guatemala's cost was twice that of Honduras (**Figure 1.4**). A similar result was found when analyzing other products, including raw materials which are LAC's main exports. The transportation cost per 10,000 km of a unit of soybeans (HS-120190) to China is twice as high for Uruguay as for the United States. For Brazil, the transportation cost per 10,000 km of one unit of copper ores and concentrates (H2-260300) to China by sea is three times the cost for the United States (US$ 0.001).

Box 1.1 Transportation costs in LAC

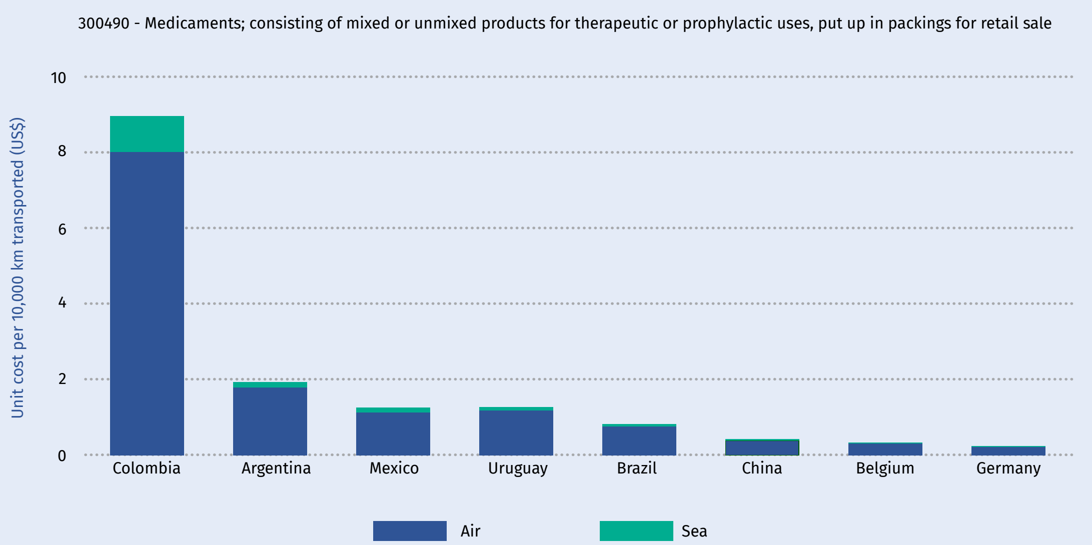
Figure 1.4 Transportation costs to the United States for textile goods (2016)



Source: Own production using data from UNCTAD (2020a).

This disadvantage remains when looking at medium and high-technology products. In 2016, the transportation cost per 10,000 km of a packaged medicine for therapeutic or prophylactic use from Germany to the United States was US$ 0.23 by air and US$ 0.018 by sea, followed closely by Belgium and China. For Brazil, the cost was three times higher than for Germany, both by air and by sea. Even though Colombia has great potential in this industry, the cost for this country was over US$ 8 by air and close to US$ 1 by sea (**Figure 1.5**).

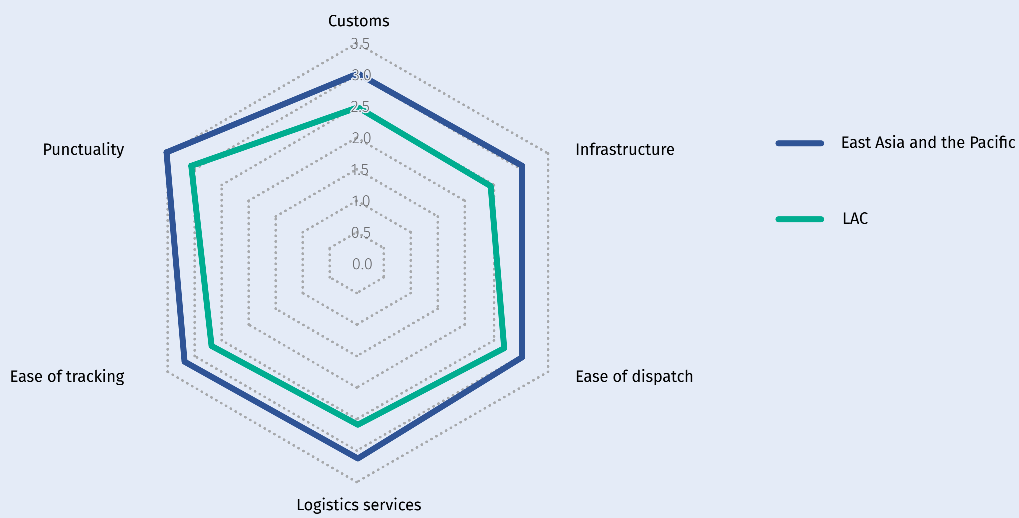
Figure 1.5 Transportation cost to the USA for pharmaceutical products (2016)



Source: Own production using data from UNCTAD (2020a).

If we look at Southeast Asia —one of the regions that is frequently mentioned as an example for LAC countries because of its productive transformation, particularly given the importance that intermediate and manufactured goods have in its trade profile— it can be observed that, compared to LAC, its logistics performance is systematically superior for all components analyzed and, in particular, those related to infrastructure and customs efficiency (**Figure 1.6**).

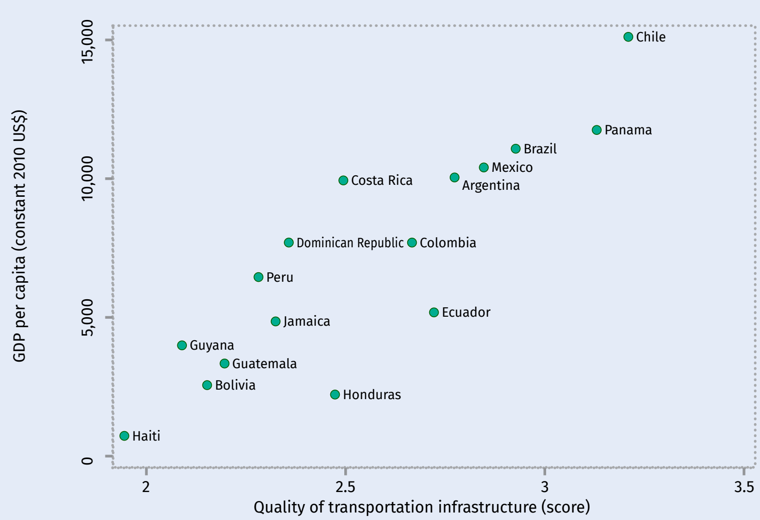
Figure 1.6 Logistics performance in LAC vs. East Asia and Asia-Pacific (2018)



Source: Own production using World Bank data.

The performance gap regarding infrastructure should be of concern given that, as evidenced in the literature (section 1.2), it is a key enabler of international trade and, therefore, of economic development. In this sense, **Figure 1.7** shows the correlation between GDP per capita and quality of transportation infrastructure for middle and low-income countries. Within the region, the most backward group includes Haiti, Bolivia, Guyana, Guatemala, Peru, and Jamaica, while the most advanced group includes Mexico, Brazil, Panama, and Chile.

Figure 1.7 Real GDP per capita and quality of transportation infrastructure in middle and low-income LAC countries (2018)



Source: Own production using data from World Development Indicators (WDI).

How much would the region benefit from improving its logistics performance? To answer this question, we have developed an econometric model that approximates the relationship between logistics performance and international trade flow, related to the market access variable identified in section 1.2. Specifically, we have modeled the relationship between trade flow and the quality of logistics services and transportation infrastructure. Based on the study carried out by Marti et al. (2014), we have used a **gravity model** using the trade flows of 155 countries by origin and destination, for the period 2007-2018, as follows:

$$logT_{ijt} = \alpha + \theta_i + \eta_j + \phi_t + \beta_1 logY_{it} + \beta_2 logY_{jt} + \beta_3 K_{it} + \beta_4 \Gamma_{jt} + \lambda X'_{ijt} + loge_{ijt} \quad (1)$$

Where T_{ijt} represents the exports from country i to country j in a year t; θi, ηj, Φt, denote fixed effects by exporting country, importing country, and year, respectively; Y represents the GDP of the countries; Kj is the score that corresponds to the logistics performance of the exporting country, using the quality of its logistics services for the first estimation and the quality of its infrastructure for the second estimation; Γj denotes the logistics performance of the importing country, using the quality of its logistics services in the first estimation and the quality of its infrastructure in the second; $X'ijt$ represents a set of bilateral variables between country i and country j in a year t, including weighted physical distance (in logarithm), and dummy variables to capture whether the two countries have a common currency, language, border, whether they have a free trade agreement, whether they shared the same colonizer, and whether they are both landlocked. Finally, $eijt$ represents the idiosyncratic error of commerce. **Table I-I** in **Annex I** contains a summary of the descriptive statistics on the variables included in the model[4]. The following **Table 1.2** presents the results of the econometric exercise, both for aggregate international trade and for trade according to the sector of economic activity – either primary or secondary.

The results suggest that logistics performance has a positive and significant impact on a country's containerized exports[5]. In particular, they predict that, **if the quality of a country's logistics services improved by one unit, its exports (in US$) would increase by about 7%. A 5% increase would be achieved** in the case of a similar improvement in the **quality of its transportation infrastructure**. Benefits are even greater when exports are considered by economic sector. Exports of **manufactured goods** would increase by 18% with a one-unit improvement in the quality of logistics services, and by 12% if such an improvement were made in transportation infrastructure. This is in line with the findings presented in the study conducted by Gani (2017), which considered the trade flows of Asian countries —whose average country presents a logistics performance comparable to the average LAC country—, analyzed by Marti et al. (2014) with respect to trade in manufactured products, and by Mesquita-Moreira et al. (2008), who studied the case of Latin America and pointed out that *ad valorem* freight rates represent one of the most important challenges for the region's competitiveness. Thus, improving logistics performance in LAC would contribute to the export of higher value-added goods. Finally, improving the quality of logistics services would also benefit the importing country of manufactured products, although to a relatively lesser extent (8%).

Improving these indicators by one unit is neither trivial nor will it come immediately, but it can be achieved. Rwanda is a case in point: within ten years, it went from having a logistics services rating of 1.7 to 2.9, while its transport infrastructure quality increased from 1.5 to 2.7. This is explained by a drastic reduction and simplification of administrative control procedures related to foreign trade logistics, and by the increased investment in the infrastructure of its main corridors (the country's total investment in fixed capital formation as a percentage of GDP increased from 16.3% in 2007 to 23% in 2018 - World Bank, 2019a). Other countries that achieved similar

4. The theoretical specification of *gravity with gravitas* is considered with multilateral resistance terms and multiplicative idiosyncratic error according to Anderson & Van Wincoop (2003). The sources for the consolidation of the database are UN Comtrade, World Integrated Trade Solution (WITS), World Trade Organization (WTO), CEPII, and the World Bank.
5. The model is initially estimated by Pseudo-Poisson Maximum Likelihood which allows to approximate *gravity with gravitas* with multiplicative idiosyncratic error, making use of the full sample of countries, including those reporting zero trade between them, and so, an easy interpretation of the coefficients as simple elasticities is achieved. Given the nature of the indices it cannot be estimated in a single specification without causing collinearity problems. Aware of the endogeneity problem, the specification has been estimated in the following columns, as a robustness test, including fixed effects for each exporting-importing country pair (denoted Exp-Imp. FE) and, finally, as a dynamic panel as per Arellano-Bover/Blundell-Bond.

improvements of approximately one point in the area of logistics services were: Mauritius (1.1-point improvement), Côte d'Ivoire (0.85), Republic of Chad (0.8) and Czech Republic (0.7). The only Latin American country that has significantly improved its score in this area over the last ten years is Panama, with a 0.6 growth. Panama significantly increased its fixed capital investment as a percentage of GDP, from 28% to 38% between 2007 and 2018. In addition, the implementation in 2017 of the maritime single window (MSW) system allowed different logistical processes in the ports[6] to be automated. In terms of infrastructure quality, the improvements made by Djibouti (0.9), Egypt (0.8), Qatar (0.75), Afghanistan (0.7), and Armenia (0.7) are noteworthy.

Table 1.2 Results of the gravity model considering total containerized exports and containerized exports by economic sector

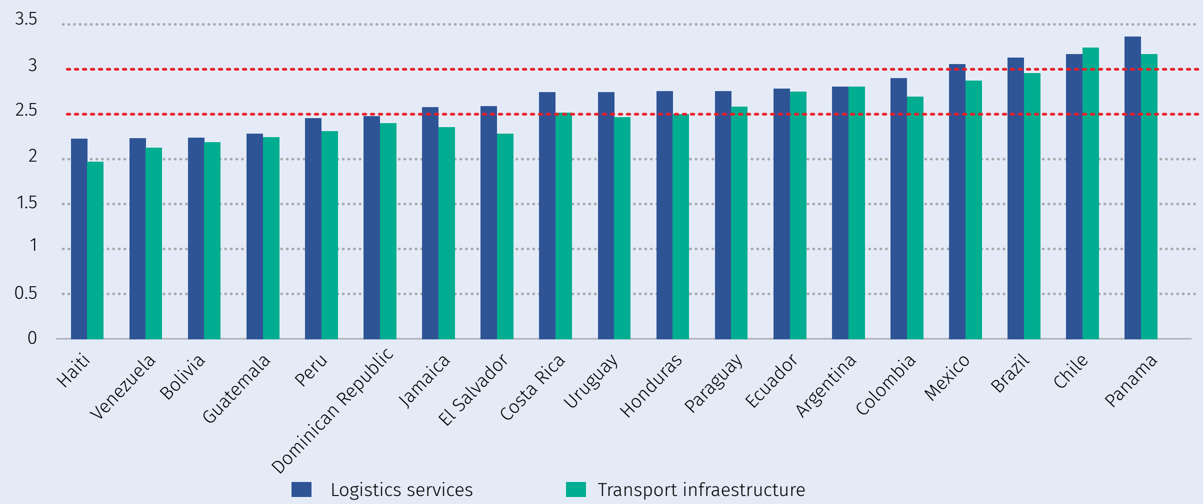
Variable	Total Trade			PPML - Economic sector	
	PPML	Exp.-Imp. FE	ABBB	Primary	Secondary
Exporter's logistic services (score)	0.089***	0.073***	0.092***	0.120***	0.180***
	(0.028)	(0.026)	(0.038)	(0.031)	(0.034)
Importer's logistics services (score)	0.027	-0.032	0.026	-0.023	0.081***
	(0.023)	(0.024)	-0.038	(0.024)	(0.023)
N	100,113	99,939	51,285	82,139	95,019
R^2	0.888	0.042	-	0.821	0.930
Exporter's infrastructure (score)	0.045*	0.053***	0.053	0.091***	0.124***
	(0.024)	(0.027)	(0.036)	(0.027)	(0.028)
Importer's infrastructure (score)	0.003	-0.000	-0.071*	-0.020	0.029
	(0.026)	(0.025)	(0.039)	(0.029)	(0.029)
N	100,113	99,939	51,285	82,139	95,019
R^2	0.887	0.042	-	0.821	0.930

Notes: All estimates include the set of controls, individual fixed effects by exporting and importing country, and year fixed effects. ABBB represents the linear dynamic panel estimation according to Arellano-Bover/Blundell-Bond. In this model, the independent variables are included in their first lag. Cluster standard errors by distance between countries are in parentheses. *** p<0.01, ** p<0.05, * p<0.1. PPML= Pseudo-Poisson Maximum Likelihood.

To analyze the results from a regional perspective, we have classified the LAC countries into three groups, according to the scores obtained in the LPI components analyzed: (i) countries with scores above 3; (ii) countries with scores between 2.5 and 3; and (iii) countries with scores below 2.5. **Figure 1.8** shows the scores obtained by the countries of this region for the components of logistics services and transportation infrastructure.

6. According to the World Bank (2020a), the MSW system in Panama (called VUMPA) eliminated manual ship declaration procedures, benefiting 20,000 ships, and has managed to save 3,260 man-hours annually thanks to the automation process.

Figure 1.8 Logistics performance in LAC countries (2018)



Source: Own elaboration using data from the World Bank.

According to the results of this model, and compared with countries at the same income level, if the quality of **logistics services** in a country like Jamaica (94th in the 2018 ranking) reached the same level as Indonesia (44th position), its exports would increase from US$ 1.60 billion (total value in 2019a) to US$ 1.64 billion, reaching 10% of the national GDP (World Bank, 2019a; UNComtrade, 2019). Likewise, if Bolivia's logistics services (139th in the 2018 ranking) were to perform closer to India's, its exports could increase by US$ 584 million, equivalent to 1.42% of its GDP in 2018 (World Bank , 2018b; UNComtrade, 2018). Regarding the improvement of **transportation infrastructure**, if a country like Guatemala (122nd in the 2018 ranking) were to reach Thailand's score (41st position), its exports would increase from US$ 11.3 billion to US$ 12 billion, an amount that would represent about 15% of its national GDP (World Bank, 2019a; UNComtrade, 2019). Finally, if Peru's transportation infrastructure (111th in the 2018 ranking) were to perform closer to Chile's (34th position), its exports could increase by US$ 2.1 billion, which is about nine times what the country invests in research and development (World Bank, 2018b; UNComtrade, 2019).

Below we analyze the impact of logistics performance on trade in manufactured goods, according to the **technological intensity** of the traded product according to the Standard International Trade Classification (SITC)[7]. The results of the model show that **the more technology-intensive the product, the greater the dependence on the quality of logistics services for both the exporting and the importing country. The same applies to the quality of infrastructure, but only on the part of the exporting country (Table 1.3)**. Note that the results on trade in manufactured goods from **Table 1.2** are consistent with the results on trade in low technology products as shown in **Table 1.3**. **In the case of highly technology-intensive products, a one-unit improvement in the quality of logistics services would increase exports of such products by 25% and imports by 17%. An increase of approximately 17% would be achieved if improvements in the quality of transportation infrastructures were made by the exporting country**.

7. This classification is based on Lall (2000), where more information is provided on the products that fall into each category.

Table 1.3 Results of the gravity model considering the trade in products of the secondary sector according to their level of technology

Variable	PPML - Technology level		
	Low	Medium	High
Exporter's logistics services (score)	0.183***	0.221***	0.245***
	(0.035)	(0.045)	(0.081)
Importer's logistics services (score)	0.100***	0.064***	0.167***
	(0.035)	(0.024)	(0.060)
N	85,087	81,193	75,289
R^2	0.922	0.925	0.933
Exporter's infrastructure (score)	0.085***	0.151***	0.170***
	(0.031)	(0.037)	(0.065)
Importer's infrastructure (score)	0.057	0.005	0.074
	(0.047)	(0.037)	(0.061)
N	85,087	81,193	75,289
R^2	0.922	0.924	0.933

Notes.: All estimates include the set of controls, individual fixed effects by exporting and importing country, and year fixed effects. The estimation method is Pseudo-Poisson Maximum Likelihood. Clustered standard errors by distance between countries are shown in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Another relevant aspect that should be analyzed is the impact of logistics services and transportation infrastructure on the **intensive** and **extensive margins** of international trade. The first one (the intensive margin) refers to the strengthening of existing trade links, i.e., on the changes of exports from one country to another in response to changes in their logistical indicators, considering already existing trade relationships. While the extensive margin focuses on stablishing new trade relationships, i.e., the probability that trade flows between pairs of countries may vary in response to changes in their logistical indicators. For this purpose, we have considered an indicator variable that takes the value of one in the case of non-zero trade, and a zero value in the case of zero trade is reported or if neither country has reported a value in their national accounts. **Table 1.4** compares the results for the year on both margins. The gravity model reports that, when **quality is improved by one point, whether that of a country's logistics services or transportation infrastructure either by the exporter or the importer, the probability of establishing a new trade relationship in manufactured goods would increase by about 2 and 8 percentage points, respectively**. For goods with a higher technological content, the improvement in logistics services increases the trade-intensive margin by one additional percentage point for both countries involved, when compared to the overall result for manufactured goods. The results of the extensive margin are consistent with those previously obtained from the elasticity analysis conducted.

Table 1.4 Results of the gravity model on the intensive and extensive margins of trade in manufactured and technology-intensive products

Variable	Secondary sector		High-tech	
	Extensive	Intensive	Extensive	Intensive
Exporter's logistics services (score)	0.022***	0.180***	0.027***	0.245***
	(0.007)	(0.034)	(0.009)	(0.081)
Importer's logistics services (score)	0.087***	0.081***	0.091***	0.167***
	(0.007)	(0.023)	(0.009)	(0.060)
N	123,457	94,829	123,457	75,057
R^2	0.328	0.930	0.386	0.933
Exporter's infrastructure (score)	0.016***	0.124***	0.017*	0.170***
	(0.007)	(0.028)	(0.009)	(0.065)
Importer's infrastructure (score)	0.082***	0.029	0.073***	0.074
	(0.007)	(0.029)	(0.009)	(0.061)
N	123,457	94,829	123,457	75,057
R^2	0.328	0.930	0.386	0.933

Notes: All estimates include the set of controls, individual fixed effects by exporting and importing country, and year fixed effects. The estimation method is Pseudo-Poisson Maximum Likelihood. Clustered standard errors by distance between countries are shown in parentheses. *** p<0.01, **p<0.05, * p<0.1.

To sum up, this analysis suggests that: (i) as a result of the improvements made by the exporting country in the quality of its logistics services and transport infrastructure, an increase in total bilateral trade flows can be expected; (ii) this relationship mainly occurs for trade in manufactured goods, a sector in which not only the logistics of the exporting country is important but also that of the importer; (iii) the quality of logistics services and infrastructure becomes more important when technology-intensive products are traded; and (iv) the logistics services and transport infrastructure of the exporting country are crucial for the intensive margin of trade, while the quality of logistics in importing countries is key for the extensive margin of trade. Thus, the relatively poor logistical performance of LAC countries today is a major barrier to greater international integration. This becomes even more important when considering the potential changes on international trade as a result of the COVID-19 pandemic (see **Box 1.2**).

Box 1.2 Supply chains in the post-COVID era: better logistics to capitalize on the benefits of nearshoring and global reconfiguration

The COVID-19 pandemic has disrupted global supply chains in a way not seen since World War II. In the first quarter of 2020, the measures put in place by China to prevent the spread of the virus, which included the closure of factories, roads and ports, quickly impacted the global sourcing of all types of goods. For example, as early as February 2020, shipping between China and California ports —a key global supply corridor— had fallen by more than a third and imports by about 45% over the same period a year earlier (WSJ, 2020). In the following weeks, industries such as the automotive, electronics and, especially, medical equipment and supplies started to experience stock-outs. The strategic, technical, and financial importance of a sound risk management strategy became clearer than ever before.

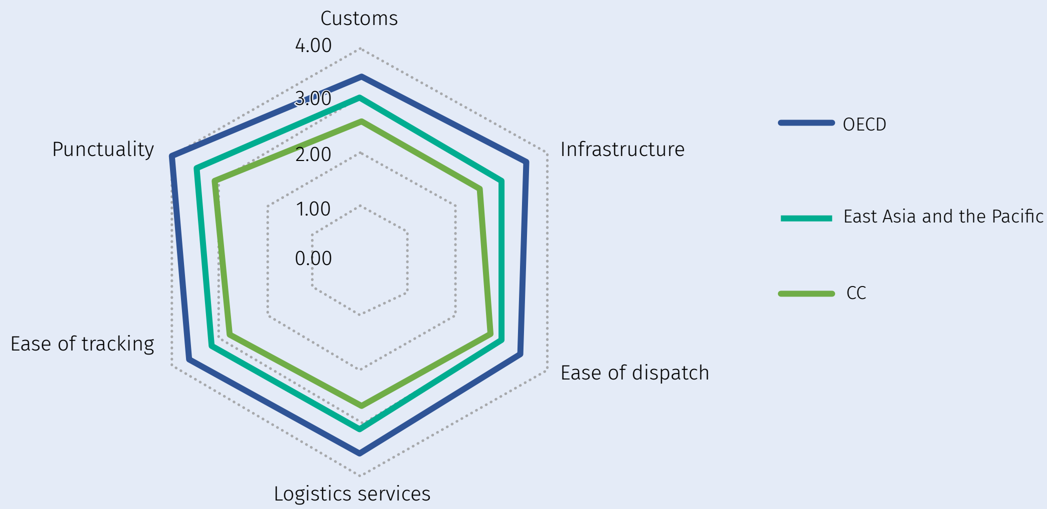
Risk management covers different factors that can affect the normal operation of a supply chain, including the timely availability of suppliers of inputs and services (Calatayud & Ketterer, 2016). In this regard, because of this pandemic, it became apparent that several industries had a higher risk of being affected due to the high number of suppliers located in China. Therefore, in the post-pandemic era, issues such as geographic diversification and the reduction of distances between suppliers and buyers —also known as *nearshoring*—, are gaining relevance among global companies seeking a supply chain reconfiguration. 40% of the leaders of these companies are planning actions that involve nearshoring and supplier base expansion to increase the resilience of their supply chains (McKinsey, 2020). This potential change could amount to as much as 20% of the value of auto parts and 45% of the value of textiles currently exported by China (McKinsey, 2020).

This is where, paradoxically, the pandemic presents a great opportunity for the countries located in Central America and the Caribbean (CC). Because of their proximity to the United States, the existing free trade agreements and their experience in exporting textiles, pharmaceuticals, electronics, food, and auto parts to the United States, this region could benefit from the need to diversify suppliers and shorten U.S.-based supply chains. In particular, the opportunity for CC lies in increasing exports of higher value-added goods, which, because of their economic complexity, contribute more to the region's economic growth (Hausmann et al., 2013).

However, in order to take advantage of this unique opportunity for economic recovery and job creation in the post-COVID-19 era, CC countries must radically improve their logistics infrastructure and services, where they consistently score below all regions, with the exception of Sub-Saharan Africa (**Figure 1.9**).

Box 1.2 Supply chains in the post-COVID era: better logistics to capitalize on the benefits of nearshoring and global reconfiguration

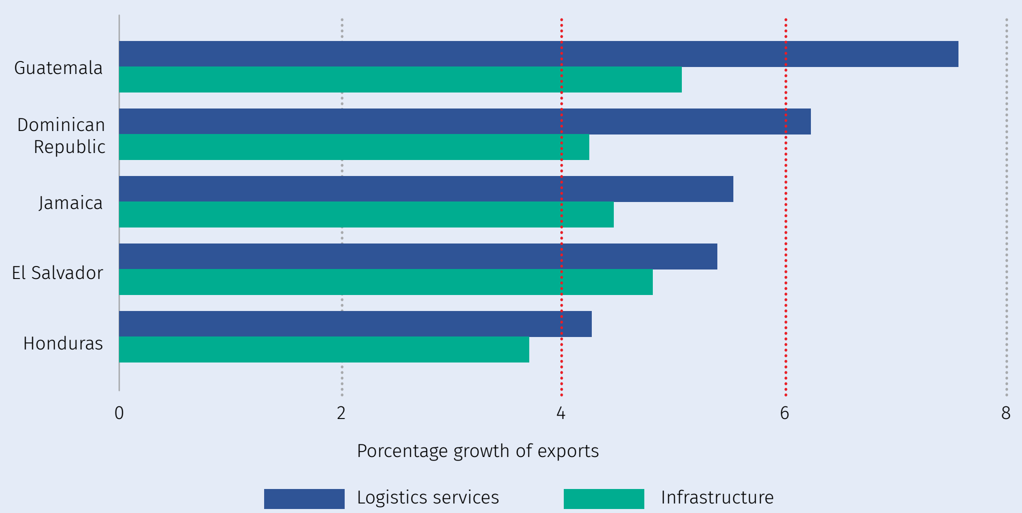
Figure 1.9 Logistics Performance Index for CC vs. other regions



Source: Own elaboration using data from the World Bank.

What benefits would logistics improvements bring? According to the results obtained from the gravity model in section 1.3, if CC countries were to reach the levels of Chile —the best performer in Latin America—, their exports would increase between 4% and 8%, by an average value equivalent to 1.5% of the GDP, which is proportional to 30% of the average investment in education in the subregion (**Figure 1.10**). This is in addition to the benefits in terms of domestic trade, which would also be facilitated by improved logistics performance.

Figure 1.10 Percentage growth of exports associated with a trade logistics big push



Source: Own elaboration.

Conclusions

Logistics is a fundamental component of supply chains, as it enables the necessary inputs and goods to be available at the right time and in the right place. Logistics is also a factor of economic competitiveness and an enabler of regional integration. In this context, it is important to note that on average, the logistics performance of LAC is low when compared to advanced economies and those with a similar level of development. As evidenced by the results of the gravity model, improving the provision and quality of logistics infrastructure and services, as well as the regulatory framework, will be key to fostering greater development of the region's economies. In the following chapters, we will analyze the factors that contribute to the low performance level of these components; we will divide the analysis by mode of transportation (by road, rail, sea, and air) and we will also explore the challenges in terms of urban logistics, trade facilitation, technological modernization, and decarbonization. Based on this analysis, in the last chapter of this publication we will create a road map for the design of public policies that will lead to improved logistics performance in LAC.

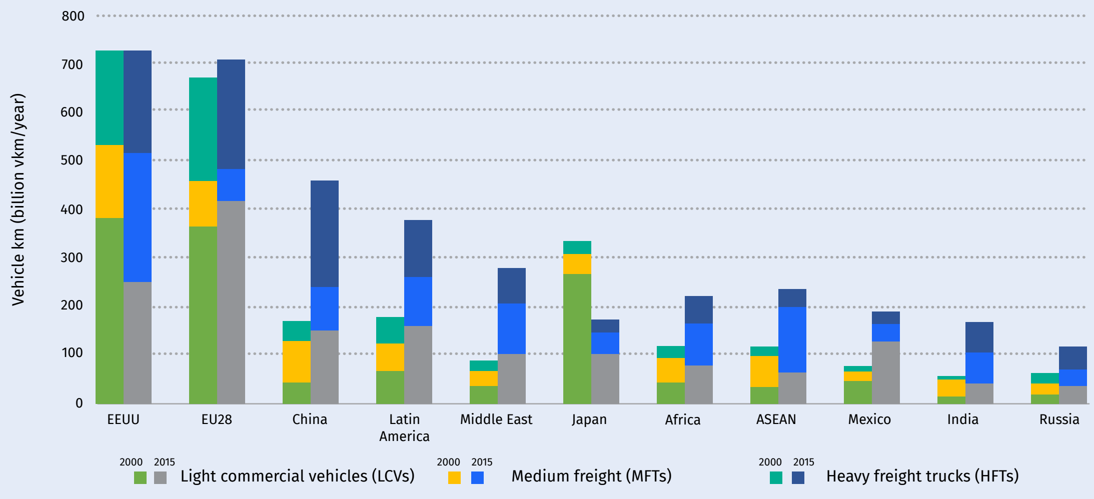
CHAPTER 2

THE CHALLENGES OF ROAD FREIGHT TRANSPORTATION (RFT)

2.1 Sector description

Over the past 15 years, economic growth has been accompanied by a **significant increase in global road freight transportation** (RFT) activity. **Figure 2.1** provides an overview of the resulting vehicle-kilometers traveled in the main regions according to vehicle type (Light Commercial Vehicles [LCV], Medium Freight Trucks [MFT] and Heavy Freight Trucks [HFT]). The United States and the European Union were the two regions with the highest road freight vehicle activity, while China and LAC (including Mexico) experienced the highest growth (IEA, 2017).

Figure 2.1 Trends in vehicle-kilometers traveled by region (2010-2015)



Source: IEA (2017).

LAC's logistics matrix is characterized by **the predominance of road freight transportation**. More than 85% of domestic freight movement (by weight) in the region is by road (IDB, 2020a). This mode is used for 30% of intra-regional trade in South America (2 million tons, 40% of the value) while in Central America, it is the preferred mode for virtually all freight movements (30% of exports) (Barbero et al., 2020; ECLAC, 2019). The importance of this sector for regional economies is also evidenced by its share of GDP. On average, this sector accounted for 5.7% of the region's GDP in 2016 (Barbero et al., 2020). In addition, RFT generates a significant share of jobs[8]. In Mexico, for instance, this sector employed more than 1.1 million people in 2017, which accounts for more than 50% of the total transportation sector employment and nearly 2% of total employment nationwide (INEGI, 2019).

Business organization in this sector has a pyramidal structure, where numerous micro and small operators coexist with a more limited number of large companies. In most LAC countries, micro[9], small and medium-sized (MSMEs) freight transportation companies account for around 99% of the total number of companies in the sector (see **Table 2.1**). These firms are generally characterized by limited operational and financial capabilities, limited professional development and low levels of business training and productivity. On the other hand, the small group of large companies, including local and international operators, tend to show performance levels similar to those of advanced countries. Although most RFT companies and freight shippers are independent of their suppliers of goods and services, it is important to highlight the growing role of in-house transportation, which is estimated to represent up to one third of total RFT activity (Barbero et al., 2020). It should also be noted that some of these companies have also expanded their scope of work and have evolved into logistics operators.

Table 2.1 Indicators of micro, small and medium enterprises (MSMEs) in selected countries

Indicator	México*[10]	Costa Rica**	Peru***	Colombia****
Number of MSMEs	179,885	8,632	128,887	5,393
% of MSMEs in all companies	99.4%	97.2%	99.5%	99.3%

Source: * Mexican Goverment (2019); ** MEIC (2019); *** Ministry of Production (2018); **** Economía Aplicada (2019).

2.2 Performance of RFT services

RFT-related services play a fundamental role in LAC economies, as they provide local, regional, and international connectivity to value chains, performing long-haul movements at national and international level, and are also involved in the urban distribution of goods. The **efficiency and quality** of these services have been identified as determining factors to improve the competitiveness of local and international trade. According to Barbero et al. (2020), the average number of kilometers a truck travels in a year can be used as a proxy for analyzing the productivity of this mode of transportation. In LAC, that number is 40% lower than in the United States and the European Union (about 62,000 km per year on average in LAC, compared to more than 110,000 km in France and the United States) (IDB, 2020a). Although these numbers should be analyzed with caution, as they do not take into account the heterogeneity of RFT services (long distance vs. last mile), the different segments of activity they serve (general cargo vs. containers), and the different sizes of the countries (Caribbean islands vs. non-island countries), the gap in the average productivity of LAC's transport units cannot be ignored.

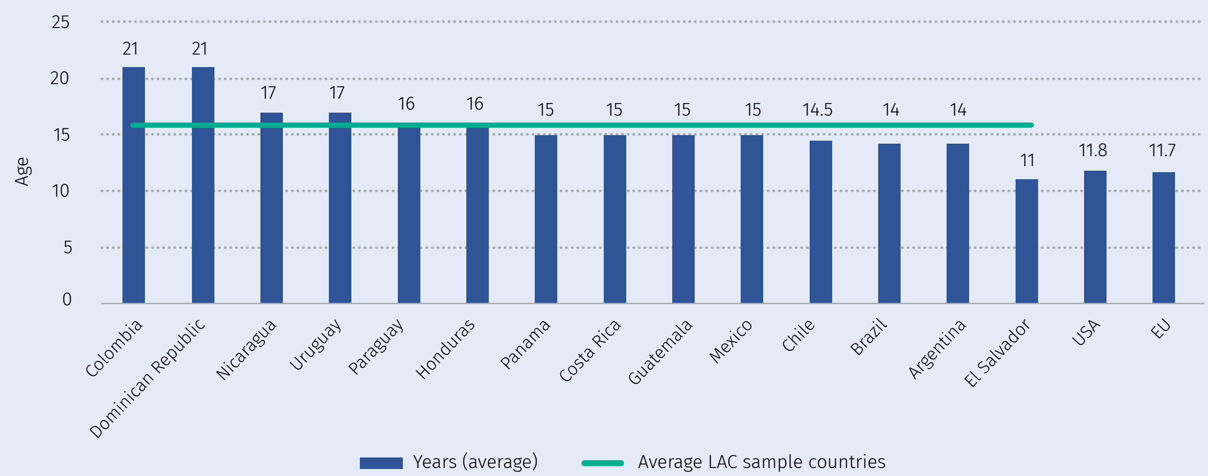
In addition to the distance traveled, other key performance indicators are related to vehicle load factors. In the region, load factors are usually under 60% and, on average, empty hauling makes up around 40% of total vehicle-km. By contrast, in Europe the average is 25% and around 20%-25% in North America. In addition, capacity

8. In Colombia, Costa Rica, Argentina, Trinidad and Tobago and Peru 7.3%, 5.1%, 7.4%, 6.3%, 8.6% of the population work in the Transportation and Warehousing sector, respectively (Central Bank of Trinidad and Tobago, 2020; DANE, 2020; Government of Argentina, 2020; The National Institute of Statistics and Census (INEC, in its Spanish Acronym), 2020; Peru's National Institute of Statistics and Informatics (INEI, in its Spanish Acronym) 2018).
9. In the LAC context, a dominant type of microenterprises are individual operators with a fleet of 1 to 5 trucks which they operate and commercially exploit on their own. They are also known as one-man firms, self-employed, single haulers, or truck men (hombres-camion, trucks operated by their owner) (Barbero & Guerrero, 2017). In 2019, these companies accounted for 82% of the companies in the sector in Mexico.
10. It includes the truck-man classification, with a fleet of one to five trucks (147,966 companies) (Mexican Government, 2019).

utilization in LAC is estimated at about 50% to 60%, strongly affected by the spatial distribution of demand (Barbero et al., 2020).

Another dimension of RFT performance is linked to the quality of services. According to the results of the Logistics Performance Index, LAC has obtained a score of 2.59 out of 5 for the logistics competence indicator, which includes the quality of RFT services. Such a low quality is influenced by factors related to the assets and infrastructure needed for the provision of services. For example, the **average age of the fleet** in the region is 15 years (ranging from 10 to 23 years), while in countries such as Colombia and the Dominican Republic the average age is 21 years (e.g., compared to 11.7 years in the European Union). Not only does this negatively affect the environment due to the environmental impact[11] associated with less efficient vehicles (see Chapter 10), but it also affects sector productivity and road safety. For example, trucks are involved in 20% of road accidents in Brazil, while in Peru one out of three accidents involve trucks (IDB, 2020b). Another fact to consider is that the longer vehicles are owned, the longer it will take for a new vehicle technology to penetrate the market in a meaningful way.

Figure 2.2 Average age of the road freight transportation fleet



Source: El Salvador, Panama, Costa Rica, Guatemala, Paraguay, Honduras, Nicaragua, Colombia, Dominican Republic (Barbero & Guerrero, 2017). Argentina, Brazil, Chile, Mexico, Uruguay and the EU (Barbero et al., 2020).

Service reliability is another critical dimension in this region. Although rigorous measurements of reliability-related aspects are scarce, some countries are beginning to take these issues into consideration when it comes to their data collection instruments. For example, according to the National Logistics Surveys conducted in Colombia in 2018 and in Bolivia in 2019, the Perfect Order Index, —which measures the percentage of orders delivered on time, completed orders, orders received without damage free and,orders with accurate documentation—, was 75% and 62%, respectively, which is lower than the average for developed economies, which have a Perfect Order Index of 90% (Barbero et al., 2020).

From the point of view of international services, it is important to emphasize that there are still **institutional and regulatory challenges** that affect travel times and costs. Some of the main concerns are the level of institutional transparency and the great number of processes and documents requested by public agencies for logistics opera-

11. Indeed, road freight transportation vehicles have the highest energy demand, particularly from fossil fuels (LAC is responsible for 12% of global CO_2 emissions from fossil fuels), and they are one of the major causes of the deterioration of air quality in urban areas (Barbero et al., 2020).

tions, aggravated by a limited inter-institutional coordination between all the agencies involved (Doing Bussines, 2018). According to the latest available data, informal payments and delinquency were cited by 25% and 7% of logistics professionals, respectively, as a constraint to on-time delivery of goods (Arvis et al., 2018).

At national level, in recent decades there has been a renewed interest in developing a **technical regulation** for this sector, especially regarding environmental and road safety issues. This was reflected in numerous rules on the requirements to be met by vehicles, drivers, and operating practices. **Annex II** compiles the existing regulations in eight LAC countries regarding technical and economic aspects. Consistent with international experience, economic regulation is scarce. In fact, most countries have aimed at economic deregulation, with low barriers to entry and exit in the sector, in order to encourage market competition. Among the main regulatory challenges that this sector must face in the near future are updating the technical regulations to modernize and decarbonize RFT and strengthening regulatory compliance through effective controls.

The low **integration of clean technologies** in the provision of services represents an opportunity to improve the quality of services and their efficiency. For instance, according to ITF (2019b), the introduction of low or zero carbon dioxide emissions in long distance road freight transportation could reduce emissions by 16% by 2050[12]. In addition, the use of technologies such as IoT and digitalization can contribute to improving the operational efficiency of RFT (see Chapter 8); for example, sensors placed in trucks can provide information to the fleet manager and customers on indicators such as fuel consumption, speed, location, and potential faults that require preventive maintenance of the vehicle. Similarly, the use of wireless connections combined with *Adaptive Cruise Control* to form a platoon of trucks that dynamically adjust their speed and distance together, leads to greater coordination and efficiency in truck driving, with annual fuel savings of between 10% and 30%. It has also been estimated that the use of the *Advanced Emergency Braking System* (AEBS) could reduce the number of accidents involving trucks by up to 80% (Calatayud & Katz, 2019).

12. The IDB has participated in projects promoting clean technologies. For example, contributing to the pilot development of a hydrogen ecosystem favorable to the decarbonization of the freight and long-distance transportation sector in Paraguay. The project consists in the installation of a hydrogen production plant to supply a fleet of up to 10 heavy vehicles, including intercity buses and freight trucks on high-frequency routes with a central hub in Montevideo.

Box 2.1 The impact of COVID-19 on road freight transportation

The RFT industry has been one of the most affected sectors by the COVID-19 pandemic. Estimates made by IRU (2020) concluded that, worldwide, these services experienced an 18% decline in turnover, with South America (analysis carried out for Argentina, Brazil, and Colombia) being one of the most impacted regions, facing a 20% decline (estimated at €29 billion ~ US$ 35.2 billion) in turnover.

Demand for transportation services has been affected in two dimensions. On the one hand, mobility restrictions affected productive capacity in urban centers and generated bottlenecks in the logistics systems at border crossings. On the other hand, changes in consumer behavior (sudden increase in demand for essential products and in online purchases) put greater pressure on transportation services. This led to a slowdown in freight transportation operations. As a result, transport operators face serious short-term financial problems, such as lack of liquidity and falling revenues. In addition, there are other operational challenges such as the implementation and monitoring of compliance with health protocols, sick leaves and the difficult working conditions faced by drivers (health controls, long waiting times at borders, lack of available rest areas, etc.).

To avoid disruptions to the transportation of essential goods, governments around the world have implemented measures to facilitate the movement of goods, such as the relaxation of rules governing driving and rest times, and regional trade agreements, among others. According to IRU (2020), among the measures that have been considered successful are exemptions to the rules governing driving and rest times, the extension of driving licenses and certificates, and the facilitation of the transportation of goods where it was interrupted. Unsuccessful measures include restrictions on land border crossings around the world, which led to logistics disruptions and delays in the delivery of goods, mandatory truck convoys, and insufficient implementation of green lanes for essential goods and foodstuffs.

The economic crisis and the slow recovery of domestic and international trade make financial and operational forecasting difficult for this sector. For example, in Mexico, Argentina, Brazil and Colombia there have been significant reductions in imports and exports of 5%-10%, 3%-8%, 6%-10%, and 2%, respectively. Likewise, a reduction of between 20% and 33% in the sector's turnover during the taxable year is also expected (IRU, 2020). In this context, the main challenge in the coming months for the road transportation industry is to be operationally and financially ready to support the economic recovery ensuring full logistics capacity.

2.3 RFT Informality

RFT in LAC is characterized by a **high prevalence of informality**[13], which has been estimated to affect between 20% and 40% of operations (Barbero et al., 2020). In many parts of the world, and in particular in emerging economies, the road transportation market is dominated by informal transportation operators that emerged as a consequence of deregulation processes which lacked sufficient support measures to encourage the professional development of the sector (World Bank & IRU, 2019). According to Barbero & Guerrero (2017), micro-enterprises in LAC tend to operate under informal schemes, characterized by obsolete vehicles and low levels of professionalism. These authors also point out that informality does not stem exclusively from transportation operators, but also from freight shippers and, consequently, informality levels in LAC economies are high.

Given the difficulty of measuring the different levels of informality properly, few rigorous estimates that quantify this problem in a standardized manner are available. However, it should be noted opportunities for informal transportation can be found in **different links of the chain**. Qualitative analyses conducted in Uruguay for the country's main agro-industrial chains suggest that informality (understood as tax evasion) can potentially occur in the initial and intermediate stages of the chain. In the case of the meat chain, for instance, the likelihood of experiencing higher rates of informality has been identified during the transfer of livestock between farms, while in the case of the forestry, dairy and grain chains, the probability of informality is greater during domestic market transactions (IDB, 2021). According to World Bank & IRU (2019) informal players distort the market, generating unfair competition with formal operators, resulting in cost and tariff distortions (World Bank & IRU, 2019). This informality also reduces revenues for the sector and tax authorities, increases road safety risks, reduces service quality, and entails a lack of social protection for workers.

Under this scenario, there is a clear need to carry out reforms with the aim of reducing or eliminating informality in the provision of RFT services, thus improving the quality of RFT services. However, considering the high percentage of operators that are financially dependent on the informal provision of freight transportation services, reforms to reduce informality must be balanced and gradual against the negative social effects that they may generate. Thus, the objectives of such reforms should focus on promoting a more formal and professional sector to make it reliable, sustainable, and profitable for the economy, fostering a sense of progress rather than exclusion. For example, the development of fleet renewal programs exclusive to formal operators should be accompanied by tax incentives to encourage informal carriers to formalize their operations by starting carriers' cooperatives or associations. Thus, the creation of formal sector enterprises is encouraged, and the informal sector is weakened (World Bank & IRU, 2019).

13. There are different levels of informality, as it can refer to: (i) carriers that operate without any formal contract; (ii) operators that evade the payment of taxes and other social charges; (iii) individual operators that are not registered as commercial entities and do not have accounting records.

Box 2.2 Estimating the the size, composition, and informality potential in the RFT

Studies conducted by the IDB (2021) have analyzed the size of the RFT market in Uruguay and the incidence of informality in it from the perspective of evasion of tax and social security contributions (SSC). The study sizes the market by analyzing the information on the supply of transport services and demand. On the supply side, it is based on data from the technical market regulator and information from the National Accounts and Household Survey. The demand side analyzes the main agro-industrial chains responsible for 2/3 of road flows (forestry, agricultural, dairy and meat) and general loads. The simultaneous approach from supply and demand allows a very reasonable degree of certainty about the estimates made. At the same time, hypotheses were established about the business strategies of the different groups that compose the supply (micro to large carriers) and the demand (agro-industrial chains), which were then verified in in-depth surveys. Additionally, the gap between the tax and social security contributions that should have been made was estimated, considering the size of the market and those made as reported by the General Tax Directorate (GTD) and the Social Security Bank (BPS)[14].

The work shows that the RFT market works competitively, verifying the low barriers to entry and exit, atomizing at least part of the supply. In parallel, it is demonstrated that medium and large RFT companies have similar profitability to the medium profitability of the economy as a whole if they are considered companies of similar size. The latter is consistent with a market that operates competitively. The results also indicate that informality in the sector is significantly higher than in the economy's average. However, it is limited to certain very particular flows since most transport is linked to productive chains where evasion is not possible due to the levels of control. There are no business incentives to incur in such practices.

The overall results estimate that the probability of informality decreases as the size of the company increases (see **Table 2.2**). For example, an individual who works in a company with more than 20 employees is 14 percentage points less likely to be informal, compared to if they worked in a company with 2-4 employees, and almost 35 percentage points less than if they worked in a company with 1 employee. Additionally, the probability of informality is higher for workers with incomplete primary or primary education than workers with higher education (secondary, technical, and tertiary education). Similarly, the data suggest that, as the income level from work increases, the lower the probability of informality. Based on these results, the authors conclude that informality is associated with lower productivity jobs and lower profitability firms.

Table 2.2 Potential evasion of taxes and social security contributions by companies in the inter-regional and international road freight transportation sector - Millions of US$

Company size segments according to the number of employees	IRAE and IRPF dividends	VAT	SSC	Total
Less than 4	49.4	35.9	4.3	89.6
5 to 9	5.8	4.3	0.9	11.0
10 to 19	3.4	2.5	0.3	6.2
20 to 99	6.7	4.8	0.2	11.7
100 or more	1.6	1.1	0	2.7
Total	**66.9**	**48.6**	**5.7**	**121.1**

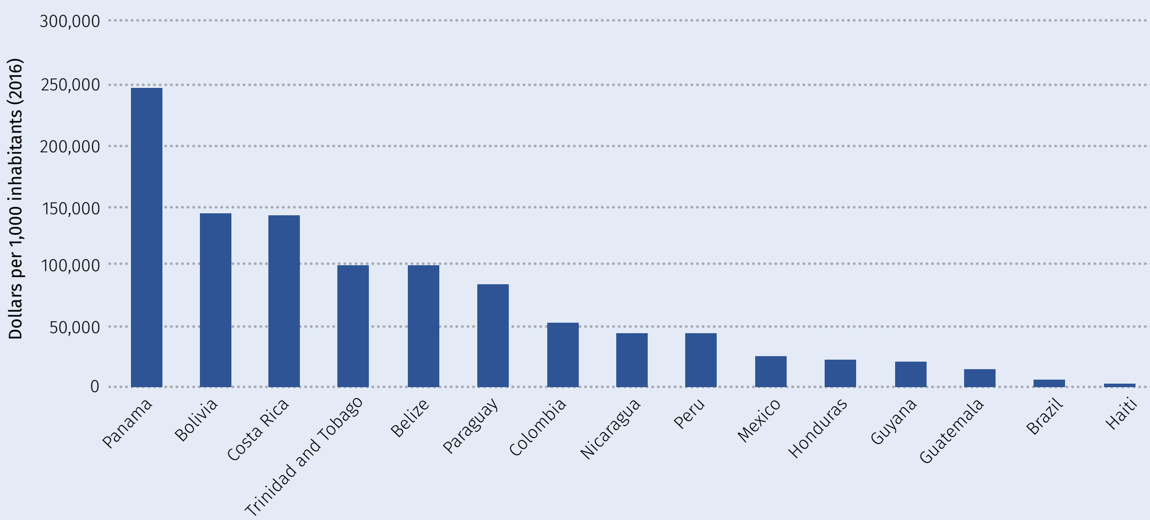
Source: IDB (2021).

14. BPS is the independent agent responsible of coordinating governmental social assistance in Uruguay. For further details on the methodology used and the results, please visit (IDB, 2021).

2.4 The challenges of road transportation infrastructure

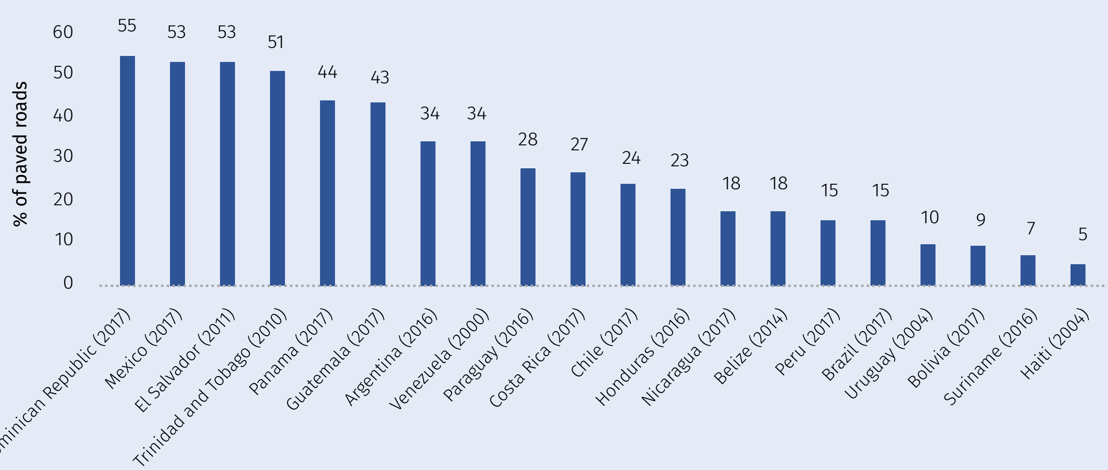
Investment in road infrastructure has not kept pace with the growth of road freight transportation activities (**Figure 2.3**), which has had a negative impact on the provision of transportation services, such as longer travel times and higher travel costs. Available data show that road networks have **low coverage, quality, capacity, and connectivity**, not only in rural roads but also in interurban and urban roads. Only 23% of the roads in the region are paved (**Figure 2.4**), while in other parts of the world the percentage of paved roads is between 60% and 80% (except Sub-Saharan Africa, with 14.5%) (IDB, 2020b). However, great differences have been found within the LAC region: while countries such as Mexico have about half of their road network paved, other countries such as Peru —which has a similar territorial extension—, have less than 20% of roads paved (IRF, 2019). In addition, road maintenance in the region is far from satisfactory. In fact, a significant part of the main road network is in poor condition (**Figure 2.5**).

Figure 2.3 US$ invested in the transportation sector per 1,000 inhabitants - public investment (2016)



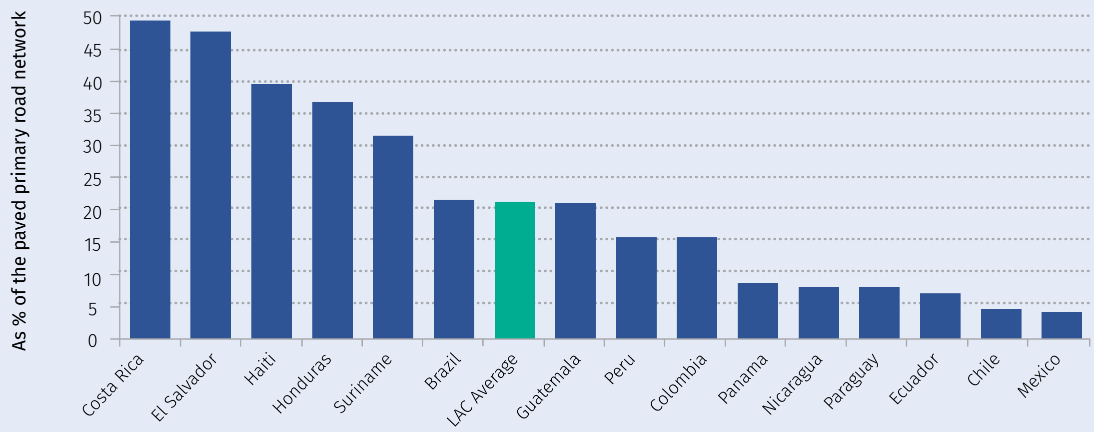
Source: Infralatam (2017).

Figure 2.4 Percentage of paved roads



Source: IRF (2019).

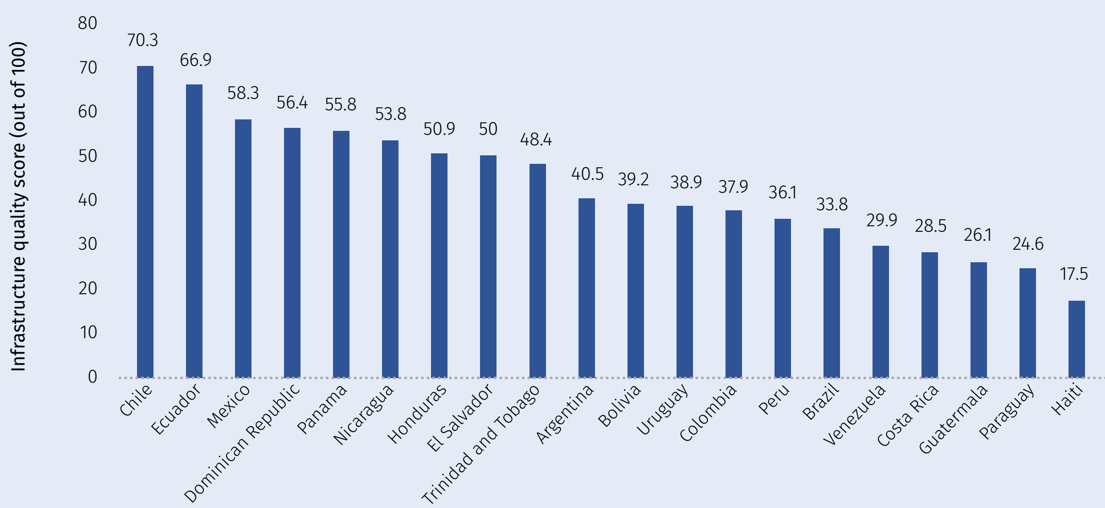
Figure 2.5 Paved primary road network in poor condition



Source: IDB (2020a).

The low quality of road infrastructure is also reflected in international indicators based on user perception. For example, the region obtained an average score of 43.1/100 on the road quality indicator in the 2018 World Economic Forum's Competitiveness Index, while Eastern Europe and Southeast Asia, scored over 60 points (WEF, 2018). Likewise, a high level of heterogeneity can be observed between the different countries in the region: while Chile and Ecuador ranked higher than the LAC average at regional level, Costa Rica, Guatemala, Paraguay, and Haiti are lagging behind in terms of quality (**Figure 2.6**).

Figure 2.6 Road infrastructure quality score



Source: FEM (2018).

In addition, multimodal and intermodal transportation is limited in the region, which also affects logistics performance. According to Barbero et al. (2020), intermodal transportation is more developed in Mexico than in other LAC countries, accounting for between 7% and 8% of the total road freight in 2010. In Colombia, however, the Ministry of Transportation (2018) has estimated that only 1.5% of the cargo is transported using a multimodal transportation system, while in the United States domestic multimodal transportation is used to transport 2% of total tons (12% in value) (FHWA, 2016).

The impact of **climate change** on road infrastructure is another major challenge in the region. In general, LAC countries are at high risk from climate change impacts due to their high levels of exposure and vulnerability to natural hazards. In fact, the World Risk Index shows that more than 60% of the countries in the region have a medium, high or very high level of disaster risk (ECLAC, 2018). In the specific case of road infrastructure, extreme weather events can cause total or partial restrictions to the flow of goods, resulting in substantial economic losses. For example, as a result of the Tropical Storm Eta & Hurricane Iota in November 2020, 617 roads were damaged or destroyed in Guatemala and 746 in Honduras. Nicaragua estimated economic losses and damage to transportation infrastructure equivalent to US$ 361 million (OCHOA, 2020).

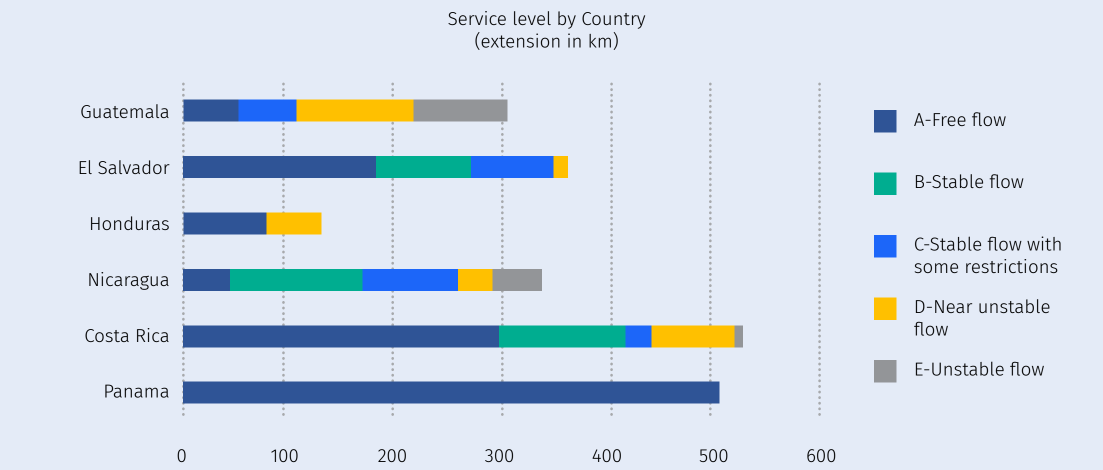
Box 2.3 The Pacific Corridor Geo-Data, a platform for infrastructure monitoring along 2,140 kilometers between Guatemala and Panama

Nowadays, technology plays an important role in investment planning processes. With this in mind, the Inter-American Development Bank (IDB) proposes using the visualization tool known as the "Geo-Data Pacific Corridor", which integrates key indicators to measure the performance of the Mesoamerican Integration Corridor. This corridor passes through six Central American countries and Mexico, along 3,240 connected kilometers, with an average daily traffic flow of 9,000 vehicles. This route plays a key role for goods traded in the region which are transported by road. In addition, it is the shortest route between the Tecun Uman border crossing in Guatemala and the entrance to the Panama Canal, so its optimization and monitoring represents an important opportunity to increase the region's economic and physical integration.

Geodata is based on the Operational Study for the Pacific Corridor conducted between 2017 and 2020 and contains a comprehensive diagnosis of the condition of the physical infrastructure of the corridor's road network. A significant percentage of the road sections that make up this corridor show low levels of service (Categories D and E in **Figure 2.7**). These levels of service are calculated based on traffic flow conditions, where category "E" indicates that the density of traffic flow is high but stable, and category "F" shows that traffic volumes are close to the maximum capacity of that section, which results in a lower traffic speed (Mozo Sánchez, 2012). Based on current and desirable levels of service, Geodata can estimate the number and level of interventions required to bring the Corridor to a fully functional level. Currently, the road interventions required have been estimated at about US$ 1,086 million. This investment would generate net economic benefits of at least US$ 2,325 million and create at least 43,000 direct and indirect jobs. It has also been projected that, thanks to this investment, around 65,000 fatalities could be avoided within a period of 20 years.

Box 2.3 The Pacific Corridor Geo-Data, a platform for infrastructure monitoring along 2,140 kilometers between Guatemala and Panama.

Figure 2.7 Service level by country (extension in km)



Source: Rodas et al. (2019)
Note: The Level of Service of a road is defined as the quality of service offered by this road to its users, which is reflected in the degree of satisfaction or dissatisfaction they experience when using the road. The percentage reduction in the average speed of vehicles traveling on the road, in accordance with the ideal speed for the section under study, is considered as one of the measures of effectiveness that reflect this quality of service (INVIAS (National Roads Institute), 2020).

Conclusions

This chapter describes the main challenges of road transportation from two perspectives: (i) RFT services, and (ii) road infrastructure. Both aspects are interconnected, and international evidence has shown that in order to improve the sector's efficiency they must be addressed in a holistic manner. In the past few decades, investments in the sector have focused on physical infrastructure, while the soft component of services has been the forgotten side of infrastructure, as described in IDB (2020a). Indeed, from this perspective of services, LAC is characterized by a low load factor and utilization rate —distance traveled— of the transportation fleet, two factors that reduce the productivity of this sector. In addition, the structure of the supply of RFT services is segmented and atomized, presenting limited operational and financial capacities and high levels of informality. This, combined with the high average age of the fleet, generates losses in terms of operational and energy efficiency, also affecting the quality (including emissions generation) and the cost structure and fares of the services. From the point of view of road infrastructure, there are still challenges to overcome with regard to the capacity, coverage, connectivity and quality of the road network (primary, secondary and tertiary roads), as mixed results have been obtained for the countries in the region. These problems in the road network have a negative impact on connectivity between productive zones, consumption centers and foreign trade nodes, and in general affect the access of LAC countries to international markets. In this regard, the effects of climate change add an additional challenge for the infrastructure dimension. The increased severity and frequency of extreme weather events (i.e., hurricanes) have caused significant damage and losses in critical transportation infrastructure, and as a result, greater investment is needed in climate resilience, adaptation of infrastructure and mitigation of the effects of climate change.

CHAPTER 3

THE CHALLENGES OF RAIL FREIGHT TRANSPORTATION

The search for a more environmentally friendly freight transport modal matrix involves fully developing the potential of modes of transportation such as rail and water transportation, which generate significantly lower emissions per ton than RFT. Several countries in the region have included railroads among the pillars of their National Logistics Policies, recognizing the need to strengthen this mode of transportation. In this chapter we present the main challenges that such policy actions should address to encourage a modal shift.

3.1 Description of railways in the cargo matrix of the region[15]

The development of rail freight transportation has been a constant item on the agenda to improve LAC's logistics performance. For countries where a rail network already exists, the priorities revolve around enhancing its use and promoting the diversion of traffic from road transportation, while in countries that do not have a rail freight system in place, the focus is on developing studies to assess the technical and economic feasibility of implementing one. Some pre-feasibility studies are currently under development, such as for the Limonense Electric Freight Train in Costa Rica, the Guatemalan Segment of the Central American Rail Connection, the Pacific Train in Central America, and variants of the Central Bioceanic Corridor[16].

However, the share of railways in the region's cargo matrix is still very limited. On the one hand, the rail network for freight transportation is one of the least extensive networks in the world and is concentrated only in a few countries. This mode of transportation is mainly used in Brazil and Mexico. Although Argentina is the country with the second largest rail network, fewer tons are moved there than in Chile, whose network is less than one-sixth the size of the Argentinian railway system. On the other hand, the two main types of transported cargo are: i) mining-related cargo (iron ore and coal), which represents 62% of rail traffic, and ii) general cargo[17], which represents the remaining 38%. According to Aritua (2019), railroads in emerging economies such as those in LAC depend, to a greater extent, on traffic volumes captured from low-value minerals, while North American railroads have evolved towards high-value, intermodal and more complex logistics.

15. This chapter is based on the results of the study: 25 years of rail freight concessions in Latin America: What went well? What went wrong? (Kohon, 2021). For a more detailed analysis of rail freight transportation in LAC, we recommend reading said publication.
16. For a comprehensive review of the main rail corridors in South America, see United Nations of South America (as per its Spanish accronym UNASUR) / South American Council for Infrastructure and Planning (as per its Spanish accronym COSIPLAN) (2017).
17. Depending on the country, this category includes more traditional rail traffic (soybeans, grains, sugar, fuels, construction materials), containers and industrial products.

Table 3.1 Rail network data by country in 2018

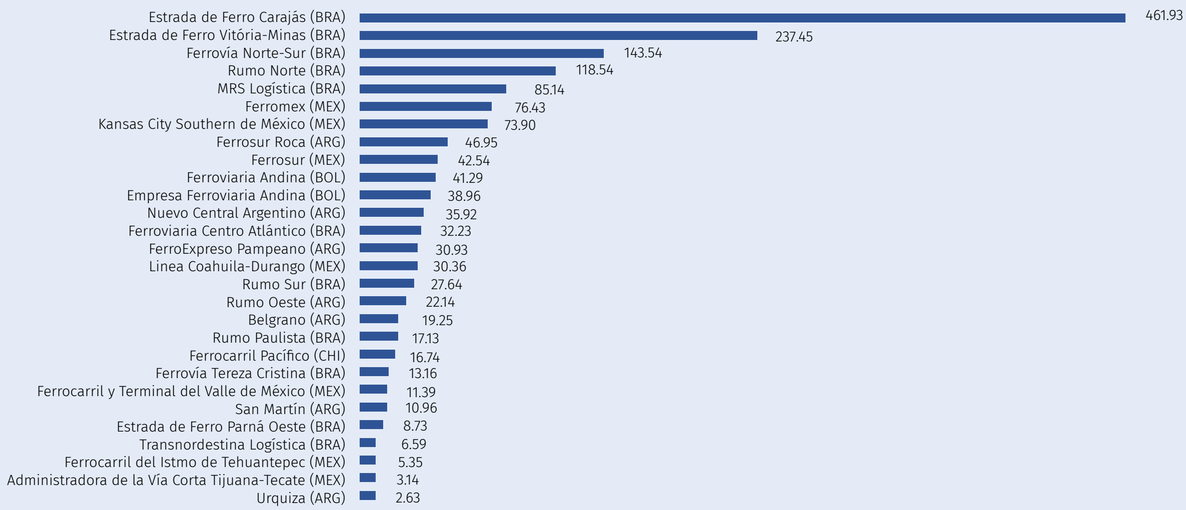
Country	Network length [Km] / GPD per capita [$US]	Cargo carried [Tons] / GPD per capita [$US]
Bolivia	0.48	4,636,117.91
Argentina	2.77	6,801,486.60
Chile	0.27	96,053,612.19
Colombia	0.18	264,552,104.16
Mexico	2.62	47,762,911.50
Brazil	2.75	196,056,314.10
Germany	0.86	295,095,515.85
Canada	0.93	335,326,946.50
India	30.21	33,434,511.69
Russia	7.12	168,582,905.26
China	12.11	264,145,056
United States	3.95	506,119,791.57

Source: Own elaboration.

At the regional level, there are **strong disparities in the efficiency** of freight railroads depending on the type of traffic analyzed. Estimates made by Kohon (2021) for the 30 main freight railways in LAC concluded that Brazilian railroads associated with the transportation of minerals to be exported are the most efficient. This is influenced by the characteristics of these systems —a single origin and destination, the same type of product and the degree of vertical integration in the mining chain—, as well as by the railroad management model, which is explained in the following section. Taking as an example the productivity of locomotives, measured in terms of ton-kilometers per locomotive, the available data show that the productivity of the Carajas[18] railroad is approximately ten times higher than the average for LAC, while the productivity of its railcars is about six times higher. This is consistent with previous quantitative analyses which used Data Envelopment Analysis (DEA) in Brazil, and whose findings showed that the most efficient companies in Brazil are those which are linked to Vale, one of the largest mining companies in the world that transports its own cargo, exploiting economies of scale by moving a large amount of cargo (Caldas et al., 2013).

18. This railroad connects the world's largest open-pit iron mine in Para with the Port of Ponta da Madeira in Sao Luis, Brazil.

Figure 3.1 Benchmarking of locomotive productivity for 2016 (in million ton-km per locomotive)

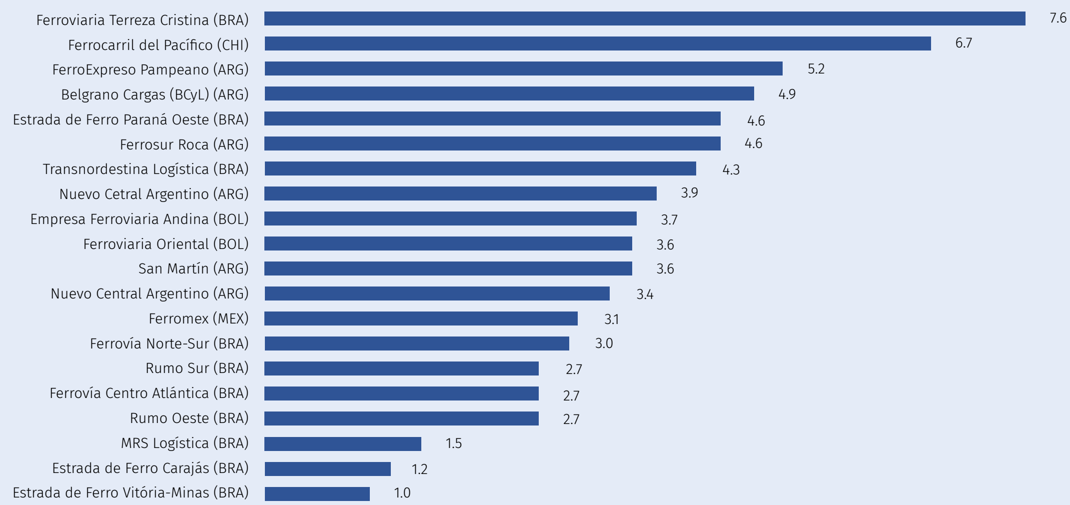


Source: Kohon (2021).

In addition to differences in asset utilization (locomotives and cars), labor productivity and fuel use also affect overall efficiency levels. For example, labor productivity, understood as average ton-km generated per person working at a railroad company, shows significant differences among North American freight railroads. A study conducted by the Mexican Transportation Institute (2016) concluded that, in 2013, Mexican companies (6.8 ton-km/employee) presented the lowest labor productivity values compared to companies in Canada (14.7) and the United States (17.3). However, complementary analyses using DEA techniques to calculate the technical efficiency of these railroads confirmed that, as the operating size of the railroads increases, the effects of scale are reflected in higher productivity. For example, when variable returns to scale are considered, one of the Mexican companies analyzed (Kansas City Southern de Mexico) showed efficiency levels similar to those of Canadian and U.S. companies.

From a **rate** perspective, freight rates are slightly higher than the U.S. benchmark, internationally recognized as one of the lowest rates in the world (Beck et al., 2013). The average U.S. Class I railroad freight rate was estimated at around US$ 3 cents in 2010. According to **Figure 3.2**, only a few companies in Mexico and Brazil approach those tariff levels. In this regard, Kohon (2021) points out that new railroad concessionaires in these countries achieved a lower cost structure, thanks to a better utilization of assets and a reduction in the staff needed to operate the trains, which in turn allowed the elimination of explicit subsidies from the public treasury.

Figure 3.2 Average rates for railroads under concession in 2016 (in US cents per ton-km)



Source: Kohon (2021).

In addition to the rolling stock, another determining factor in efficiency is the **infrastructure**. The width between the rails (gauge) and the number of tracks on the line directly affects the operating speed and track capacity (Tongo, 1982). Márquez (2017) concluded that in Colombia the adoption of the narrow gauge, due to savings in infrastructure construction costs, had important implications on the performance of its rail network, especially in terms of lower operating speed. The same study found that in Argentina, Brazil, Chile, and Peru, railroad networks have two or three different gauges, which makes freight transport difficult as the cargo needs to be transferred to another train. Other factors that influence efficiency in the operation are the topographic characteristics of the terrain, such as steep slopes and level crossings, which cause inefficiencies as they lead to speed variations due to interruptions caused by urban traffic (Sánchez Abril, 2011).

Box 3.1 Freight Rail Investment Plans

Rail freight transportation has similar characteristics to other network industries: high entry costs, economies of scale and economies of density in production. In addition, in the case of small and medium-sized companies, profit margins are low (Kohon, 2021). Considering these challenges and the level of competition between rail and road freight transportation, the public sector has made significant investments to contribute to the development of railways. Prior to the COVID-19 pandemic, several countries in the region defined ambitious goals to increase the modal share of rail freight in their cargo matrix, accompanied by investment plans to improve their infrastructure and management models. The investment[19] objectives of some of these plans are described in the next page.

19. Detailed information on the progress of the execution of these plans is not available currently.

Box 3.1 Freight Rail Investment Plans

- **Argentina:** The aim of the Freight Railway Investment Plan (PIF, as per its Spanish acronym), which considers making an investment of US$ 14,982 million until 2035, is to make a freight modal shift from road to rail and reach a 12% railroad share of cabotage freight in ton-km, thus reducing emissions by 29.8% by 2030 (Argentinian Ministry of Environment and Sustainable Development & Ministry of Transportation, 2017). The Argentinian public sector invested US$ 867 million in railway infrastructure in 2016, equivalent to 0.15% of the national GDP (Infralatam, 2020).

- **Bolivia:** The Bi-Oceanic railway is scheduled to be completed by 2025, linking the port of Santos, in Brazil, with the port of Ilo in Peru, passing through Bolivia. This project, with an estimated investment of US$14 billion, will reduce foreign trade times from 67 to 42 days by shortening the transfer of export cargo to Asian countries and imports from South America (APAM, 2018; Mundo Marítimo, 2018). Between 2015 and 2019, the public sector in Bolivia invested US$ 464 million in railway infrastructure (Infralatam, 2020).

- **Brazil:** The government expects to make investments of around US$ 2.58 billion in the next few years, focusing on the West-East Integration Railway (FIOL, as per its Spanish acronym); and the Central-West Integration Railway (FICO, as per its Spanish acronym). The National Logistics Plan envisages doubling the country's railway network and increasing the share of railroads in its cargo transportation matrix to 30% by 2030 (National Logistics Plan, 2018). The medium and long-term goal is to connect railroads to Brazilian ports. Between 2015 and 2019, the Brazilian public sector invested US$ 1,338 million in rail infrastructure (Infralatam, 2020).

- **Chile:** The government is considering the need to assign a large share to railroads, close to 30%. To this end, EFE (Chile's state-owned railway company) and the port companies are planning rail corridors to serve the ports (Desarrollo Logístico, 2018). The Chilean government approved a US$ 1.9 billion investment plan between 2020 and 2022, which is part of a US$ 5.57 billion long-term plan to increase annual cargo tonnage from 11.5 million to 21 million (Mundo Marítimo, 2020). Between 2015 and 2019, the Chilean public sector invested US$ 4 billion in rail infrastructure (Infralatam, 2020).

- **Colombia:** The national government plans to increase its investment in the railroad network fourfold in order to revitalize rail transportation. The strategy includes: early operating phases; launching the Railway Master Plan; a railway law; structuring national and regional corridors and, finally, attracting private investment DNP, 2019). Between 2015 and 2019, the public sector in Colombia invested US$ 58.69 million in rail infrastructure (Infralatam, 2020)

- **Mexico:** Its logistics plan aims for the rail sector to achieve a 40% share of land freight, equivalent to transporting 122.91 billion ton-kilometers by 2030 (Transportation, 2020). Between 2015 and 2019, the Mexican public sector invested US$ 7,732 million in rail infrastructure (Infralatam, 2020).

3.2 Management model (institutional dimension)

In the railway sector, there is an ongoing debate about which is the most efficient **ownership** and management **model** for the development of this mode of transportation. Both dimensions have varied significantly over time and across countries, and a variety of literature has analyzed the relative efficiency of private versus public ownership. In general, the literature shows that private operation of rail services generates greater efficiency, better service and, under adequate competition, lower fares (Beck et al., 2013; ITF, 2019a; Thompson, 2013). Econometric analyses to assess the impact of the ownership model on growth of the railway network between 1860 and 1913 concluded that railroad nationalization reduced network growth, while greater private ownership increased the network (Bogart, 2007). Likewise, the privatization of Mexican railroads in the 1990s resulted in a significant growth in infrastructure investment and competition, which led to improved efficiency and a tariff reduction (Beck et al., 2013; Kohon, 2021).

Management models have also been widely studied in the United States, Europe, and Latin America. Traditionally, freight rail has been managed under a vertical integration model[20], to exploit the economies of scope derived from minimizing transaction costs and the economies of scale derived from having a single operator. However, this model has been questioned since the late 1980s and several countries have adopted models with greater rail competition. Although there is no consensus on the impact that different structures may have on system efficiency, some authors conclude that vertical separation or, alternatively, third-party pathway agreements, may generate greater competition and contribute to lower tariffs under some circumstances (Beck et al., 2013). Other stakeholders consider rail to be a natural monopoly, and conclude that increased competition reduces productive efficiency, as it may prevent rail operators from exploiting economies of density and increase transaction costs. Comparisons of the different models of competition introduced in freight railroads in the United Kingdom, India and Japan conclude that a uniform type of competition cannot be replicated without considering market characteristics and the history of this type of reform. For example, the introduction of an open access policy with vertical separation in areas of high traffic density results in increased costs, as dense networks require close coordination within the system (Kurosaki & Singh, 2016).

In the context of Latin America, **Table 3.2** presents the management and ownership models in place, showing **heterogeneity in terms of the models adopted**[21]. For example, countries such as Argentina, Bolivia, Brazil, and Panama have some vertically integrated concessions with commercial exclusivity[22], while countries such as Chile, Colombia, and Peru implement structures with varying degrees of rail competition, from open access to vertical integration with competitive access. On the other hand, Mexico uses a hybrid model where it combines commercial exclusivity with regulated competition in prioritized sectors. As for the ownership model, Kohon (2021) showed that regarding the concessions structured in the 1990s during the Latin American railway reform, the countries of the region retained the infrastructure as state property and granted concessionaires the right to manage it[23]. In the case of rolling stock, in some countries, such as Argentina, Brazil, Colombia and Peru, it is still owned by the government, while in countries such as Mexico, Chile and Bolivia it became the property of the concessionaires.

20. According to the World Bank (2011), vertical integration implies a single responsible party for the operation of rail infrastructure and trains.
21. For an analysis of the historical evolution of the ownership and management model in LAC, see Kohon (2021).
22. Commercial exclusivity implies that only the incumbent railroad can pick up cargo in its concessioned territory (Kohon, 2021).
23. The only exception was the narrow gauge Ferronor railroad, operating in the northern part of Chile, which was entirely sold, with all its rolling stock and infrastructure.

Table 3.2 Ownership and management model of freight railroads in LAC		
Property	**Management**	**Countries**
Public	Public	Argentina, Brazil, Uruguay, Uruguay, Bolivia, Chile, Peru, Colombia, Venezuela, Panama, Mexico
Public	Private	Argentina, Brazil, Chile, Bolivia, Peru, Colombia, Mexico
Private	Private	Brazil, Colombia, Chile, Peru

Source: Kohon (2021).

3.3 Potential for modal shift to rail

The need to develop and expand rail freight transportation is justified by the **economic and environmental benefits** associated with this mode. On the one hand, the use of railways is seen as an alternative to reduce the emissions associated with freight transportation. In general, rail generates a smaller carbon footprint. Estimates for U.S. freight railroads show that, on average, they are three to four times more fuel efficient compared to trucks[24] (AAR, 2020), while estimates for the European Union show that railroads can be up to five times more efficient. Considering then that a single freight train can replace several hundred trucks, transferring freight from truck to rail can generate significant savings in pollutant emissions (see Chapter 10). On the other hand, rail usually offers more competitive prices to transport massive cargo volumes over long distances and with shorter travel times, thus helping reduce logistics costs (World Bank, 2011). In addition, railways provide highly secure and reliable services, as they are not affected by the impacts of road congestion (Minnesota DOT, 2013; Transport Scotland, 2017).

Despite the many advantages of using rail for freight transport, this subsector faces some **difficulties in increasing its share in the LAC modal matrix**. Until 1950, rail was the predominant mode (90%) for freight movements in Latin America, Africa, and South Asia. However, due to the accelerated expansion of the road network and the deterioration in the quality of rail infrastructure and services, railroads were quickly replaced by trucks (Aritua, 2019). Other barriers to greater use of railroads are related to the limited investment in the sector, the lack of flexibility of these systems and the absence of direct door-to-door services (World Bank, 2011). In this sense, rail-related traffic is usually restricted to bulk traffics[25], with a limited number of origins and destinations (Bureau of Infrastructure & Transport and Regional Economics, 2009).

In general, rail competes with several modes of freight transport in LAC, but **this competition is more unequal between truck and rail**. As described in Chapter 2, there are high levels of informality in the RFT sector in LAC which favors the development of RFT services with lower tariffs. Another factor related to the tariff structure of both systems is the fact that RFT does not fully internalize the cost of the negative externalities it generates. Likewise, the fact that public investment in roads (construction, rehabilitation and maintenance) is higher than rail investment (exclusively for construction) represents another source of inequality between both modes of transportation (Barbero et al., 2012; Kohon, 2014). The RFT also benefits from soft credit lines for fleet renewal, while rail companies have more limited access to soft financing.

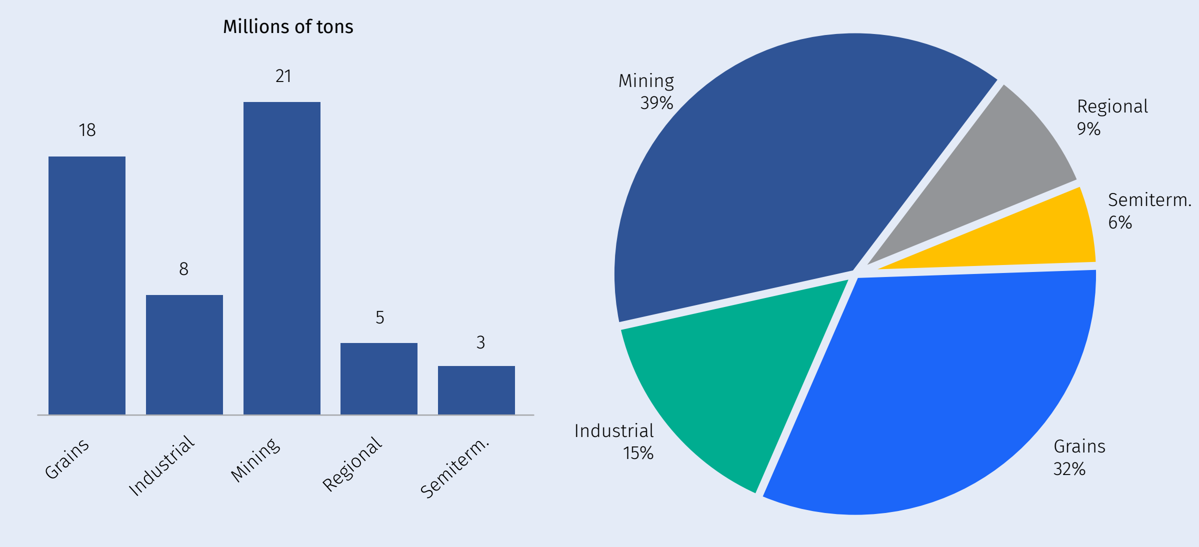
24. These estimates will naturally vary according to different variables, including occupancy factors, proportion of diesel and electric rail operation and the characteristics of the road transportation fleet, among others.
25. Bulk traffics are characterized by involving large quantities of a homogeneous product (liquid or solid), transported in bulk and without packaging, and with generally low unit values (Bureau of Infrastructure, Transport and Regional Economics, 2009).

The choice of rail transportation as the main mode for moving goods depends on qualitative and quantitative factors (Floden et al., 2017). For example, service quality, measured in terms of frequency, travel times, reliability, safety, and flexibility are some of the factors to consider when selecting the mode of transportation. Some authors also point out that the choice varies depending on the type and size of cargo, time constraints, customer characteristics, cost of services and cross-elasticities with other modes of transportation. Internationally, the impact of each of these factors varies depending on the study conducted, however, there is a point of convergence regarding cost as the most decisive factor in the selection of a transportation mode (Zeybek, 2019).

In order to explore this issue in more detail in the LAC context, the following is a case study of grain logistics in Argentina and Brazil, one of the products with the greatest potential for modal shift in two of the most important LAC markets. In addition, according to freight rail expansion plans, freight diversion from road is a policy objective shared by Argentina and Brazil. This analysis is based on new information collected through interviews conducted by the IDB in 2020 and 2021 with rail operators and shippers in both countries[26].

Starting with the case of Argentina, recent analyses conducted for this country have identified that the products that have the greatest "rail vocation" are agricultural and mining bulk and, on a smaller scale, industrial, regional and semi-finished products (Ministry of Transportation, 2019). In particular, it is estimated that rail could be used to transport 18 million transfered tons of grains (**Figure 3.3**).

Figure 3.3 Potential for modal shift from road to rail



Source: Ministry of Transport (2019).

Argentina has approximately 18 thousand kilometers of railroads in operating condition (De Marco, 2019) and its railway system is composed of three private concessionaires (8,818 kilometers) and three under the responsibility of Belgrano Cargas y Logística, the state-owned management company (9,038 kilometers). Two of the three privately managed railroads (Nuevo Central Argentino —NCA— and FerroExpreso Pampeano —FEPSA—) and two of the three state-managed railroads grouped in Belgrano Cargas y Logística (the Belgrano and San Martín lines) are involved in grain transportation. According to Fundación Agropecuaria para el Desarrollo de Argentina (the Argentinian Foundation for Agricultural Development), it is estimated that the share of trucks in the movement of grain and by-products is around 85%, compared to 13% for railroads (Agro-Proyectual, 2016).

26. The companies interviewed were: Ferrocarril Ferro Expreso Pampeano (FEPSA), Ferrocarril Belgrano Cargas y Logística (BCyL), Asociación de Cooperativas Argentinas (ACA), Bunge Cono Sur, Tomás Hermanos, Ferrocarril Rumo, C. Vale, Bunge Brasil and Cargill Brasil.

Some of the obstacles to increasing the share of railroads in grain transportation are related to the available infrastructure. On the one hand, railway operations in the Rosario Metropolitan Area —the largest grain export hub in the world (see Chapter 4)— providing access to the ports are complex because railway lines are inserted in the city, in addition to the limitations of the original and foundational layout of the Argentine railway network. Not to mention the fact that some parts of these lines have been occupied by the population in search of precarious housing solutions. Another relevant obstacle has to do with the availability of rail access/routing from the stockpiles at origin. Indeed, an analysis conducted by the FEPSA railroad with data from the year 2017 showed that, out of 64 stockpiles surveyed with fixed structure (silos), only 17 have a spur track (27%). The proportion is even much lower in the case of stockpiles that use silo bags (7%). Regarding infrastructure at ports (where most of the grain processing industry is located), 69% of them are connected by rail (**Table 3.3**). As a result, FEPSA concludes that only 24% of the grain storage capacity has potential access to railroads, which is a strong limitation to increasing railroad share.

Table 3.3 Railroad share in stockpiles with fixed structures (silos) and bag silos

Type of storage	Without railways	With railways	Total	% With railways
Bag silos	42	3	45	7
Fixed structures	47	17	64	27

Source: FEPSA (2017).

In line with the literature described in this chapter, the interviews conducted also reflected the impact of tariffs on the use of railroads to transport grains. In particular, short haul services (covering transportation from field/farm to silo) is a key factor that influences the producer's decision on the mode of transportation and is one of the main entry barriers for railroads. General estimates indicate that producers must pay a "short haul" transportation service between the field/farm and the silo of around US$ 5. They must also pay for storage and other services (drying, fumigation) that grains may require, which represent about US$ 3-4 per ton. This implies that, for the railroad to be competitive with trucks, the price offered to producers must deduct the US$ 8-9 in which they incurred for the short haul and storage services. Otherwise, a producer is most likely to send the cargo directly to the port by truck.

For example, for a 400-kilometer trip to the port of Bahia Blanca, the railroad charges US$ 17 per ton in high season (harvest time) and US$ 14 per ton in low season (outside harvest time). To these values must be added the aforementioned short haul freight and storage costs. In low season, the truck charges US$ 16 for direct freight from field/farm to port. However, it should be noted that these dynamics vary considerably between high and low harvest season. In high season, when demand for road transport is high, railroads can avoid absorbing the short haul freight service partially or totally. On the contrary, in low season, with the truck-rail transportation system oversupplied, direct freight trucking services do not apply the official rates and offer discounts to compete with the railroad, and other truckers. In other words, indicative freight rates for trucking are strictly applied during the six peak months of crop mobilization, while outside peak months, or when tonnages harvested in a given year are low, the market is de facto deregulated, and the rate is negotiated directly between the parties and generally at lower levels than the reference rates.

Truck-rail competition also varies according to the distance between production areas and ports. Longer distances increase the price of travel and reduce the impact of short haul and storage services on the freight rates for transporting the grain from the storage facilities to the port, making rail transportation more attractive. This is especially evident in the new producing areas of the Northeast (NEA) and Northwest (NOA) of Argentina, mainly the provinces of Chaco, Santiago del Estero, Tucumán, and Salta. These areas are located far from Rosario and its ports, with distances averaging 700 kilometers, where the supply of trucks and truckers is decreasing and the practice of charging below RFT guideline rates is also less frequent, favoring the modal choice of rail over road.

From the service point of view, the main challenge to make rail transportation more attractive is linked to its efficiency and quality. This implies, on the one hand, the development of logistics solutions that allow the loading of a train of 50 wagons (just over 3,000 tons, equivalent to about 100 trucks) to be completed in 6 to 8 hours (this is hindered by the fact that not all warehouses are equipped to achieve this) and, on the other hand, that the shipper has a guaranteed unloading quota at a destination port with rail unloading facilities. Therefore, rail transportation requires high levels of coordination among all the actors involved (the railroad itself, the port, the shipper, and the exporter) in order to achieve the aforementioned goals.

Unlike what happens in Argentina, the Brazilian railroad system has an important presence in the national cargo matrix, with 27% of the total tons mobilized in the country (15% in the case of Argentina). Its level of activity also makes it the most important railway system in Latin America. In 2018, it mobilized 72% of the region's rail cargo, of which more than 80% was from the mining industry. Brazil currently has 13 railway concessions (twelve are privately managed and one is state managed[27]). As in Argentina, all its concessions are vertically integrated and have commercial exclusivity. Four railroads concentrate the main agricultural traffics, where grains and soy flour are specifically significant. These are: Rumo Norte (20.4 million tons in 2018); Rumo Sur (12.4 million); Ferrovía Centro Atlántica (11.8 million); and Ferrovía Norte Sur Tramo Norte (6.6 million tons). It is important to note that, although trucks are also an essential component of grain movement in Brazil (67%), their share in the cargo matrix is lower than in Argentina (85%).

According to interviews with rail operators and shippers, the logistics costs to move a ton of grain from the field/farm to the overseas vessel vary substantially between the South and the Center-West of the country, mainly due to the distances involved. In the south of the country, and for distances of over 400 kilometers, the long freight is estimated at between US$ 13 and US$ 18. Another US$ 12 should be added to this in order to pay for the short haul transport, storage and conditioning of the grain at the storage facilities and other fobbing charges, which makes it a total of between US$ 25 and US$ 30. These average values do not include marketing expenses and taxes and are similar to the values described above for Argentina (US$ 30-34 for an average distance of 400 kilometers). In the case of the Center-West, logistics costs are estimated at between US$ 60 and US$ 70. These values include the short haul freight rate, storage and conditioning, other fobbing components, and transshipments. Regarding the latter, exporting grains through the Northern Arc ports, for example, may involve traveling more than 900 kilometers, and transferring the cargo to barges for part of the journey.

In this sense, the obstacles to increasing the railroad's participation vary depending on each region within the country. In the South (the states of Rio Grande do Sul, Parana, and Sao Paulo), distances to export ports do not exceed 600 kilometers, and there are defined and structured logistics corridors for exports. On the other hand, in the Center-West zone (the states of Mato Grosso, Mato Grosso do Sul and Goias), distances to export ports can be three times those of the South, reaching 2,000 kilometers for some locations. These large transportation distances are difficult to overcome for a weak infrastructure —still under development— which continues to seek routes and ways to combine modes of transportation and ports of exit with lower logistic costs.

Regarding rail-truck competition, the analysis conducted by Gudolle (2016) shows interesting results in this regard, comparing the transportation costs and rates of a grain trading company, mainly engaged in soybean exports through the port of Rio Grande. During the 2010-2015 period, this company transported 216 thousand tons per year by truck (41%) using its own fleet and 317 thousand tons by rail (the remaining 59%) through Rumo Malla Sur. The cost of shipping to port by truck[28] was estimated, on average, at US$ 27.5 per ton (**Table 3.4**). The average rate for rail transportation was US$ 19.2 per ton (30% less than for a truck). Thus, assuming an average distance of 415 kilometers to port, the truck rate was approximately US$ 6.6 cents per ton-km transported, while the rail rate is estimated at US$ 4.6 cents. The interviews conducted in the context of this publication confirm the economic advantage of rail versus RFT for the Southern zone of Brazil.

27. It refers to Estrada de Ferro Paraná Oeste (Ferro Oeste), which serves only 0.1% of the country's total rail freight traffic.
28. It is important to clarify that the comparison does not correspond to the difference between market rates. Since the company uses its own fleet of trucks, the value reported corresponds to the formal costs of motor vehicle transportation, including all the infrastructure for its management.

Table 3.4 Costs per truck and railroad rates of a grain company

Year	Truck (US$)	Railways (US$)
2010	26.8	17.9
2011	33.1	22.3
2012	26.4	18.3
2013	26.0	18.4
2014	28.2	20.5
2015	20.7	15.3
Average	**27.5**	**19.2**

Source: Gudolle (2016).

In the last decade, Brazil has made significant investments in grain logistics infrastructure, including interventions in ports and their storage facilities, in new storage facilities close to production areas, and in roads and railroads. This expansion of infrastructure resulted in a less saturated logistics system during the key months of the soybean harvest, which is currently limited to a maximum of two weeks per harvest. The increase in infrastructure supply has also encouraged the development of greater intra-modal competition, streamlining the process of negotiating and contracting rail services. Likewise, investment in infrastructure has sought to increase intermodality including the country's maritime and river network, taking advantage of the flow transported by the tributary rivers of the Amazon, especially for the state of Mato Grosso, which generates 35% of the country's grain production.

Conclusions

Several LAC countries aim to significantly increase the share of rail in their cargo matrix as part of their strategy to solve the environmental and competitiveness challenges faced by their economies. Indeed, available evidence shows that the operating cost of an efficient unit train is significantly lower than that of trucks, thus demonstrating that shifting freight from road to rail could achieve significant savings in logistics costs under certain conditions, especially considering traffic densities. In addition, international benchmarks show that rail transportation generates lower pollutant emissions per ton-km compared to RFT. However, to achieve these benefits in LAC, substantial investments are required to expand the quality and connectivity of rail networks, as well as their connection with other logistics infrastructure, and to improve the quality, efficiency, and competitiveness of rail services. This requires taking a multimodal transportation approach (see Chapter 11), where rail can act as the structural hub for the flows of goods for which it is most efficient (in terms of cost and time). This is particularly relevant for the supply chains of some products such as grains and oilseeds, where rail still has a limited share in LAC and the potential for cargo diversion from trucks is greater. Finally, it is important to consider the current levels of competition between truck and rail when planning and prioritizing investments in this subsector, in such a way that freight shippers have the right incentives when choosing the best transportation mode.

CHAPTER 4

THE CHALLENGES OF MARITIME TRANSPORTATION

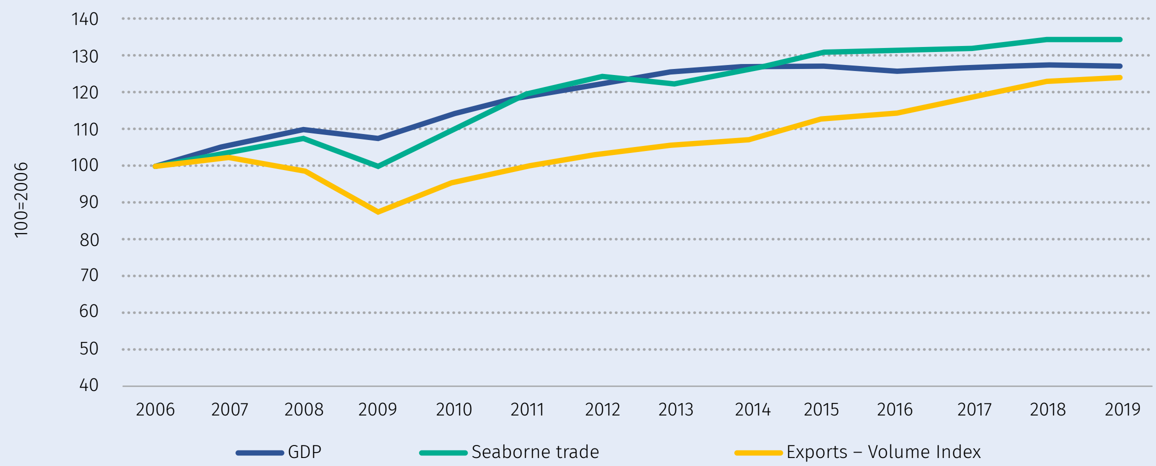
Maritime transportation is key to the international integration of LAC countries. It is the preferred transportation mode for the products of this region, and it also provides business opportunities to countries that are trade hubs within the main international trade routes. Based on the analysis of the scope and state of maritime transportation in LAC, this chapter complements the existing literature on the subject by focusing on three aspects that are particularly relevant for the region's maritime performance[29], namely: (i) horizontal and vertical concentration in the container market; (ii) governance and competition challenges; and (iii) the port performance gap in LAC. The analysis results are discussed in the last chapter of this publication, which presents a road map for improving the region's logistics performance.

4.1 Scope of maritime transportation in LAC

Maritime transport is a **key enabler of global trade**, accounting for approximately 80% of internationally traded goods by volume and 70% of global trade by value (UNCTAD, 2020b). Waterway transportation (see **Box 4.1**), and maritime transportation together account for 95% of LAC's international trade (ECLAC, 2019). For the last 14 years (between 2006 and 2019, prior to the COVID-19 pandemic), this mode of transportation showed an upward trend, consistent with the evolution of regional GDP and foreign trade indicators (**Figure 4.1**).

29. These challenges are expected to continue in the post-COVID-19 scenario.

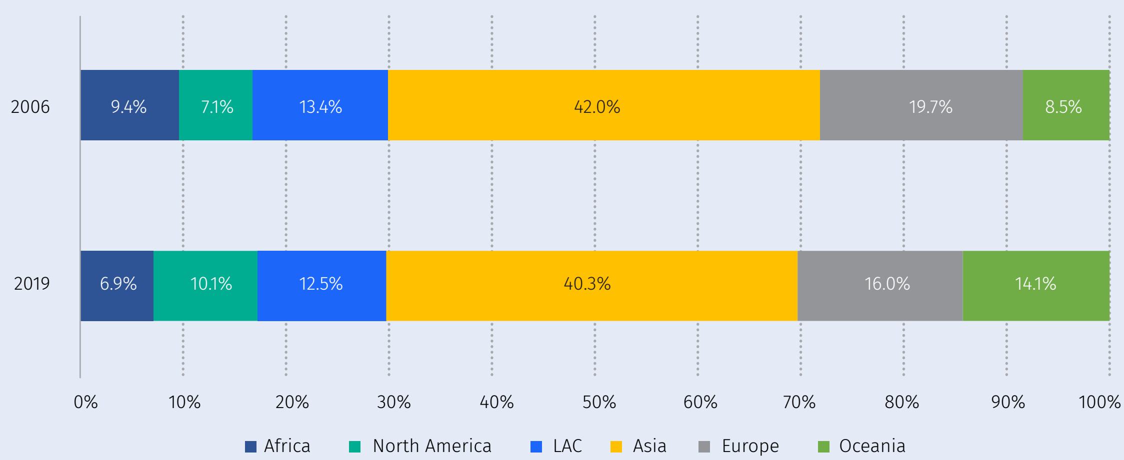
Figure 4.1 LAC's GDP growth, seaborne trade and exports (2006-2019, 100=2006)



Source: Own production using UNCTAD data, available at: https://unctadstat.unctad.org/EN/
Note: GDP in constant 2015 dollars. The information on seaborne trade takes into consideration the millions of metric tons loaded. The export volume index has changed its base year from 2005 to 2006.

Despite recent growth, **LAC has a small share** of the global shipping industry. In 2019, LAC's share reached just 12.5% of total metric tons loaded globally (compared to Asia's 40.3%, Europe's 16.0%, and Oceania's 14.1%), having fallen 0.9 percentage points below 2006 values (**Figure 4.2**). It is also worth mentioning that there is **heterogeneity among LAC countries** regarding the intensity of their international seaborne trade. While most Caribbean countries transport their goods by sea, in Mexico and Central America this mode accounts for 48% of the subregion's trade (ECLAC, 2019).

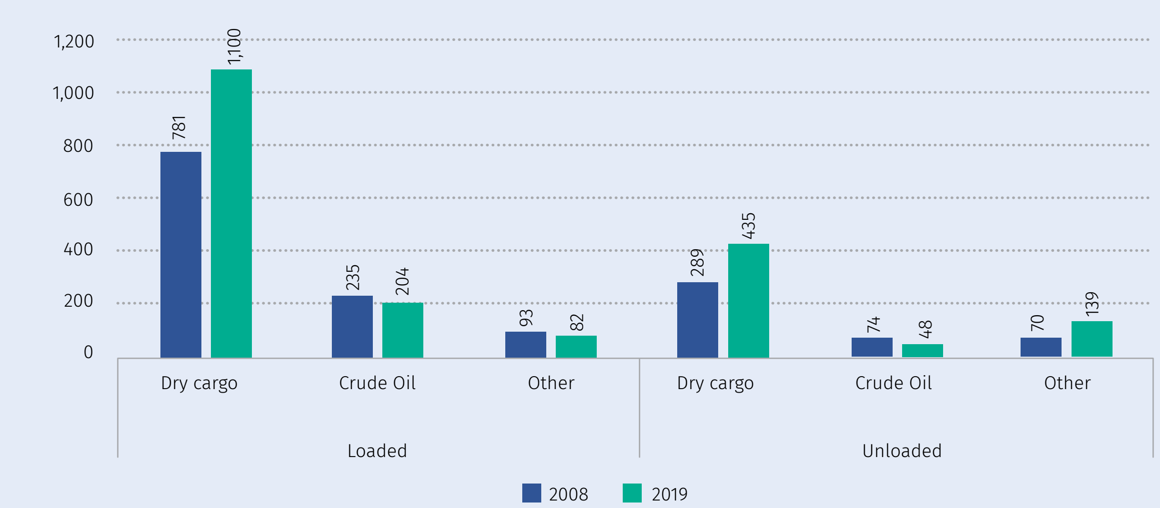
Figure 4.2 LAC's share of world seaborne trade (% of millions of tons loaded, 2006 vs. 2019)



Source: Own production using UNCTAD data.

Most of LAC's maritime transportation involves **dry cargo** movements, which includes containerized cargo and dry bulk cargo. In 2019, this represented 79.3% of the metric tons loaded and 70.0% of the metric tons unloaded in LAC, thus evidencing a cargo imbalance favoring regional exports (**Figure 4.3**). It is worth mentioning here that this imbalance is related to the fact that regional exports tend to be dominated by primary products, which have a higher volume density —the relationship between monetary value and cargo volume— than those of primary products, which have a higher volume density.

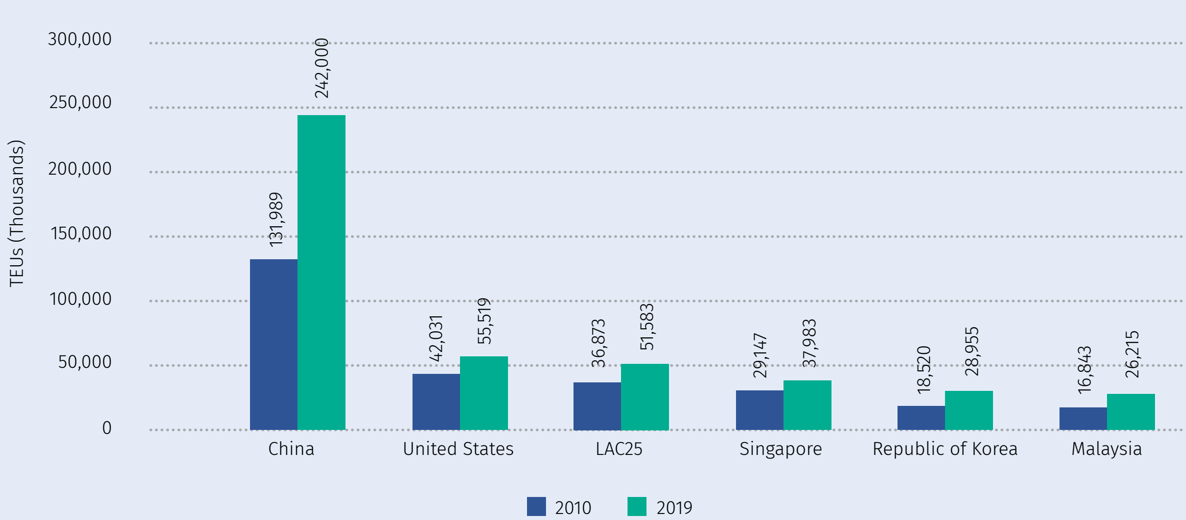
Figure 4.3 International seaborne trade in LAC by cargo type (millions of metric tons, 2008 vs. 2019)



Source: Own production using UNCTAD data.

Within dry cargo, if we consider only the **movement of containerized cargo** —the one with the highest added value—, it can be observed that the share of TEUs[30] mobilized by LAC countries in 2018 amounted to 6.5% of the global. This represents a slight decrease compared to 2010 volumes (6.54%) (UNCTAD, 2020b). From an international perspective, the sum of TEU movements for the entire region (LAC[31]) is equivalent to 21% of China's movements and 93% of United States' movements (**Figure 4.4**).

Figure 4.4 Top 5 countries with the highest movement of containerized cargo vs. LAC (2010 and 2019)



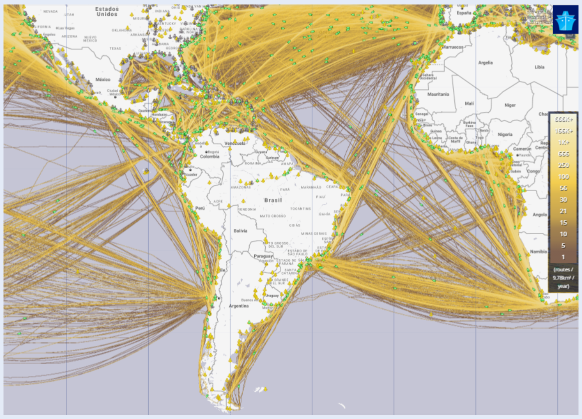
Source: Own production using UNCTAD data.

30. Twenty-foot Equivalent Unit, is the internationally standardized unit used to measure containerized cargo.
31. Bolivia has been excluded.

The **leading countries in container movement** in the region are: Brazil (20.2% of the LAC total in 2019), Panama (14.3%), Mexico (13.8%), Chile (8.8%) and Colombia (8.6%). Of these five countries, Mexico has experienced the highest growth in TEU movement (3.7%) between 2010 and 2019 (**Figure 4.5**). On the other hand, Panama has lost 1% of its movements, due to the reduction of activity at the port of Balboa (**Figure 4.6**).

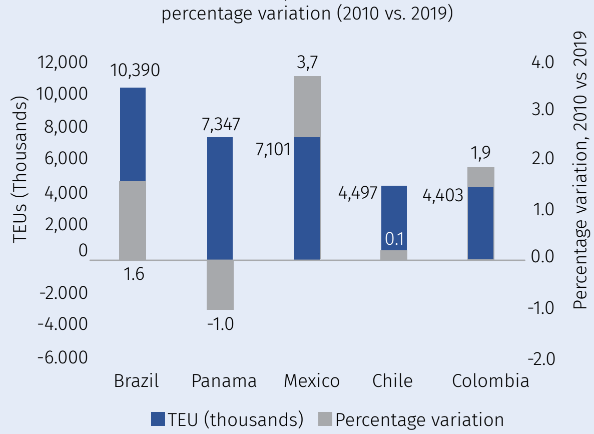
Figure 4.5 Traffic and evolution of maritime activity in LAC

a) Density of containerized maritime transportation routes (2019)



Source: Marine Traffic.
Note: The size of the route represents its density for the full year of 2019.

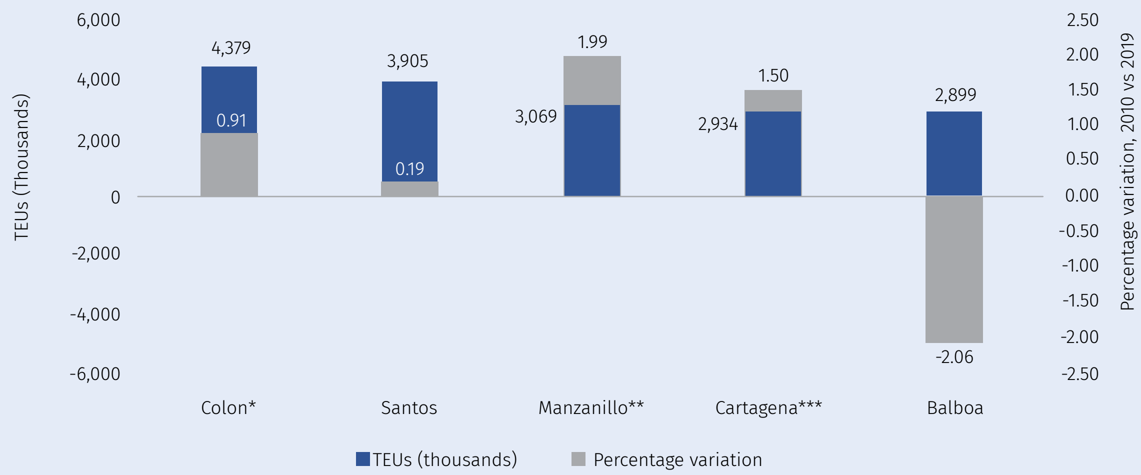
b) TEU movements (top 5 LAC countries, 2019) and percentage variation (2010 vs. 2019)



Source: Own production using ECLAC data.

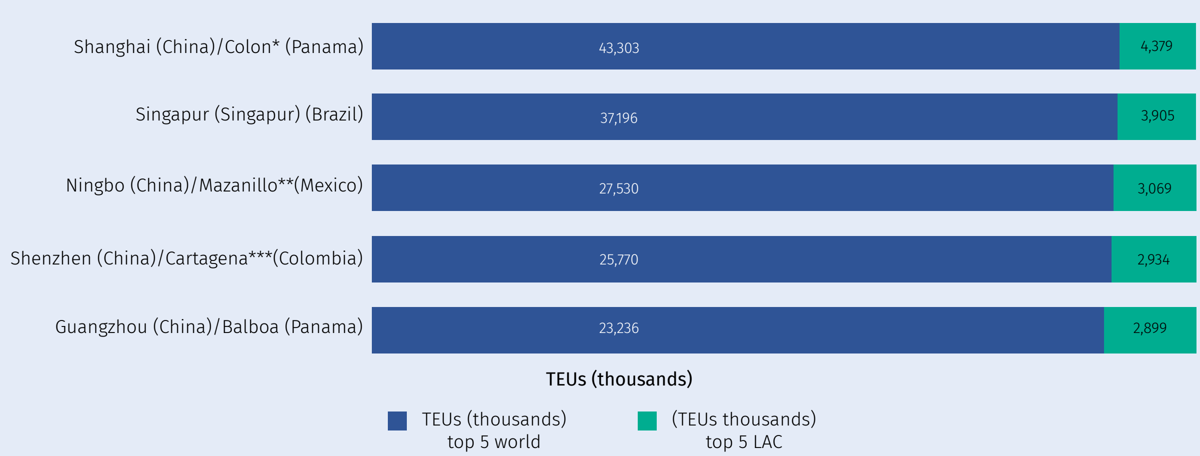
The five **ports with the highest TEU movements** in 2019 are located in four countries: Colon and Balboa in Panama (accounting for 14.3% of total movements in the region), Santos in Brazil (7.7%), Manzanillo in Mexico (6%) and Cartagena in Colombia (5.8%) (**Figure 4.6**). While a significant portion of Santos and Manzanillo's movements are related to domestic cargo, transshipment plays a key role in the regional positioning of Colon, Balboa and Cartagena —the main transshipment ports in LAC. Located on both sides of the Panama Canal, Colon and Balboa are important hubs for container transshipment between East-West and North-South global routes. In fact, transshipment accounts for 87% of the movements in Colon and 89.7% of those in Balboa (ECLAC, 2020). Transshipment in Cartagena accounts for 72.2% of the port's total movements, especially due to its strategic positioning in the Caribbean, where regional (North-South) and global (East-West) routes come together. In terms of historical trend and with the exception of Balboa, which recorded a 2.06% loss of movements during the last decade (2010-2019), the remaining four ports slightly increased their activity. However, the values reported by the region's leading ports are only a fraction of those of the world's most important ports (**Figure 4.7**). In addition to these regional nodes, there are also ports that play an important role in sub-regional traffic, such as Callao (Peru) on the west coast of South America (6th position in TEU throughput in LAC in 2019), and Kingston (Jamaica) in the Caribbean (9th position).

Figure 4.6 TEU movements (top 5 LAC ports, 2019) and percentage variation (2010 vs. 2019)



Source: Own production using ECLAC data.
Note: *Colon (MIT, Evergreen, Panama Port). **: Manzanillo, Mexico. ***: Cartagena (inc. S.P.R, El Bosque, Contecar, ZP).

Figure 4.7 Top 5 international ports vs. top 5 LAC ports (thousand TEUs, 2019)

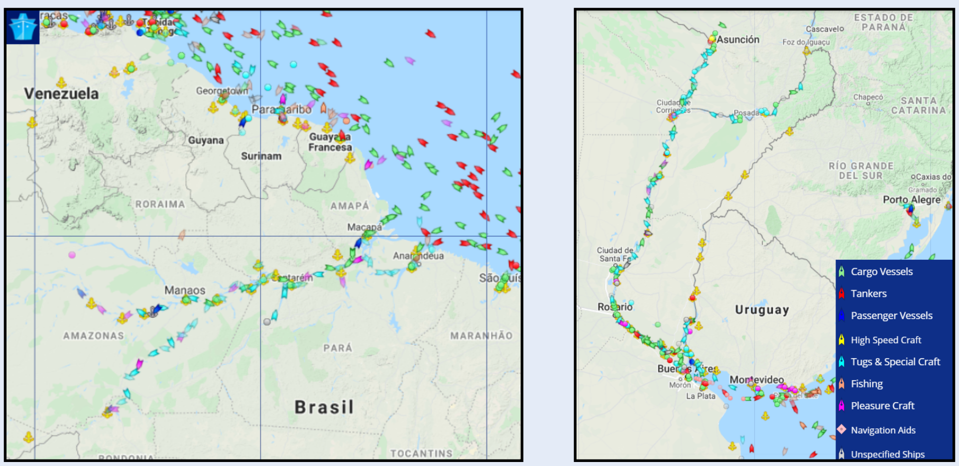


Source: Own production using data from ECLAC & Lloyd´s List.
Note: *Colon (MIT, Evergreen, Panama Port). **: Manzanillo, Mexico. ***: Cartagena (inc. S.P.R, El Bosque, Contecar, ZP).

Box 4.1 River Transportation in LAC

Together with maritime transportation, river routes play an important role in the territorial development of the region, due to their contribution to intra-regional and international transport generated in the South American basins. Colombia is the LAC country with the highest density in its river network (in 2015, it exceeded 1.6 kilometers per 100 square kilometers of territory); followed by Peru (0.7), Bolivia (close to 0.6), Argentina (0.4), Paraguay (0.3) and Brazil (exceeding 0.2) (Jaimurzina & Wilmsmeier, 2017). By way of comparison, Paraguay's river density is similar to France's. The main river basins in LAC are those of the Amazon River and the Paraguay-Parana Waterway. The former covers approximately seven million square kilometers and encompasses the territories of eight countries (68% in Brazil). The second has a navigable length of 3,442 km and covers territories of five countries (mostly Paraguay) (Jaimurzina & Wilmsmeier, 2017) (**Figure 4.8**). Both basins are of critical economic importance for the countries that form them since a significant part of their agri-bulk exports pass through them. Landlocked Bolivia and Paraguay are particularly dependent on these basins for their international trade. Other basins of great value include the Parana-Tiete, Orinoco, Araguaia-Tocantins, San Francisco, La Plata, Essequibo, Magdalena, Uruguay, and Xingu basins.

Figure 4.8 Maritime activity in the Amazon (left) and Paraguay-Parana (right) river basins (2021)



Source: MarineTraffic.
Note: Traffic during March 5, 2021.

The total movement of cargo through the main basins has increased considerably since the beginning of the 21st century. In the case of the Paraguay-Parana waterway, data for the Gran Rosario hub, the most important agribulk export node in the world, show an increase of 64% between 2010 and 2019, from 48 million to 79 million tonnes exported (Bergero et al., 2020).

Box 4.1 River Transportation in LAC

There are also other basins that have significant growth potential for river transport in LAC. Among them is the Magdalena River in Colombia, which covers approximately 1,500 kilometers and connects the central area of this country with the seaports located in the Caribbean Sea. The cargo mobilized by this route has experienced a 155% increase in the decade 2010-2019, reaching 3 million tons this year, corresponding mainly to hydrocarbons (84% of the tons mobilized) and dry bulk (Cormagdalena, 2020).

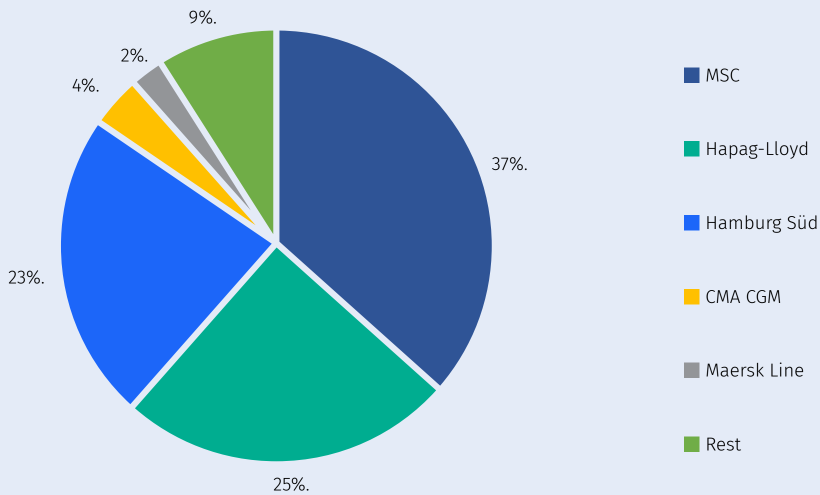
Although river transportation in LAC cargo movements as a whole is marginal (less than 1% of the total tons and value of cargo transported), its further development will be key to: (1) achieving a more sustainable freight transport matrix; (2) increasing market access for Mediterranean areas and countries (especially in the case of Bolivia and Paraguay); and (3) reducing logistics costs for agricultural exports, of lower value added and higher volume. Based on this potential development, the OECD has predicted that Latin America will have one of the largest increases in river freight transportation after China and India by 2030 and 2050 (ITF, 2019b).

4.2 Concentration of containerized maritime transportation

Once the scope of maritime transportation in LAC has been analyzed, we will now focus on the container segment. The most important goods for a country's economic growth are those with the highest value added among internationally traded goods. Indeed, following the theory of economic complexity, the greater the diversity and sophistication —in terms of technology and inputs— of a country's export basket, the higher the level of income and the greater the likelihood of future development of that country (Hidalgo & Hausmann, 2019). From a transportation point of view, products with such characteristics are generally transported in containers (UNCTAD, 2020b). Thus, containerized cargo transportation, together with its infrastructure and services, acquire particular importance in economic terms.

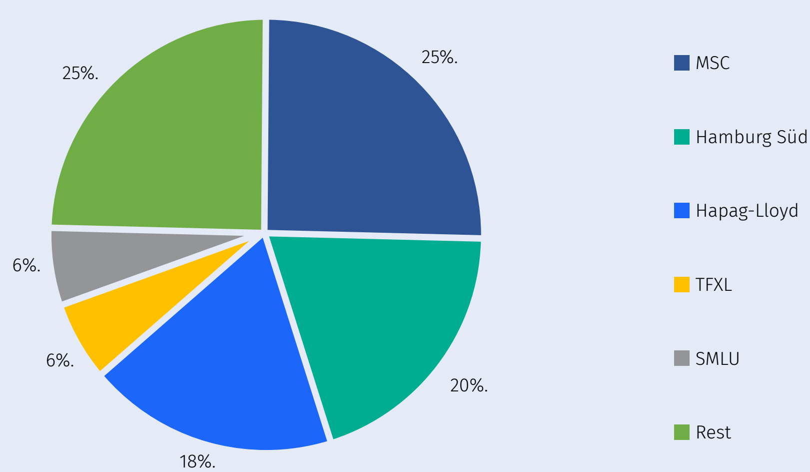
What are the main trends in this segment? In the last decade, the industrial organization of container shipping has undergone **increasing horizontal and vertical consolidation** originating from the search for greater economies of scale —this is also related to the significant increase in the size of vessels— and increases in efficiency. Globally, between 2014 and 2019, the combined market share of the top ten **carriers** increased from 68% to 90%, respectively (UNCTAD, 2020b). This trend can also be seen in LAC, where international trade is carried by a handful of shipping lines. If we take trade with the United States —the region's main trading partner— as a reference, in 2019 three companies transported 84.5% of the TEUs mobilized to the region. These companies were: Mediterranean Shipping Company (MSC) (33.6%), Hapag-Lloyd (24.8%) and Hamburg Süd (23%) (**Figure 4.9**). The same was found for LAC exports to the United States, where the same three companies accounted for 63.4% of TEU movements in 2019: MSC (25.5%), Hamburg Süd (19.8%) and Hapag-Lloyd (18.1%) (**Figure 4.10**). A major point worth noting is that in 2017 Maersk Line acquired Hamburg Süd, so Maersk Line currently owns about 25.5% of import movements and 21% of the export movements to the United States. A very similar trend has been observed in terms of product value (**Figure 4.11**): in 2019, the total value of goods transported by MSC from LAC to the United States was about US$ 800 million, followed by Hapag Lloyd and Hamburg Süd, each of which transported goods valued at just over US$ 400 million. On the other hand, the rest of the companies did not even reach a quarter of the value of goods transported by MSC.

Figure 4.9 TEUs mobilized from the United States to LAC-12 by shipping companies (%, 2019)



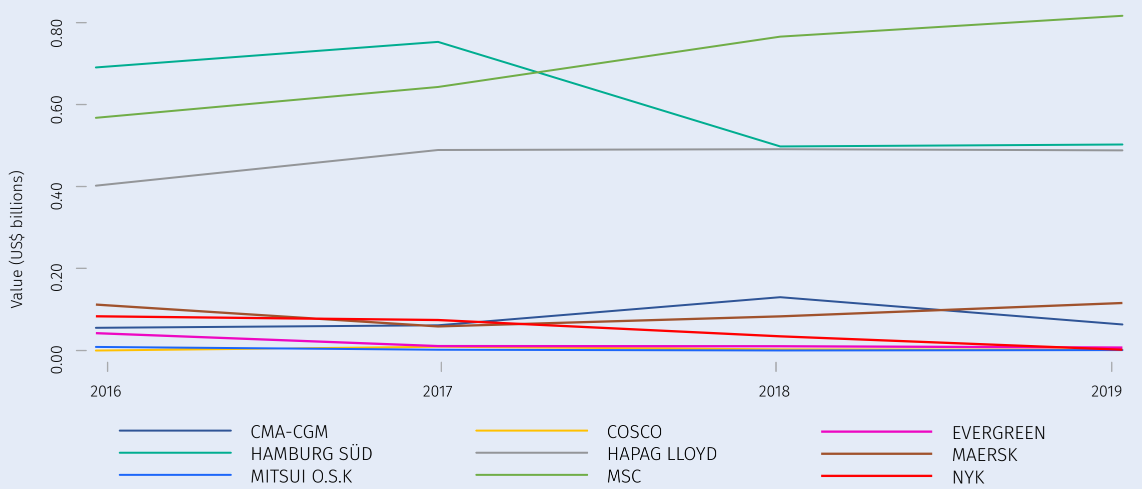
Source: Own production using data from Panjiva.
Note: LAC-12 includes Mexico, Costa Rica, Panama, Colombia, Chile, Bolivia, Brazil, Ecuador, Peru, Paraguay, Uruguay, and Venezuela.

Figure 4.10 TEUs mobilized from LAC-12 to the United States by shipping companies (%, 2019)



Source: Own production using data from Panjiva.

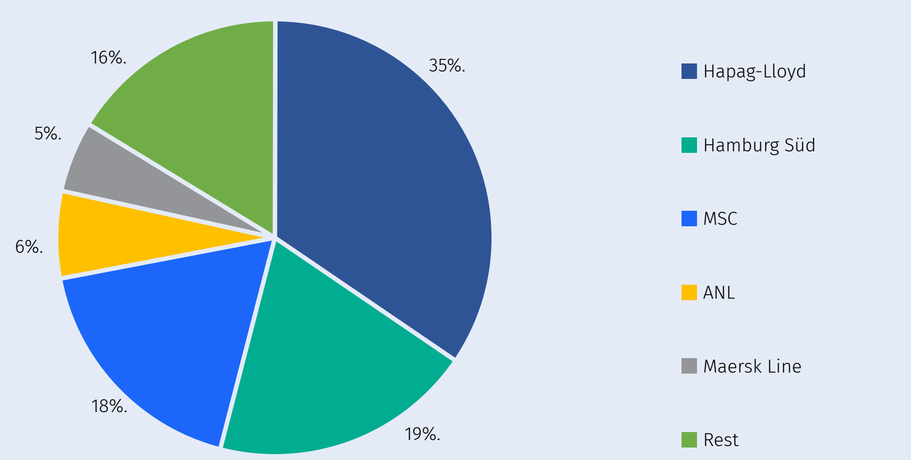
Figure 4.11 Value of cargo transported from LAC and unloaded in the United States (top 10, 2016-2019)



Source: Own production using data from Panjiva.

In intra-regional trade, a high degree of concentration can also be found, with Hapag-Lloyd (34.6%), Hamburg Süd (19.4%), and MSC (17.9%) accounting for two-thirds of the TEUs mobilized in LAC (**Figure 4.12**). Likewise, container shipping company alliances have been gaining considerable market share in the region: together, the three formed alliances (2M, Ocean Alliance, and THE Alliance) went from carrying 64% of TEUs in 2016, to carrying 86% in 2019[32]. 2M was the alliance that increased its market share the most (15 percentage points), followed by THE Alliance (6 percentage points) (**Figure 4.13**).

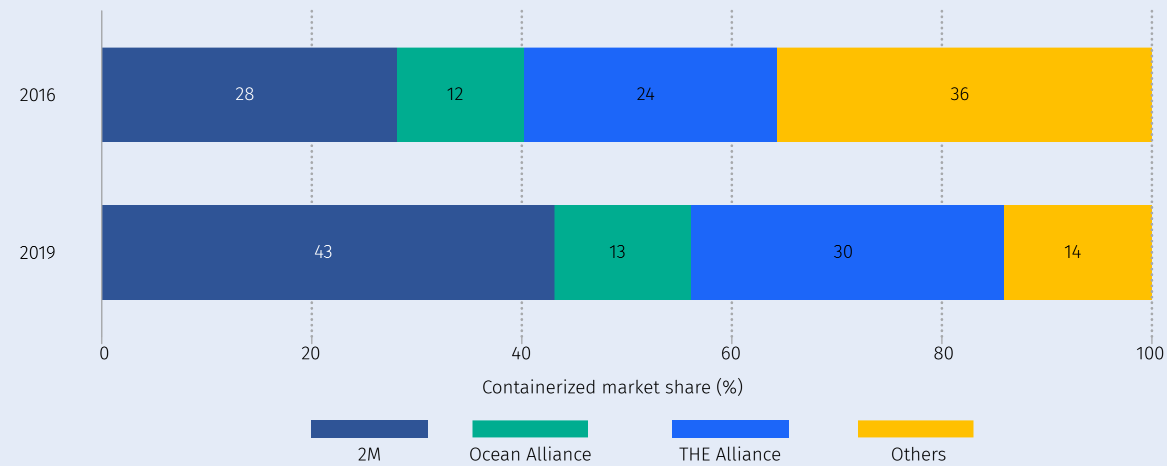
Figure 4.12 TEUs mobilized in LAC-12 by shipping companies (%, 2019)



Source: Own production using data from Panjiva.

32. The 2M alliance is made up by Maersk and Mediterranean Shipping Company; while COSCO, CMA CGM and Evergreen form the Ocean Alliance; and, finally, THE Alliance consists of ONE, Yang Ming and Hapag-Lloyd.

Figure 4.13 Intra-regional market share of container shipping alliances (LAC-12)



Source: Own production using data from Panjiva.
Note: The 2M alliance includes Maersk and Mediterranean Shipping Company; Ocean Alliance includes COSCO, CMA CGM, and Evergreen; THE Alliance includes ONE, Yang Ming, and Hapag-Lloyd. The year 2020 includes shipments until September.

What impact can this have on the sector? The literature shows that a **higher concentration of companies in the maritime transportation sector has direct consequences on transportation costs**. The study carried out by Mesquita-Moreira et al. (2008) shows a positive and statistically significant effect of the number of shipping firms on freight costs for LAC countries. The authors present a decomposition of the differences between maritime export rates from LAC and the Netherlands to the United States. The regional average indicates that 5% of this difference is due to the level of competition. However, this does not affect all countries in the region equally. The authors point out that Honduras is the most affected country (accounting for 34% of the tariff difference), followed by the Dominican Republic (12%), Colombia and Mexico (8%), Peru (7%), Uruguay (5%), and Panama, Argentina, Brazil, Chile and Venezuela (between 3% and 5%). Hummels et al. (2009) also found evidence of price discrimination in the region. This means that shipping prices are higher for goods with lower demand elasticities. Transportation firms take advantage of their market power to increase shipping prices when they know that producers and buyers do not have a wide margin of action and, ultimately, they bear the cost without significant variation in the quantity transported.

Horizontal integration has also taken place in the **container terminal** segment. Similar to what happens at the international level, a small number of companies operate most of the container terminals in LAC. In fact, nearly 60% of the region's TEU movements are carried out by five operators (**Table 4.1**).

Table 4.1 Top 5 terminal operators in LAC (PPP modality, 2019)			
Operator (Headquarters)	**# Terminals**	**Total TEUs (thousands)**	**% of total LAC TEUs**
SSA (USA)	6: St. Vincent and San Antonio (Chile); SMITCO (Colombia); Manzanillo (Mexico); Manzanillo (Panama)	6,044	16%
Hutchinson (China)	8: Buenos Aires (Argentina); Manta (Ecuador); Ensenada, Manzanillo, Lazaro Cardenas and Veracruz (Mexico); Balboa and Cristóbal (Panama)	5,532	14%
APM (Netherlands)	10: Buenos Aires (Argentina); Itajai, Santos BTP (Brazil); TCBuen and Compas Cartagena (Colombia); Moin (Costa Rica); Quetzal (Guatemala); Lázaro Cárdenas y Progreso (Mexico); Callao (Peru)	4,881	13%
TIL (Netherlands)	4: Exolgan (Argentina); Santos, Navegantes and Rio de Janeiro (Brazil); Callao (Peru)	3,133	8%
SAAM (Chile)	5: Antofagasta, Iquique, San Antonio and San Vicente (Chile); Caldera (Costa Rica)	2,790	7%

Source: Suárez-Alemán et al., (2020).

Finally, the **vertical integration** process **among shipping lines, terminals and logistics operator**s worldwide is worth mentioning. To reduce costs and provide better services in a highly competitive market with a reduced profit margin, companies such as Maersk Line and CMA CGM are moving forward to offer door-to-door services to their customers. Thus, within the A.P. Moller-Maersk group, some companies are already operating terminals (APM Terminals), maritime services (Maersk Line), and land logistics (Damco). In line with this trend, in 2019 CMA CGM acquired CEVA, one of the leading global logistics companies, and COSCO formed a joint venture with Jd.com venturing into e-commerce as well.

While greater integration of logistics processes can certainly help reduce operational complexity and improve the sector's performance, **it is also key to ensure that market competition is maintained from a public policy point of view**. Of particular concern are the following factors derived from increasing horizontal and vertical integration: (i) reduction in the number and frequency of maritime services; (ii) limited availability of containers and space on vessels; (iii) consequent increase in transportation times and freight costs; (iv) lower quality of services and options regarding their characteristics; (v) delays in technological upgrading; (vi) limited transparency and availability of information; and (vii) penalties for companies with a lower number of movements. Along with governance, ensuring adequate competition in the sector will be one of the main challenges faced by the region in the coming years. This will require appropriate sector-oriented policies and regulations. Does LAC have the regulatory and institutional capacity to do so? This will be the focus of the next section.

4.3 Governance and competition challenges in the sector[33]

In the 1980s and 1990s, a large number of LAC countries undertook processes to **reform the sector's regulatory framework** to improve the efficiency of the port sector and encourage private sector participation. Argentina (1989 and 1992), Brazil (1993), Chile (1981 and 1997), Colombia (1991), and Mexico (1993) were the pioneering countries in carrying out these reforms, followed by Uruguay, Peru, and, to a more limited extent, Panama, Ecuador and Jamaica a decade later (Suárez-Alemán et al., 2019). On the whole, these reforms led to an improvement in the average performance of LAC ports (Serebrisky et al., 2016). Particularly, it is worth mentioning is the positive impact of the shift from purely public models such as tool or service port, to the landlord model, which invigorated the sector through concessions with private operators, while the State retained ownership

33. Abstract compiled from the article "Port Competitiveness in Latin America and the Caribbean", by Suárez-Alemán et al. (2019).

of the assets. However, they were not fully implemented in most countries, after facing sectoral, political, and social challenges (**Table 4.2**).

Table 4.2 Scope of port reforms in LAC						
Country	**Decentralization of port governance**	**Labor market liberalization**	**Elimination of the national state monopoly**	**BOT[34], BOOT[35] concessions**	**Fully implemented**	**Difficulties**
Argentina	Partially	Yes	Yes	Yes	No	Yes
Brazil	Partially	Partially	Yes	Yes	Mostly	Yes
Colombia	Yes	Yes	Yes	Yes	Yes	No
Chile	No	Yes	Yes	Yes	Mostly	Yes
Ecuador	Yes / Reversed	Yes	Yes	Yes	-	-
Jamaica	No	N / A	No	Yes	-	-
Mexico	Partially	Yes	Yes	Yes	No	Yes
Panama	No	Yes	Yes	No	-	-
Peru	No	Yes	Yes	Yes	Mostly	Yes
Uruguay	No	N / A	Yes	Yes	No	Yes
Venezuela	Yes / Reversed	N / A	Yes / Reversed	Yes / Reversed	No	Yes

Source: Adapted from Suárez-Alemán et al. (2019).

Following the reforms, the challenges became less about management, as they had previously been about, and more about institutionalization and regulation. Different **institutional arrangements** for the sector were made (**Table 4.3**). Although port authorities were created or strengthened to give them a greater degree of autonomy, the prerogatives and institutional capacity of such authorities are limited when compared to leading international ports. For example, in the cases of Rotterdam and Hamburg, —which are the first and third most important container ports in Europe, respectively— their Port Authorities are responsible, among many other things, for the administration, planning, management and contracting operations that improve port performance. In this context, they carry out planning activities on a regular basis, in order to adapt plans and strategic actions to the business needs of the port community. Through this technique and thanks to the constant communication with the private and academic sectors, both ports have developed, for example, digital transformation plans. These are already significantly advanced, having been provided with a budget and the necessary specialized personnel for this purpose. In this regard, LAC has also failed to establish an institutional framework that would increase true intra- and inter-institutional collaboration, with the wide variety of private and civil society actors related to the port industry, to achieve a shared vision for the development of the port[36]. Thus, the formulation and implementation of medium- and long-term strategies to adapt to changing trends in the sector have been virtually absent in the region.

34. Build, Operate, Transfer (BOT) Model
35. Build, Own, Operate, Transfer (BOOT) Model
36. In contrast, international success stories such as those of the ports of Antwerp, Hamburg, and Rotterdam show that close collaboration between the Port Authority, local government and the private sector can generate gains in terms of competitiveness and territorial development for the city-port, as well as reduce the negative externalities of port activity in these cities (OECD, 2014).

<table>
<tr><th colspan="8">Table 4.3 Institutional arrangements for the sector</th></tr>
<tr><th>Country</th><th>Port</th><th>Concessio-naire</th><th>Administrator</th><th>Planner</th><th>Regulator</th><th>Tender</th><th>Compliance with conces-sions</th></tr>
<tr><td>Argentina - Type 1</td><td>Buenos Aires</td><td>Ministry of Transportation</td><td>Port Authority</td><td colspan="3">Port Authority, Ministry of Transportation</td><td>Port Authority, Ministry of Finance</td></tr>
<tr><td>Argentina - Type 2</td><td>Rosario, Dock Sud</td><td>Port autho-rity Regional Government</td><td>Port Authority</td><td colspan="4">Port Authority, Regional Government</td></tr>
<tr><td>Brazil - Type 1</td><td>Santos, Itaguaí</td><td>Port Secre-tariat</td><td>Port Authority</td><td>Port Authority Port Secre-tariat</td><td colspan="2">National Regulatory Authority for Inland Waterways, Port Secretariat, Port Councils</td><td>Port Secretariat</td></tr>
<tr><td>Brazil - Type 2</td><td>Paranagua, Rio Grande</td><td>Port autho-rity Regional Government</td><td>Port Authority</td><td>Regional government</td><td>National Regulatory Authority for Inland Wa-terways, Port Councils</td><td>Regional Government, Port councils</td><td>Regional gover-nment</td></tr>
<tr><td>Chile</td><td>Valparaíso, San Antonio</td><td colspan="6">Port Authority</td></tr>
<tr><td>Colombia</td><td>Cartagena, Buenaventura</td><td>The National Infrastructure Agency</td><td>Port Authority</td><td>The National Planning Authority</td><td>Superin-tendency of Transportation</td><td>The National Infrastructure Agency</td><td>Superinten-dency of Trans-portation</td></tr>
<tr><td>Ecuador</td><td>Guayaquil, Bolivar</td><td>Ministry of Transportation</td><td>Port Authority</td><td colspan="4">Ministry of Transportation</td></tr>
<tr><td>Jamaica</td><td>Kingston</td><td colspan="6">Port Authority</td></tr>
<tr><td>Mexico - Type 1</td><td>L. Cardenas, Manzanillo</td><td>Department of Transportation</td><td>Port Authority</td><td colspan="2">Port Authority, Department of Transportation</td><td>Department of Transportation</td><td>Department of Transportation, Port Authority</td></tr>
<tr><td>Mexico - Type 2</td><td>Campeche</td><td>Regional government</td><td>Port Company</td><td>Regional government</td><td colspan="3">Port Authority, Regional Government</td></tr>
<tr><td>Panama</td><td>All major ports</td><td>Completely private</td><td colspan="2">Private concession</td><td colspan="3">Port Authority</td></tr>
<tr><td>Peru</td><td>Callao, Paita</td><td>Ministry of Transportation</td><td>Private con-cession</td><td>Ministry of Transpor-tation, Port Authority</td><td>Transportation Regulatory Authority</td><td>The National Institute of Concessions</td><td>Ministry of Transportation</td></tr>
<tr><td>Uruguay</td><td>All ports</td><td colspan="6">Port Authority</td></tr>
</table>

Source: Suárez-Alemán et al. (2018a).

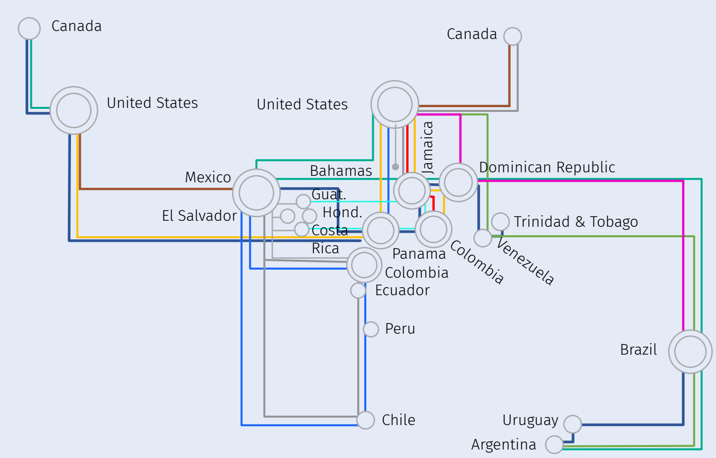
In terms of competition, the reforms were aimed more at favoring **intra-port competition** than at safeguarding competition in the sector as a whole. Consequently, as noted in the previous section and in line with Ancor Suárez-Alemán et al. (2019), today, the region today faces the **challenge of high concentration in terms of both terminals and service provision**. In this scenario, it is essential that the competent authorities carefully analyze and monitor whether the concentration is being transferred to variables such as freight prices, surcharges, shipping frequencies, transit times, and, in general, the quality of services, which could be detrimental to the competitiveness of LAC countries. Indeed, as the cases compiled by Suárez-Alemán et al. (2019) show, the sector has not been exempt from sanctions for anti-competitive actions. It is worth noting that these actions have been most evident in the Ro-Ro and bulk solids and liquids segments.

Likewise, given that the market structure has evolved since the sectoral regulations were drafted, regulatory and institutional alignment is urgently required with the aim of redesign concentration processes so that they result in increased efficiency without affecting competition. Finally, given the global nature of the market and of containerized shipping companies —usually subject to jurisdictions outside the region— collaboration and information exchange with institutions in other countries, both inside and outside of the region should be strengthened to ensure fair competition and prevent anti-competitive practices in these markets (Crucelegui, 2020).

4.4 Port performance gaps

For shipping companies, the configuration of container transport services is based on two determining factors: the total cost of the service network and the network's overall performance (Ducruet & Notteboom, 2012). The choice of ports where these ships will call depends on a multiplicity of supply and demand factors, including vessel and port characteristics, port efficiency, interconnection with other modes of transportation, the availability of value-added logistics services, and the economic and political characteristics of the country (Notteboom, 2006). Thus, ships transporting international trade from a LAC country will call not only at that country's ports, but also at a set of ports distributed throughout the region (**Figure 4.14**).

Figure 4.14 Container shipping network in the Americas

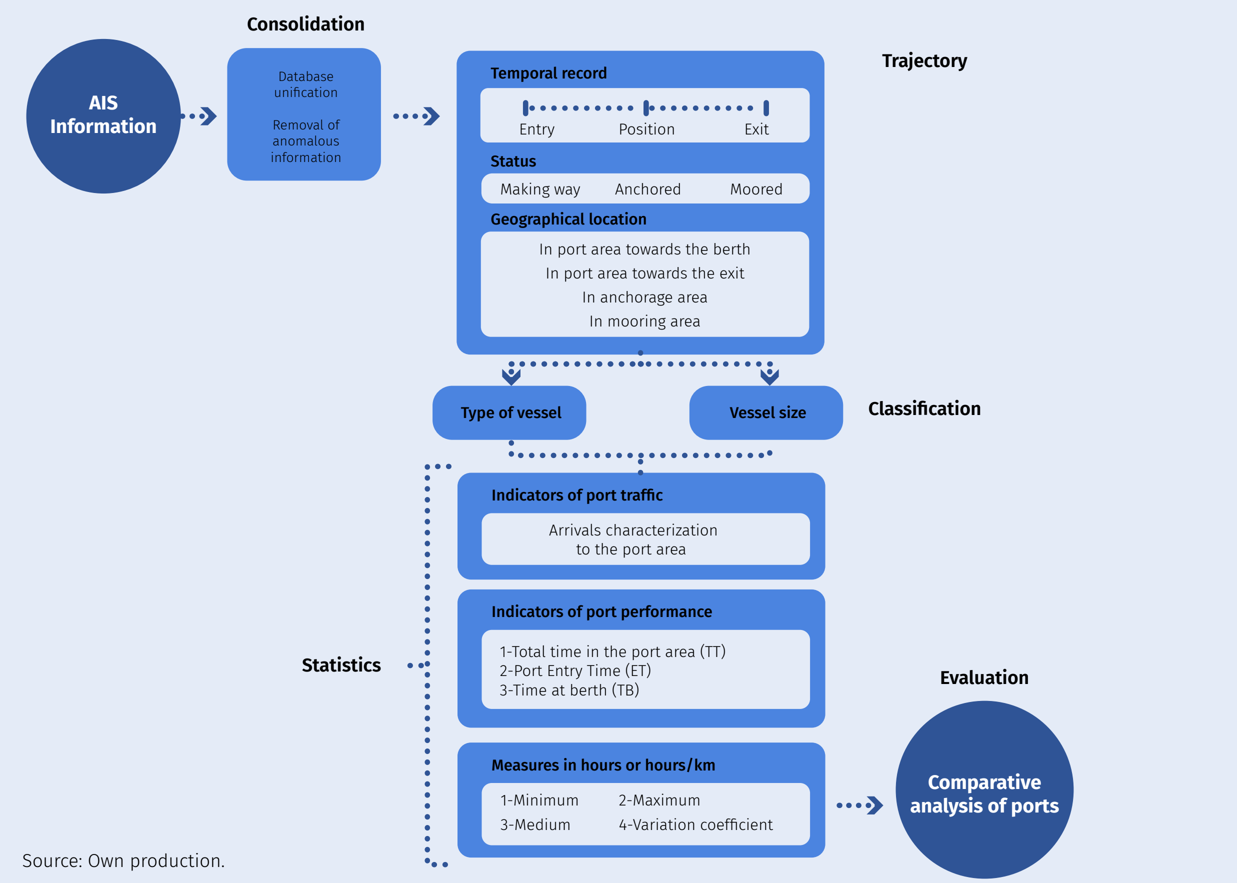


Source: Calatayud et al. (2017).
Note: With the exception of Costa Rica and Guatemala (for visual simplicity), the east and west coasts are indicated for countries with ports on the Atlantic (or the Caribbean Sea) and Pacific oceans, respectively.

This means that, before reaching its destination, a country's international trade must be transported through other ports in the region. Thus, it is not enough for the LAC exporting country to achieve high port efficiency. The rest of the ports through which such trade goods move must also perform well. The question then is: how efficient are the LAC ports through which the region's international trade is moved? Serebrisky et al. (2016) analyzed the **technical efficiency** in the land segment of LAC terminals, using a stochastic frontier model with information on the performance of each terminal, port terminal area, dock length, and the number of cranes. The authors found that, in recent decades, the technical efficiency of land segments has increased by 20%, reaching an average of 64% for the region (84% for Santos, the most efficient port). Suárez-Alemán et al. (2016) compared the efficiency of LAC with that of other regions and concluded that the region, despite ranking below ports in China, had achieved a good position with respect to other developing countries (which reported an average of 61%). However, this level is well below the possible port efficiency frontier (100%).

As a complement to said study, we have analyzed here the **efficiency of the water segment** in the nine most relevant Latin American ports in 2019, according to traffic and weight of the cargo moved. These ports are: Buenos Aires, Callao, Cartagena, Guayaquil, Manzanillo, Montevideo, Rio de Janeiro, Santos and Valparaíso. To this end, we used *big data*, consisting of 12 million AIS (Automatic Identification System) data records[37], the primary maritime tracking system, which reports information on unique vessels (a total of 4,233) that called at the nine selected ports in 2019. Since vessel type and size are linked to port efficiency, we used three types of vessels in our analysis: container ships, non-containerized bulk cargo or general cargo ships, and oil and chemical tankers. We then divided them according to their gross tonnage (GT): medium-sized ships, with a GT of between 500 and 25,000; large ships, with a GT greater than 25,000 and less than or equal to 60,000; and very large ships, with a GT greater than 60,000. The latter is important to control, for example, for the larger size of container ships calling at some of the ports analyzed. **Figure 4.15** summarizes the methodological steps for processing and analyzing the data (for more information, see **Annex III**).

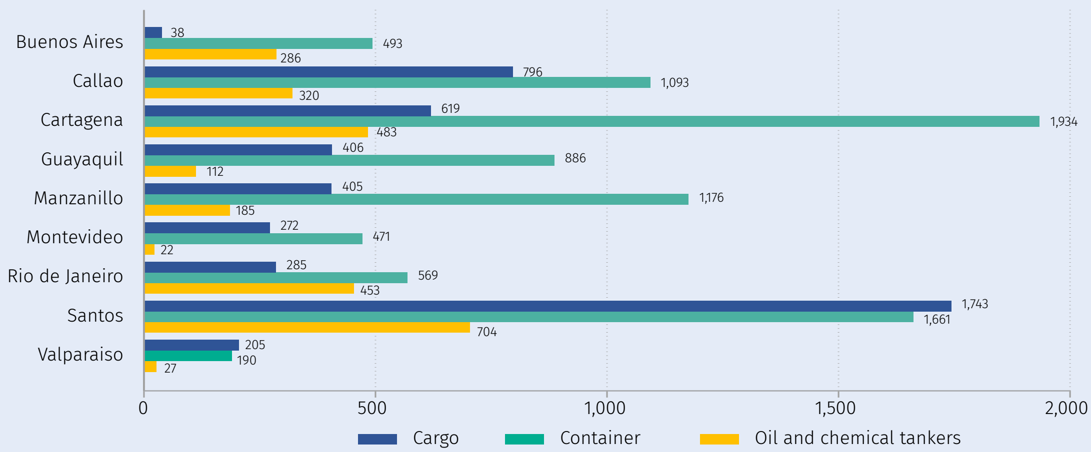
Figure 4.15 Methodological steps in the comparative port analysis



Source: Own production.

37. System required by the International Maritime Organization's Convention for the Safety of Life at Sea for all cargo ships of 300 gross tonnage or more, and all passenger ships, regardless of size.

Figure 4.16 Total number of ships by type, main LAC ports (2019)



Source: Own production using Marine Traffic data.

To analyze port performance on the sea side, and in accordance with Feng et al. (2020), we used three indicators:

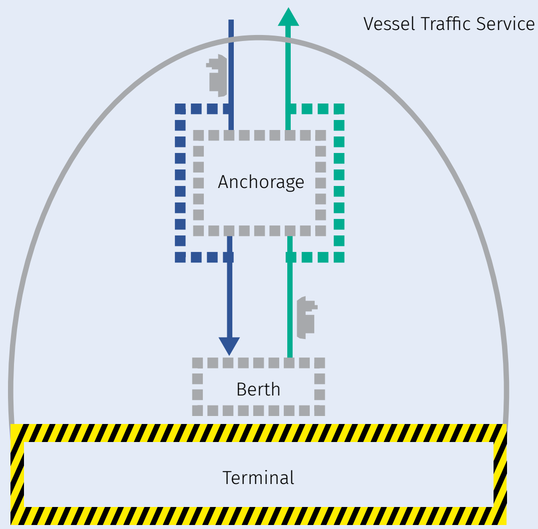
1) Total Time in the port area (TT): This indicator refers to the time it takes for the vessel to complete the full cycle within the port area. Note that this includes both the time berthed in the process of loading and unloading as well as the time of anchorage entry and/or exit in case it is carried out.

2) Port Entry Time (ET): This indicator reflects the time it takes for the vessel to arrive at the berth from the moment it enters the port area. It includes the entire time whether the vessel has stopped in the anchorage area or not. Note that, in order to control for differences between port areas, this indicator is reported in hours per kilometer to ensure comparability of the indicator between ports.

3) Time at Berth (TB): This indicator records how much time vessels spend at the berth carrying out loading or unloading operations.

Figure 4.17 illustrates these three indicators in a simplified form. TT is calculated as the time it takes for a vessel to complete the process from the time it crosses the VTS line (in gray) towards the berth, until it crosses it in the opposite direction; ET refers to the time it takes a vessel to cross the red line, regardless of whether or not it has stopped in the anchorage area. TB is the time the vessel remains in the berth box.

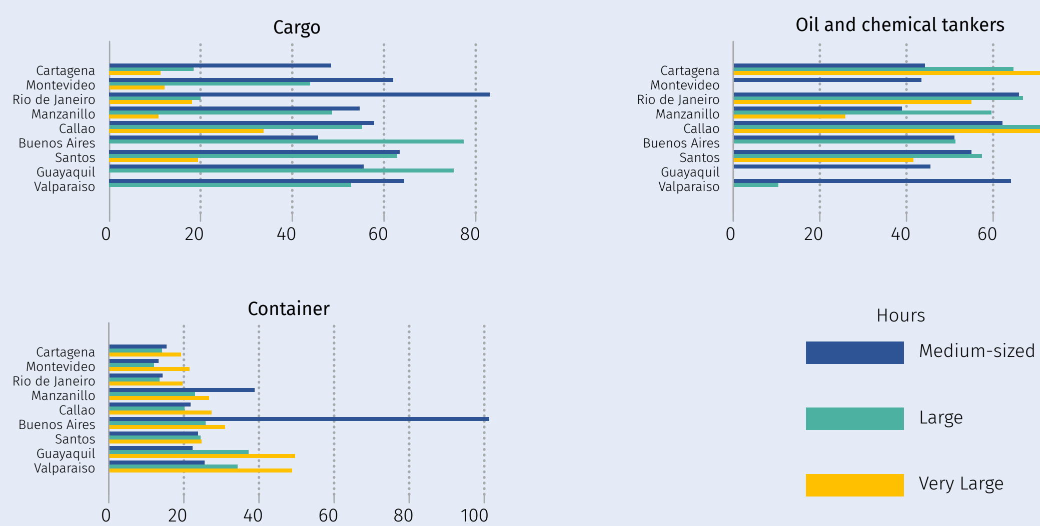
Figure 4.17 Graphical representation of indicators



Source: Own production.

When these timings were taken in the ports analyzed, Cartagena stood out as the most efficient port regarding TT for container ships of less than 25,000 tons, with a median time of around 14 hours for medium-sized ships; Montevideo was the most efficient for large ships with around 12 hours, and Rio de Janeiro for very large ships with 19 hours. The port of Rio de Janeiro was the least efficient port in TT for medium-sized vessels (95 hours), and the port of Santos was the least efficient for large vessels and Guayaquil for very large vessels (**Figure 4.18**).

Figure 4.18 Median TT by vessel type and size (2019)

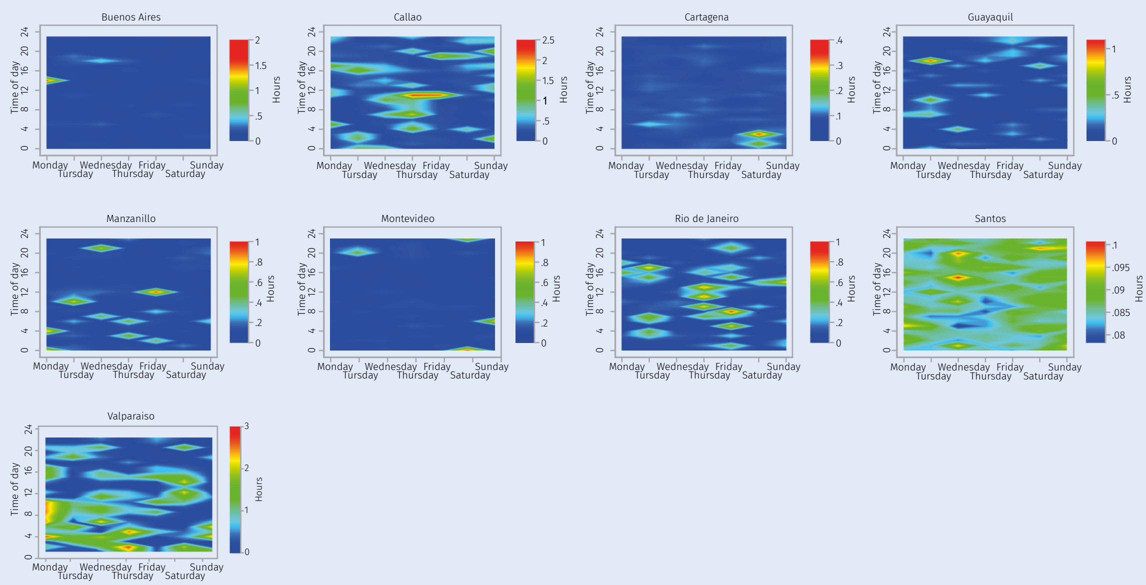


Source: Own production using Marine Traffic data.

This order changes when comparing the times of non-containerized cargo ships. For medium-sized ships, Cartagena and Buenos Aires were the most efficient (just over 55 hours) and Rio de Janeiro the most inefficient (110 hours). The most efficient port for oil and chemical tankers. Manzanillo was the least efficient port for large oil and chemical tankers, and Callao was well above the rest regarding very large vessels, exceeding 154 hours.

To establish at what times the highest congestion occurs at the ports under analysis, **Figure 4.19** shows the breakdown of the median ET by day of the week and time of day. In the ports of Valparaiso, Buenos Aires, and Manzanillo, the longest times occur during the first day of the week (Monday); while in Rio de Janeiro and Callao, the longest times are found towards the end of the work week (Thursday and Friday); and in Cartagena and Santos, during weekends.

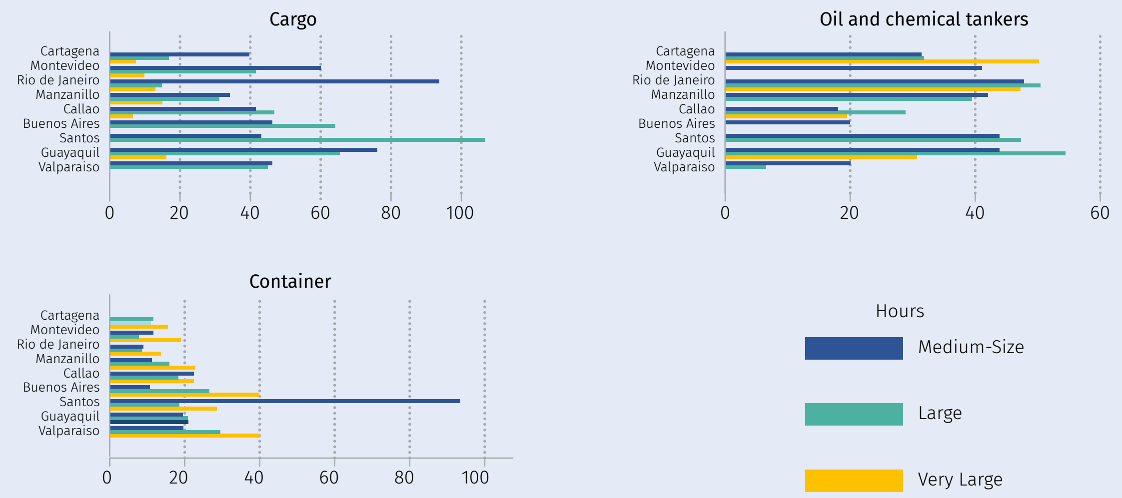
Figure 4.19 Temporal disaggregation of ET in selected ports (2019)



Source: Own production using Marine Traffic data.

Another key performance indicator is the time that loading/unloading (TB) processes take a vessel. **Figure 4.20** reports the median time for this indicator by vessel type and size. Cartagena, Callao and Manzanillo are the most efficient ports for medium-sized non-containerized dry cargo ships, Rio de Janeiro for large vessels and Manzanillo for very large vessels. Turnaround time is relatively high in Montevideo for medium-sized vessels, and in Buenos Aires for large vessels. In the case of container ships, Cartagena, Montevideo, Rio de Janeiro, and Guayaquil show the highest efficiency for medium vessels and Rio de Janeiro and Montevideo for large vessels, although Cartagena and Rio de Janeiro are the most efficient for very large vessels. For oil and chemical tankers, Manzanillo, Guayaquil, and Valparaiso have the highest relative efficiency for medium-sized vessels (approximately 20 hours). For very large oil and chemical tankers, Callao ranks first, with a median time of less than 1 hour.

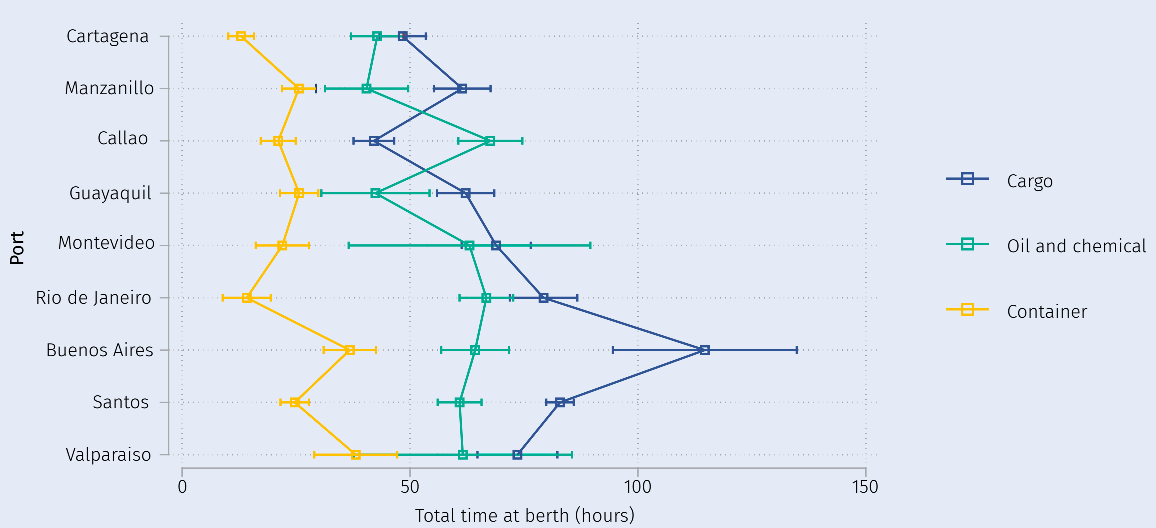
Figure 4.20 Median TB by vessel size and type



Source: Own production using Marine Traffic data.

To isolate the effects that ship size and type might have when comparing the TB in the different ports, we performed an analysis of covariance (ANCOVA). **Figure 4.21** shows the performance of the ports taking into account the variability of the indicator during 2019. In the case of container ships, Cartagena and Rio de Janeiro are the ports with the best relative performance (between 13 and 14 hours), followed by Callao (21 hours). At the other end, we find Buenos Aires (37 hours). Regarding dry cargo, Callao is the best performing port (42 hours), followed by Cartagena (48 hours). Buenos Aires is the worst performing port for this type of vessel (115 hours). Finally, Manzanillo (40 hours) and Guayaquil (42 hours) show the best performance for oil and chemical tankers, with Callao at the opposite end (68 hours).

Figure 4.21 ANCOVA analysis of TB by vessel size and type (2019)



Source: Own production using Marine Traffic data.

What factors explain these differences in water performance? Regional studies show that the reasons lie, in part, in the levels of assets available at the terminals. For example, López-Bermúdez et al. (2019) found that, in the case of Argentina, ports with a higher number of gantry cranes reported better waterborne performance versus ports which had a greater number of mobile cranes. In particular, their results indicated that a 1% increase in gantry cranes represents a 0.56% increase in the volume of containers handled annually by the terminal. On average, that translates into 651 more TEUs per terminal per year. Another important aspect is the different number of private and public operators in a port, as well as the organizational structure of the port (see Suárez-Alemán et al., 2018b), delays in the administrative processes for import and export (Sánchez et al., 2003), and the level of technology adoption to manage port operations (Calatayud et al., 2020).

In conclusion and based on the differences in technical efficiency pointed out by Serebrisky et al. (2016), **we found a wide dispersion among LAC ports in terms of their sea segment performance**. Due to the relationship between time efficiency and transportation costs (Sánchez et al., 2003) and to the importance of maritime transportation for international trade and, consequently, for the economic growth of a country, it is essential to advance towards the improvement of land and water transportation performance. In Chapter 11, we will address the policy actions needed in this regard. An important issue from a regional perspective is the **interdependence between ports** when considering container transportation —the one with the highest added value and, therefore, the one with the greatest potential for economic development. Because ships in service often call at more than one port in the region, it is not enough for the LAC exporting country to achieve high port efficiency. For this reason, regional coordination between the port and maritime authorities should be part of the physical integration agenda, as is the case in Europe through the Motorways of the Sea.

Conclusions

By way of summary, in this chapter, we present three key challenges to improve the region's shipping performance, namely: (i) greater horizontal and vertical concentration in the container market; (ii) limited governance and institutional capacity of the sector; and (iii) port performance gap. A fourth challenge is related to the limited inter and multimodal transportation systems in the region, as discussed in Chapter 10 on logistics corridors. Indeed, according to ITF (2017), the region should increase the provision of road infrastructure that provides access to port terminals by 2030 by 15% to meet the demand arising from the expected growth in international trade. These challenges for maritime transportation will be revisited in the last chapter of this publication, where we will analyze the actions required to overcome them.

CHAPTER 5

THE CHALLENGES OF AIR TRANSPORTATION

Over the last 10 years, air cargo has maintained a positive trend in LAC, driven by factors such as the growth of e-commerce. Although the share of air transportation in the countries' modal matrix is lower when compared to road, maritime and rail transportation, it plays an important role in facilitating the movement of time-sensitive products, either because they are perishable or because of the need to have them available in the shortest possible time. In general, because of its ability to connect distant markets quickly and reliably, air transportation profoundly impacts on a country's ability to insert itself into global trade. In this regard, Arvis et al. (2016) found that a 1% growth in the Air Connectivity Index (ACI)[38] is correlated with a 6.33% growth in trade volume. Additionally, having adequate air transportation infrastructure and services provides a channel for insertion into more sophisticated industrial segments. Indeed, due to the higher cost of this mode —estimated between 4 to 6 times higher than the cost of maritime and road transportation products transported by air are generally of higher added value (World Bank, 2009; Freightos, 2020).

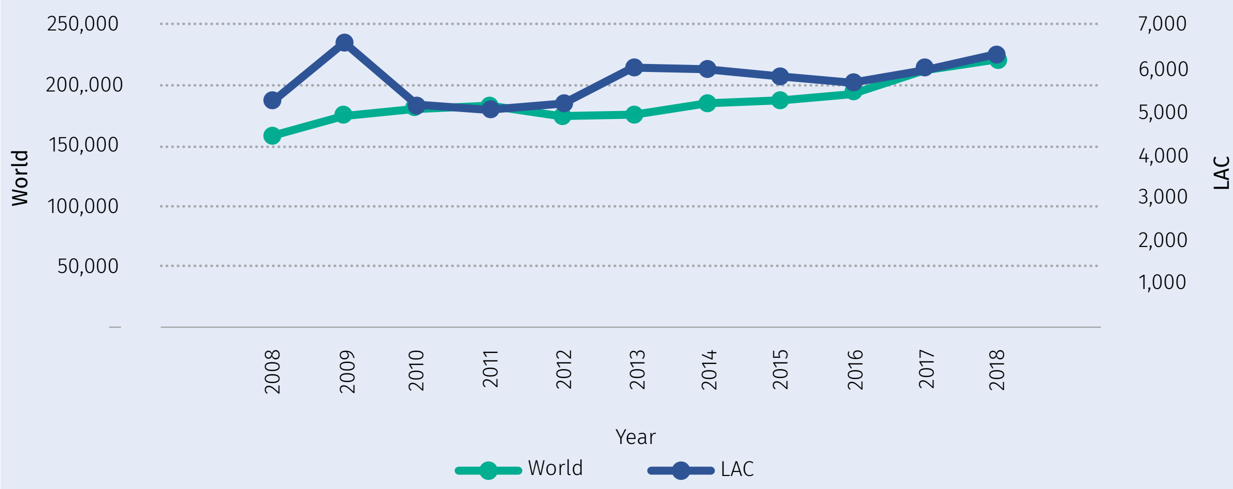
This chapter updates the results obtained by Serebrisky et al. (2011) in the past decade. It is divided into four sections to analyze the challenges of the air sector in LAC. The first section describes trends in air cargo. The second section analyzes the air cargo regulations and policies of the countries in the region. The third section summarizes the operational needs and conditions of the cargo airport infrastructure based on recent data and a survey of air transportation providers and users in the region carried out in collaboration with the Latin American and Caribbean Air Transport Association (ALTA, as per its Spanish acronym). Finally, the last section concludes with challenges and recommendations for the sector in the region.

5.1 Trends in air cargo in LAC

Between 2008 and 2018, **the sector has grown** by an average of 3.3% per year in the region, following the global trend, although in a more unstable manner (**Figure 5.1**). This includes an interruption in growth during the years following the financial crisis of 2009 and the economic crisis in Brazil in 2015/2016.

38. Arvis and Shepherd et al. (2016) developed this indicator to measure the position of a country in the global air transportation network. Countries with a high ACI score have stronger air connections to a wider range of destinations than countries with a lower score. A higher ACI score, which shows better air connectivity, is strongly associated with a deeper degree of global trade integration.

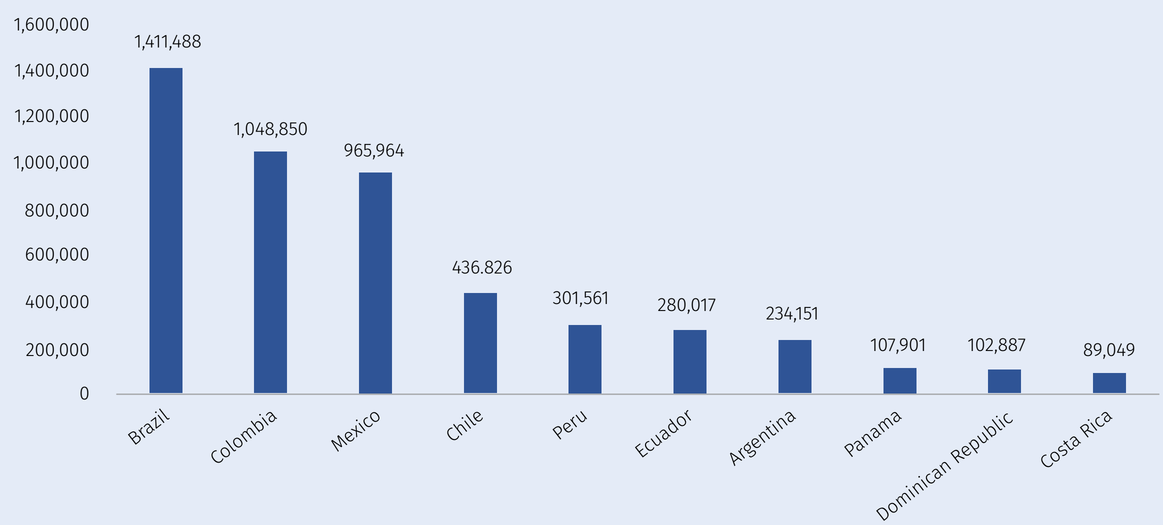
Figure 5.1 Cargo transported by air in LAC vs the world (millions of tons – km, 2008-2018)



Source: Authors' production based on World Bank data (2021) .
World development indicators. Air transport, cargo (million ton-km).
Available at https://data.worldbank.org/indicator/IS.AIR.GOOD.MT.K1

According to Airports Council International (ACI, 2020), Brazil, Colombia and Mexico concentrate two thirds of the tons mobilized in LAC by air, respectively reaching 27%, 20%, and 18% of total cargo in 2018 (**Figure 5.2**). Although in these three cases the volume of international cargo exceeds domestic cargo, it is worth highlighting that in Brazil the latter amounts to 46.97% of its market. With respect to the beginning of the period under consideration (2008), there is evidence of a significant increase in Colombia's share of the regional market (5.23%). Other countries whose share has also grown significantly are Mexico (1.40%) and Peru (1.21%).

Figure 5.2 Cargo mobilized in LAC – Top 10 (metric tons, 2018)

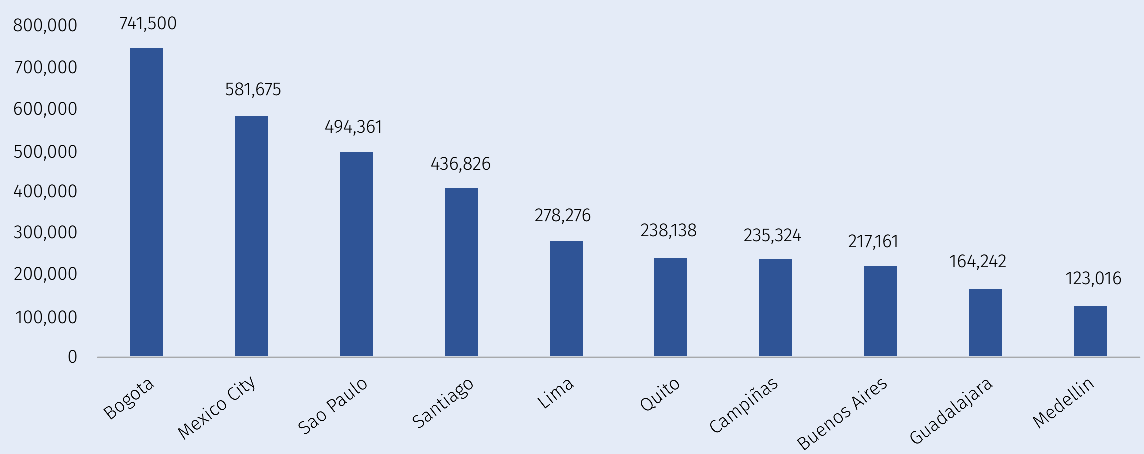


Source: Authors' production based on data from ACI (2020).

Overall, **the size of the LAC market** (2.8% of the world market in 2019) **is small** when compared to volumes in Asia (34.6%) or North America (24.2%) (IATA, 2020e). This is due to the region's trade specialization, with the preponderance of bulk agricultural exports and products of greater weight and low relative added value (see Chapter 1), as well as the progress in cold chain technology, which makes it possible to maintain the quality of products for a longer time and, consequently, makes their maritime transportation viable. However, it is worth noting the **growth of niche segments** in the air transportation of goods, such as flowers and fresh fish, which have a very short shelf life and therefore require a fast mode of transportation for them to be consumed before they expire.

At the regional level, El Dorado airport in Bogota has remained the main node, with 14.14% of the total tons mobilized in the region in 2018 (**Figure 5.3**). The airport with the highest growth in the 2004-2018 period has been Benito Juarez (MEX) in Mexico City (1.15%), followed by Mariscal Sucre (UIO) in Quito (1.10%), Jorge Chavez (LIM) in Peru (0.77%), Tancredo Neves/Confins (CNF) in Belo Horizonte, and Arturo Merino Benitez (SCL) in Santiago (0.59%).

Figure 5.3 Air cargo moved in LAC, main airports (metric tons, 2018)



Source: authors' production based on data from ACI (2020).

For the three main airports in the region (Bogota, Mexico City, and Sao Paulo/Guarulhos), the United States are the main destination for air cargo (67%, 36% and 42%, respectively). The second main destination for cargo exported from El Dorado airport is LAC countries (22%). At the other airports, the European Union is the second destination region (33% at Mexico City and 44% at Guarulhos) (see **Table IV-I** in **Annex IV**).

Miami is the main gateway for air cargo to LAC and stands out as the leader in international cargo for the region, distributing perishable products, high value-added commodities, telecommunications products, textiles, pharmaceuticals and industrial machinery. The airport is responsible for 79% of air imports and 77% of exports to and from LAC countries (Miami Airport, 2018). **Table IV-II** in **Annex IV** shows the main trade flows with LAC countries.

Box 5.1 Regulatory frameworks

Pre-COVID projections were encouraging. According to Boeing's World Air Cargo Forecast, the global market would grow by around 4% through 2039, with a significant share of growth in tons transported between Central America and North America, and Central America and Europe. However, the pandemic has negatively impacted cargo and passenger traffic at airports, with large losses for airports and airlines[39]. For air cargo, there was evidence of a 21.3% reduction in demand (ton-km) compared to 2019 and 35% reduction in capacity (IATA, 2020a), leading to an increase in load factor. As of October 2020, nearly 46,400 special cargo flights carried 1.5 million tons of cargo, mostly medical equipment to areas in need (IATA, 2020b). Additionally, the air cargo logistics capacity required to address the global distribution of COVID-19 vaccines is expected to scale, adapting infrastructure, processes, and resources to efficiently and safely respond to the logistical needs of these medicines (IATA, 2020c).

According to (IATA, 2020d), it is only by 2024 that the 2019 domestic Revenue Passenger Kilometers (RPKs) levels are expected to recover. In particular, cargo movement will be conditioned to the recovery of the economy, the return of international trade flows, and the slow recovery of passenger flights, since on average, 60% of air cargo is transported in the cargo holds of commercial passenger aircraft. Regarding the latter, the 20% capacity expansion in dedicated cargo aircraft has not been enough to balance the more than 50% reduction of capacity in the cargo holds of commercial aircraft (IATA, 2020a).

5.2 Regulatory structures

International connectivity between countries is governed by Air Service Agreements (ASAs)[40], which are bilateral and multilateral agreements that establish the rules and conditions for an air connection between two or more countries, such as routes, tariffs, capacity, among others, and may be restrictive, depending on the national policies of each country. Some LAC countries have less restrictive air transportation policies, such as Brazil, Chile, Paraguay and Uruguay, while others are more restrictive, such as Argentina and Venezuela. (**Table IV-IV in Annex IV**).

In this regard, it is worth noting the importance of the **Multilateral Agreement on the Liberalization of Air Transportation**[41] in LAC, for the liberalization of standards and regulations in international aviation to promote the supply of flights and connectivity between countries, such as: (i) Open Skies Agreement for Member States of the Latin American Civil Aviation Commission (LACAC)[42], signed in 2010 and which involves Brazil, Colombia, Chile, Dominican Republic, Guatemala, Honduras, Panama, and Paraguay; (ii) "Andean Open Skies" of the Andean Community (Bolivia, Colombia, Ecuador, Peru, and Venezuela), signed in 1990; (iii) Sub-regional Air Services Agreement, commonly known as the Fortaleza Agreement, signed in 1996, by Argentina, Bolivia, Brazil, Chile, Paraguay, Peru and Uruguay, to promote new sub-regional air services; and (iv) Pacific Alliance, signed by Chile, Colombia, Mexico, and Peru.

39. ACI estimated a reduction of 4.6 billion passengers and over US$97 billion in revenues by 2020 (ACI, 2020).
40. Whose basis in international law is established by the international treaty of the Chicago Convention.
41. The liberalization of the air sector considers the simplification and/or extension of rules and/or conditions for air operations within a country and/or between several countries.
42. LACAC (2019).

As part of this study, a quantitative analysis was carried out to determine whether air service agreements (ASAs) in force in LAC represent a barrier to the movement of air cargo services within the region. For this purpose, the methodology used in the report by Serebrisky et al. (2011) was applied, where, for each pair of countries with scheduled cargo services, the percentage of capacity authorized by the ASAs that is actually used by the airlines of both countries is identified. Serebrisky et al. (2011) performed this exercise in 2010 for a total of 13 countries. In this case, we have used 2019 data and expand the sample to a total of 29 countries in LAC. The quantitative analysis focuses on identifying potential capacity constraints between countries with scheduled cargo services. For country pairs where there is no service at all, it can be assumed that regulations, at least those determined in the ASAs, are not the reason for the lack of services.

The Official Airline Guide (OAG, 2019), which contains the schedules of most airlines worldwide for both 2010 and 2019, was used as the source of information for the analysis. Information was extracted from all scheduled cargo flights within LAC, considering all flights with traffic rights and the airlines that operate them. This means that flights with traffic restrictions (such as the impossibility to pick-up cargo) and flights published under another code-sharing carrier (for marketing purposes) were not included in the analysis. Since airline schedules can vary significantly during the year as a result of seasonal fluctuations in demand, rather than selecting an "average" week of the year, which runs the risk of picking a week that either under or over represents the average, the analysis was conducted using yearly traffic and capacity figures published by OAG[43].

Serebrisky et al. (2011) concluded that, in almost all cases, **bilateral agreements did not appear to be restricting cargo services**. Carriers based in most country pairs where capacity was not unlimited often used less than 50% of available frequencies. Mexico-Brazil was an exception, with Mexican carriers using 61% of available capacity. It could be argued that this market was somewhat restricted, even more so considering the fact that all of these frequencies were used by a single operator, perhaps limiting opportunities for a second airline willing to enter the market. The Air Service Agreement (ASA) between Venezuela and Panama, which had been in place since 1975, was the only one that unequivocally restricted cargo services in 2010.

In order to analyze the status in 2019 and compare it with the results of Serebrisky et al. (2011), we first identified the annual scheduled cargo flights for this year, for the same 13 countries of the 2010 sample. The criterion used for the definition of the number of yearly frequencies for cargo —expressed in the rows of **Table 5.1**— is the country where the airline is based (i.e. where it has its legal domicile). This is what the bilateral ASAs consider for the calculation of frequencies. For example, a Buenos Aires-Sao Paulo-Bogota flight operated by a Colombian carrier would not be using any frequencies of the Argentina-Brazil bilateral agreemet, despite the fact that it connects these two countries. Since the airline of the example is based in Colombia, the flight would take one frequency from the Colombia-Argentina bilateral agreement and another from the Colombia-Brazil bilateral agreement. Only flights operated by carriers based within the region, and only to/from points within the region, have been considered.

43. It is worth mentioning that schedule information may not provide a complete picture of cargo services in the region, since many cargo flights are operated as non-scheduled services and, as such, their schedules are not published (therefore, they do not appear in the OAG database). This fact, which is not particular to LAC, can also be observed in all other regions.

Table 5.1 Scheduled air cargo services, by airline domicile (yearly frequencies, 2019)

Flying to (columns) / Airline domiciles (rows)	Argentina	Brazil	Chile	Colombia	Costa Rica	Ecuador	El Salvador	Guatemala	Honduras	Mexico	Panama	Peru	Venezuela
Argentina													
Brazil	552		552	260		104						52	104
Chile	210	209											
Colombia		365			104	677		52			270	260	
Costa Rica		365											
Ecuador													
El Salvador													
Guatemala													
Honduras													
Mexico					51			102					
Panama				156	366		104	104	261				574
Peru													
Venezuela				631							632		

Source: Authors' production based on data from OAG.
Note: 1. Blank cells indicate non-existence of services. 2. Only services offered by airlines domiciled in LAC have been considered for this analysis, and only for international services to/from points within the region.

The percentage of authorized capacity in use in 2019 (**Table IV-III** in **Annex IV**) was estimated by cross-referencing the data on scheduled frequencies in OAG by country of domicile of the airline, together with the points of origin and destination of the flights. The results show that, in 2019 there was an underutilization of capacity only in the bilateral relations between Brazil and Peru, Mexico and Guatemala, and Panama and Venezuela. In other words, the existing services in 2019 were less than the capacity limits imposed by the bilateral agreements. The relationship where there was a capacity restriction was between Brazil and Argentina, with 52% of excess capacity offered by Brazilian airlines. In the rest of the bilateral relationships, where there were exclusive air cargo services in 2019, there were no capacity limits.

Table 5.2 shows the results of the comparison for the years 2010 and 2019. The main change observed is the elimination of the services offered by Guatemala, due to the exit of DHL Aero Expreso Guatemala from the market. As a result, the services that this country had with Costa Rica, El Salvador, Honduras, Mexico, and Panama were also eliminated. Similarly, there has been an increase in the services offered by Panama, due to the increase in the operations of DHL's local subsidiary. In this sense, in 2019, Panama offered services to Colombia, El Salvador, Guatemala, Honduras and Venezuela that did not exist in 2010. The other fundamental variations between 2010 and 2019 occurred mainly in the increase in frequencies offered by airlines from Brazil (Latam Cargo Brazil) and Colombia (Tampa Cargo), and, particularly, in cargo services offered by Colombian airlines to Brazil, which increased by 600%.

Table 5.2 Scheduled air cargo services, by airline domicile (2010 vs. 2019)

Flying to (columns) / Airline domiciles (rows)	Argentina	Brazil	Chile	Colombia	Costa Rica	Ecuador	El Salvador	Guatemala	Honduras	Mexico	Panama	Peru	Venezuela
Argentina													
Brazil	+100%		+100%	+25%		-33%						S/C*	-50%
Chile	+100%	+33%											
Colombia		+600%			+100%	+334%		+100%		-100%	+100%	+145%	-100%
Costa Rica													
Ecuador											-100%		
El Salvador													
Guatemala					-100%		-100%		-100%	-100%	-100%		
Honduras													
Mexico		-100%	-100%	-100%	S/C*	-100%		+100%					-100%
Panama				+100%	-30%		+100%	+100%	+100%				+100%
Peru													
Venezuela				S/C*	+100%						+73%		

Source: Authors' production based on data from OAG.
Notes: 1. Blank cells indicate no services in both 2010 and 2019.
2. Only services offered by airlines domiciled in LAC are considered for this analysis, and only for international services to/from points within the region.
3. For all cases where the legend shows a value of "+100%", it represents relations where in 2019 cargo services were registered when in 2010 there were no services, with the exception of the Panama-El Salvador relation, where the number of frequencies that had been registered in 2010 effectively doubled in 2019.
4. S/C indicates ratios in which the number of frequencies recorded in 2010 is maintained in 2019.

Table 5.3 presents the variations in the terms offered by bilateral agreements between 2010 and 2019, for the 13 countries considered. With the exception of some specific relations, such as those between Brazil and Argentina, and Peru and Venezuela, in most cases agreements that allow free determination of cargo services have been maintained or even agreements that previously imposed capacity limits have been liberalized (the most important in terms of increase in the total number of frequencies offered were Brazil-Colombia, Brazil-Mexico and Mexico-Colombia). There was also an improvement in the agreement between Venezuela and Panama: while in 2010 there was a number of frequencies that exceeded the maximum limit established by the ASA in force, in 2019 the frequencies offered represented 35% of the maximum capacity. Overall, similar to what was observed in 2010, the bilateral agreements did not appear to restrict cargo services in 2019, as **all relationships used a lower number of frequencies than those allowed by the ASAs.**

Table 5.3 Scheduled air cargo services, by airline domicile (variation of bilateral relations and capacity limitation - 2019 vs 2010)

Flying to (columns) / Airline domiciles (rows)	Argentina	Brazil	Chile	Colombia	Costa Rica	Ecuador	El Salvador	Guatemala	Honduras	Mexico	Panama	Peru	Venezuela
Argentina													
Brazil	E		A									B	B
Chile	C	A											
Colombia		A				C					A		
Costa Rica													
Ecuador											N/A*		
El Salvador													
Guatemala													
Honduras													
Mexico		A	C	A				B					
Panama													
Peru													
Venezuela				C							D		

Legend:
A - In 2010, there was a capacity restriction, with effective capacities that did not exceed this limit, and in 2019, capacity restrictions were lifted
B - Capacity restrictions are maintained, with a level of frequencies below the limit
C - The agreement is maintained without capacity restriction
D - In 2010, there were capacity restrictions, with effective frequencies exceeding the limit set by the ASA, and in 2019, the restrictions were lifted or permitted frequencies were added
E - In 2010, there were no frequencies, and in 2019, there was a yearly capacity limit which is overcome by supply through precarious agreements
N/A*: information not available
Source: Authors' production based on data from OAG.

Regarding companies operating exclusive cargo services, in 2010, 53% of the frequencies offered in exclusive cargo services corresponded to **extra-regional airlines**, mainly from the United States (Amerijet International being the most relevant operator), the Netherlands (KLM) and Germany (Lufthansa). The 2019 data show an increase in the share of regional operators, from 47% in 2010 to 52% in 2019 (**Figure IV-I** and **Figure IV-II** in **Annex IV**). This increase was due to a greater participation of Venezuelan operators (mainly Vensecar Internacional, with strong operations in intra-regional services to Panama and other destinations in the Caribbean) and Colombia (Tampa Cargo). However, about 25% of regional movements corresponded to local DHL subsidiaries, whose main bases are outside the region (Bonn, Germany). Thus, it can be seen that in 2019 there will continue to be a predominance of extra-regional operators in the operation of scheduled air cargo services within LAC.

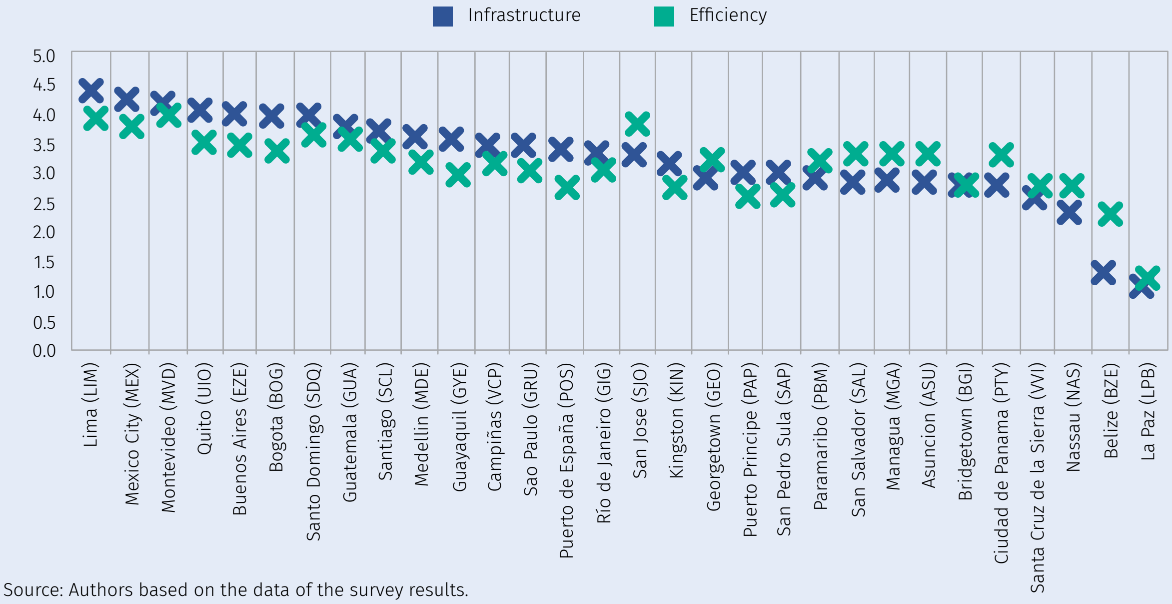
5.3 Operational and infrastructure challenges

The other key dimension for understanding the evolution of air cargo transportation in the region is the supply and quality of airport infrastructure. In this context, with the support of the Latin American and Caribbean Air Transport Association (ALTA, as per its Spanish acronym), the IDB conducted a survey of airlines in the region to determine the status of air cargo infrastructure and operational processes at LAC airports. The region's cargo airlines rated the airports in terms of infrastructure and processes on a scale of 1 to 5, where 1 represents very poor and 5 very good (see **Figure IV-V** in **Annex IV** for the survey form). The aspects evaluated were as detailed on the next page.

- Quality of import and export facilities and areas, such as facilities for normal cargo, hazardous cargo, refrigerated and perishable goods;
- Quality of interface areas with inland transportation;
- Quality of customer service areas;
- Quality of the aprons at the foot of the aircraft;
- Quality of the custom control areas;
- Quality and efficiency of computerized systems for storage, customs and invoicing;
- Quality and efficiency of holding processes on aprons and transport to warehouses;
- Quality and efficiency of specific import processes, such as phytosanitary controls, customs, deconsolidation, transportation to the cargo terminal and clearance of clients;
- Quality and efficiency of specific export processes, such as security screening, cargo consolidation/palletization and transportation to the cargo terminal.

Figure 5.4 shows the best and worst rated airports according to infrastructure quality and quality and efficiency of services and processes. The airports of Lima, Mexico City, Montevideo, Quito, Santo Domingo, Bogota, and Buenos Aires (EZE) received the best ratings in infrastructure quality, being classified as good infrastructure according to the respondents, while the airports of La Paz, Belize and Nassau received the worst ratings (in the ranges of poor and very poor). It is worth mentioning that **70% of the airports were rated as fair in terms of the quality of their cargo infrastructure**. In relation to process efficiency, the airports of Montevideo, Lima, San Jose, Mexico City received the best ratings, while the airports of La Paz and Belize received the worst ratings (near the very poor and poor range). Also, almost 70% of the airports were classified as fair in terms of the **quality and efficiency of their cargo processes**.

Figure 5.4 Comparison between infrastructure quality and efficiency in LAC airports (2020)



Source: Authors based on the data of the survey results.

Note that airports such as San Jose, San Salvador and Panama received considerably higher efficiency ratings than infrastructure, indicating better utilization of infrastructure for service generation.

Box 5.2 New airport infrastructure projects in the region

The CAF (2016) has analyzed in a study the gaps and investments needed in LAC airports until 2040, based on a projected average annual growth of 5.3% in the number of passengers. While the impacts of the pandemic on the air sector have led to a scenario of uncertainty in the forecast, improvement works should occur at some point, when the sector recovers. According to the CAF, estimated investments to close the gap amount to more than US$ 19.5 billion for the period 2016-2040 (CAF, 2016).

In the last ten years, significant investments were made in cargo facilities at the region's airports. Highlights include the Air Logistics Center (Lima Cargo City, with 55,000 m^2) at Jorge Chavez Airport-Lima, and cargo terminals at the airports of El Dorado-Bogota (68,000 m^2), Mariscal Sucre-Quito (12,000 m^2) and Guadalajara-Mexico (27,000 m^2).

Also noteworthy are the expansion of Tocumen Airport in Panama and the new Santa Lucia Airport in Mexico City. In Panama, the Tocumen International Airport Logistics Zone is under construction, a 49,070 m2 multimodal air cargo terminal with logistics areas of more than 207,619 m^2, which will complement the country's logistics conglomerate with a comprehensive range of services. In Mexico, the airport's cargo complex includes first-, second- and third-line activities. According to its Master Plan, first-line services will have an area of 252,900 m^2 and second-line services, 72,500 m^2, with an expected cargo handling of 470,000 tons by 2032.

Conclusions

Although the proportion of air cargo transportation in the region is small compared to other regions such as Asia and Europe, this mode has an important role to play in increasing LAC's insertion in higher value-added value chains. However, its performance is limited by the low quality of infrastructure and cargo services, which affect 70% of the airports analyzed here. In order to achieve the potential of this mode, the following recommendations emerge from the analysis conducted for this document (see Chapter 11 for more details):

- Improvement of the **efficiency of cargo processes**. Governments and airports in the region should seek to simplify and improve processes and procedures related to cargo management, considering the operational context of each airport. strengthen IT systems, advance in the digitalization of operational processes and increase integration and interoperability with the activities carried out by public sector control agencies, such as customs. The integration of processes for passenger and cargo management is also advisable since most cargo is transported in passenger aircraft.

- **Adequacy and expansion of specialized infrastructure**. Airport infrastructure in the region has undergone significant modernization and expansion, especially in the countries with larger markets, including a more robust pipeline of specialized cargo infrastructure projects. However, there are still significant imbalances between the supply and quality of services offered. It is advisable to align investment in specialized infrastructure for cargo in investment plans, concessions and a multimodal vision of transportation. Considering that most of the large airports in the region are under concession, it is essential that concession contracts incorporate the cargo service dimension among their performance indicators, as well as in the investment plans required for the private sector.

- Regulation for a competitive sector. Although market regulation issues do not appear to be a barrier to cargo transportation at this time, given that most bilateral and multilateral agreements do not impose relevant limitations in terms of capacity or destinations —at least in the case of cargo flights—, it is essential to **continue with air liberalization efforts** to prevent the appearance of future barriers.

CHAPTER 6

CUSTOMS AND BORDER MANAGEMENT: DIGITAL TRANSFORMATION AND NEW TECHNOLOGIES

International trade is one of the main drivers of development for LAC. IDB (2019b) estimates show that, in the absence of the policies and measures adopted in the LAC region between 1990 and 2010 for further trade liberalization, Latin America's GDP per capita would have grown between 30% and 40% less. Indeed, trade policy contributed to accelerate the growth of trade flows in the region, however, evidence shows the limitations of trade policy and the need to address non-tariff barriers (including high logistical costs) in order to foster further trade expansion and regional integration (IDB, 2019b).

This chapter presents the challenges and opportunities to generate efficiencies in LAC foreign trade logistics, in terms of time and costs, and in turn incentivize foreign investment and intra-regional trade. The first section of the chapter presents the context of regional trade in Latin America and the Caribbean that emerged with the COVID-19 pandemic, highlighting the reorganization of value and supply chains. The second section addresses the importance of customs and border management in trade facilitation and presents channels for innovation and digital transformation through the use of new technologies in customs and border management. A series of conclusions are presented in the last section.

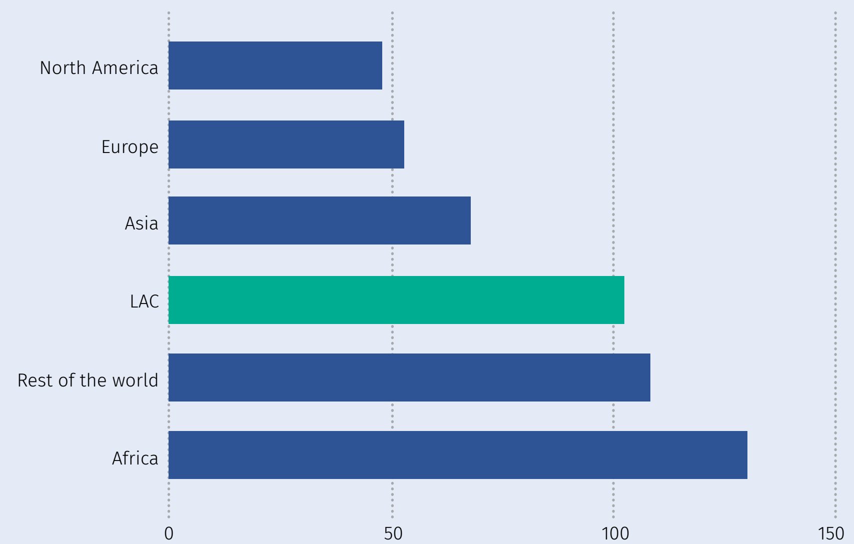
6.1 International trade in the new post-pandemic context

The COVID-19 pandemic has had a profound impact on trade and investment in the LAC. To cope with the health crisis, governments took social distancing measures that in turn generated a supply and demand shock with a chain of business closures, rising unemployment, dropping production of goods and services and a situation not seen in recent periods, such as the partial closure of borders, mainly for passengers, and exportation restrictions. While the value of goods exports had already fallen by 2.3% in 2019, it experienced an acceleration of the year-on-year contraction from 3.5% in the first trimester of 2020 to 27.5% in the second trimester. The fall in extra-regional flows explained most of the contraction in total trade in LAC, nevertheless, the reduction in intra-regional trade was more intense[44]. The share of the latter fell by 1.2 percentage points compared to 2019 and accounted for 12.8% of total trade (Giordano, 2020).

44. For example, there was an average decrease of -30.3% in the Andean Community, -24.6% in MERCOSUR, -24.0% in the Pacific Alliance, -8.8% in Central America and the Dominican Republic, and -25.4% in the Caribbean.

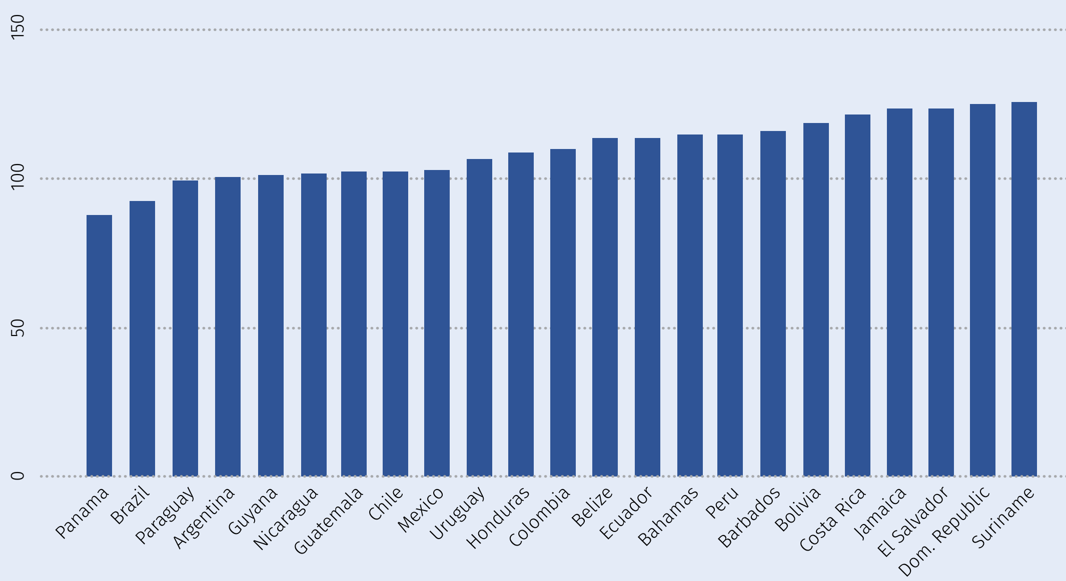
During the second half of 2020, exports began to recover; however, to promote economic reactivation and resume the growth path in the region, it is necessary to increase trade volumes and diversify the type of products. This implies reducing the current dependence on commodity price increases, LAC's main export basket, to sustain improvement and growth. It is also necessary to reduce the region's trade costs, which are higher than those of North America, Europe and Asia (see **Figure 6.1** and **Figure 6.2**), and to increase the reliability of national and regional regulatory frameworks in order to achieve greater and better integration of regional value chains by taking advantage of nearshoring initiatives and, in turn, the region's integration into global chains.

Figure 6.1 Trade costs by region (2015, world average = 100)



Sources: IDB elaboration (IDB, 2019c) for document Integration and Trade Sector Framework 2019, with data from the World Bank-ESCA trade costs database.
Note: Figure 6.1 and Figure 6.2 show the standardized trade costs (where 100 shows the world average trade costs) for each region and each LAC country.

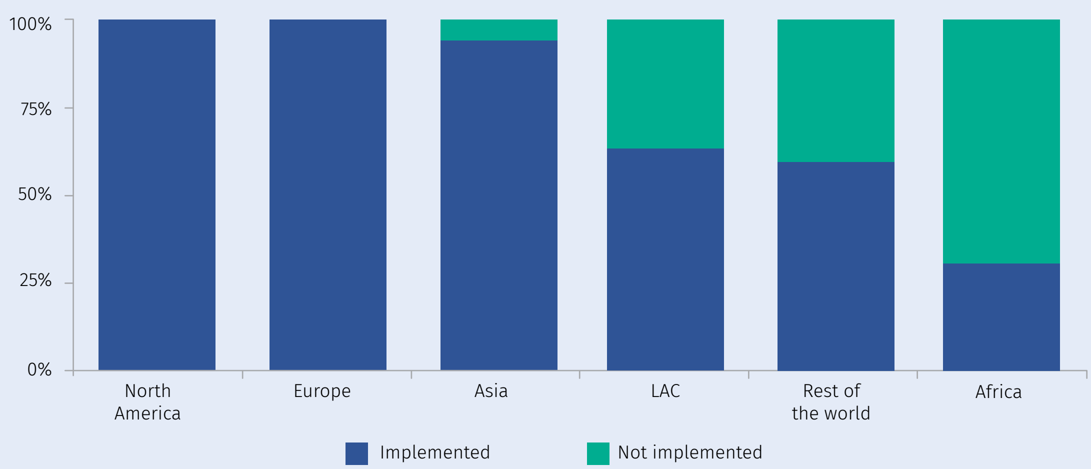
Figure 6.2 Trade costs by country in LAC (2015, world average =100)



Sources: IDB elaboration (IDB, 2019c) for document Integration and Trade Sector Framework 2019, with data from the World Bank-ESCA trade costs database.

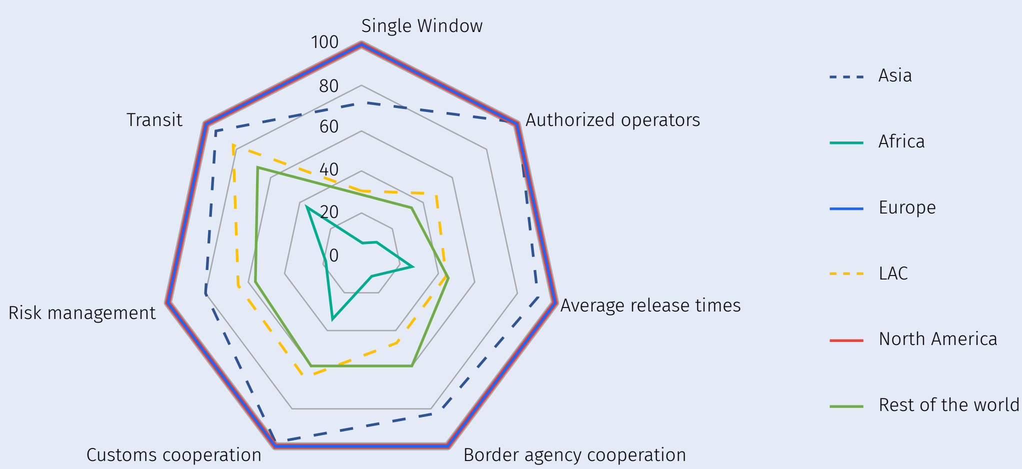
The LAC region has made significant progress in terms of **implementing trade facilitation measures**, but gaps are still identified compared to other regions of the world. According to the WEF Global Competitiveness Report (2019a), the LAC region has a score of 51 out of 100 in pillar 7 where the border management efficiency indicator is included. The region would be in fifth place only ahead of Sub-Saharan Africa and South Asia. Also, according to the 2018 Logistics Performance Index (LPI), none of the LAC countries are among the top 30 out of 167 countries and economies. Indeed, LAC has varying levels of progress in implementing commitments made under the World Trade Organization (WTO) Trade Facilitation Agreement, and the World Customs Organization's (WCO) SAFE Framework of Standards to Secure and Facilitate Global Trade. The main opportunities for improvement for LAC are related to risk management, release and clearance times and cooperation between border control agencies (**Figure 6.3**, **Figure 6.4**, and **Figure 6.5**). In addition, COVID-19 has reflected the challenges in terms of supply chain resilience to pandemics and natural disasters.

Figure 6.3 Implementation of WTO Trade Facilitation Agreement commitments, LAC in comparison with other regions



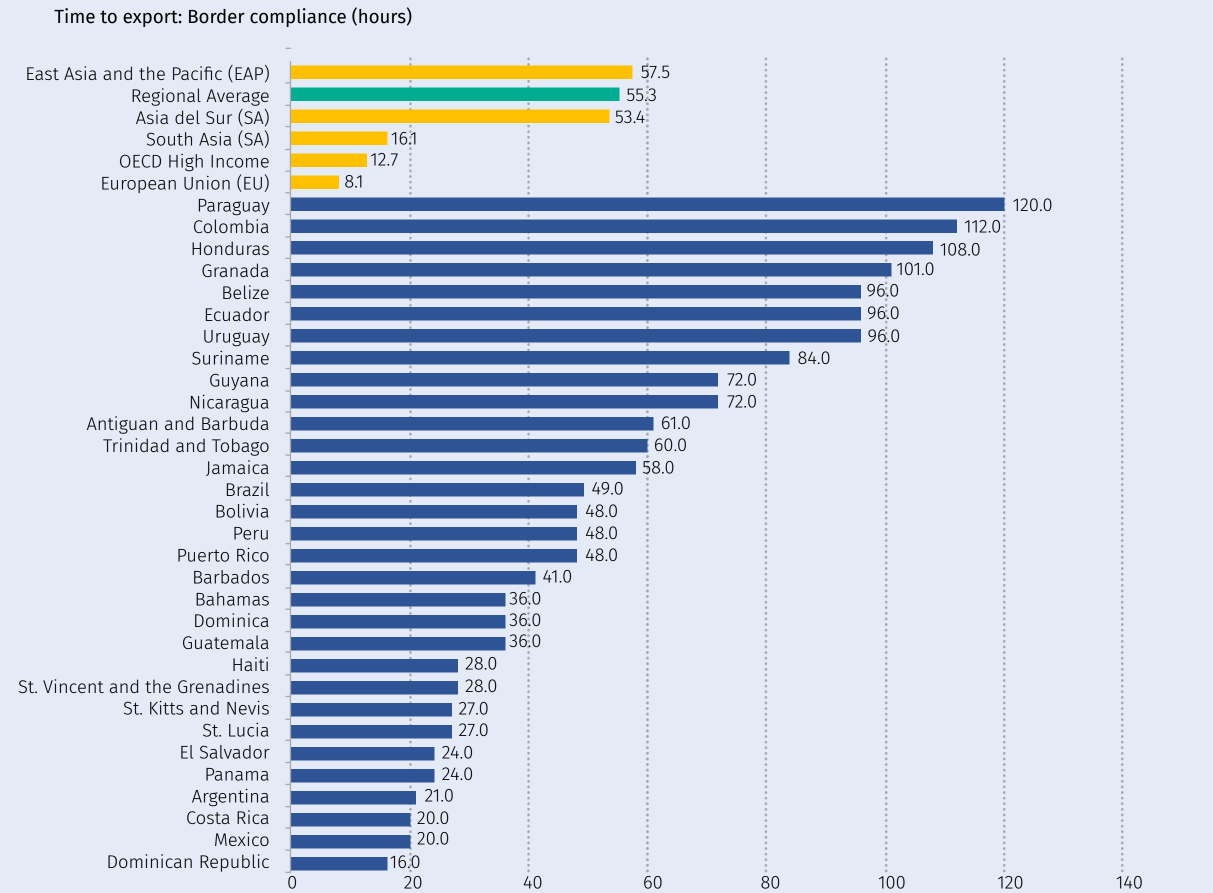
Source: Mesquita Moreira et al. (2019) calculations based on the data provided by each country to the WTO.

Figure 6.4 Implementation of WTO Trade Facilitation Agreement commitments, 2019



Source: Mesquita Moreira et al. (2019) calculations based on the data provided by each country to the WTO.
Note: The figure shows the simple average of the percentage of WTO Trade Facilitation Agreement commitments implemented in different countries in each region, the percentage of these commitments implemented in each country in LAC, and the percentage of countries in each region that have implemented the respective commitment.

Figure 6.5 Times to export in ALC, Doing Business, WB 2020



Source: World Bank (2020b).

6.2 Digital transformation of customs and border management

Customs and other border control agencies are critical links in foreign trade supply chains, and thus in the trade facilitation agenda. Their role was evident during the health crisis caused by the COVID-19 pandemic when they had to facilitate the entry and exit of tons of goods intended for personal protection, such as masks, gowns and medical equipment, medicines, and disinfection products, as well as food and essential goods.

The release and clearance of these cargoes had to be conducted in a priority, expeditious and secure manner, without neglecting the regular flow of trade. The risks of the pandemic have therefore required the implementation of simplified and secure procedures, the automation of control tasks and strong coordination skills among the different government entities and between them and the private sector (WCO, 2020). All this, to provide the necessary resilience[45] in supply chains from the management of foreign trade, and to contribute to the economic reactivation of LAC countries.

45. The IDB has promoted the Regional Public Goods initiative (ATN/OC-18291-RG), https://www.iadb.org/projects/document/EZSHARE-623824448-19?project=RG-T3765 to develop customs and border contingency plans in order to address health and natural disaster crises in the LAC region. This initiative will be developed in collaboration with the World Customs Organization (WCO) and the United Nations Office for the Coordination of Humanitarian Assistance (OCHA).

Those customs offices that already had high levels of automation and digitalization of their operations, as well as non-intrusive control equipment prior to the pandemic, were able to maintain higher levels of efficiency in their operations. The new reality of sanitary logistics has been a transformative experience from which customs have learned important lessons to accelerate the processes of their digital transformation, aimed at greater effectiveness and efficiency in their controls, without detriment to trade facilitation. These efforts are also taking advantage of opportunities arising from new emerging technologies (artificial intelligence (AI), blockchain, the internet of things (IoT), and big data, among others), the beginnings of the fourth industrial revolution (WCO, 2019; WEF, 2019b), particularly with the adoption of blockchain (Ganne, 2018) and AI tools (Iansiti & Lakhani, 2019).

In fact, customs that have taken this path of **technological modernization** or are moving in this direction tend to be at the top of international rankings in terms of efficiency, effectiveness, and quality service to foreign trade operators. Customs in Korea, Japan, the Netherlands, Sweden, Singapore, and Australia are some of the examples that stand out according to the 2018 LPI. Given the impact on the level of service, digital transformation processes are always well received by the private sector, seeing how their cargoes are released and cleared in less time and with lower costs. In fact, there is a direct relationship between the successful implementation of digital transformation projects and the degree of collaboration between Customs and the private sector, through committees such as the Commercial Customs Operations Advisory Committee (COAC)[46], which collaborates with U.S. Customs; Customs and Border Protection (CBP); or the Border Commercial Consultative Committee (BCCC), which collaborates with Canada Customs, Canada Border Service Agency (CBSA) (CBSA & CSCB, 2016). In the case of both the United States and Canada, the private sector worked hand in hand with customs in their respective projects to create Single Windows for Foreign Trade. Other examples are public consultations with the private sector on the adoption of emerging technologies by customs[47]. Therefore, it is important that the digital transformation is also articulated with the private sector, and that advantage is taken of the strategic alliance developed between the two through programs such as the Authorized Economic Operator (AEO).

The following sections present the fundamental elements to efficiently manage a customs operation in a post-pandemic context, reflecting the bases to innovate, and to model an automated, digital, and non-intrusive customs management that makes borders invisible to reliable operators with a good compliance track record, and reducing their operating time and costs.

Optimization, automation and digitalization of customs and border processes

The cornerstone of the Customs modernization effort is the **automation** of all its processes, both operational and administrative. One of the main challenges faced daily by customs and border control agencies is to have early access to data associated with foreign trade operations to effectively and efficiently determine their level of risk prior to the arrival of cargo at (sea, land, and air) entry points. Customs' ability to obtain, process and analyze a large amount of quality data is one of the key aspects for agile and secure supply chains. That said, it is important to note that automation is not an end in itself, but rather the culmination of a re-engineering and optimization of customs processes. The release and clearance of goods, people and means of transportation can be as fast or slow as allowed by the procedures that regulate them and the systems that support them. Manual procedures based on paper and a high degree of discretion on the part of customs officials result in longer clearance times and therefore higher costs.

Technology is at the service of the functionality of customs management systems, so the process of designing and building systems must revolve around the current needs of customs control and facilitation. The use of open-source code and modular design are a guarantee for an adequate evolution of the systems in line with

46. The COAC advises the Secretaries of the Department of the Treasury (Treasury) and the Department of Homeland Security (DHS) on the business operations of U.S. Customs and Border Protection (CBP), in accordance with Section 109 of the Trade Facilitation and Trade Enforcement Act of 2015.
47. COAC April 2020 Emerging Technologies External Issue Paper (cbp.gov)

the needs of customs management and supply chains. Another aspect to consider in automation processes is to generate the ability to interoperate with internal and external systems. This can be done through Single Windows for Foreign Trade (SWFTs)[48] with foreign trade operators and other government entities for customs clearance purposes, such as phytosanitary, health or security agencies, and, of course, for tax control purposes, and even with other customs offices for cross-border exchange of data and information. Gaps in interoperability between systems is one of the most important obstacles to achieving optimal management of clearance and impacts on the efficiency of supply chains. Atomized and isolated management by the systems of each entity does not guarantee the integrity of the operation, but rather hinders and increases the cost of international trade operations.

In turn, automation requires other innovative but critical components for **digital transformation**. These are the use of electronic signatures and authentication mechanisms for internal and external users. Similarly, operating with data and systems requires ample computing capacity, performance, scalability, security and backup, which is offered today by the cloud. For example, machine learning and artificial intelligence techniques are already being used in customs management and this requires the capacity to access all possible and available information, and to be able to process and analyze a large amount of data and images. Likewise, the investment in the automation of customs management systems must be coupled with an investment in human and financial resources that allow the entity to have the autonomy and capacity for its operation, maintenance, and evolution. Owning the source code and having trained technical personnel allows for an efficient and constant response in time and form to the necessary adjustments in the customs management system, to meet the constant dynamism generated in the supply chains.

Another important aspect of automation is the **digitalization of management** based on sufficient, reliable, and timely digital data. Digitalization should not be confused with the simple conversion of a paper document into an image; for example, a commercial invoice or a paper bill of lading converted into digital copies in PDF format. When we talk about management digitalization, we are referring to the use of electronic data, which can be validated, organized, and processed immediately through the customs management system.

The appetite for more information should not result in onerous, duplicated and excessive data requirements. Hence, it is imperative to determine the data set, following the WCO[49] data model, that will be required from economic operators for the release and clearance of import, export, and transit cargoes, and from passengers to manage their entry and exit from the country, with a view to ensuring that each piece of data is truly useful in risk management and is not duplicated. To carry out this task, customs must enter into agreements with all government entities involved in the release and clearance of goods, passengers and means of transportation, as well as collaborate closely with the private sector. Indeed, an essential aspect of digital management is the opportunity to maintain strict protocols for access, custody, protection, use and disclosure of electronic data and information. Today, cybersecurity is more than just a vault for the safekeeping of customs information; it is also a means of gaining the trust of economic operators.

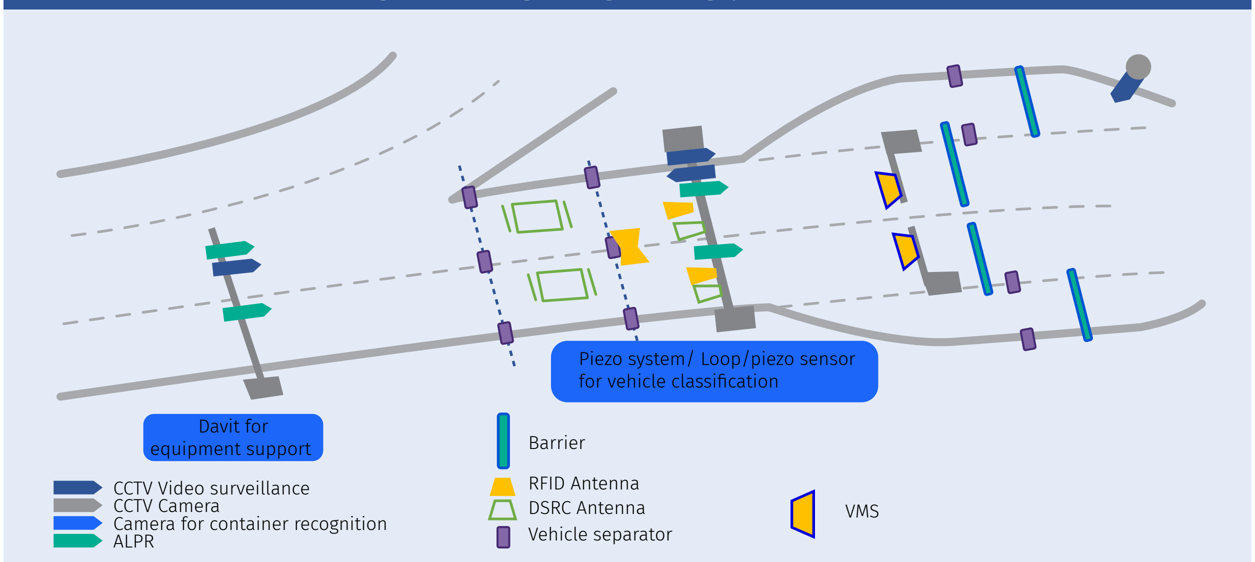
48. The Trade and Investment Division (INT/TIN) has acquired extensive experience in the design and execution of operations with SWFT components: Honduras (HO-L1055); Chile (CH-L1061); Bahamas (BHL1016); Colombia (CO-L1138); Uruguay (UR-L1060); Ecuador (EC-L1116); Costa Rica (CR-L1066); Nicaragua (NI-L1083); Peru (PE-L1159), Trinidad and Tobago (TT-L1044) and Argentina (AR-L1251). In recent years, support began to be provided for sub-regional interoperability of the SWFTs in Mesoamerica and the Pacific Alliance (RG-T2073 and RG-T3007).
49. WCO data model, http://www.wcoomd.org/en/topics/facilitation/instrument-and-tools/tools/data-model.aspx

Operation based on risk management with the use of new technologies

One of the great challenges faced by customs worldwide is the **traceability of goods** from their point of origin to their final destination. This is not only a risk management challenge when goods arrive at ports of entry, but also a control challenge within their territories, both for cargoes in transit and for those under special regimes to promote production and exports. New technologies such as radio frequency identification (RFID) systems, the internet of things (IoT), geolocation, location through smartphones and e-seals for container and trailer doors, optical character recognition license plate readers (OCR) make it possible to track cargo and vehicles and the people transporting them (Corcuera-Santamaria, 2018). These systems can be deployed in critical points of the territory, such as road corridors that connect with land border crossings, ports and airports, as well as production centers and bonded warehouses. The data they capture, when converted into digital data and associated with transport and goods documents (cargo manifests, bills of lading, customs declaration data) are of immense value for customs and border risk management (including coordination with neighboring countries), as well as for the regulatory functions of other state institutions.

Thus, for example, the Ministries of Transportation can know precisely the sectorized inventory of vehicles on the road corridor at all times, their weight, license plates, licenses and transportation and circulation permits. What is more, they can control the payment of tolls and road tax and improve road safety and incident response standards. Customs and authorities performing phytosanitary controls have data in advance of the vehicle's arrival at the border crossing to investigate the traceability of a customs file (e. g., declared weight) or transit through high phytosanitary risk areas. In addition, the system allows to check that all vehicles crossing the border enter the respective control points along the corridor, which facilitates control and mitigates the risk of evasion. Tax administrations can control the payment of taxes such as Value Added Tax (VAT) between subnational states or control the movement of regulated goods subject to excise taxes within the national territory. The Ministry of Security can also obtain information to act in the event of a crime. Furthermore, the system allows external users (carriers, customs officers and agents, importers, exporters) to consult the status of their customs operations in real time via the Internet.

Figure 6.6 Intelligent cargo tracking system on a road



Source: Example of a Management Station designed in the Management Control System Study of the Corridor and Border Crossing at Cristo Redentor between Argentina and Chile, financed by the IDB and carried out by the consortium CIS Ingenieros/SERMAN & Asociados/ EPYPSA S.A, December 2017.

Several customs offices in the LAC region have designed and are implementing these systems through **Management Control Systems**, as is the case of Nicaragua, Costa Rica, and Panama in Central America with IDB support. Also noteworthy is the system of *Receita Federal do Brasil,* which integrates technology to track and follow the movement of transits between Brazilian states on par with the implementation of electronic invoicing (Da Silva Bahía et al., 2017). Indeed, the automation of processes and the availability of digital data makes it possible to build a robust and reliable risk management system. Its comprehensive application in all phases of control, in the phase prior to the arrival of cargo, during customs clearance and in the subsequent control has a positive impact on the levels of compliance of foreign trade operators and on the release and clearance times of goods. For example, with the implementation of these measures, New Zealand Customs achieved 99% of import declarations to be processed within 30 minutes and increased the level of compliance to 96% of operations (New Zealand Customs Service, 2011). Good risk management also increases the degree of assertiveness, i. e., findings are increased while fewer cargoes are selected for inspection. Similarly, the use of risk management and the consequent reduction of inspection times have a positive effect on the increase of exports and imports of firms as they become more competitive. A study conducted in Uruguay concluded that exports fall by 3.8% in response to a 10% increase in customs clearance times (Volpe, 2017).

As the brain of Customs management, a **risk management system** must be formalized and institutionalized in the organizational structure of customs and permeate the entire organization. In this way, customs can submit for inspection by the competent authority any cargo that represents any type of risk (fiscal, sanitary, phytosanitary, national security). In this sense, the creation of a committee helps to ensure the definition, coordination, and monitoring of the risk management strategy. A good system should also have a risk parameterization and definition of profiles based on the development of risk formulas and algorithms (IDB, 2010). In addition to these algorithms and risk criteria for the selection of cargo and persons, the most advanced customs offices in the world[50] also apply artificial intelligence, machine learning and big data tools. Such tools allow processing and analyzing large volumes of information for the identification of sophisticated and complex patterns and links of risk and fraud operations (Desiderio, 2019). In this context, the WCO created a group named BACUDA[51] to support customs in the development of these management techniques[52].

Articulation of Coordinated Border Management (CBM) measures and system interoperability

Coordinated Border Management optimizes and establishes procedures for coordinated action supported by automated procedures prior to the loading/arrival of cargo through single windows and their release through an efficient and effective clearance process between customs and other competent entities. Hence the CBM eliminates duplication and reduces time and costs for economic operators and authorities. Currently, the regulations of the different border control agencies that companies must comply with when exporting and importing can create a maze of formalities (Carballo et al., 2016). The cost of compliance with regulatory requirements has been estimated to be between 3.5% and 7% of the value of goods, and can even reach 10% to 15% in the case of errors or omissions of information (see Van Stijn et al., 2011). Therefore, CBM is essential to achieve true expediting of goods flows and to reduce transactional costs, both for economic operators and for customs and government authorities. Coordination between border control agencies, joint optimization of foreign trade processes, along with data and certificate sharing, and the materialization of inspection actions with the participation of all agencies are some of the main elements of CBM according to the SAFE Framework of Standards (Canales Ewest et al., 2019; WCO, 2016).

50. Customs in Korea, Japan, the Netherlands, Canada, and Brazil (Lacerda Coutinho and Schoucair Jambeiro, 2018), among others, are using advanced techniques and technologies to evolve their risk management in cargo and e-commerce flow release and clearance (Giordani, 2018).
51. BACUDA https://mag.wcoomd.org/magazine/wco-news-91-february-2020/bacuda/
52. The IDB is developing a pilot project with several customs offices in the LAC region to strengthen their risk management systems with AI/ML techniques to be applied to e-commerce flows.

In a digitalized world, CBM also requires the **interoperability of the systems** of the competent agencies, though, for example, SWFTs and Port Community Systems (PCS). Empirical evidence shows that the introduction of information technologies in customs processes such as SWFTs is associated with an expansion of the number of exporting companies in a country and with the volumes of companies' exports in both the extensive and intensive margin of international trade (Carballo et al., 2016). For example, the adoption of the SWFT in Costa Rica is associated with a growth of 1.4 percentage points in exports of companies that made use of the SWFT compared to exports of companies that exported through non-computerized processes. This increase can be attributed to a higher frequency of exports, greater diversification of buyers and higher sales volumes per buyer. On an aggregate basis, Costa Rica's exports would have been, on average, 2% lower than they actually were in the 2008-2013 period, which is equivalent to approximately 0.5% of the country's total GDP (Volpe, 2018).

On the other hand, PCSs in addition to adding value to port operations, save costs for operators. It is estimated that, in the port of Valencia/Spain, the ValenciaportPCS system allows the port community to save approximately EUR 23 million per year (Mendes Constante, 2019). Similarly, the PCS operating in Singapore, Portnet, reported savings exceeding US$ 80 million over a three-year period (Port Strategy, 2012). In LAC, several initiatives are being developed for the creation of PCS in Chile, Jamaica, Brazil, and Panama, following the Smart Ports concept with a methodology promoted by the IDB in attention to international good practices (Fundación Valenciaport, 2020).

For the benefit of supply chains and thanks to progress in new technologies, CBM can be taken to the regional and international level through the development and implementation of systems and applications that facilitate **cross-border interoperability**. This is the case of certificates of origin, phytosanitary and declaration data between the SWFTs of the Pacific Alliance countries (Mejia Rivas & Maday, 2019). Currently, technologies such as blockchain allow customs authorities of eight Latin American countries to validate the data exchange of their companies certified as Authorized Economic Operators through the CADENA application (Cuerca and Moreno, 2020). Other customs are following the trend and conducting proofs of concept with blockchain technology, such as the Korean Customs Service (KCS), to share export data, manifests and bills of lading and letters of credit with the logistics community, thus bringing transparency, visibility and efficiency in processes (Kang, 2019). The U.S. Customs and Border Protection (CBP) has implemented several pilots to verify certificates of origin for goods subject to the North American (NAFTA and now USMCA) and Central American Free Trade Agreements (CAFTA) (Svetlana Angert, 2019). These initiatives also require a high degree of standardization of the data to be shared, according to the WCO data model and coordination of processes.

All these technology-supported efforts are paving the way to develop **B2G2C systems**[53] and apply the concept of data pipeline, whereby data originating at the source is entered in a single instance electronically and can be used by multiple actors in the supply chain, as many times as necessary, regardless of whether they are logistics service providers, carriers or border regulatory agencies (UNECE & UN/CEFAT, 2018; Hesketh, 2011). Data originated both by individuals and legal entities, as well as by data capture devices and technologies (IoT, OCR, RFID, images, etc.) coexist under this concept. Initiatives such as Tradelens (tradelens.com), a digital platform for maritime transport built with blockchain technology in a joint project between Maersk and IBM, involving shipping companies, ports, customs, 3PLs, financial institutions, etc., are examples of initiatives built from data pipeline. In order to enhance intra-regional trade, the flow of cargo in the international transit regime of goods can also benefit from the adoption of technologies, agreements between border agencies and the potential of interoperability between systems (Volpe, 2017).

In addition, CBM requires the implementation of clear and effective **operating protocols** at entry and exit points, using Management Control Systems (MCS) taking advantage of synergies of intelligent traceability systems and interoperability between all systems. The MCS integrates all data and information received by cus-

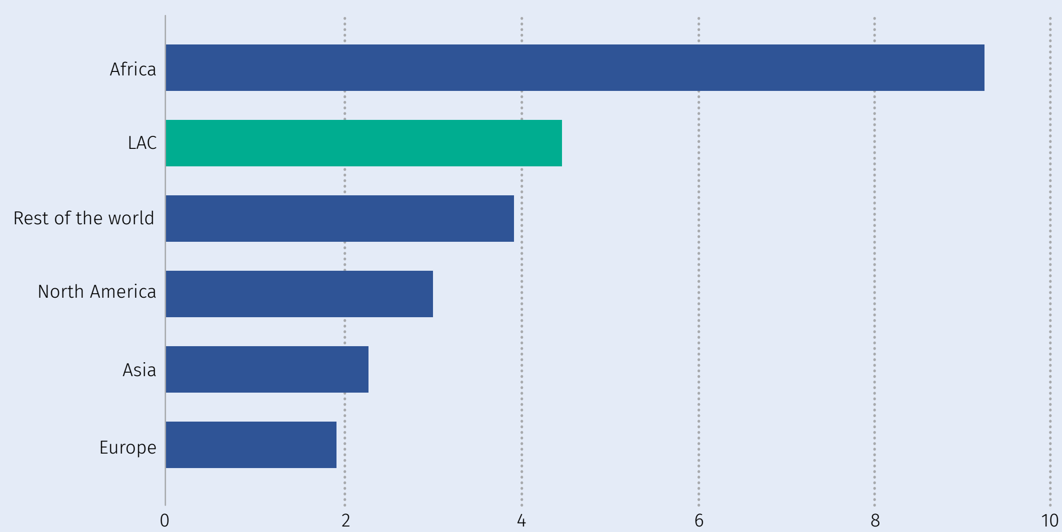
53. Systems and platforms that include the governmental regulatory and logistical aspects of the private sector so that they cover the integral spectrum of the foreign trade operation including the consumer.

toms and other entities in their systems through their customs management systems or SWFTs, together with digital data from intelligent traceability systems (license plate readers, vehicle and cargo weight, dimensions, images, driver biometric data, etc.). This electronic, digital, and advance information is key to carry out risk management for efficient clearance and cost reduction for foreign trade operators.

Infrastructures and technological equipment at the service of border processes

All the elements described above cannot have the desired effect without a **functional infrastructure at the entry and exit points** of goods, equipped with the most advanced technological systems for entry, exit, inspection and monitoring controls. The region's deficiencies in transportation and telecommunications infrastructure are exacerbated in the areas surrounding land, sea, and border crossings. Similarly, investments in building infrastructure improvements at entry points, which are usually located in remote areas of the territory, are not prioritized, partly due to a lack of recurrent resources (it is estimated that investments in land border crossings are made every 25 to 30 years), and partly because the mandates and responsibilities for building infrastructure do not normally fall on the same functional entities that make use of it. Together with regulatory and systems deficiencies, to excessive export processing times (see **Figure 6.7**). For example, a study conducted with a freight forwarder in Central America showed that it took the driver 145 hours to travel the 3,210 kilometers of the Mesoamerican Pacific Corridor from Puebla (Mexico) to Panama City. In this route, only 30% of the time was driving and the other 70% of the time was for border crossings and overnight stays (Rodriguez and Montes, 2017).

Figure 6.7 Average time to export by sea or by air – average by region (2018)



Sources: Own production by IDB with World Bank data.

The infrastructure and technological control equipment (scanners for cargo, vehicles, baggage and passengers, drones, densimeters and portable radiation detectors, among others) must therefore be at the service of the release and clearance process, and not the other way around. The infrastructure must be functional and defined once the processes have been optimized and the control model established. As in CBM, infrastructure decisions must be made by consensus between customs and all the competent entities operating at the entry and exit points, taking into account the specific needs of each one in terms of space distribution and equipment for its operation.

CBM and automation are the basis for the implementation of **joint clearance** processes, which in turn requires infrastructure for joint inspections. These can be carried out both nationally and with the peer authorities of neighboring countries in more sophisticated schemes of juxtaposed controls that result in significant time and cost savings for economic operators and the authorities of the countries involved. These programs require joint facilities and even the shared use of equipment and laboratories to determine the correct tariff classification, detect prohibited or restricted import substances, or pests and undesirable elements.

Adequate infrastructure and the application of technology at entry points allows for the segmentation of vehicles and users based on risk criteria and the creation of an invisible border user experience through automation and the provision of fast channels without human presence. The Customs Technology Integration Project (PITA, as per its Spanish acronym)[54] of Mexico's Customs is an example of a comprehensive border technology and infrastructure intervention. Following in this line of modernization, Nicaragua's Customs, with IDB support, has carried out a reform process at the Peñas Blancas border crossing, including border facilities and the incorporation of the latest technologies[55].

Conclusions

Customs has witnessed and been part of commercial transactions in supply chains for centuries. In the context of the Fourth Industrial Revolution, customs can be expected to continue to transform in light of new technologies and digitalization. The COVID-19 pandemic has accelerated the digital transformation processes that many customs offices, including those in the LAC region, had already begun. Emerging technologies, such as artificial intelligence/machine learning (AI/ML), blockchain and IoT, have the potential to drive and implement innovative customs and border processes, to turn borders into invisible lines for foreign trade operators.

In this context and as described in this chapter, LAC has made significant progress in its trade facilitation agenda. However, there are still challenges related to the hard and soft components that enable international trade flows, including: low automation and digitalization of customs and border processes, limited inter-institutional coordination and collaboration between border control agencies at the national level and with neighboring countries, gaps in infrastructure and technological equipment in trade nodes, weaknesses in the interoperability of systems; limited development of risk management systems; and low traceability of cargo and vehicles, among others. In addition, the adoption of emerging technologies for customs and border management remains low in the region. As a result, logistic costs continue to represent a major barrier to the growth of international trade.

54. Customs Technology Integration Project (PITA, as per its Spanish acronym): http://omawww.sat.gob.mx/PITA/Paginas/default.htm
55. See more about this project in: https://www.el19digital.com/articulos/ver/titulo:91983-puesto-de-control-fronterizo-de-penas-blancas-una-moderna-infraestructura-en-nicaragua

CHAPTER 7

URBAN LOGISTICS IN LAC MEGACITIES

The term "urban logistics" refers to the storage, transportation, and delivery of goods in the urban context[56]. Indeed, the economic and social activities that take place in a city usually require the provisioning of a diverse set of goods, making cities a key node for supply chains. Supermarkets, pharmacies and basic necessities stores, businesses selling various products, hotels and restaurants, health centers, construction companies, public administration and inhabitants in general are the main demanders of goods and, consequently, of logistics activities. The supply of urban logistics services includes transportation companies, couriers and postal services, on-demand delivery companies and manufacturing industry transportation fleets, among others.

In recent years, urban logistics has become particularly important due to the rise of e-commerce. As opposed to purchases made physically in retail and department stores, new consumer trends require the delivery of products directly to consumers, in smaller quantities, but with a greater frequency. This implies an increase in the number of trips for the distribution of goods, particularly in areas of high density, with limited space and growing vehicle congestion. With projections of a triple increase in (i) urbanization; (ii) congestion; and (iii) e-commerce in LAC cities over the next decade, it is necessary to reflect on the role of urban logistics and the actions needed to integrate it into cities that are increasingly efficient, sustainable, and inclusive.

In this chapter, we will analyze the current situation of urban logistics in LAC cities in the light of recent trends in the sector; we will present the main challenges for efficient and sustainable logistics which are integrated with the urban space; and, based on a survey of successful international experiences, we will identify a set of tools to improve the management of this activity from the standpoint of public policy.

7.1 The boom in urban logistics

Traditionally, urban logistics has been limited to supplying stores where consumers come to shop. These stores can range from department stores, such as shopping malls or supermarkets, to small neighborhood retail stores. Despite the expansion of large supermarkets, retail and local businesses continue to have an important presence in Latin American cities, representing 45% of the retail market and supplying the base of the socio-economic pyramid in the region's cities (Fransoo et al., 2017). Due to their multiplicity, these actors generate a large flow of goods transportation in cities. In particular, the small size of neighborhood stores and the lower

56. We refer here to the strict concept of urban logistics, related to the circulation and delivery of goods in a city. There are cases where cities act as nodes of international trade —i. e., port-cities— or of goods production, where the urban context also serves as a space for the development of international and national logistics processes.

availability of liquidity make frequent replenishment of these establishments necessary, with an average of two to three deliveries per day (Fransoo et al., 2017).

At the same time, the growth of e-commerce, boosted by the change in the traditional consumption patterns of the different strata of the middle- and high-income population, is having a significant impact on large supermarkets, and consequently on the organization of this part of urban logistics. At the international level, retail chains such as Sears, K-Mart and Toys-R-Us have had to restructure or have declared bankruptcy because they are unable to compete in segments now dominated by e-commerce. Large supermarket chains such as Walmart and Carrefour are radically changing their business strategy, with greater emphasis on e-commerce, to reduce the migration of customers to digital platforms such as Amazon and eBay. At the regional level, although e-commerce in LAC may be considered incipient when compared to levels in the United States or China, for example, the volume of sales has been increasing consistently in recent years. In 2019, this channel grew 52% in Argentina, 14% in Brazil, 25% in Chile, 16% in Colombia, 36% in Mexico, and 32% in Peru, with cumulative growth of 650% expected between 2020 and 2030 for this same group of countries (IDB, 2020b; Euromonitor International, 2019). In particular, the restrictions on mobility implemented by countries to contain the COVID-19 contagion has given a significant boost to e-commerce. Between March and April 2020, revenues from this channel increased by 130% in Brazil and Colombia, 500% in Mexico and 900% in Peru (Statista, 2020).

The rise of e-commerce has generated a boom in urban logistics, with opportunities for different types of companies, including courier companies, postal services, and on-demand delivery companies (**Figure 7.1**).

Figure 7.1 Main companies involved in urban logistics (selected cities, LAC, 2020)

Source: Own elaboration.

Concurrently, new demands have arisen for the sector: the logistics services offered must be flexible enough to accommodate a variable demand, made up of multiple types of products, with different consumer preferences in terms of place and delivery times, and characterized by high seasonality and failed deliveries. To this end, companies in the region are facing the challenge of modernizing the infrastructure and management of warehouses and distribution centers, adapting the transportation fleet to increasingly fragmented shipments and highly congested contexts (see section 7.2), and improving visibility and service levels to customers and end consumers, among others. This flexibility does not always go hand in hand with the implementation of traditional strategies to optimize logistics operations in terms of the use of infrastructure and transportation fleet, so logistics costs are expected to continue to rise. This is the trend shown by the leading e-commerce logistics company: between 2007 and 2018, the share of logistics costs in Amazon's total net sales increased from 16.6% to 26.5% (Statista, 2019).

The need to reduce logistics costs, while increasing customer satisfaction and avoiding migrations to other service providers and shopping platforms, is driving logistics and e-commerce companies to increasingly turn to new technologies, such as artificial intelligence, the internet of things and automation. For example, in 2011 Amazon patented anticipatory shipping, which uses historical order and customer data to predict future orders and consequently ship products to the nearest distribution centers before customers place orders. In addition, voice assistants are increasingly being used for online shopping. In terms of automation, there have been numerous tests of deliveries with autonomous vehicles, including in LAC. For example, in April 2020, Rappi began its pilot distribution plan with robots in Medellin. Delivery and pick-up points have also been made more flexible: customers can now pick up/return their packages at lockers located in transportation stations, supermarkets, and other businesses.

Finally, the current digital revolution has enabled the emergence of new players in urban logistics: on-demand delivery platforms. These platforms bring together different types of businesses, such as restaurants, supermarkets, and pharmacies, with end customers and transportation service providers. Once a customer makes a purchase through the platform, transportation service providers, usually freelancers who travel by car, motorcycle, or bicycle, receive the request to pick up the product from the participating business and deliver it to the location indicated by the customer. For example, the Colombian startup Rappi currently operates in 9 countries in the region and has 10 million active users per month. The company started with home delivery of food, moved on to groceries, then to medicines and cash, until it expanded to deliver any product (iProUP, 2020).

7.2 Key challenges for LAC cities

The boom in urban logistics, especially as a result of the increase in e-commerce, makes it necessary to analyze the context in which such logistics are being handled in LAC cities. This is to design public policies that allow for efficient and sustainable integration of logistics into urban activities. From the perspective of the public sector, there are four main areas of attention related to logistics: high congestion, restricted spaces, and challenges in terms of security and sustainability. These are particularly pressing in LAC large cities and megacities, which concentrate a significant part of the population, economic and social activities, and the negative externalities of agglomeration — i. e., congestion and pollution.

High congestion levels

According to the 2019 INRIX Global Traffic Scorecard, 4 of the 10 most congested cities in the world are in LAC. Bogota (191 hours lost per person per year), Rio de Janeiro (190 hours), Mexico City (158 hours), and Sao Paulo (152 hours) rank first, second, third, and fifth, respectively, out of the 963 cities included in the ranking (INRIX, 2019). According to recent IDB estimates, in 2019 cities such as Montevideo and Buenos Aires lost 1% of their annual GDP due to the high level of delay present in urban traffic (Calatayud et al., 2021). Congestion affects the efficiency of logistics operations: among other factors, it generates delays in deliveries, hinders the optimization of the transport fleet and increases operating costs. Now, coupled with increasing levels of motorization in the region (average annual growth of 4.7% in the last 10 years, compared to 0.5% in advanced economies) and the drop in the use of public transport (from 50.5% in the 1990s to 35.5% in the 2010s), logistics is also one of the causes of urban congestion (IDB, 2020b). The example of New York is illustrative in this regard: the main parcel gateway to the city is the George Washington Bridge, which connects the distribution centers in New Jersey. It is the most congested freight bottleneck in the country. In the last five years, the traffic speed has decreased from 50 km/h to 40 km/h (NYT, 2019). In addition to the number of freight vehicles in circulation, the lack of space for parking and for loading and unloading has a negative impact on traffic, creating additional trips in search of a place to park. In many cases, vehicles end up double parking, which affects not only vehicular traffic, but also road safety. On this basis and with the rapid increase in e-commerce, the number of trips for product distribution is expected to grow radically and, consequently, generate greater pressure on the already high levels of congestion in LAC (IDB, 2020b).

Lack of dedicated space

Related to the above, it should be noted that, in general, few mobility plans include provisions for freight transportation and its integration with other transportation activities. However, logistics also uses urban infrastructure. As a result, there is a regulatory vacuum and even conflict with the mobility of people. Land use plans do not usually address the challenges of urban logistics. The presence of mixed-use zones is limited, distancing logistics operations from distribution areas. Studies conducted in Belo Horizonte showed that, between 1995 and 2015, logistics sprawling had increased by 1.2 km, with distribution centers now located 19 km from the city (Oliveira, Odirley, et al., 2018). The result of logistics sprawling is an increase in the number of trips and distance traveled, with undesirable impacts on congestion and urban pollution. In contrast to this trend, the expected growth of e-commerce will make the presence of mixed-use areas in cities even more necessary, where small warehouses and distribution centers can be established, in order to build more flexible logistics networks, closer to consumers and environmentally more sustainable, involving the reduction of the number of trips, lower levels of empty trips and the use of vehicles powered by clean energies (see section 7.3).

Lack of safety

The lack of road and public safety is a particularly important issue in LAC cities. Speeding, parking in prohibited areas and non-compliance with traffic regulations are some of the challenges faced by the sector to reduce its impact on road insecurity. As 2-3 day or even next day delivery services are becoming standard for many online retailers, the pressure on drivers to meet ever shorter deadlines continues to grow. This incentivizes dangerous driving leading to speeding, a major factor in the occurrence of accidents.

The increased use of motorcycles and bicycles for home delivery also creates road safety challenges, as these modes have increased their share of traffic accidents. Crime in the region also has an impact on logistics operations. This is the case for transporters distributing to neighborhood stores, since most transactions are carried out in cash, which increases the risk of robbery (Fransoo et al., 2017). Working conditions are another aspect related to security in the sector, especially for independent workers of on-demand platforms, whose legal relationship with the platforms and, the obligations and rights of such workers are currently being evaluated by regulatory authorities in different countries.

Sustainability

As discussed in Chapter 9, one of the key challenges of the sector is to reduce its GHG emissions and, consequently, its contribution to climate change. Although large international distribution companies are migrating towards the use of hybrid and electric vehicles —for example, UPS and DHL aim to switch to 100% renewable energies within the next decade—, in the region the use of internal combustion vehicles, especially diesel, is predominant in urban distribution. Another factor that works against greater sustainability of operations is the underutilization of vehicles: indeed, the load factor is often at 30% to 40% of their capacity (Letnika et al., 2018), generating GHG emissions from semi-empty trips. Another important challenge for the sustainability of urban logistics is to reduce the waste of plastics and cardboard used to package the products to be distributed. The region produces more than 400 million tons of plastic each year and 36% of this is single-use plastic, generating economic, environmental and health problems for future generations (IDB, 2020b). The Walmart case illustrates the benefits that could be gained by making small modifications to product packaging: the supermarket chain worked with laundry detergent producers to develop concentrated versions in smaller bottles. After three years, it had saved more than 57,000 tons of cardboard, 43,000 tons of plastic resin, and 400 million gallons of water (Manners-Bell, 2019).

7.3 Management tools and policies

Given the key role that urban logistics plays in economic activities and life in cities, public policies are needed to improve its performance while mitigating its negative externalities, such as its contribution to congestion and deterioration of air quality. This is of particular importance in light of the growth of e-commerce and, consequently, of the urban distribution of products purchased by this means. **Table 7.1** shows the classification of public policy measures for urban logistics, developed from an extensive review of international and regional experiences. In general, there are three types of tools: (i) technical standards and regulations; (ii) economic regulations; and (iii) infrastructure availability. Since different levels of government (federal, state, local) converge in the urban context, inter-institutional collaboration is key for the design and implementation of actions to improve urban logistics. This also applies to the different technical areas of government, given that urban logistics involves land use planning, transportation, infrastructure, public safety, and labor markets, among others. Above all, logistics is an essentially private activity, which requires strong collaboration with the private sector, which can provide the information necessary for evidence-based management, as well as determine the success of policy implementation (e.g., in the case of the logistics platforms mentioned below).

Table 7.1 Public policy tools for urban logistics management

Type of tools	Tools
Technical standards and regulations	Zoning Low emission zones Restricted traffic zones Vehicle type restrictions Off-peak delivery of goods
Economic regulations	Congestion charges Parking charges
Infrastructure	Loading and unloading bays Dedicated lanes Urban logistics platforms, urban consolidation centers and cross-docking centers Provision of spaces for lockers

Source: Own production based on Oliveira, Matos, et al. (2018), and Cardenas et al. (2017).

What is the level of implementation of these tools in the main LAC cities? **Table 7.2** presents the cases of Bogota, Buenos Aires, Mexico City, Lima, Montevideo, Rio de Janeiro, Santiago, and Sao Paulo. The table indicates there is a gap to be filled by the region's cities, good practices must be adopted for more efficient and sustainable urban logistics.

Table 7.2 Implementation of good practices in selected LAC cities

Public policy tools for urban logistics management		Cities							
		Bogota	Buenos Aires	Mexico City	Lima	Monte-video	Rio de Janeiro	Santiago	Sao Paulo
Technical Standards and Regulations	Zoning	●●	●●	●●	●●	●●	●●	●●	●●
	Low emission zones	●●		●●				●●	
	Restricted zones	●●	●●	●●	●●	●●	●●	●●	●●
	Vehicle type restrictions	●●	●●	●●	●●	●●	●●	●●	●●
	Off-peak delivery of goods			●●					●●
Economic Regulations	Congestion charges	●●							
	Parking charges		●●	●●	●●	●●	●●	●●	●●
Infrastructure	Loading and unloading bays		●●			●●		●●	●●
	Dedicated lanes				●●				
	Urban logistics platforms, urban consolidation centers, and cross-docking centers		●●	●●			●●		●●
	Provision of spaces for lockers		●●			●●	●●	●●	●●

Source: Own production based on a review of the regulations of each city.

What do these actions consist of and how can they contribute to reducing the negative impacts described in section 7.2? The following is a summary of the three types of tools that have been reviewed from international experience: (i) technical standards and regulations; (ii) economic regulations; and (iii) availability of infrastructure. References to successful examples of their implementation, which have led to a significant improvement in urban logistics, are also included.

Technical standards and regulations

Standard or regulatory measures are rules or prohibitions designed to shape private behavior to achieve a broader social benefit. The main regulatory tool for urban logistics management is territorial planning, which seeks to order the type of land use according to a city's priorities. The key mechanism for doing this is **zoning**. In general terms, zoning has been used to locate large consumption centers (large stores and supermarkets) outside the historical districts and more congested areas, as well as to move warehouses and logistics infrastructure to peri-urban areas. However, in view of the changes in consumption patterns —from physical shopping to e-commerce— zoning needs to be rethought to improve the efficiency and sustainability of logistics activities. The current context calls for mixed-use zones, where small storage and distribution spaces can be set up to distribute products to surrounding areas, potentially through clean technologies. In Amsterdam and Oslo, for example, small warehouses have been established from which electric bicycles are used to distribute goods, replacing diesel vehicles, and for which parking is easier to find. Allowing warehouses and micro-distribution centers to be located in more central areas could also help to repurpose empty spaces previously used by retail businesses.

Zoning can also encourage the transition to more sustainable logistics. To this end, several cities in Europe have implemented **low emission zones**, which consist of geographic demarcations whose access is limited to vehicles with a certain minimum requirement of non-polluting emissions. These zones may be permanent demarcations, or they may be implemented during periods of high environmental pollution. Normally, to enter these zones, it is necessary to have a distinctive sign indicating that the vehicle complies with the zone's restriction. In addition to minimizing the environmental impact, the objective is also to encourage the renewal of the transport fleet. This is the case in London, whose Low Emission Zone covers most of Greater London and operates every day of the year, all day long. It coincides with the Congestion Charge Zone, in which a fee is paid for driving between 07:00 and 18:00 hours, Monday to Friday working days. In the most central part of the city is the Ultra-Low Emission Zone, which means that vehicles that do not meet the permitted emissions standards pay a daily charge for driving in that area. The fee is US$ 15.16 (£ 12.50) for most vehicles and £ 100 for freight vehicles (over 3.5 tons) and buses. Vehicles are monitored by cameras which take pictures of the license plates to check on a database that the vehicles are registered and the type of emissions they produce. Based on this, the charge that should be paid for entering the zone is applied. (TFL, 2019).

Restricted traffic zones are one of the most frequently implemented measures for freight traffic management. In general, it involves geographically and/or temporarily limiting the circulation of freight vehicles in the city to reduce congestion, preserve the road network, mitigate the risk of road accidents and optimize the use of infrastructure. **Table 7.2** shows which of the selected cities in LAC have restriction zones for the circulation of freight vehicles.

Other traffic restrictions are related to **vehicle type**, referring to characteristics such as vehicle weight or maximum speed, engine type, energy use, among others. Examples of these measures are restrictions on heavy traffic in areas where there are schools, as well as on narrow streets — for example, those in historic districts. With regard to the latter, several European cities are encouraging the use of electric bicycles as a more suitable vehicle for the preservation of heritage in these areas.

Off-peak delivery of goods is a policy that has been tested in several cities around the world. To be effective, it requires businesses to have staff available to receive the goods and to comply with low noise standards, especially for night-time deliveries. Studies in New York and Sao Paulo evidence that, depending on the magnitude of the change in delivery hours, these types of measures are effective in reducing environmental pollution, achieving decreases between 45%-67% (Holguín-Veras, Trilce Encarnación, et al., 2018). Other economic benefits derived from these measures include reductions in operating costs and parking fines; in inventory levels, thanks to more followed deliveries; and in drivers' stress and working hours (Holguín-Veras, Hodge, et al., 2018). Pilots conducted in the city of Bogota showed that these programs could reduce costs per trip by 32%, CO_2 emissions by 42% and unloading time by 60% (ANDI, 2016).

Economic regulations

These regulations seek to correct, through pricing, the negative externalities of urban logistics. Measures based on market-based instruments such as **congestion and/or parking charges**, accompanied by technological innovations to make more efficient use of urban space (sidewalks, parking lots, etc.), have proven to be successful in reducing urban congestion. A pilot conducted in Washington, D.C. that evaluated the effectiveness of implementing dynamic parking pricing in commercial loading zones resulted in a 7-minute reduction in finding parking space, reduced congestion and pollution, and improved safety. The number of double-parked vehicles decreased by 43% and fines by 55%. Other examples of "smart" public space management have been observed in Amsterdam, Barcelona, and Helsinki with reservation systems that provide real-time information on parking spaces. (IDB, 2020b; Calatayud & Millán, 2019).

Infrastructure availability

One of the most widespread measures in LAC cities is the designation of special areas for loading and unloading of goods. These constitute a low-cost and easy-to-implement infrastructure solution to smooth logistics operations (Merchán & Blanco, 2016). They also help prevent double-parking or other forms of illegal parking that hinder the mobility of pedestrians and other road users (McLeod & Cherrett, 2011), positively influencing traffic flows and urban logistics efficiency (Iwan et al., 2018). For example, a study conducted in Oslo concludes that the implementation of loading bays reduced carbon monoxide emissions by 5%, hydrocarbons by 3% and nitrogen oxides emissions by 4% (Iwan et al., 2018).

Pilot tests conducted in Queretaro, Mexico, showed that transit and parking time of delivery vehicles could be reduced by 30% with better use of loading/unloading areas (Fransoo et al., 2017). The literature suggests that the main limitation of loading/unloading bays lies in reserving the parking area and enforcement to ensure that the maximum allowed parking time is not exceeded and that the reserved space is not used by other vehicles. The use of artificial intelligence and video detection tools can contribute to improve enforcement (Miranda-Moreno et al., 2020). The pilot developed jointly by the IDB and the mayor's office of Bogota showed that the effective use of loading and unloading bays in the city is hampered by the inappropriate use that motorcycles make of such spaces, providing critical information for better management of traffic flows and parking in urban space.

A measure which is adopted more and more is the designation of dedicated lanes for trucks or the like, with the objective of separating freight traffic from vehicular traffic. This measure is often used in industrial and logistics zones to facilitate access/egress of related traffic, as well as to improve road safety. In some cases, dedicated lanes can be shared with public transportation, especially when the flow of public transportation is not sufficient to justify an exclusive lane.

Other infrastructure provision measures include Urban Consolidation Centers or **urban logistics platforms**, which are usually located in peri-urban areas with easy access to the main roads of the cities. From these platforms, urban deliveries are made in smaller, environmentally friendly vehicles, or even coordinated with micro-platforms located in more central areas, from which they continue with small, non-polluting vehicles. Studies for London point out that, of the pilot projects established in the city, those dedicated to the consolidation of commercial waste had been the most successful (TFL, 2019). An example of success renowned in the literature is the Paris Chapelle International urban rail terminal. This is a rail terminal that combines logistics services of warehousing, cargo consolidation and de-consolidation and departure point for motorized distribution. One point to note in this case is the size of the effort required: its commissioning took more than ten years of planning, obtaining construction permits, environmental and safety standards. In turn, the investment has a payback period of more than 20 years.

Finally, with the rise of e-commerce, the **creation of spaces** in public places and residential areas for the installation of lockers, where products can be picked up or returned, is gaining momentum. Often installed in private spaces —such as local stores and supermarkets—, cities such as Seattle and Barcelona have allowed the installation of lockers in public transportation stations as an alternative for the delivery of B2C packages.

Conclusions

As a brief conclusion to this chapter, we will mention that, together with the challenges already existing in cities in terms of goods distribution, the expected boom in e-commerce suggests rethinking the relationship between city and logistics, balancing the use of restricted urban space. To this end, as noted in Chapter 11, it is essential to integrate logistics into land-use and transportation planning. In the future, and in line with the progress made in implementing road pricing in cities, pricing mechanisms will also have to be applied to urban logistics to internalize the negative externalities of this activity. New technologies will be an important ally for cities, facilitating data collection for decision making and charging for the use of scarce infrastructure.

CHAPTER 8

LOGISTICS 4.0 IN LAC

In recent years, we have witnessed unprecedented technological breakthroughs, including artificial intelligence, automation, and digitalization. Globally, the logistics sector has been one of the most prone to adopting new technologies, with the use of drones for transportation to remote areas, the application of artificial intelligence algorithms to predict changes in demand, and the digitalization of processes to access ports, among many others. The COVID-19 pandemic is accelerating the pace of technological transformation in the sector, for example, through increased robotization of warehouses, the use of autonomous vehicles for the distribution of medication, and the adoption of digital platforms to have real-time information and better manage risks in operations. However, the situation at the regional level is different. The extensive survey of information about the state of supply chains 4.0 in LAC, conducted by the IDB and the World Economic Forum, evidenced that the region is at least a decade behind the situation in advanced countries (Calatayud & Katz, 2019). This delay is particularly worrying, given the importance of technology as a vector for reducing costs and times, increasing visibility, and strengthening resilience in logistics processes.

This chapter summarizes the technological breakthroughs within the Fourth Industrial Revolution and their application to the logistics context. It then analyzes the state of logistics 4.0 in LAC countries. Finally, it establishes the main aspects to be considered to drive the technological transformation of logistics in the region, in anticipation of the policies that will be addressed in the last chapter of this report.

8.1 Logistics and new digital technologies

The technological developments of the last decade have given rise to the so-called **Fourth Industrial Revolution**. While the First Industrial Revolution was characterized by the application of steam engines in production, the Second used electricity to enable mass production and the Third used information technology to automate processes, the Fourth Industrial Revolution is based on an unprecedented breakthrough in **converging digital technologies**, which are beginning to erode the boundaries between physical and digital spaces, with the potential to create significant economic benefits (Schwab, 2016). Within the main technologies that characterize the Fourth Industrial Revolution, the available literature agrees in identifying the following: the Internet of Things (IoT) and digitalization, artificial intelligence, automation, and 3D printing (Calatayud & Katz, 2019).

Globally, logistics is one of the sectors where these technologies drive the race (McKinsey, 2018), leading to the adoption of the term **Logistics 4.0**, to mention the transformation of the sector. Logistics 4.0 is characterized by a high level of interconnection between the physical and digital domains. IoT sensors make it possible to collect and transmit information in real time, and big data analytics, artificial intelligence and cloud computing make it possible to make decisions simultaneously for different processes. In turn, automation and robotization facilitate the implementation of decisions without the need for human intervention. With the convergence of IoT technologies, artificial intelligence, automation and cloud computing, and their application to logistics processes, huge gains in time, cost, agility and risk management, among other key elements of supply chain performance, are expected to be achieved. Below, we illustrate the uses of different technologies in logistics processes. Obviously, there is a cost associated with the adoption and use of these technologies. However, the available evidence suggests that the benefits for logistics performance, competitiveness and business survival outweigh them, as shown in the case of freight forwarding companies mentioned below.

The Internet of Things (IoT) and digitalization

IoT refers to the set of sensors, devices and networks that connect objects with computer systems, allowing objects to generate information about themselves and the environment in which they are located. The spread of IoT and the digitalization of processes once performed manually are expected to create unprecedented benefits, particularly in terms of business-to-business "connectivity" (the ability to share information in real time) (Calatayud, 2017). This is crucial to improving the performance of logistics operations, where a varied number of actors are involved. For example, a "connected" bottle can transmit information about its temperature, time, and location, favoring quality and inventory control. Sensors on trucks can provide information to the fleet manager and his customers about fuel consumption, speed, location, and potential faults requiring preventive maintenance of the vehicle. A "connected" forklift can generate inventory data and transmit it in real time to both the warehouse manager and its users to ensure optimal management of products in transit (DHL, 2015). In particular, IoT-generated information can increase visibility throughout logistics processes and supply chains, enabling more informed decisions, reacting in real time to any changes or deviations from the plan, minimizing the risk of disruption and meeting increasingly volatile demand.

Another way in which the Internet is revolutionizing logistics is through the **digitalization of processes** such as freight forwarding and customs management. In recent years, different platforms have emerged that provide users with information on prices and services offered by different operators, thus facilitating their comparison and increasing transparency and competition in the sector. Other platforms are characterized by linking transport supply and demand, especially in the last mile of logistics (see Chapter 6). Some of them fall under the concept of the sharing economy, which refers to the shared use and/or ownership of goods or services through digital platforms. In the logistics field, this has become particularly relevant for the warehousing process. For their part, e-commerce companies are beginning to integrate logistics and customs solutions into their own platforms, offering their customers the possibility of contracting the entire import or export management and even reserving space in shipping line containers. Finally, freight forwarders are moving towards the provision of comprehensive digital services in the form of "control towers", to which their customers can delegate logistics and supply chain management. These platforms provide an overview of the entire supply chain, making it easier to identify risks, create mitigation plans and thus minimize potential disruptions due to, for example, extreme weather events, procurement failures, transportation disruptions or even cyber-attacks.

Artificial intelligence

Artificial intelligence is the computerized execution of operations that are typical of human intelligence. It is estimated that, of the US$ 42 trillion in value to be generated by this technology, one third will come from the logistics sector (DHL, 2020). In this sector, artificial intelligence is being used to predict demand, fulfill orders, perform preventive maintenance of equipment, optimize warehouses and transportation fleets, provide customer service and manage risks, among others. Thus, it is not surprising that 79% of logistics professionals consider that artificial intelligence is already a key skill for any company that wants to be competitive (DHL, 2020).

The availability of big data —e. g., through the IoT technology mentioned above— and of great processing power through cloud computing are facilitating the deployment of increasingly sophisticated algorithms to improve the predictive abilities of artificial intelligence and, with it, proactively make process optimization decisions, as opposed to the reactivity of the techniques traditionally used in the sector. Amazon's anticipatory shipping is an interesting example in this regard. Algorithms build a profile of a customer based on their purchase history, searches performed, demographic characteristics, location, etc. From this profile, predictions are made about what purchases they will make in the future. These products are sent to warehouses closer to the consumer so that, when the purchase is completed, they can be delivered immediately, increasing customer satisfaction.

Automation

Automation refers to the execution of tasks by a machine, without human intervention. This technology is already widely present in mass production, such as automotive and electronics manufacturing, and used more and more in warehouse management, and transportation. Major developments for the logistics sector include platooning, autonomous trucks and ships, drones, and automated logistics infrastructures.

Platooning uses wireless connections, combined with Adaptive Cruise Control, to form a platoon of trucks that dynamically adapt their speed and distance to replicate the changes in gear and direction made by the truck leading the platoon. Most of the major companies in the industry, such as Volvo, DAF, Daimler, Scania, and Iveco, are testing the technology along geofenced corridors in the United States, Europe and Singapore, mainly[57]. Data collected from different tests show that, because of the increased coordination and efficiency in truck driving, this technology could generate fuel savings between 10% and 30% per year (UK Government Office for Science, 2019). Furthermore, the technologies required for platooning, such as the Advanced Emergency Braking System (AEBS), could reduce the number of accidents involving trucks by up to 80%, even if they are not being platooned (World Maritime University, 2019).

Autonomous trucks are those that have an autonomy of level 4 or higher[58]. Recent data for the United States indicates that, with the implementation of autonomous trucks, the trucking industry's operating costs could be reduced by 45% (McKinsey, 2018). The benefits of autonomous trucks can be significant, they include: (i) reduction of repetitive and lower value-added tasks, thus freeing up driver time for control tasks, load management, etc., and increasing interest in the profession (currently in worrying decline in advanced countries); (ii) reduction of labor costs, which account for about 60% of operating costs in trucking; (iii) reduction of the 'human factor' (fatigue, errors, etc.), which is often the major cause of traffic accidents; (iv) increase in operating hours, as it is not subject to drivers' shifts; (v) when combined with vehicle-to-vehicle and vehicle-to-infrastructure connection (V2V and V2I, respectively), increased efficiency in routing by the transport company and traffic

57. See, for example Reuters (2018), "Volvo, FedEx test truck platooning on public U.S. road", available at: https://www.reuters.com/article/us-volvo-fedex-trucks/volvo-fedex-test-truck-platooning-on-public-u-s-road-idUSKBN1JN2JI.
58. The U.S. NHTSA made a classification of vehicle automation levels, establishing five categories, where 0 corresponds to no driving automation and level 5 corresponds to full automation. For more information, see: https://www.nhtsa.gov/technology-innovation/automated-vehicles-safety

management by the infrastructure operator; and (vi) improved infrastructure capacity, reduced congestion, and increased order fulfillment, based on coordinated and safe driving between vehicles, leading to a decrease in the required distance between vehicles. (National Academy of Sciences, NAS, 2019).

In recent years, different technological development projects have been announced to provide ships with autonomy. In general, research projects include the use of sensors and artificial intelligence for monitoring ship operations, identifying the characteristics of the environment and communicating with it (ports and other vessels), as well as making decisions regarding direction, speed, and energy consumption. Industry representatives estimate a 20% decrease in operational cost of autonomous vessels and significant improvements in maritime safety (World Maritime University, 2019).

Unmanned aerial vehicle technology —commonly called "drones"— has received a great deal of attention from the technology and logistics industries, having been tested in a wide range of operations such as, delivery of light products purchased through e-commerce, transportation of medication to remote areas, and transportation of emergency medical equipment to areas with low connectivity or congestion. Other uses include supporting surveillance tasks during the transportation of goods, inventory management in warehouses, and imaging for transportation planning.

While logistics industry experts note that the use of drones in urban areas is impractical in the near future, due to the risks they could pose to pedestrians and the low availability of landing and take-off zones, **mini-robots** have emerged as an option to ensure faster last-mile deliveries that are less sensitive to urban congestion. Available tests have employed robots that can carry up to 10 kg and use sidewalks and segregated lanes (e.g., bicycle lanes) for travel (the Wall Street Journal, WSJ, 2018). Upon arrival at the destination, consumers receive a notification with a code to be able to open the robot's container and pick up their order. Some companies have suggested starting to use these robots as temporary order storage spaces to reduce the cost of failed deliveries. Restrictions on mobility due to the COVID-19 pandemic has given a further push to testing this technology, including the distribution of medicines in confined areas and the transport of laboratory tests between healthcare facilities (United Nations Industrial Development Organization (UNIDO), 2020).

Automation technology is also beginning to be present in the operation of logistics infrastructures. In the case of **warehouses**, the adoption of robots and artificial intelligence for inventory movement and management, picking and order fulfillment has been very fast —especially since the COVID-19 pandemic—, given the progress of technological development for the sector, the lower technology acquisition costs compared to other segments, the clear return on investment (significant savings in labor, faster processes with lower error rates, 24/7 operations without interruption, higher storage density and lower utility costs since, for example, robots do not need electricity to operate) and the ability to meet peak demand, given a growing volume of business led by the advance of e-commerce. One of the most emblematic examples in this regard is the Amazon warehouse located in Baltimore, U.S.A. In its 93,000 m^2, different types of robots and automated machinery prepare 1 million orders per day and manage an inventory of 10 million products. (WSJ, 2019).

On the other hand, in the case of **port terminals**, the automation of cranes and container handling equipment also promises to generate significant improvements in productivity through standardized and consistent operations, 24 hours a day, 7 days a week. This is an important factor considering that vessel size will continue to increase, creating significant operational challenges in dockside loading and unloading maneuvers, as well as in container yard management. However, the substantial investment required, coupled with concerns about the future of the port's workforce, has led to low levels of adoption, with only 2% of terminals currently semi-automated and 1% fully automated worldwide.

Box 8.1 Blockchain: traceability and simplification of procedures

Blockchain is among the new digital technologies that promise to generate benefits for the logistics sector. It is a distributed logging technology, through which information shared across the network can be stored at each node, facilitating access and traceability of the history of stored transactions. Distributed logging technology also makes the system more resilient to possible failures or attacks. It also reduces the risks of alterations or falsifications to the stored information, given that each change to this information must be approved by consensus by all the nodes in the network, using cryptography. Finally, the decentralization and consensus necessary for the registration of information reduces the need for third parties to validate the shared information, thus reducing transaction costs for the agents involved. As addressed in Chapter 6 on trade facilitation, the use of blockchain technology is expected to improve product traceability and streamline the control tasks of public organisms, significantly reducing trade costs.

An important aspect of technology adoption in logistics is that, to obtain the expected benefits from it, it is essential that all actors involved start their digital transformation process. This is due to the fragmentation of logistics processes among various actors, which makes it necessary that, for example, the big data generated by IoT sensors in a supermarket, alerting on the change in demand, can be transmitted and used as input in the storage and transport processes, to make the most of this information in the optimization of such processes. Alternatively, information via IoT and artificial intelligence used for the management of operations in a port can also be used by logistics companies for the planning of their operations and by the public sector for the proper management of cargo traffic in the port area. Similarly, full product traceability requires the implementation of sensors and systems to generate and share information not only between suppliers and manufacturing companies, but also with carriers and traders.

8.2 Logistics 4.0 in LAC

In 2019, the IDB and the World Economic Forum conducted the first survey on the **status of digital transformation of supply chains** in the region, including logistics processes in the analysis (Calatayud & Katz, 2019). The study covered the main supply chains in six countries —Argentina, Brazil, Colombia, the Dominican Republic, Mexico, and Paraguay— gathering observations from business leaders, the public and academic sectors, and conducting an extensive review of studies and data from secondary sources. This section includes the main conclusions of the study.

LAC countries have specific **conditions that limit the adoption of technologies**. Important conditions are:

- Somewhat instable economic and political environments and investment-unfriendly conditions present in some countries in the region, which delay the implementation of innovative foreign business transformation initiatives.
- Low labor costs, which compete with the potential economic benefits generated by the adoption of digital technologies.
- Limited local availability of technologies adapted to the needs of companies in the region, which forces them to seek and acquire advanced solutions abroad, involving higher costs and reducing the return on investment.

- Reduced availability of services to implement and maintain the new technologies.
- Lack of knowledge and prioritization by middle and management levels, and lack of qualified workers.
- Cultural resistance caused by generational factors and fear of job loss.
- Lack of transportation and telecommunications infrastructure which relegates public and private investment priorities to promote digital transformation.

With reference to the logistics sector, a significant **gap was evident between large companies operating internationally and small and medium-sized enterprises in LAC**. In the first case, the pace of digital transformation of manufacturing multinationals and the competitive pressures of a sector with low profit margins are stimulating innovation, through three main strategies: (i) acquiring technology capabilities directly related to their core logistics business; (ii) vertically integrating processes along the supply chain; and (iii) partnering with technology companies to implement solutions that improve operations performance. In contrast, small and medium-sized operators face human resource and investment barriers, as well as resistance from management, which limits their ability to transform. As a result, the vast majority of transactions are done on paper or through systems that cannot be connected to those of other actors in the supply chain. In turn, this delay is detrimental to their business options. Increasingly, multinational companies tend to select only those logistics providers that promise full traceability of goods in transit.

Special mention should be made of **road freight transportation**, especially small and medium-sized enterprises, which other actors in the supply chains tend to point to -both in LAC and internationally- as a major bottleneck in terms of digitalization. Some of the main causes of this falling behind are:

- Fragmentation and scale limitations. The land transportation industry is made up of a majority of small companies, which present the typical barriers to the digitalization of a SME: low investment capacity, limitations in technological implementation capacity, and limited access to financial resources.
- Low transparency. Small carriers are reluctant to allow full transparency in the management of information on the status of freight transportation. Visibility into carrier performance allows the manufacturer to identify where delays are occurring, thereby increasing the liability of the transportation operator.
- Technological barriers. Partly due to lack of resources, but also due to lack of human capital, small and medium-sized transportation operators are reluctant to assume the cost of developing interfaces between their systems and those of logistics service providers. Also, in many cases, they do not see the benefits of digital transformation for their business (See **Box 8.2**).
- Multiplicity of actors. The implicit complexity in logistics processes, with multiple actors involved and each with its own information system, creates an additional barrier to digitalization.
- Limited access to investment capital. Within the transportation industry, the freight transportation segment faces greater difficulties in accessing investment capital when compared to passenger transportation.
- Difficulties in recruiting and retaining talent. In general, transportation companies have little attraction for digital talent, which is more concentrated in start-ups or technology companies.

Box 8.2 Estimating the benefits of technology adoption in road freight transportation

The IDB, together with the Universidad de los Andes (Colombia), the Florida Institute of Technology (United States) and the Universidad Andrés Bello (Chile), estimated the freight shippers' willingness to pay to increase visibility in road transport, based on a greater adoption of technology in trucks. Indeed, one of the barriers to digital transformation mentioned by trucking companies is the uncertainty about whether there will be an economic return on investment for their business.

The methodology used involved an experiment based on the revealed decisions of 170 freight shippers in Colombia, complemented by a quantitative survey of trucking companies in the country, as well as qualitative interviews in Colombia and Chile with trucking companies, shippers and visibility technology providers. The results showed a willingness to pay for GPS transportation services —the main technology to pinpoint the location of cargo during transport— substantially higher than the costs of adopting such technology. In particular, freight shippers are willing to pay an additional US$ 600 to hire a truck with a GPS instead of a truck without GPS (and up to US$ 1,200 if GPS and Geofencing are included), while the cost of equipping a truck with a GPS system is only US$ 10 for a three-day trip.

A very interesting aspect revealed by the study is that, when available, most companies do not use the data collected by GPS technology other than to have traceability of the cargo during its journey, or to verify situations in which accidents, theft or contamination of products occurred. This is a lost opportunity for all the actors involved, since having and using data on routes, transit times, delays, etc., can contribute to improve the planning of logistics operations and optimize processes in a comprehensive manner throughout the logistics chain. Among the limitations for the use of this data, the companies interviewed mentioned the lack of IT infrastructure for storage, the lack of technical capabilities for processing and identifying the indicators of interest, and even the lack of knowledge of the usefulness of this data for operational planning. In line with the analysis at the regional level, micro and small enterprises are the ones who most frequently mention these barriers.

In this context, two trends have emerged to address these barriers. First, logistics service providers are integrating ground transportation operations into their services to facilitate the deployment of digital technologies. Second, technology companies with the profile of digital matching platforms are being developed to provide a more efficient relationship between logistics providers and transportation services. These include *CargoX, Fretebras, Busca Cargas* and *Truckpad* in Brazil, and *Humber*, *Circular* and *Avancargo* in Argentina. These firms provide digital services aimed at solving coordination failures between freight shippers, logistics service providers and inland carriers (see **Box 8.4**).

LAC's **transportation infrastructure** also shows a low level of digitalization. The efficient operation of logistics in the context of the Fourth Industrial Revolution requires ports, airports, border crossings, roads, and rail networks, among others, to be equipped with digital technology. In recent years, several leading ports worldwide have implemented "smart port" systems, with the ability to digitally connect their automated, semi-automated and manual platforms to monitor information on the positioning and status of goods and assets entering and leaving the port, combining this with weather, labor, and traffic status information. Based on this information, decisions are made to optimize port operations, including waiting times, vessel berthing times, and location of vessels on the docks. Some LAC **ports** have made progress in this regard. Cartagena, for example, implemented a modernization program that included mechanical storage, scanners for non-intrusive inspection, virtual port management systems and digital information processing, which improved efficiency. In Paraguay, some river ports have increased container monitoring and traceability through GPS and radio frequency identification. Similarly, some of Argentina's most advanced terminals are introducing IoT solutions to check grain conditions in silos, drones for inventory management, and artificial intelligence-based systems to respond to customer queries. In addition, several LAC ports have implemented shift systems, whereby trucks are assigned a specific day and time for loading and unloading operations at those ports.

However, there are still challenges to be faced to maximize the adoption and expected benefits of the technology. Among those highlighted by the sector's stakeholders, the following can be mentioned: (i) lack of digital culture in companies related to maritime transportation; (ii) reluctance to share information and collaborate in the development of opportunities based on the use of new technologies; (iii) costs associated with the adoption of technologies; (iv) concerns about data privacy and data security; (v) uncertainties in the regulatory framework; (vi) insufficient deployment of telecommunications infrastructure; and (vii) lack of interoperability of digital systems and common standards (Calatayud & Millán, 2019).

The higher relative level of technological adoption in ports contrasts with that of **roads and rail freight transportation**. The deficiencies in the quantity and quality of road and rail infrastructure mean that investment plans are focused on trying to fill the infrastructure gap first, leaving technological modernization for later. In fact, it is in those modes where a higher level of development has already been achieved —i. e., ports and airports—, where a certain deployment of technology begins to take place, in order to optimize the use of infrastructure.

In addition to the limitations of the transportation infrastructure, there are also **telecommunications** limitations. Digital transformation cannot be achieved without the existence of an advanced telecommunications network. In LAC, wireless telecommunications networks do not provide complete coverage and adequate performance levels to support constant communications between vehicles in transit, logistics company control centers and customers. This happens mostly in rural areas and affects the possibility of having complete traceability of goods or containers in transit. The region is also far from the connectivity standards of more developed countries: the average connection speed is 5.27 Mbps, compared to significantly higher levels in the emerging countries of Asia and the Pacific (8.13 Mbps), the United States (18 Mbps) and Europe (19.86 Mbps).

Finally, the degree of **collaboration between the public, private and academic sectors** is very low compared to advanced countries. This is a particularly relevant challenge for two reasons: (i) the main innovations in logistics emerge from the private and academic sectors; and (ii) the public sector can be key to the promotion of policies that encourage private innovation and the adoption of technologies in those logistics processes where public institutions are involved. In addition, **inter-institutional collaboration** is very limited, even when digital transformation is influenced by policies and regulations involving multiple public sector agencies (e.g., privacy, cybersecurity, infrastructure investment, transportation processes, trade facilitation) (Calatayud & Katz, 2019).

8.3 Initiatives to promote Logistics 4.0 in LAC

The available studies coincide in pointing out that: (i) awareness in the region's private and public sectors about new technologies, their advantages and the imperative need to begin the transition to the Fourth Industrial Revolution is low —in part also because evidence of the advantages of new technologies is scarce (see **Box 8.3**); and (ii) even when they are aware of the technologies, their development and adoption is very incipient. and (iii) there is no comprehensive digital transformation at the supply chain level in the region, but rather isolated experiences in processes or companies are evident. Given the systemic nature of supply chains and the involvement of multiple actors and modes of transportation in them, it is essential to move forward with a strategy for the comprehensive technological transformation of such chains.

Box 8.3 Comparative benefits of Technology Investment in Logistics

In order to guide investment decisions by the Colombian public sector, the IDB, together with the Florida Institute of Technology (U.S.) and the Universidad del Norte (Colombia), analyzed the impact that economic, technological and geopolitical trends would have on port activity in the three main ports on the country's Caribbean coast (Barranquilla, Cartagena and Santa Marta). The study used 12 scenarios evaluated on a computable general equilibrium model of international trade, adjusted for port planning in the specific region, for the period 2019-2035.

The results of the analysis show that the greatest benefits for port activity (approximated through the increase in exports and imports managed by a port) would be obtained from the digital transformation of the transportation sector, especially through the adoption of electronic tolls in the corridors connecting the hinterland with the ports, increased connectivity of trucks with intelligent transportation services, and the use of Geofence in the port area. The adoption of these technologies would generate an increase in trade of more than 10%, as a result of increased logistics efficiency and reduced transportation costs. The impact would be greater than the impact of increasing free trade agreements with major trading partners (6%) and investments in infrastructure for port expansion (4%).

To reverse this situation, the IDB is accompanying the countries of the region in the adoption of international best practices, the generation and exchange of knowledge, and the design of policies and regulations that pave the way towards Logistics 4.0. From the multiple national, regional, and international dialogues promoted by the IDB, as well as the research conducted, at least four action areas have been identified to promote Logistics 4.0, within a framework of public-private collaboration. These areas are summarized in **Table 8.1** and will be dealt with in more detail in the last chapter of this report.

Table 8.1 Initiatives to accelerate the development of Logistics 4.0 in LAC

Action area	Public sector	Public-private collaboration
Develop integrated public policy frameworks	• Generate integrative policy frameworks and inter-ministerial coordination bodies to promote the adoption of technology 4.0 in all logistics nodes and processes. • Anchor the digital transformation of the supply chain (including logistics) in a state policy, to provide a horizon of stability and foreseeability to private investments. • Establish an institutional structure led by the highest executive level, which promotes the collaboration of the different areas of government acting along the supply chain. • Generate information and indicators to monitor the status of the digital transformation of the most important supply chains, including their logistics processes, which can be accompanied by the creation of a digital transformation observatory.	• Involve the private sector in the development of national plans aimed at digitally transforming the logistics sector. • Coordinated analysis of logistics processes, guided by competitiveness improvement objectives and identification of bottlenecks.
Support SMEs in the logistics sector	• Include the digital transformation of companies in the logistics sector in existing SME support plans. • Deploy technological centers focused on the logistics sector, aimed at providing training and pilot testing facilities for SMEs to develop specific capabilities in support of their digital transformation. • Reduce federal and state taxes, as well as import tariffs on equipment to encourage digital transformation of SMEs in the sector. • Support the development of start-ups focused on use cases for the application of digital technology in logistics.	• Implement awareness campaigns targeting freight transportation companies to explain the benefits of digital transformation. • Develop roadmaps and manuals to help logistics SMEs launch their digital transformation programs. • Consider identifying advanced companies in the sector that can play the role of leaders in promoting the digital transformation of their peers. • Promote the association with digital service providers for the creation of technological centers. • Promote links with large technology companies to develop digitalization capabilities with logistics SMEs. • Leverage technology providers in the development of training centers.
Accelerate the development of smart infrastructure	• Support pilots aimed at demonstrating the benefits of adopting technology in logistics infrastructure (see Table 8.2). • Digitalize processes and procedures at ports, airports, border crossings and other logistics nodes. • Articulate IoT in transportation networks and foster the interconnection with logistics services. • Create a regulatory framework to allow experimentation with new technologies, such as autonomous vehicles and blockchain.	• Involve the private sector in the development of national plans aimed at the digital transformation of the logistics sector and in technology pilots. • Coordinate analyses of logistics processes and the potential of their digitalization, guided by competitiveness improvement objectives and the identification of bottlenecks.

Table 8.1 Initiatives to accelerate the development of Logistics 4.0 in LAC		
Action area	**Public sector**	**Public-private collaboration**
Solve barriers and challenges of the regional environment	• Support pilots aimed at demonstrating the potential of digital transformation in logistics processes (see Table 8.2). • Develop training programs aimed at resolving human capital limitations and imbalances between technological demand and labor force. • Promote greater competition in the transportation sector that, among other things, encourages digital transformation as a factor of competitive advantage	• Involve the private sector in the development of technology pilots. • Consider regional context factors (such as the relative cost of labor, lack of human capital, or difficulties in acquiring advanced digital technologies) in the development of national logistics digitalization plans.

Source: Adapted from Calatayud & Katz (2019).

As shown in the table, the public sector can play an important role in promoting the digital transformation of logistics and, in general, of LAC supply chains. For example, it can be: (i) a catalyst of new technologies, identifying those that present opportunities to generate value to their chains and economies; (ii) a facilitator of innovation ecosystems, promoting the testing of technologies in real scenarios; (iii) an incentive provider, either through fiscal or financial stimulus for the development and adoption of technologies; (iv) a regulator, mitigating potential risks of technologies; and (v) a pioneer in adoption, demonstrating the capacity and benefits of technologies (UK Government Office for Science, 2019).

Table 8.2 Selected pilots for the promotion of new technologies				
Initiatives	**Sector problem**	**Technology solution**	**Application**	**Results**
Video analysis for monitoring loading/ unloading areas and urban logistics operations	Urban space (sidewalks, walkways, etc.) is a limited resource, with a growing demand due to the increase in urban logistics operations. The implementation of loading/unloading bays is a tool used to manage parking demand related to urban distribution of goods. However, the multiplicity and dispersion of such areas make it difficult to control them and, thus, their appropriate use. There is also little information available on the efficiency of these bays, partly due to the lack of data to measure their performance.	Design and implementation of a system to monitor and collect data on urban logistics dynamics, using computer vision and convolutional neural network techniques. The system automatically generates indicators on the use of space on roads and sidewalks, including loading and unloading bays, legal or illegal parking areas, as well as traffic conditions and road safety on streets.	The developed algorithms were trained and tested using data from the city of Bogota in Colombia, with videos from both fixed city cameras and temporary cameras.	Effective use of loading and unloading bays is hampered by the inappropriate use of these spaces by motorcycles, providing critical information, previously unavailable, for better management of traffic flows and parking in urban space.
Using IoT to improve traceability and reduce risks in the pharmaceutical supply chain	The absence of traceability in the pharmaceutical supply chain increases costs and logistics times, as well as the risk of inventory loss and/or theft, oversupply, or stock-outs, and use of counterfeit drugs. As evidenced by the COVID-19 pandemic, the correct performance of the pharmaceutical supply chain is critical for health security.	Design and implementation of a medication traceability system via IoT and digital management, along the entire supply chain, including pharmaceutical companies, logistics service providers and hospitals/health centers.	The pilot was implemented in the supply chain of public hospitals in Medellin, Colombia.	The information provided by the IoT sensors (RFID) and its analysis through the management platform allows improving different performance indicators in the supply chain, such as inventory turnover, order fulfillment time, transportation times and storage costs.
Connected sensors for real-time monitoring of weight and location of trucks	One of the factors affecting the quality of road infrastructure and the efficiency of transportation operations is the prevalence of overweight freight vehicles. In addition to damage to road infrastructure, overloaded trucks are also associated with impaired road safety and unfair competition. Although several countries have defined specific regulations to control the weight and dimensions of freight vehicles, they face significant challenges in ensuring compliance with these regulations. For example, there is a limited infrastructure of operational weighing stations and, as a result, there is no comprehensive monitoring of compliance with the regulation.	Driven by the IoT, this solution proposes an alternative to weighing stations, using a system of wireless sensors, on-board information devices and communication modems, allowing real-time weight reporting to the driver, fleet owners and government authorities.	This pilot is implemented in Costa Rica, El Salvador and Guatemala.	Reduced cost of fuel and truck maintenance by maximizing the freight transported, always keeping it under the established limits. Reduced cost of government oversight to ensure compliance with weights and dimensions regulations. Elimination of time spent by freight companies when they have to stop and weigh their trucks at weigh stations.

Source: Own production.

Box 8.4 New business models for road transportation and technology-based last mile solutions – the case of FreteBras

New business models are revolutionizing traditional "freight exchanges" for road transportation and last mile solutions. Such models make use of wireless broadband and smart mobile device offer, cloud computing, big data, the Internet of Things and artificial intelligence to provide innovative solutions through digital platforms, with a number of interesting features.

Platforms for consolidated (LTL-less than truck-load) or full (FTL-full truck-load) freight transportation, such as *FreteBras* in Brazil, use technology to help solve some of the challenges faced by this segment in the region.

First of all, these solutions make it possible to offer consolidated logistics services from independent carriers to freight shippers with quality and reliability standards, which reduces the uncertainty and intermediation caused by the atomization and informality of the sector. *FreteBras* benefits freight shippers by offering a centralized digital platform for publishing freights and finding carriers. In addition, the digital platform also enables drivers to find freights more efficiently. In order to ensure quality and safety, freight shippers interested in using the platform must go through a strict validation process. Carriers must register their trucks to access freights through the platform, and this information is verified with government information systems.

Second, by generating smart matching mechanisms, these solutions increase the operational efficiency of freight vehicles. Through its platform, *FreteBras* automatically connects large freight shippers with small carriers. In turn, the matching mechanisms enable carriers to use idle capacity on their vehicles to serve more customers and reduce the number of empty trips. A survey of 577 *FreteBras* truck drivers found that 35% of total kilometers were performed without freight, a significant improvement over the industry benchmark of 59% (ILOS, 2017).

Third, increased operational efficiency has the potential to reduce the carbon footprint by reducing the number of trips required to transport the same amount of cargo. *FreteBras* also uses technology to optimize truck routing, which reduces travel times and fuel expenditure per trip.

Finally, these platforms employ solutions to automate processes, ensure real-time cargo traceability, and increase information availability. The latter contributes to greater reliability of services and transparency for all stakeholders.

Operating with a base of nearly 1.4 million registered truck drivers and 9,000 active freight shippers in its network, *FreteBras* is the largest online freight marketplace platform in Brazil and South America. The increasing sophistication of these models is expected to bring confidence and quality to freight transportation users, revolutionizing the freight market in the region.

IDB Invest, a member of the IDB Group, granted a US$ 14.4 million capital investment to *FreteBras*, comprised of US$ 9.9 million in capital investment from *IDB Invest* and US$ 4.5 million in concessional capital from the Clean Technology Fund (CTF). The funds will support increased transportation efficiency through data optimization models that reduce truck idle time, as well as the development of a methodology to track greenhouse gas (GHG) emissions savings. In addition, the funds will help the company develop improvements to its platform, particularly in terms of safety.

Conclusions

This chapter identified the main technologies that are revolutionizing logistics within the context of the Fourth Industrial Revolution. These technologies are IoT and digitalization, artificial intelligence, automation and blockchain. Internationally, the adoption of these technologies has accelerated since the COVID-19 pandemic, where they have proven their value in reducing the risk of disruption in supply chains. At the regional level, however, there is a two-speed sector, with a handful of large international and regional companies that are making progress in the adoption of technologies for the management of their operations and assets, compared to a majority of SMEs, especially in the road transportation sector, which present serious barriers to modernization. In terms of infrastructure, the road sector also lags behind the maritime and airport sectors, although there is also considerable room for modernization in the latter. Given the systemic nature of supply chains and the involvement of multiple actors and modes of transport in them, it is essential to move forward with a strategy for the comprehensive technological transformation of such chains. The public sector can play an important role in this regard, leveraged by close collaboration with the private and academic sectors.

CHAPTER 9

FREIGHT TRANSPORTATION AND CLIMATE CHANGE

Climate Change (CC) is a globally shared challenge, which "*is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods*" (UNFCCC, 1992). Over the last century, the use of fossil fuels (such as oil, gas and coal) has increased the concentration of carbon dioxide (CO_2) in the atmosphere, one of the main anthropogenic Greenhouse Gases (GHG) contributing to CC. Given that this phenomenon can trigger a series of eventualities such as: a decrease in water resources, extreme weather events and changes in precipitation, among others (IDB, 2012), the effects of CC are identified as **one of the main challenges to achieve sustainable development** worldwide (United Nations, 2015).

Indeed, at the international level, a goal has been set to keep the global average temperature increase below 2ºC. To this end, various international agreements have been reached, the most important of which are the Kyoto Protocol, adopted in 1997, and the Paris Agreement in 2015. Both contribute to strengthening the international response to the CC threat and recognize the need to define and implement **different CC mitigation and adaptation strategies**. Such adaptation measures aim to reduce the —current and future— vulnerability of human and natural systems to the —actual or potential— effects of CC (IPCC, 2018). On the contrary, mitigation strategies seek to reduce greenhouse gas emissions, thus modifying this phenomenon in the long term (CIIFEN, 2016b, 2016a).

These mitigation and adaptation strategies have a strong emphasis on sectors that account for 73% of global emissions, electricity, heating, industry and transportation (CIAT, 2016). Particularly from an emissions production standpoint, **the transportation sector is responsible for 24% of the emissions** generated by the consumption of fossil fuel-based energy. Additionally, the emissions from this sector are one of the sources with the highest growth rate, as they increased 6.4 times between 1980 and 2018 (IEA, 2019a). Likewise, according to data from the International Energy Agency (IEA) 2020 road transport of passengers (3.6 gigatons —GT— of carbon) and goods (2.4 GT) accounts for almost three quarters of CO_2 emissions from transportation, while the remaining 25% corresponds to emissions generated by air (0.9 GT), maritime (0.9 GT) and rail (0.2 GT) transportation modes. Although environmental sustainability challenges are evident for both passenger and freight transportation, this chapter focuses exclusively on the challenges for the decarbonization of freight transportation[59].

59. For an in-depth analysis on the decarbonization of passenger transportation , see Taddia et al. (2021).

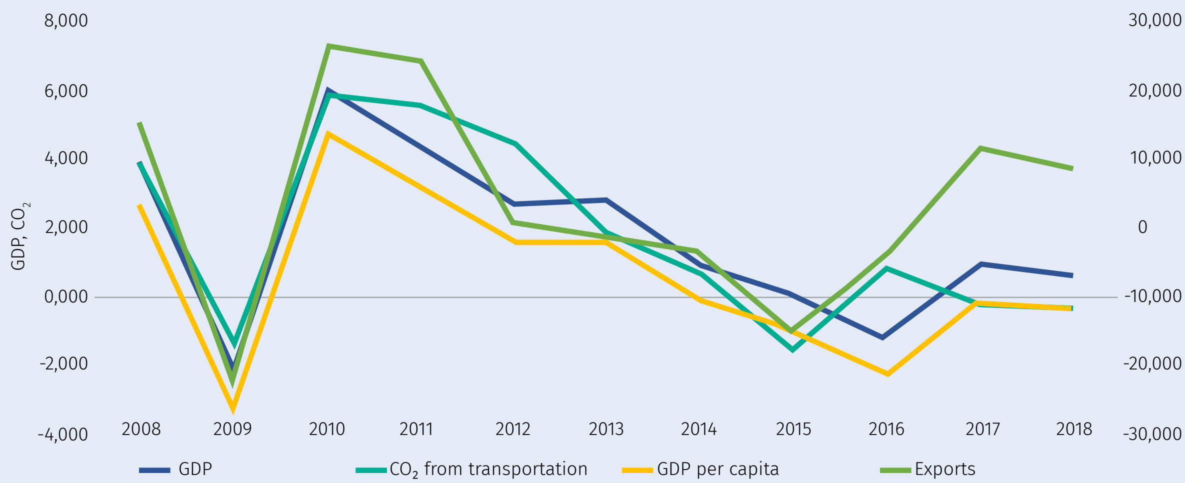
9.1 Total emissions from the transportation sector

The link between the evolution of GHG emissions and economic growth has been extensively studied in the literature, especially in light of the "Environmental Kuznets Curve" hypothesis. This theory argues that there is an inverted U-shaped relationship between environmental quality and per capita income, suggesting that, in the short term, the early stages of economic growth are correlated with a deterioration of environmental indicators. However, above a certain income level, higher economic growth would be accompanied by improvements in environmental quality, given a greater investment in technologies to improve energy efficiency and the implementation of stricter environmental laws and standards (Grossman & Krueger, 1995). Although this theory is empirically verified only for some developed countries and some types of pollutants (Kunst & Nuroglu, 2017), studies conducted by Falconí et al. (2016) for developing countries conclude that when per capita income is below US$ 22,258, there is a positive relationship between income and per capita CO_2 emissions. However, once this income threshold is exceeded, emissions growth remains constant, and does not decrease as expected by the Kuznets curve.

Similarly, different studies analyze how higher levels of growth and economic integration also represent an **increase in the volumes of goods transported** between increasingly dispersed origins and destinations, and **therefore of emissions from the transportation sector** (OCDE, 2015). For example, estimates made by Cristea et al. (2011) conclude that international freight transportation generated 146 grams of CO_2 per dollar of international trade worldwide, i.e., one third of the emissions related to international trade. Additionally, the International Transport Forum estimates that global freight volumes will increase by a factor of 4.3 between 2010 and 2050 (measured in ton-kilometers), and this will be accompanied by a 290% increase in CO_2 emissions from international trade.

In the case of LAC, **Figure 9.1** shows a direct and positive correlation between Gross Domestic Product (GDP) and total emissions from the transport sector (a relationship that is clearer between 2008-2015). While the average GDP growth rate was 1.76% in the period from 2008 to 2018, CO_2 emissions in the transport sector grew at a faster rate with a rate of 1.82%. The behavior of emissions reflects economic cycles, also affected by variations in exports. Thus, the highest peak in transportation emissions growth coincides with the peak in exports and GDP growth, contrary to 2015, which has the lowest peak in exports and emissions.

Figure 9.1 GDP growth rate*, GDP per capita, exports and CO_2 emissions in the transportation sector (2008- 2018, LAC)**



Source: Own production using data from UNCTAD and IEA.

Notes: * The information used to make these estimates for LAC can be found at: https://unctadstat.unctad.org/EN/.
** Information compiled from AIE (2019), CO_2 Emissions from Fuel Combustion. It contains information for 22 LAC countries (LAC-22).

It is also important to highlight the inequalities in the production of emissions worldwide according to income levels. According to data for the year 2018, 35% of emissions from the transportation sector were generated by OECD countries in the Americas, while the rest of the countries in the American continent contributed 6.9% of global emissions. Within the LAC region, there are also **disparities in terms of each country's contribution** to the total emissions generated by the transportation sector. According to IEA data, LAC-22[60] generated a total of 594.13 million tons of CO_2 corresponding to the transportation sector in 2018. Of these, the country that contributed most to total regional emissions was Brazil with 191.66 million tons (32% of the total emitted by LAC-22), followed by Mexico (26%), Argentina (8%), Venezuela (6%) and Colombia (5%). At the other end of the distribution we find the countries that generate the least emissions, including mainly small countries in terms of population, located in the Caribbean and Central America, such as: Suriname (0.1%), Haiti (0.2%), Jamaica (0.4%), Nicaragua (0.4%), and Trinidad and Tobago (0.4%).

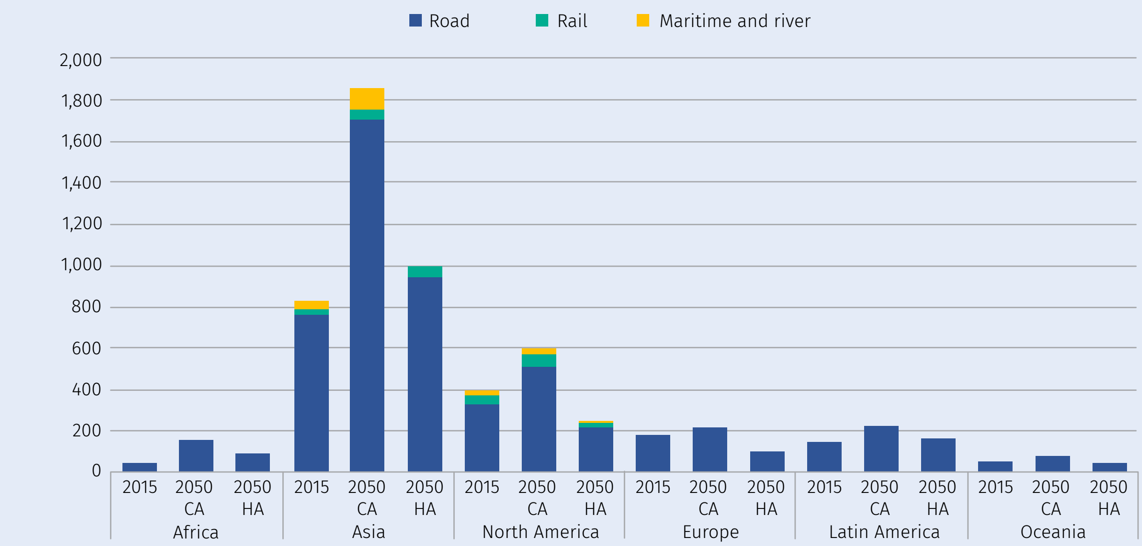
9.2 Emissions generated by freight transportation

According to the latest available data, freight transportation in LAC is responsible for generating 141 million tons of CO_2, of which **96% come from road transportation** (ITF, 2019b). This is similar to what happens with total emissions, the region is below the levels of advanced countries in terms of emissions generation (Asia and North America emitted 825 and 393 million tons of CO_2, respectively) (IDB, 2020b). Regarding the outlook for the region, studies developed by ITF (2019b) prior to the COVID-19 pandemic have analyzed two scenarios of freight transportation emissions growth, which vary depending on the mitigation measures that may be implemented. The first scenario corresponds to the current ambition (CA) scenario and reflects existing policies and regulations, technology adoption scenarios in line with new policy scenarios envisaged by the IEA and projections of international trade activity to 2050 according to the OECD ENV-Linkages model[61] (Château et al., 2014). The second one, a high ambition (HA) scenario, assumes a broader scope of the mitigation measures, including, for example, a more comprehensive electrification of surface freight transportation and a reduced demand for fossil fuels, given a lower volume of trade in these commodities compared to today.

60. The 22 countries taken into consideration are: Argentina, Brazil, Bolivia, Chile, Colombia, Costa Rica, Dominican Republic, Ecuador, El Salvador, Guatemala, Haiti, Honduras, Jamaica, Mexico, Nicaragua, Panama, Paraguay, Peru, Suriname, Trinidad and Tobado, Uruguay, and Venezuela.
61. Refers to a Computable General Equilibrium model that links economic activity to environmental pressure, specifically GHG emissions.

The ITF results conclude that the implementation of the **mitigation measures** considered in the HA scenario **can reduce the region's current emissions** (154 million tons of CO_2) by 30% with respect to the current ambition scenario (221 million tons of CO_2) by 2050. This reduction comes largely from road freight transportation, while emissions from sea and rail freight would remain the same between 2015 and the HA scenario, at 2 and 4 million tons of CO_2, respectively. However, air cargo emissions would remain almost identical in 2050 in both scenarios —CA and HA—, due to increasing air cargo transportation demand and to the limited decarbonization options in the aviation sector (see **Figure 9.2**).

Figure 9.2 CO_2 emissions in the freight transportation sector in million tons (2015-2050)



Source: ITF (2019b).

Box 9.1 Post-COVID sustainable freight transportation

The COVID-19 pandemic has had a major impact on the volumes of goods transported worldwide. ITF (2020b) analyses estimated a reduction in global freight transportation volumes in 2020 of more than one-third. This reduction in transportation activity results in immediate environmental benefits, with a reduction in global CO_2 emissions, estimated at 30% for national and international transportation, and 14% for urban transportation. As can be seen in the figure below, the transportation of goods within cities is expected to be less affected, given the changes in sales channels, with a rapid increase in e-commerce (see Chapter 7).

Figure 9.3 Projected Covid-19 impact on freight and CO_2 emissions for 2020

Regions	Urban freight activity	Inter-urban freight activity	CO_2 Emissions urban freight	CO_2 Emissions Inter-urban freigth
ASEAN countries	-16	-53	-22	-42
China	-3	-27	-10	-23
India	-14	-51	-20	-46
Japan and Korea	-10	-33	-17	-26
Russia and Central Asia	-6	-53	-13	-54
Other Asia	-5	-32	-12	-25
Oceania	-3	-42	-10	-41
Middle East	-6	-36	-13	-31
North Africa	-15	-36	-21	-25
Southern Africa	-12	-32	-19	-41
Other Africa	-10	-50	-16	-38
South America (Andean)	-14	-50	-20	-37
South America (South Cone)	-5	-35	-12	-31
Caribbean	-15	-43	-21	-39
Central America	-12	-39	-19	-35
North America	-10	-37	-17	-35
Scandinavia	-15	-41	-21	-37
Western Europe	-12	-43	-19	-37
Eastern Europe	-14	-40	-20	-36
Global	**-8**	**-37**	**-14**	**-30**

Legend: Urban freight transport activity red = Δ ≥15% orange = Δ ≥10%. Inter-urban freight transport activity red = Δ ≥50% orange = Δ ≥40%. Red urban freight transport CO_2 emissions = Δ ≥25%, orange = Δ ≥13%. CO_2 emissions from inter-urban freight transport red = Δ ≥40% orange = Δ ≥33%.

Source: ITF (2020b).

Although significant reductions in CO_2 emissions are expected in the short term, these gains may be for a short period of time and do not replace the need for actions to combat CC. For example, during the 2008 recession, global CO_2 emissions fell by only 1% and then rose again driven by economic revival plans. Thus, post-pandemic recovery and decarbonization of freight transportation can be carried out simultaneously. Thus, given the urgency for climate action, post-pandemic recovery and decarbonization of freight transport must be pursued simultaneously. Therefore, comprehensive regulatory policies that promote greater energy efficiency of vehicles and transportation operations are required, together with innovation and the adoption of clean technologies for all types of vehicles (from urban distribution to long-haul trucking) (see Chapter 11). Such a public policy push is especially important considering that most of the Nationally Determined Contributions (NDCs) of LAC countries do not include specific emission reduction targets linked to the transportation sector and refer mainly to urban passenger transport. This goes to show the limited ambition to reduce emissions from freight movements and the need to re-evaluate this perspective in the light of accelerating climate change.

Road transportation

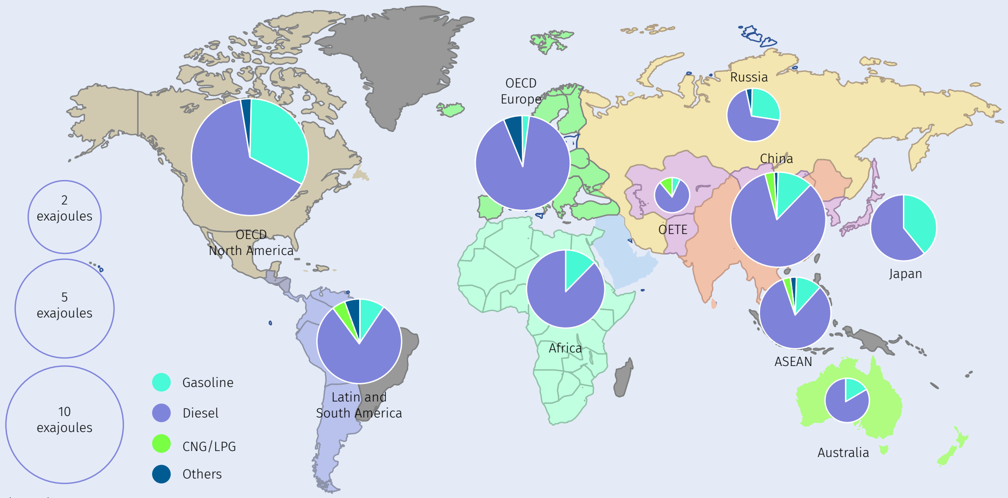
Due to its heavy reliance on fossil fuels[62], road freight transportation is a major contributor to global energy-related CO_2 emissions. At 2.6 Gigaton in 2015, direct CO_2 emissions from road freight vehicles globally amounted to about one-third of total transportation-related CO_2 emissions, and about 7% of total CO_2 emissions from energy production and use (IEA, 2017). However, although CO_2 emissions from road transportation have grown rapidly in most countries since 2000, their contribution to total emissions growth varies among regions.

For example, in industrialized countries, road freight vehicles were the main contributors to the growth in transportation-related emissions which offset the overall trend of declining CO_2 emissions in several of those countries. In the United States (where emissions from road freight transportation increased by more than 50 Mt of CO_2), the growth in emissions from road freight vehicles more than offset the decline in emissions from passenger vehicles. The upward trend in U.S. trucking emissions makes a sharp contrast with the efforts made to reduce total CO_2 emissions from fuel combustion, which fell by about 650 Mt during the same period. In developing and transition economies, emissions generally grew in all areas of the energy sector, in line with the present economic growth model based on high CO_2 emissions. Since 2000, road freight transportation has contributed to a 40% increase in CO_2 emissions from road transportation in these countries and to an 8% overall increase in CO_2 emissions from fuel combustion.

Road freight transportation vehicles have, without a doubt, the highest energy demand in LAC, particularly from fossil fuels. Even though it is still well below the levels of advanced countries, the region is responsible for 12% of global CO_2 emissions from fossil fuels. The latest available data show that LAC consumes approximately 1.4 mb/d, of which about 90% are of diesel (see **Figure 9.4**). The decarbonization of the RFT sector is a major challenge for LAC countries given the projected increase in terms of tons transported by road by 2050, and the higher average age of the fleet in LAC, which is 15 years, reaching 21 years in countries such as Colombia and the Dominican Republic —compared to 11.5 years in the European Union—, which results in lower energy efficiency. Furthermore, LAC countries face a particular challenge that takes place in a different context from the one in which advanced countries developed: although LAC's share of emissions in the sector is far from those of advanced countries, global environmental urgency will require **innovative solutions to promote economic growth in the region**, with its consequent increase in transportation, while at the same time **ensuring CC mitigation**.

62. At about 17 million barrels per day (mb/d), oil demand from road transportation vehicles accounts for about one-fifth of global oil demand, equivalent to the current oil production of the United States and Canada combined.

Figure 9.4 Energy consumption of freight transportation



Source: IEA (2017).
Notes: 1. This map is not intended to harm the status or sovereignty of any territory, the delimitation of international borders, or the names of territories, cities or areas.
2. ASEAN: Association of Southeast Asian Nations; OECD: Organization for Development and Economic Cooperation. OETE: Other European Economies in Transition.

Box 9.2 Policies to reduce emissions from road freight transportation

Different policies have been adopted worldwide for the decarbonization of road freight transportation. For example, since January 2019 the European Union established mandatory monitoring and reporting of fuel consumption and emissions using the Vehicle Energy Consumption Calculation Tool (VECTO), for the four classes of new heavy-duty trucks (HDV), which emit the most CO_2 emissions and have high fuel consumption (European Commission, 2020). In June of the same year, the Official Journal of the European Union published a regulation requiring some specific average emissions to be reduced by 15% by 2025 and 30% by 2030 (compared to the baseline period from July 2019 to June 2020) for new trucks across all regulated classes. The 2030 target is mandatory, but subject to review in 2022 (Teter, 2020).

Likewise, standards set in China on fuel consumption limits for heavy commercial vehicles have begun to increase the efficiency of trucks sold in the world's largest HDV market (GB National Standar of China, 2018). Similarly, Japan updated its fuel efficiency standards for trucks and buses in March 2019, requiring that, by 2025, manufacturers improve fuel efficiency by approximately 13.4% for trucks, versus 2015 values (Ministry of Economy & Trade and Industry, 2019). India also implemented new HDV fuel economy standards in April 2018, increasing the policy coverage of new bus and truck sales to more than half of global sales.

Other countries have responded to the sector's environmental challenges by implementing charges for commercial trucks based on the distance traveled and vehicle type. Under this scheme, trucks with lower emissions pay significantly less than trucks with higher emissions. In Germany, this policy contributed to changing the composition of the truck fleet. Recently, this country agreed on a € 130 billion COVID-19 economic recovery package, including about € 8 billion to support the automotive industry and accelerate the transition to electric mobility, mainly in the light-duty sector. To revive the

Box 9.2 Policies to reduce emissions from road freight transportation

commercial vehicle sector, the German government intends to introduce a temporary EU-wide fleet renewal program for 2020-2021, financed by EU funds.

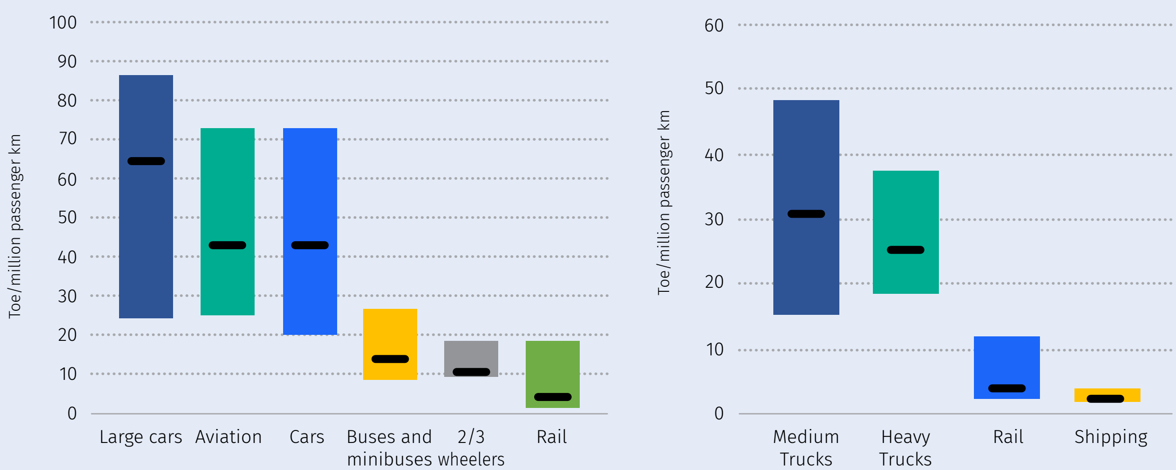
In a recent IDB publication, Barbero et al. (2020) mentioned four policy actions for the decarbonization of the sector in LAC: (i) implementing fleet renewal and scrappage schemes; (ii) adjusting rates according to emissions; (iii) implementing self-regulated programs (Smartway type, in which carriers commit to reducing emissions); and (iv) controlling imports of used vehicles. In Latin America, various fleet renewal strategies for heavy vehicles have been promoted. Countries such as Chile (Change your Truck), Colombia (Vehicle Renewal) and Mexico (Vehicle Substitution and Renewal Scheme) provide fiscal and financial incentives for freight operators to withdraw their older and polluting vehicles, and acquire more efficient units, leading to a reduction in CO_2 emissions (IEA, 2017). Other initiatives include the voluntary national Clean Transportation Program in Mexico, which aims to reduce fuel consumption, emissions, and transportation operating costs for both passenger and freight transportation through the adoption of strategies, technologies, and best practices. In Brazil, there is the strategic initiative “Brazilian Green Logistics Program (PLVB)”, run by a group of private companies, whose purpose is to capture, integrate, consolidate and apply knowledge with the aim of reducing the intensity of GHG emissions and improving the efficiency of logistics and national freight, by training shippers, carriers and logistics service providers that support and/or operate in these activities (IEA, 2017). Argentina has also established a pilot road freight efficiency program (“Intelligent Transportation Program”) and is in the initial stages of creating its own clean transportation program.

Currently, several fuel and vehicle technologies are still in the research, development and demonstration (RD&D) stage which, if they are successful, could scale up the decarbonization of the RFT sector. Some examples include the construction of an Electric Road System (ERS) or the production and supply of hydrogen for transport. China is currently the market leader for commercial electric trucks operating in urban environments (65% of the world’s fleet), with nearly 250,000 electric trucks on its roads. It has introduced about 1,800 light commercial vehicles powered by hydrogen fuel cells, most of which operate on fixed routes and refuel centrally at a single service station. South Korea and Japan also have ambitious plans to use hydrogen fuel cell technology in the heavy-duty vehicles subsector. In Europe, the number of electric trucks doubled in 2019, with nearly 750 new vehicles registered, 80% of them in Germany, a country which already has electric road pilot programs. In 2020, 1,000 heavy-duty electric trucks were sold in a single year (Teter, 2020). Particularly, in the context of the LAC region, there is no market for electric light and heavy-duty trucks (CALSTART, 2020).

Rail transportation

Internationally, carbon footprint estimates for rail freight transportation are considerably **lower than those for truck transportation**. For example, data for Germany show that, in 2018, an average freight train emitted around 18 grams of carbon dioxide per ton-kilometer, compared to 112 grams of CO_2 per kilometer from an average truck. Also, the IEA estimates that rail consumes about 90% less energy than trucks per unit load. Analyses carried out by the Association of American Railroads concluded that railroads are three to four times more fuel efficient than trucks, meaning that moving freight by rail instead of using trucks reduces greenhouse gas emissions by as much as 75%. In fact, the Association estimates that if 25% of the U.S. truck traffic covering distances of at least 750 miles was moved by rail, annual greenhouse gas emissions would be reduced by approximately 13.1 million tons.

Figure 9.5 Energy intensity for different modes of transportation (2017)



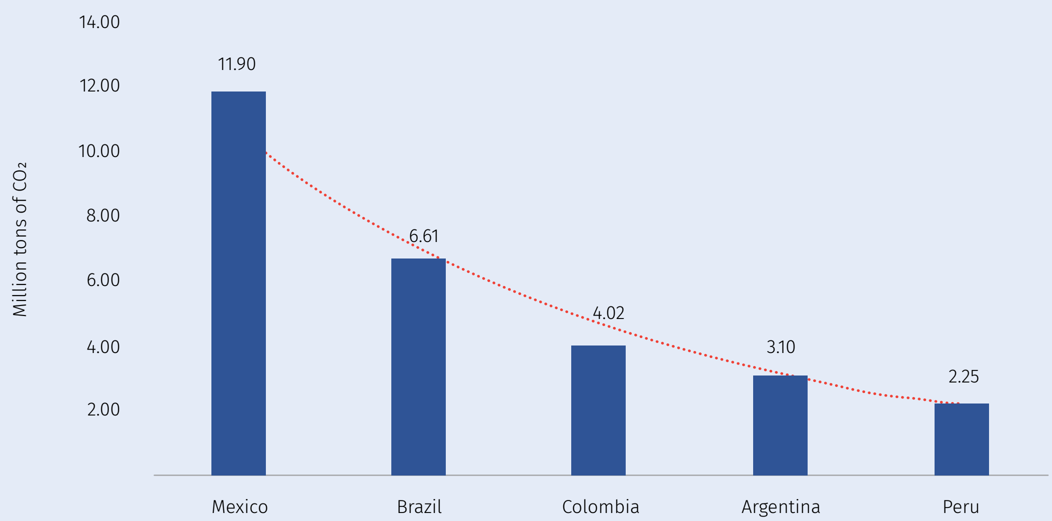
Source: IEA (2019b).
Note: The boxes in this figure indicate the range of average energy intensity in various countries, while the horizontal lines represent world averages.

In the case of LAC, **the share of railroads in freight transportation is limited**, concentrated in a few countries and focusing on specific goods. For example, in the case of Argentina, it is estimated that rail transportation moves 4% of domestic freight volumes and represents about 0.3% of all transportation emissions in the country (ITF, 2020b). In the case of Brazil, where rail transportation moves approximately 15% of the total freight, emissions generated by this mode of transportation were estimated in 2010 at 3 million tons of CO_2 (compared to the 59 tons generated by road freight transportation). In general, there is little information available on the registration and/or monitoring of emissions from rail freight transportation. It is also worth mentioning that, although worldwide rail transportation is one of the most electrified modes today, in Latin American there is still a **low proportion of electric trains**. However, in order to improve modal split for freight transportation, promote multimodal transportation systems and reduce the contribution of transportation to CC, some LAC countries are planning to invest in rail transportation in the coming years (see Chapter 3). Finally, while the potential of rail freight transportation to reduce GHG emissions has been extensively studied in other regions —i.e. Europe and China—, due to the fragmentation, age and, in some cases, lack of information on this mode of transport in LAC, similar studies at the regional level are limited. The development of this type of studies, based on sound information, will be key to informing the decarbonization policies implemented by LAC countries in the coming years.

Air transportation

The rapid growth of air cargo traffic (see Chapter 5) has also had an **impact in terms of emissions**. According to IEA data, in 2017 international aviation bunkers generated 584.86 million tons of CO_2 globally, representing an increase of 132.7 million tons of CO_2 compared to 2007. In terms of the distribution of CO_2 emissions, Asia was responsible for 42% of global emissions, followed by Europe with 30% and the Americas, with 20%; while Africa and Oceania only contributed 4% and 3%, respectively. When analyzing the information for LAC-21, 39.28 million tons of CO_2 derived from the international aviation bunker were recorded in 2017. The countries that produce the most emissions at the regional level are Mexico, Brazil, Argentina, Colombia and Peru (**Figure 9.6**).

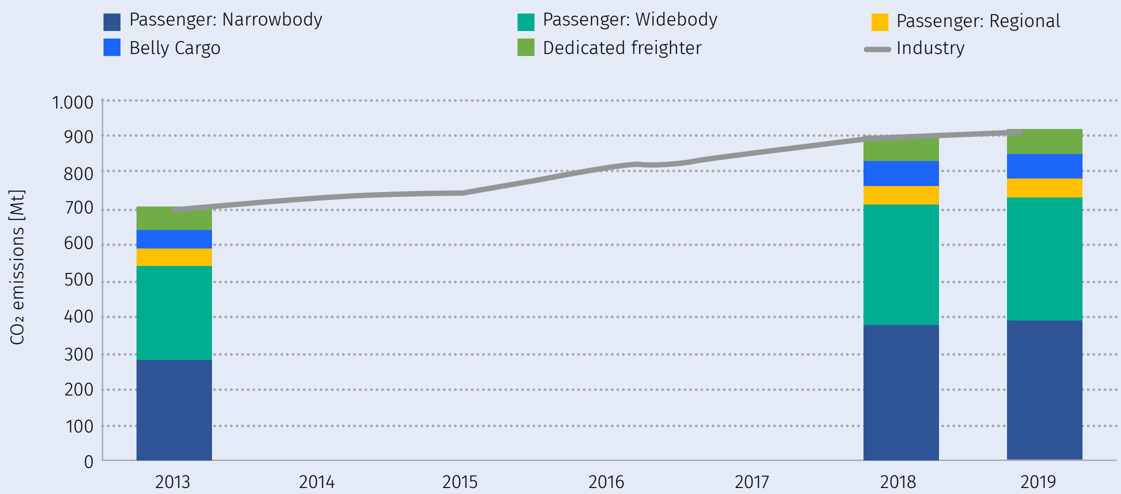
Figure 9.6 CO_2 emissions from international aviation bunkers by country LAC-21*, top 5 for 2017



Source: Own elaboration with data from IEA (2019a). CO_2 Emissions from Fuel Combustion.
Note: *LAC-21 refers to Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Dominican Republic, Ecuador, El Salvador, Guatemala, Haiti, Honduras, Jamaica, Mexico, Nicaragua, Panama, Paraguay, Peru, Trinidad and Tobago, Uruguay, and Venezuela.

It is important to highlight that emissions generated by air freight transportation (carried in hold and dedicated freight transportation) globally accounted for only 15% of the total emissions generated by commercial aviation in 2019 (**Figura 9.7**) (ICCT, 2020). In fact, some recent analyses conclude that the proportion of cargo carried in holds is the main factor explaining improvements in energy efficiency per unit of transported mass, on routes between South America and the United States, where hold cargo represents on average 22% of the payload (ICCT, 2019).

Figure 9.7 CO_2 emissions by operation and aircraft type



Source: ICCT (2020).

Box 9.3 Policies to reduce emissions from air freight transportation

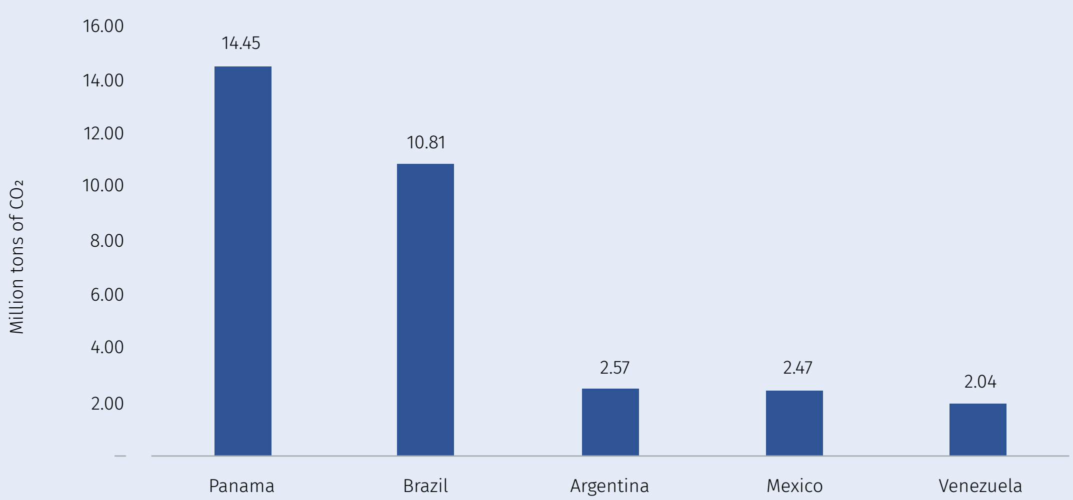
Given that aviation requires high power and energy-dense fuels for its operation, this sector is considered one of the most difficult to decarbonize (IEA, 2020a; ICCT, 2020). In fact, at the international level, different efforts have been coordinated to ensure the environmental sustainability of aviation in accordance with the objectives of the Paris Agreement (ITF, 2020a). For example, the member states of the International Civil Aviation Organization (ICAO) adopted in 2004 three environmental objectives with the aim of limiting or reducing: (i) the number of people affected by aircraft noise; (ii) the impact of aviation emissions on air quality; and (iii) the impact of greenhouse gas emissions from air transportation. In addition, in 2010 ICAO established as an aspirational goal, an annual fuel efficiency improvement of 2% by 2050 and carbon neutral growth from 2020 onwards.

To achieve these goals, policies related to operational improvements (such as modernizing air traffic management and maximizing load factors), the use of fuel-efficient aviation technologies, the development and deployment of sustainable fuels, and the implementation of market-based measures such as the Carbon Offset and Reduction Scheme for International Aviation (CORSIA) have been promoted. The first phase of CORSIA is scheduled to run from 2021 to 2023 on a voluntary basis. Emission generators (i.e., airlines) will be required to offset the growth in CO_2 emissions above 2020 levels by purchasing emission units (representing 1 ton of CO_2) from green projects, which will offset excess CO_2 levels (ICAO, 2019). According to ICAO estimates, the implementation of the three CORSIA phases will address up to 2.5 Gt of CO_2. However, ICAO highlights the need for stricter standards and commitments to require investments to accelerate emissions reductions through improvements in operational and fuel efficiency.

Maritime transportation

Around 80% of global merchandise trade by volume is transported by sea (UNCTAD, 2020b), yet this mode of transportation generates only 10% of total transportation emissions (IEA, 2019a). Although the contribution to emissions varies depending on the type of vessel, maritime transportation **is considered to be one of the most efficient modes** in terms of carbon emissions. Some studies estimate that maritime freight transportation emits an average of 10-15 grams per ton-kilometer, compared to 19-41g / t-km from rail, 51-91g / t-km from road transportation and 673-867g / t-km from aviation. According to globally available data, international maritime bunkers for 2017 generated a total of 697.1 million tons of CO_2 which represents an increase of 52.3 million tons of CO_2 compared to 2007. As in the case of aviation, Asia is the continent responsible for most emissions (with a total of 365.9 million tons of CO_2 in 2017) on a global level, while Oceania is at the opposite end. Data for LAC-15 show that, in 2017, 39.31 million tons of CO_2 were generated from international maritime bunkers, emissions to which Panama, Brazil, Argentina, Mexico, and Venezuela contributed the most (see **Figure 9.8**).

Figure 9.8 CO_2 emissions from international maritime bunkers by country LAC-15*, top 5 for 2017



Source: Own elaboration with data from IEA, (2019a), CO_2 Emissions from Fuel Combustion.
Note: *LAC-15 refers to Argentina, Brazil, Chile, Colombia, Costa Rica, Ecuador, Guatemala, Jamaica, Mexico, Panama, Peru, Suriname, Trinidad and Tobago, Uruguay and Venezuela.

Box 9.4 Policies to reduce emissions from maritime freight transportation

The International Maritime Organization (IMO) has set a target of reducing CO_2 emissions by at least 50% by 2050. However, it is estimated that this effort may not be enough to meet the Paris Agreement targets, given that CO_2 emissions from international maritime transportation would reach about 17% of global CO_2 emissions in 2050 (Halim et al., 2018) this target is still not sufficient to reach Paris Agreement goals since CO_2 emissions from international shipping could reach 17% of global emissions by 2050 if no measures are taken. A key factor that hampers the achievement of Paris goals is the knowledge gap in terms of what level of decarbonization it is possible to achieve using all the available technologies. This paper examines the technical possibility of achieving the 1.5° goal of the Paris Agreement and the required supporting policy measures. We project the transport demand for 6 ship types (dry bulk, container, oil tanker, gas, wet product and chemical, and general cargo. The IMO has been working since 1997 to control GHG emissions in international shipping. To this end, it has been responsible for creating initiatives and adapting regulations in favor of sustainability. For example, policies and practices concerning GHG reductions from ships were established in 2003 (IMO, 2019). Some of these include the creation of new pro-energy efficiency regulatory tools such as: an Energy Efficiency Management Plan (SEEMP), and the Energy Efficiency Design Index (EEDI) (IMO, 2019). Phase 1 of the EEDI came into effect in 2015 with the aim of achieving a 10% reduction in IMO's ship carbon intensity (IMO, 2019). Also, in 2016, it became mandatory for ships of 5,000 gross tons or more to collect oil consumption data to produce annual reports to IMO (IMO, 2019). Additionally, an initial IMO strategy for the reduction of GHG emissions from ships was approved in 2018, a measure that was complemented in October of the same year with the follow-up program to this strategy (IMO, 2019). Also in 2019, a technical cooperation trust fund with respect to GHGs was established and EEDI requirements for some types of vessels are being strengthened (UNCTAD, 2020b).

According to ITF (2018) technological, operational and alternative fuel measures are required to move toward the decarbonization of the shipping industry. Technological measures have been established in favor of energy efficiency (such as the EEDI), focusing on a ship's weight, design and energy recovery methods. Some of the main technological measures currently available in the market are the use of lightweight materials, slim designs and heat recovery (ITF, 2018). On the other hand, operational measures relate to the way in which ships and the maritime transportation system are operated, focusing on speed, ship size, ship-port interface (reduction of waiting time before entering a port) and onshore power (ITF, 2018). Finally, alternative fuel and energy measures focus on the development and adoption of alternative fuels and energies, since reducing the use of fossil fuels would only generate a moderate reduction in GHG emissions. Thus, these measures propose using hydrogen, electricity, solar, nuclear, and wind energy for ship propulsion (ITF, 2018).

Conclusions

Generally, growth in freight transportation activity is associated with higher levels of economic prosperity. However, in recent decades there have been strong concerns about the environmental externalities associated with transportation. Indeed, this chapter reported on the sector's significant participation in GHG emissions at global and regional levels. In the context of the increase in CC and the need to achieve the global target set in the Paris Agreement to keep the average temperature increase below 2ºC, a transition to a **low-carbon transportation model is necessary**. Even considering the impacts of the COVID-19 pandemic on freight demand, emissions reductions by 2020 will have minimal long-term impact. On the contrary, **the implementation of decarbonization measures as part of economic recovery plans**, such as the adoption of cleaner technologies or tax reforms on fossil fuel subsidies, can contribute to job creation and accelerate the recovery of economies. Such a decarbonization strategy should be integrally structured around objectives not only regarding energy efficiency, but also efficiency in freight transportation operations, encouraging a modal shift towards less polluting modes of transportation (see Chapter 11). Finally, it is essential to have reliable and historical information on the emissions of pollutants related to each mode of transportation to guide decision-making in the sector on the best policies to reduce emissions.

CHAPTER 10

IMPROVING LOGISTICS SYSTEMS IN LAC

In Chapter 1 we defined logistics as the planning, implementation and control processes that ensure an efficient flow of goods, services and information along the supply chain, from raw material suppliers to the final consumer, in order to satisfy the requirements of the latter (CSCMP, 2020; Mangan et al., 2020). Given the spatial distribution of supplies, production nodes and consumption markets, logistics —the flow of goods in particular— allows us to overcome the friction of distance and create spatial convergence between supply and demand (Barbero, 2010). In the context of economic globalization, this distance has increased substantially due to the geographical distribution of sourcing, production and marketing activities. This, together with the just-in-time strategy adopted by the world's leading companies, has had an impact on the configuration of logistics systems and the modes of transportation used to link markets of origin and destination of goods, which must be increasingly sophisticated and multimodal.

Indeed, if we return to the example of the package of coffee in Chapter 1, numerous logistical processes are necessary for it to reach the supermarket. These include, among others, the collection and road transportation of the coffee beans to the port, maritime transportation from the exporting country, road transportation to the coffee factory and, finally the coffee package is sent to the supermarket distribution center to be distributed to the corresponding supermarket. In addition to these activities those related to other inputs involved in the preparation of the coffee package, such as paper or aluminum, should also be considered. This example shows that modern logistics involves a complex network of actors, infrastructures and services, whose timing and good overall performance is key so that products can reach consumers at the time and place they require (Calatayud & Katz, 2019).

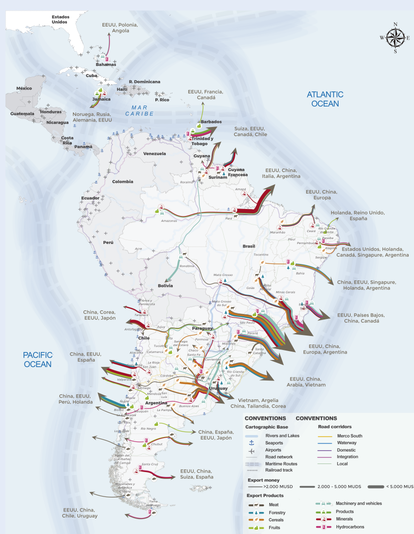
From a public policy perspective, it is clear that, in addition to overcoming the particular challenges of a given mode of transportation —such as those mentioned in the chapters on road, rail, sea or air transportation—, a country's good logistics performance requires addressing the various challenges that affect the efficiency of the logistics system as a whole. For example, in the first mile, challenges can come from unpaved rural roads, increasing transportation costs for agricultural producers and generating product losses due to poor road quality and transportation delays. In long-distance transportation, inefficiency in the road transportation market can further increase costs without improving the quality of services. Finally, upon arrival at the border, waiting times can be such that they cancel out the benefits of reduced transportation time via better roads. Thus, bottlenecks in the logistics system, wherever they occur, add cost, time and uncertainty to the shipment of products. Consistent with the systemic perspective of logistics, a large number of countries in different latitudes have adopted the vision of logistics corridors, in order to coordinate interventions along territorial axes that connect production with commercialization nodes, from a multimodal freight transportation system and an economic, geographic and regional integration perspective. Therefore, considering that the demand for transportation and logistics services is a derived demand, the logistics corridors are structured to meet the needs of the main value chains or productive clusters of a country.

10.1 Characterization of logistics systems in LAC: a supply and demand perspective

A country's strategic direction in logistics should be **planned according to the demand arising from its productive structure and its trade patterns** with domestic and foreign markets. Productive characterization makes it possible to identify the flows of goods generated by the main economic activities, i.e., those associated with the transportation and storage of inputs, production, domestic consumption, and foreign trade. That is why segmenting demand (load generators) into **priority logistics subsystems** can be very useful. These subsystems are made by grouping logistics chains and families of a sector identified as a priority for a country, with similar logistics patterns and corresponding to the development priorities established in national policy instruments (agricultural exports, regional trade, and maquiladoras, among others).

In LAC, value added by industry represents, on average, 23% of the GDP, while agriculture contributes 4%. Following this productive matrix, the priority logistics subsystems are structured around **agricultural and livestock, manufacturing, mining and tourism chains**[63]. The products to be transported are mostly products in bulk, characterized by their low price per volume transported, compared to products with higher value added. **Figure 10.1** shows, by way of example, the priority logistics subsystems and the respective logistics corridors in the Southern Cone (Argentina, Brazil, Chile, Paraguay, and Uruguay), according to the subregion's most important export products (meat products, forestry, cereals, fruits, minerals, and hydrocarbons).

Figure 10.1 Logistics corridors in the Southern Cone



Source: Rave et al. (2020).
Note: The methodology for identifying corridors included the following steps: (1) selection of products and associated chains according to 2019 exports; (2) mapping of exported products; (3) mapping of corridors based on an analysis of the distribution of cargo volumes transported by product or products in the chain; and (4) characterization of corridors.

63. According to ECLAC (2019), the main products exported by LAC include: crude oil, passenger motor vehicles and auto parts, copper ores and concentrates, statistical machines, soybeans and derivatives, trucks and vans, iron ore and its concentrates, and refined copper.

From a public policy perspective, the **logistics systems offer is composed of three main pillars:** (i) road, port, airport, rail and specialized logistics infrastructure; (ii) road, maritime, river, air, rail and logistics services; and (iii) sectoral institutions and regulations that govern the different actors involved and define the services provided by the State to support productive development and facilitate international trade (IDB, 2020b). From a systemic point of view, it is important to emphasize that the individual performance of each of these pillars determines the overall performance of the system. This is an important change in the priorities for action to improve logistics, which have traditionally been focused exclusively on improving the provision of transportation infrastructure. On the contrary, the systemic view highlights the need to also invest in improving the efficiency and quality of services, and strengthening the institutional and regulatory frameworks for the sector (IDB, 2020b).

As a result of the analysis carried out in the previous chapters, the state of infrastructure in LAC —the first pillar of logistics supply— presents challenges in terms of quality, coverage, connectivity and capacity. For example, there is limited road infrastructure to access production, particularly tertiary networks, as well as specialized logistics infrastructure (including cold chain logistics and auxiliary transportation services). Another challenge is related to the congestion that some port terminals and urban and interurban areas experience. Border facilities are also deficient, with considerable deficiencies in infrastructure, equipment and non-intrusive technologies that lead to inefficiencies in foreign trade processes (IDB, 2020b).

From the perspective of transportation services, countries face low levels of productivity in road freight transportation, as a result of using obsolete fleets that generate high operational costs, risk of accidents, and quality problems in the provision of services. The informality that surrounds the procurement of services in some chains and segments, together with uncompetitive practices, represent additional challenges for improving the efficiency of road freight transportation. In most countries there is a limited supply of value-added logistics services and a limited supply of air cargo services.

Finally, and by way of summary, from a regulatory and institutional point of view, the region still faces challenges in institutionalizing the planning, management, and monitoring of the national logistics system. Likewise, weak inter-institutional coordination at the border level and few physically integrated national controls were identified (IDB, 2020b).

10.2 National plans to strengthen logistics systems in LAC

In order to improve logistics performance, a comprehensive review of **international best practices** recommends actions aimed at:

- Creating a national logistics system adapted to the country's needs;
- Strengthening and improving the public-private participation system;
- Investing in infrastructure development;
- Developing a system of incentives for the private sector focused on the creation of an offer of logistics services, with particular attention to the strengthening of transport and logistics msmes;
- Strengthening the offer of transportation services available to satisfy demand needs;
- Promoting coordination and cooperation among freight forwarding smes that demand similar logistics services.
- Simplifying and coordinating foreign trade processes;
- Promoting the development of a digital platform to support logistics operations;
- Consolidating, rationalizing and modernizing the legal and institutional framework of the national logistics system; and
- Creating a supply of human resources adequate to the requirements of the public and private sectors.

Based on these recommendations, the IDB has supported the development of **National Logistics Plans**, which objective is to guide public sector investments and actions to maximize the performance of a country's logistics system, in accordance with its economic and commercial objectives (see **Box 10.1**). The experience of three LAC countries during the development process of their National Logistics Plans is outlined below, starting with the identification of their priority products, followed by an analysis of the bottlenecks found in their logistics system for said products, and finally, establishing investment priorities to overcome those challenges. The countries have been chosen to cover the different LAC subregions: Guatemala for Central America, Colombia for South America, and the Dominican Republic for the Caribbean.

Box 10.1 National Logistics Plans in Mesoamerica and prioritization of transportation and integration projects

The countries of the Mesoamerican region have made progress thanks to the development of National Freight Logistics Plans (PNLOGs, in its Spanish acronym), which have been defined as national planning instruments that strategically guide the development of the logistics sector. These PNLOGs use a harmonized methodology that encourages public-private coordination, integrating and organizing existing information on the multiple plans, projects and actions that have an impact on freight logistics (transportation, agricultural exports, regional trade and maquiladoras, among others). The PNLOGs analyze the problems that affect the performance of selected logistics chains, as well as the structural elements that reflect the degree of integration, sophistication and collaboration along the supply chain (use of specialized infrastructure, outsourcing of value-added logistics services, collaborative logistics practices, reduction of chain length, shared strategies, among others). Finally, the PNLOGs propose Immediate Action Plans (IAPs) structured around the basic components of the system (infrastructure, services, processes), and complementary components (legal and institutional framework, financial, human resources and technology), while setting priorities for each subsystem based on their short (1-5 years), medium (5-10 years) and long term (10-15 years) goals.

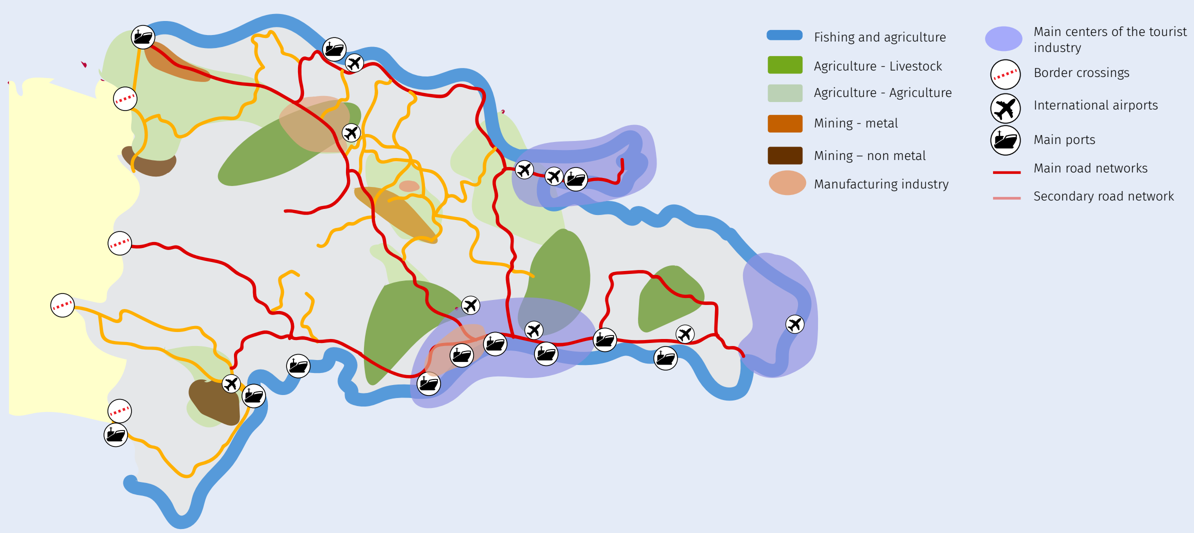
Based on these PNLOGs, the IDB, together with the Mesoamerica Project, consolidated a base of 538 regional multimodal transportation projects which, as a whole, estimate investments of US$ 26,531 billion for the basic and complementary components of logistics systems. This project base aims to support key regional value chains and their logistical potential, strengthening links between different industries in the region. Through an application —Eureka— the IDB began validating these projects with the country's government offices. In addition, a prioritization exercise was carried out with these countries using a multi-criteria methodology, which serves as a tool to arrange the investments of particular interest to the countries in the region by impact, maturity and degree of fundability. Thus, after the process of validating regional projects is completed, information was compiled for them and the above-mentioned criteria were applied, resulting in a prioritized portfolio proposal of Regional Transportation and Logistics Projects for Mesoamerica.

Dominican Republic

The PNLOG 2018-2032 for the Dominican Republic has identified two priority subsystems: (i) agricultural-livestock (including perishables and semi-perishables); and (ii) agro-industrial and textile manufacturing[64]. **Figure 10.2** shows the supply of logistics infrastructure in the country, which consists of the land transportation network (road and rail[65]), eight land border crossings, thirteen ports, eight international airports, and twenty-seven domestic airports. The most relevant axes in the country are located between Punta Cana and Jimaní (border with Haiti) and between Santo Domingo and Dajabon.

The limited quality of logistics infrastructure and services affects the competitiveness of products such as pineapple, avocado, and mango. Analyses have shown that there is a limited number of storage facilities, refrigerated transportation services and consolidation centers for these products. In addition, the poor condition of secondary and tertiary networks limits accessibility to agricultural areas. These chains also suffer from congestion and long waiting times at the access points to the ports (Haina) and airport (AILA). From an institutional point of view, responsible institutions should apply their regulations with discretion, and the limited inter-institutional coordination, and lack of training of the officials responsible for carrying out controls should be taken into consideration. In the case of manufactured goods, high transportation costs and the low reliability of land transportation services limit the performance of this chain.

Figure 10.2 Main productive areas and transportation network of the Dominican Republic



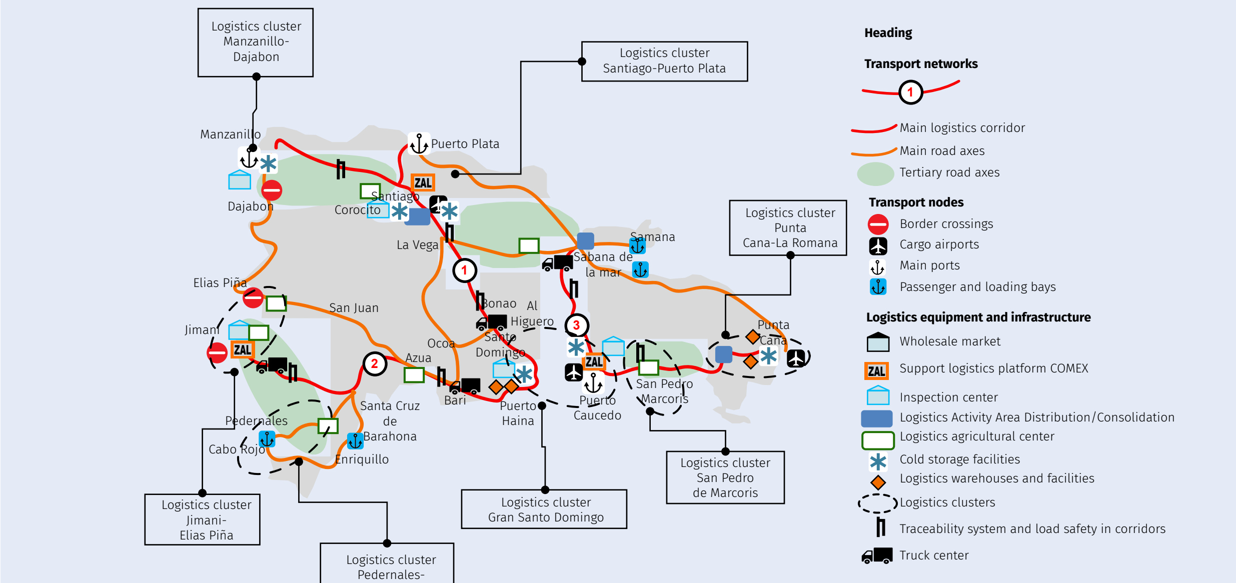
Source: IDB & CNC (2018).

Faced with these challenges, the Dominican Republic's PNLOG aims to promote the growth of national productive sectors and the continuous improvement of the country's competitiveness in harmony with territorial development objectives. To this end, it groups the country's logistics activity into seven clusters, which make up the National Logistics System: (i) Greater Santo Domingo; (ii) Punta Cana-La Romana; (iii) San Pedro de Macoris; (iv) Santiago-Puerto Plata; (v) Manzanillo-Dajabon; (vi) Jimani-Elias Piña; and (vii) Pedernales-Barahona (**Figure 10.3**). It also structures a logistics trunk infrastructure system that provides service to all strategic subsystems and promotes the creation of a range of value-added logistics services, with world-class technology and equipment that operate with maximum agility, efficiency, quality and safety. In accordance with these objectives, the following

64. The products considered within these subsystems were: semi-perishable products such as yautia, plantain and banana; perishable products including tropical fruits such as avocado, pineapple, mango and oriental vegetables (coffee and cocoa); manufactures in free trade zones including textiles and footwear, electrical products, electronics, medical instruments and pharmaceuticals; agro-industrial manufactures such as tobacco and pasta; and manufactured goods in trade with Haiti, consisting of toys, textiles, etc.
65. This is used exclusively for sugar cane transportation.

needs have been identified: (i) improving the provision of infrastructure to access production areas and specialized logistics infrastructure (e.g. agricultural centers); (ii) developing and implementing a regulatory framework that promotes free competition in the provision of services and the modernization of the land transportation fleet; (iii) developing a digital platform for the management of foreign trade operations; and (iv) consolidating the logistics hub using a comprehensive approach at country level and not only focused on some trade nodes.

Figure 10.3 Target image of the National Logistics System of the Dominican Republic



Source: IDB & CNC (2018).

Guatemala

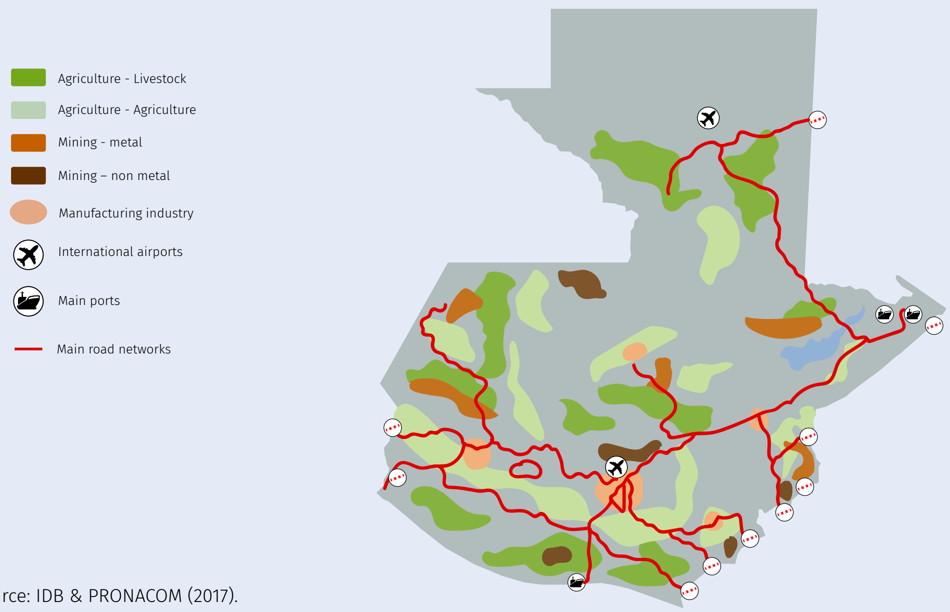
The PNLOG 2017-2032 has identified four priority subsystems: (i) agricultural; (ii) intra-regional trade in manufactured goods; (iii) maquiladoras and light manufactured goods to be re-exported; and (iv) tourism[66]. **Figure 10.4** illustrates the geographic distribution of the country's main corridors and production areas. It shows that production areas such as Alta Verapaz, Quilche, and San Marcos are not connected with the rest of the network through trunk roads. In terms of logistics services, Guatemala has a cargo transportation system based on two main road axes and a secondary axis, which links the country's northern ports with Belize and the road axis that connects the northern ports with the Honduras border. The country has one main cargo airport, located in Guatemala City, adjacent to an industrial zone. It also has numerous land borders and non-formalized crossings.

The analyses conducted with the aim of drafting the PNLOG have identified the following challenges for the improvement of the country's logistics performance: (i) urban congestion in the capital city, in the trunk network during harvest periods and at the ports; (ii) cargo security problems; (iii) limited capacity of specialized logistics infrastructure (e.g. cold chain at the airport and storage facilities) and land border crossings; (iv) weak coordination among institutions; (v) national controls that are not physically integrated, and complex, slow and discretionary inspections; and (vi) obsolete fleet for RFT.

66. The products considered within these subsystems were: traditional products such as coffee, sugar, bananas and cardamom; non-traditional products including vegetables, fresh and frozen fruits and ornamental plants; manufactured products such as food, paints, cosmetics, fabrics, plastics, pharmaceuticals, rubbers, cements and construction materials; textiles and apparel, electronics, auto parts, precision equipment, refrigeration equipment; and agricultural products, manufactured food products, linens for the tourism industry.

To overcome these challenges, the PNLOG has established that the main purpose of Guatemala's National Logistics System should be to provide, under the leadership of the sector's public and private stakeholders, logistics solutions that facilitate cargo flows and add value to the country's productive sectors. In this case, the target image is made up of five clusters: North, South, Central, East, and Peten (**Figure 10.5**). It has encouraged the development of a diversified and quality offer of logistics services, equipped in accordance with the best international practices and guaranteeing efficiency, transparency, and safety in all operations.

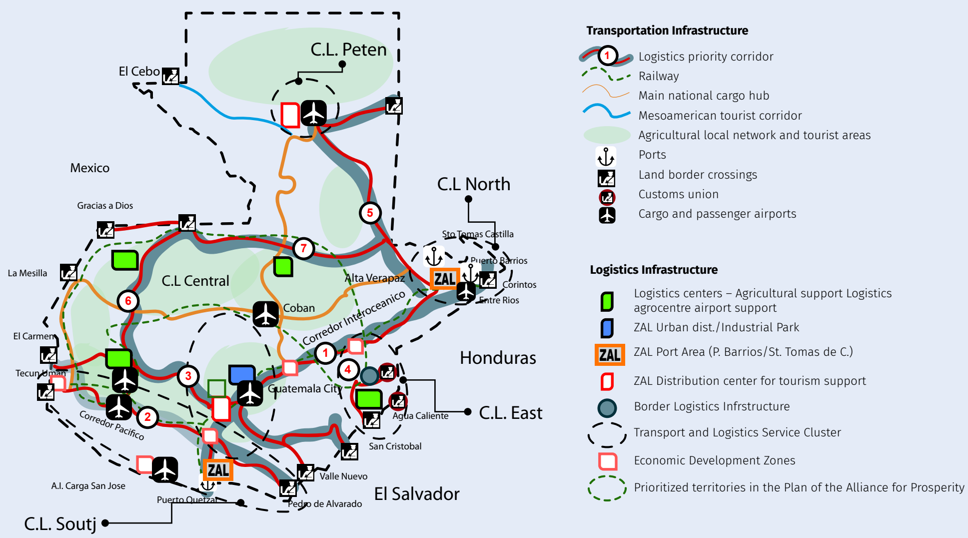
Figure 10.4 Guatemala's main productive zones and transportation network



Source: IDB & PRONACOM (2017).

Some of the proposals to improve the performance of Guatemala's National Logistics System include: (i) providing infrastructure to access production areas and specialized logistics infrastructure (e.g. cold chain facilities and agricultural centers) while guaranteeing its maintenance; (ii) implementing a plan to reduce congestion in critical transportation infrastructure; (iii) digitizing the management of foreign trade operations and implementing trade facilitation measures; (iv) reviewing the monopolistic practices of the air and maritime transportation sector; (v) promoting collaborative logistics practices for small exporters, including the development of a regional freight exchange; (vi) generating incentives to formalize transportation, renew the fleet, and increase the supply of specialized equipment; (vii) improving security; and (vii) supporting the creation of a product distribution center to serve tourist areas.

Figure 10.5 Target image of Guatemala's National Logistics System



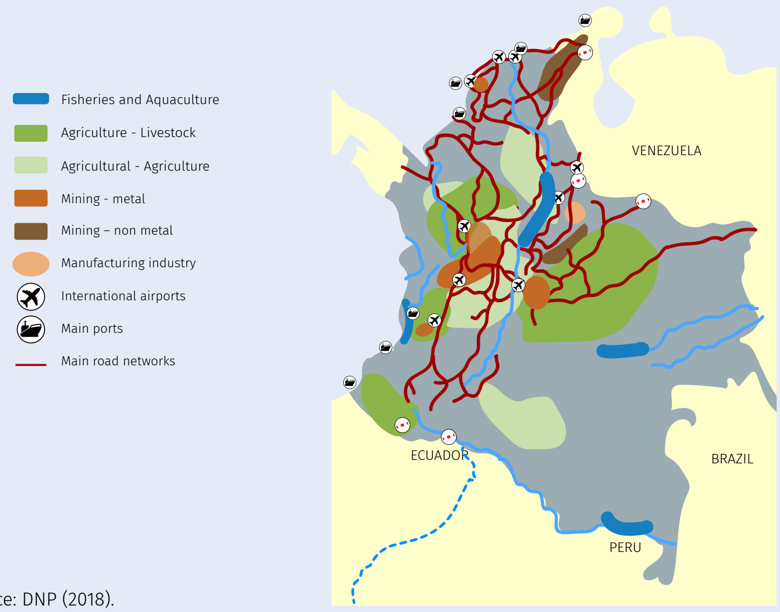
Source: IDB & PRONACOM (2017).

Colombia

At the regional level, Colombia has been at the fore in the design and implementation of a National Logistics Policy which identifies functional corridors that connect the points of entry and exit of goods with the productive areas and the main cities of the country. According to the National Logistics Policy, these corridors bring together the most relevant productive families with similar logistics dynamics, including agricultural and livestock, mining-energy, and industrial manufacturing chains. This planning process, which began more than 12 years ago, has guided Colombia's investments in the sector, enabling the modernization of infrastructure networks. Currently, Colombia's logistics system is made up of road, rail, port, airport, and border crossing infrastructure and transportation services, structured around six land-road corridors, three river corridors, three rail networks and twenty-five air hubs (**Figure 10.6**).

Some of the main challenges affecting logistics performance and, consequently, the country's competitiveness, include: urban and interurban congestion, lags in the capacity and quality of rail, river and land border crossing infrastructure, as well as operational challenges in the provision of transportation services and dispersion in the supply of logistics services (DNP, 2018).

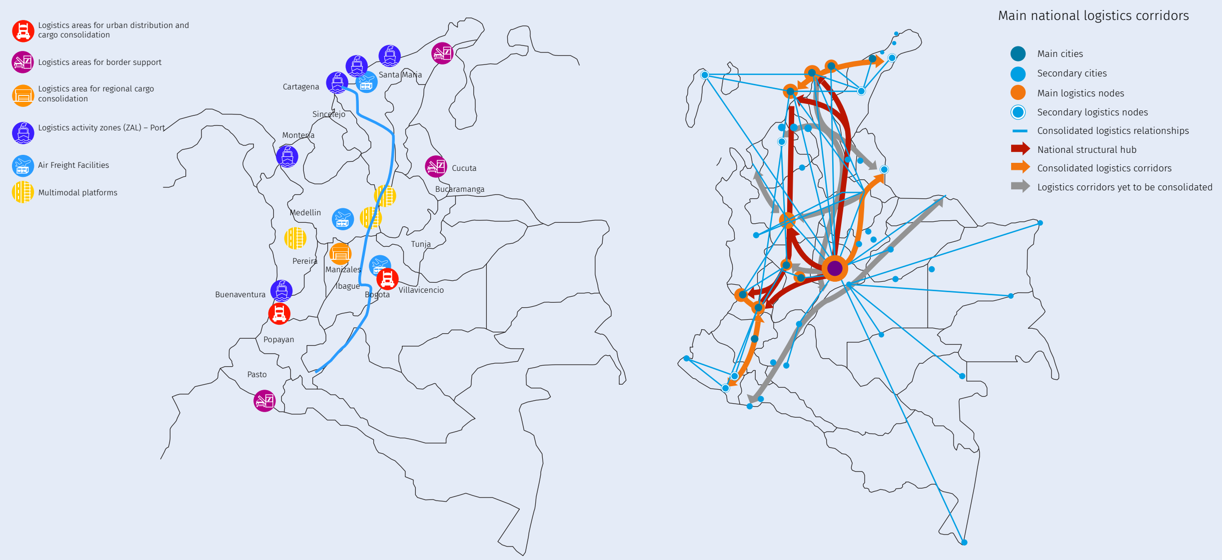
Figure 10.6 Colombia's main productive areas and transportation network



Source: DNP (2018).

In this context, the main objective of Colombia's National Logistics System is to promote logistics efficiency in order to improve the competitiveness of Colombian products in domestic and international markets (DNP, 2018). To achieve this goal, the New Vision of the National Logistics Policy, published in 2018, provides a strategy around the following main work areas: (i) improving institutional and articulation capacity between agencies and actors, promoting the creation of a National Logistics Agency that leads the implementation of the National Logistics Policy and the strengthening of logistics corridors and Regional Logistics Alliances; (ii) implementing technological tools (including artificial intelligence) to improve the quality of information that guides decision-making processes; (iii) investing in human capital training to respond to the demands of the business sector; (iv) renewing the freight vehicle fleet, encouraging the adoption of cleaner technologies; (v) promoting intermodal systems based on the strengthening of rail and river transportation infrastructure, as well as specialized logistics infrastructure; (vi) designing and implementing an urban logistics strategy; and (vii) modernizing regulations in the sector including an update of the tariff policy for freight transportation services by road, rail, and river, based on principles of free competition (DNP, 2018; Ministry of Transportation et al., 2018).

Figure 10.7 Target image of Colombia's National Logistics System



Source: DNP (2018).

Conclusions

Logistics is made up of different processes and modes of transportation. Given that in the modern economy, getting a product from its origin to its final destination frequently involves using different modes of transportation, improving logistics performance requires a systemic vision aimed at strengthening infrastructure, services, and institutions. From this perspective, National Logistics Plans, which are being implemented in several LAC countries with the support of the IDB, follow a standard methodology which starts by identifying the logistics required by the products that are strategic for their economies; continues then with an analysis of the existing limitations, and concludes with the prioritization of investments and actions to improve logistics from a systemic perspective. The diagnoses carried out as part of these Plans have confirmed the existing problems with quality, connectivity, capacity, and coverage described in the preceding chapters regarding the infrastructure of the different modes of transportation. In particular, a common challenge for the countries analyzed is the gap in infrastructure and specialized logistics services. This is important if the goal is to move towards a more sophisticated productive matrix, which will certainly require a specialized logistics system. Another common challenge is the weak inter-institutional coordination for the management of logistics systems. As will be seen in the following chapter on policy actions for the region, policy framework is a key factor in enabling actions that allow for substantial improvements in the logistics performance of LAC.

CHAPTER 11

POLICY AGENDA FOR LAC

In previous chapters, we have discussed the **importance of logistics for LAC economies and societies.** Logistics connects production centers with domestic and international consumer markets, while providing income and economic growth opportunities for the inhabitants of such centers. It is also a vector for improving people's quality of life by providing access to goods that are not manufactured in a given territory – this is the case, for example, of medicines in a country where there is no pharmaceutical industry. At the same time, it generates employment opportunities in the different processes of supply chains and helps to deepen the region's physical and economic integration. We found, however, that logistics performance in the LAC region is limited by shortcomings in infrastructure and services in multiple modes and processes, as well as by institutional and regulatory barriers. We analyzed the **main challenges faced by the region** and noted that, while the LAC region has made progress in certain areas —some countries and transportation modes more than others— some long-standing challenges still remain together with **others that have emerged in the context of the technological revolution**, the acceleration of climate change and new supply chain trends. For example, road infrastructure still has shortcomings in terms of capacity and quality. In addition, the region shows signs of lagging in the adoption of new digital technologies such as the internet of things and artificial intelligence, which are providing unprecedented improvements to logistics efficiency in other regions of the world.

Under this scenario, the question revolves around **what policies LAC countries need** to make a leap in quality so that they can face **both traditional and emerging challenges in the new international context**. Although in most cases logistics is carried out by private sector actors, the public sector can play an important role in improving logistics performance. Indeed, logistics activities are developed within a business climate framework, where the public sector is a provider of regulations, infrastructure, public services, and even financing. Governments define the regulatory framework that guides not only the development of infrastructure investment and operation and the provision of services, but also the regulations governing innovation and labor markets, among others. In addition, the public sector is responsible for planning infrastructure investments and, in some cases, for building and executing infrastructure projects. Through public resources, governments can finance some of these investments or encourage the development of financial markets where market failures hinder the provision of private sector financing for the development of transportation infrastructure and services. Furthermore, the public sector also provides support services, such as infrastructure maintenance, customs and health management of international trade, and business counseling and training, among others.

Thus, the public sector can encourage the improvement of logistics performance by providing a **long-term perspective for the sector consistent with the development vision** of the country and aligning its investments and regulatory, financial, and non-financial instruments to achieve the objectives set out in that vision. For example, in terms of the digital transformation of logistics, —an area of great relevance in the context of the Fourth Industrial Revolution— countries such as Germany, Korea, and the United Kingdom have established long-term strategies, even up to the year 2050, through which the public sector is the driving force behind this transformation, acting as a: (i) catalyst of new technologies, promoting those that offer benefits for the efficiency and sustainability of the sector; (ii) facilitator of innovation ecosystems, promoting pilot testing so that developers can test the technology in real scenarios; (iii) provider of incentives, facilitating access to credit and providing tax concessions; and (iv) active regulator, ensuring that regulation is sufficiently flexible to allow technological development and, at the same time, mitigate the risks that could arise for society (UK Government Office for Science, 2019).

However, for the public sector to fulfill its role efficiently and effectively, it must overcome a series of **challenges that limit its actions**. Among the main ones highlighted in the institutional analysis of LAC, the following are worth mentioning:

1. To develop **a strategic logistics vision that is consistent with the productive development priorities of each country**: although in the last decade some LAC countries have been pioneers in establishing national logistics policies and sectoral plans for some modes of transportation (see Chapter 10), this task is still pending for most of them. Without a long-term vision that determines the objectives to be achieved in the sector, provides a guide for private sector investments and structures public sector policies and instruments around these objectives, it will be difficult to achieve a systematic improvement in national logistics performance. Furthermore, the development of these plans without an identified budget line is another barrier to their implementation in the short term.

2. **To upgrade the technical and technological capabilities of the public sector**: the lower relative institutional quality of LAC countries is also a reflection of their human capital and has a negative impact on the prioritization and effective allocation of resources, the establishment of appropriate regulatory frameworks, the ability to catalyze private sector participation, transparency and integrity, and the planning, execution and management of investments and policy actions in the sector. In order to respond to the shift in focus towards transportation services and the disruptions created by new technologies, it is necessary to promote the modernization and diversification of "traditional" skills for transportation workers (e.g., programming, algorithm development, etc.).

3. To improve **the planning and efficiency of public spending**: the fragmentation of decision-making and the organization of the sector (usually in silos, according to mode of transportation and without a comprehensive vision of the investment cycle and the territory), the lower institutional capacities mentioned in the previous paragraph (especially in terms of planning, prioritization, evaluation, pre-investment, and supervision of projects), cost overruns in infrastructure works (that are double in LAC compared to the world average [Flyvbjerg, 2014]) and the extension of execution deadlines generate significant inefficiencies in public investment, that reach 0.65% of the regional GDP (IDB, 2020a).

4. To increase the **availability of information and empirical evidence** on the most effective policies: in LAC there is still little data on the condition of infrastructure and services, as well as limited information on the impact of investments and reforms implemented. Moreover, when data are available, they are often scattered in different sources, outdated, incomplete and of low quality when compared to the standards of advanced countries. This is detrimental to effective regulation, planning, and supervision on the part of the authorities. It also impacts transparency, prevents optimization of the use of available infrastructure, discourages private sector investment, and hinders a more effective management of operations and assets (IDB, 2020b).

5. To improve **inter-institutional coordination**: inter-institutional collaboration is scarce, both within the transportation sector —with the consequences mentioned in point 3— and outside it. Even taking into account that certain regulatory aspects exceed the prerogatives of the transportation sector, such as trade facilitation, telecommunications, data protection and cybersecurity, such levels of coordination are also limited.

6. To improve **collaboration with the private sector and academia**: as already mentioned, the private sector is a key player in logistics, as it is responsible for virtually all freight transport and operates 18 of the 20 largest port terminals and 15 of the 20 main airports in LAC, among others (IDB, 2020a). It also plays an important role in the adoption and transfer of technologies in the logistics sector (ITF, 2019c). In this regard, it is essential to improve the dialogue with the private sector, as well as the business environment in which it operates, overcoming challenges related to the lack of transparency, tax burden, legal uncertainty, limited access to financing, complexity of procedures, macroeconomic instability and lack of human talent, among other things, in order to lay the foundations for encouraging investment and greater business efficiency in the sector.

The previous chapters have shown that the different logistics modes and processes have challenges and, consequently, require the implementation of solutions adapted to the specific context of each country. However, **three common elements** for improving logistics in LAC have also been identified and are explained below:

1. **Infrastructure:** according to the available data from international indicators, it is in the infrastructure subcomponent where LAC presents a lower relative performance (2.47/5 in the LPI) compared to more advanced regions (score of 3.13 for Europe and Central Asia and 3.01 for Southeast Asia) (World Bank, 2018a). As a result, about 40% of the difference in international freight rates between LAC and the OECD can be attributed to differences in the quality of infrastructure (IDB, 2019a). The deficiencies in road infrastructure noted in Chapter 2 and 7 are of particular concern, given the predominance of land transport in the modal split of freight transportation. In most countries, rail infrastructure is limited or of low quality (see Chapter 3). Although the quality of port infrastructure (sea and river ports) and airport infrastructure has improved, especially since the private sector participates in their construction and operation, some considerable challenges still remain, especially in terms of intermodal connections (see Chapter 5). Furthermore, the infrastructure and equipment at border crossings is also deficient (see Chapter 6).

2. **Logistics services:** the poor performance of these services increases logistics costs in the region, with values ranging between 10 and 15 cents per ton/km, while in Australia and Canada the cost is 5 cents, and in Spain and the United States, it is 4 cents (Barbero & Guerrero, 2017). In Chapters 2, 3, 4, 5 and 7 we have pointed out the limitations of road, rail, maritime, air, and urban transportation services. In general, international indicators show a lower quality and relative competence of logistics services in LAC. The region (score 3.05 out of 5) ranks behind Europe and Central Asia (3.65), Southeast Asia (3.49) and the Middle East and North Africa. In addition, in Chapter 6, we pointed out the breaches of trade facilitation agreements, which generate barriers to foreign trade logistics. Overcoming these barriers is key for the sector, given that improved performance depends not only on a greater provision of infrastructure, but also on the efficiency of service providers (IDB, 2020a).

3. **Institutions and regulations:** as noted in previous pages, despite the improvements made in some countries in terms of the adoption of national logistics policies, LAC is still far from reaching the levels of institutional quality of advanced countries. The gaps in institutional capacity and transparency are particularly worrisome, as well as the multiplicity of processes and documents requested by public agencies for logistical operations, and the limited inter-institutional coordination of the agencies involved, which hinders the development of a common vision and the implementation of comprehensive and articulated policies (World Bank, 2020b).

Besides these factors, **cross-cutting aspects such as technological modernization and the promotion of economic, financial, environmental and social sustainability** must also be taken into consideration (Bhattacharya et al., 2019). While these areas are barely mentioned in plans and policies currently in place in the region, the changes resulting from the Fourth Industrial Revolution and the acceleration of climate change will require fast action if countries are to increase the efficiency and competitiveness of their logistics sector and supply chains, as well as reduce the impact of climate change and mitigate the sector's contribution to it. In Chapter 8, it was proven that LAC is lagging behind in terms of infrastructure, services, and institutions with respect to the adoption of new technologies. In Chapter 9, the major challenges that the logistics sector faces in the region in terms of environmental sustainability were identified. This sector is one of the main sources of CO_2 emissions and some technical challenges must still be faced regarding the decarbonization of some modes of transportation (e.g., air transportation). Besides environmental sustainability, it is important to highlight its relation to the social sphere, due to the fact that the sector is an important source of employment, and therefore has an opportunity to contribute to the objectives of gender equality and diversity in the region, promoting equal participation of different population groups that are currently underrepresented in the sector's labor markets (e.g. women, youth, people with disabilities, Afro-descendants or indigenous people, among others). Thus, it will become increasingly important to have a workforce —especially in underrepresented groups— with the new qualities demanded by the market regarding, for example, artificial intelligence, automation, the IoT and cloud computing.

From an economic and financial point of view, the region faces challenges to increase investment in the sector and diversify funding and financing instruments. Prior to the COVID-19 pandemic, the region already had limited fiscal space to increase investment in transportation infrastructure, and the need for such investment was estimated to be between 4% and 7% of GDP (IDB, 2018). With the economic consequences of the pandemic, in terms of the drop in tax revenues and the rising public debt, the investment outlook in the region is bleaker. However, considering the multiplier effect of infrastructure investments and their impact on employment generation, these investments are the perfect ally to reactivate the economy quickly. Estimates from Serebrisky et al. (2020) suggest that each additional point of GDP spent on public investment generates eight additional percentage points of GDP. Moreover, for every $1 billion spent, the region could create 36,000 jobs. In addition to these fiscal constraints, there are legal barriers and legal restrictions on the amount and type of participation of public entities in funding and financing sources, as well as challenges in structuring attractive projects for the private sector, which limit innovation in terms of financial mechanisms for the sector (IDB, 2020b). Reversing the situation in these areas in LAC is key to improving the region's logistics performance in the future.

Given the critical role that private companies play in improving the logistics performance of a given country, it is essential to develop mechanisms aimed at improving **public-private collaboration**. The institutionalization of areas for dialogue, the early involvement of the private sector in consultation processes for the design of public policies, the creation of training and professional excellence centers with private sponsorship, and the digitalization and greater transparency of public procedures are examples of initiatives adopted by leading countries worldwide, such as Germany, Belgium, and the United States, to strengthen ongoing dialogue and leverage the knowledge, experience, and resources of the private sector in logistics.

In addition to the sector's general challenges, each logistics mode and process faces specific challenges, as indicated in the corresponding chapters. Thus, to have more granularity on the required solutions, we have specified **the actions to be carried out in each logistic mode or process** in the next table.

Table 11.1 Policy actions according to logistics node or process and logistics system component

Subsector	Infrastructure	Services	Institutions and regulations
Road	· Comprehensive planning of infrastructure and with other transportation modes. · Improvement of the quality, capacity, connectivity, and coverage of primary, secondary, and tertiary roads. · Inter-modalism (e.g., with ports and railroads). · Intelligent management of infrastructure. · Resilience of infrastructure to climate change.	· Technical efficiency in motor transportation. · Professionalization of motor transportation. · Technological modernization in companies and vehicles. · Adoption of clean technologies to provide services.	· Business formalization in motor transportation. · Preservation of sectorial competition. · Funding and financing for infrastructure works and funding for SMEs in the sector. · Transportation safety. · Inter-sectoral coordination. · Regional coordination in infrastructure projects and regulation of the sector.
Rail	· Comprehensive planning within the sector and with other transportation modes. · Improvement of railroad network quality, connectivity, and coverage. · Inter-modal connection (e.g., road and maritime). · Intelligent management of infrastructure. · Resilience of infrastructure to climate change.	· Technical efficiency of companies in the sector. · Technological modernization of companies and services. · Adoption of clean technologies in service provision.	· Preservation of competition. · Funding and financing for infrastructure works. · Transportation safety. · Inter-sectoral coordination.
Maritime	· Inter-modal connection (e.g., road and rail). · Intelligent management of infrastructure. · Resilience of infrastructure to climate change.	· Integration of port processes with logistics processes. · Technological modernization of processes. · Adoption of clean technologies in the provision of services.	· Strategic vision and integrated planning. · Preservation of competition against horizontal and vertical integration. · Inter-institutional and inter-sectoral coordination. · Regional coordination.
Air	· Resilience of infrastructure to climate change. · Improvement of the quality of infrastructure for air cargo operations.	· Integration of air processes with logistics processes. · Technological modernization of processes. · Adoption of clean technologies in service provision.	· Transportation safety. · Inter-sectoral coordination. · Regional coordination.
Trade facilitation	· Territorial planning with a vision of local development. · Physical equipment for customs and border management at land, air and water border crossings. · Intelligent management of the allocated infrastructure.	· Integration of logistics processes with control processes. · Technological modernization in control processes.	· Simplification and digitalization of processes. · Integrated controls and unified inspection. · Transparency. · Inter-institutional and inter-sectoral coordination. · Regional coordination.
Urban logistics	· Integrated urban land use and transportation planning. · Allocation of road and urban space (e.g. loading and unloading bays). · Intelligent management of the allocated infrastructure.	· Business formalization and professionalization of the sector. · Technological modernization of companies in this sector. · Adoption of clean technologies in the provision of services.	· Integrated land use, mobility, and logistics planning. · Specific regulations. · Pricing instruments. · Inter-institutional and inter-sectoral coordination.

Source: Own production.

Taking maritime transport as an example, while several LAC countries have been improving the quality of their port infrastructure and operation efficiency, currently, the challenge lies in increasing its integration with logistics processes in which the port is involved, to achieve the underlying efficiency gains. Thus, integrated infrastructure planning and management is required, especially with road and rail modes, to promote inter-modality and reduce the negative impact of port activities in urban environments (see **Box 11.1**). On the other hand, it is essential to boost coordination and increase visibility between port and logistics processes —nowadays facilitated by the adoption of new technologies—, both for process optimization and for better risk management in supply chains (Calatayud, 2017). Another key action arising from the sector dynamics is the preservation of the competition in the face of increased vertical integration. Given the progression of climate change, it is essential, on the one hand, to incorporate the concepts of resilience and risk management into the planning and operation of infrastructure and services and, on the other hand, to reduce the sector's environmental impact. Finally, given the multiple private (e.g., shipping companies, inland carriers, TPLs) and public (e.g. Port Authority, Customs, control agencies) actors involved in port activity, it is key to continue making progress in the coordination, simplification, and visibility of processes. Technologies such as the Port Community Systems have proven to be useful in this regard (Mendes Constante, 2019).

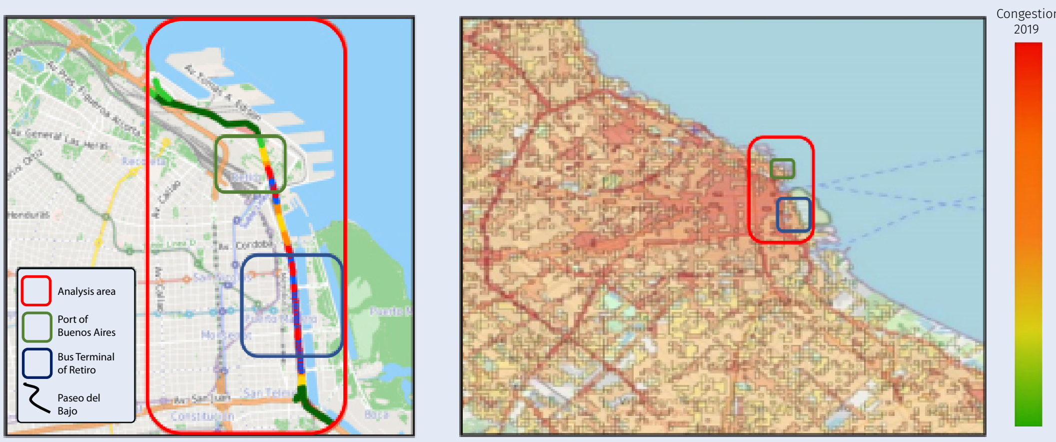
Box 11.1 Mitigating externalities of port activity in urban environments

One of the main externalities of port activities, when inserted within urban contexts, is road congestion. This phenomenon not only worsens access to terminals, but also affects the quality of life of citizens and generates significant costs in their daily activities. To mitigate this impact, the most competitive port-cities worldwide have ensured that the infrastructure is appropriate to maintain a sustainable traffic flow. For example, Rotterdam has a sophisticated infrastructure network to provide access to its port, including the A15 highway —the main arterial road connecting the port to the European highway network— and a series of bridges, tunnels and viaducts that support the flow to and from the port in a densely populated area, separating freight and vehicle traffic. According to the TomTom Index, of Europe's top three port cities, Rotterdam had the lowest level of congestion in 2019. On average, the aggregate delay in that city due to road congestion was 25% (barely reaching 15% on motorways), while in Antwerp it was 32% and in Hamburg 34%.

In the case of LAC, the recent IDB publication, which analyses congestion and estimates its costs for ten cities in the region, includes an impact assessment of the Paseo del Bajo project in the port area of Buenos Aires, inaugurated on May 27th, 2019 (Calatayud et al., 2021). This project consists of a semi-buried highway with an open-trench design, exclusively for heavy traffic (related to the Port of Buenos Aires) and long-distance buses (due to the presence of the Retiro bus station), in a key area of the city, characterized by high levels of road congestion. According to the Government of Buenos Aires (2019), around 91 thousand private vehicles, 28 thousand bus passengers and 15 thousand heavy-duty vehicles used to cross the downtown district every day and were forced to share the same road lanes. The Paseo del Bajo now extends from the Buenos Aires-La Plata highway to its northern junction with the Illia highway (**Figure 11.1**). The project runs along the avenues Alicia Moreau de Justo and Huergo-Madero, and the avenues Ramos Mejía, Antártida Argentina, and Castillo. The extension of this project is 7.1 kilometers, with 12 new lanes, 15 crosswalks (five are pedestrian), and includes a total of 13.6 hectares of public and green spaces (Government of Buenos Aires, 2019).

Box 11.1 Mitigating externalities of port activity in urban environments

Figure 11.1 Area of direct influence of Paseo del Bajo



Source: Calatayud et al. (2021).
Note: The entire layout corresponds to the structure of Paseo del Bajo. The colors of the layout represent the open-trench structure -semi-buried- of the project.

The results of the impact assessment indicate that with the inauguration of the project congestion was reduced by 18%, on average, in comparison with the pre-event period. The temporal disaggregation of the data collected allowed for an estimation by subsample, which confirms that this reduction occurred mainly during peak hours, with a 26% decrease in the 7-11am period, and a 30% decrease in the 3-8pm period. Considering the first 30 working days after the inauguration of this project and an average of 72,461 total hours lost per day by travelers in this area due to traffic congestion, an average reduction of 18% of the time spent stopped in traffic means a monthly saving of 391,228 hours, which was maintained during the rest of the year.

In addition to requiring specific actions per node or process, **solutions may differ according to the level of performance achieved by a country**. International indicators such as the LPI by the World Bank or the World Competitiveness Index by the World Economic Forum make it possible to identify a country's performance level and compare it with the regional average and with its peers by income level or geographic location, among other variables, thus being able to establish its lag or progress with respect to its comparators. In **Table 11.2** we have summarized the priority actions according to the relative logistical performance level of a country in the corresponding component. It is worth mentioning that, as observed in the international indexes, a country can have a high performance in some components and then a much lower performance in others. Thus, the measures indicated must be **adapted to the reality of each component in each country**.

Normally, the measures suggested for countries with lower relative performance include strengthening the basic elements of a logistics system. For example, in the case of road transportation, it will be necessary to focus on the construction and maintenance of basic trunk and rural roads, the professionalization and formalization of transportation services, the creation or strengthening of the associated institutional framework, and regional coordination. Similarly, in rail transportation, planning exercises and feasibility analyses on the development of rail freight transportation need to be carried out, in addition to first-generation reforms focused on defining the institutional management and financing model. In the case of maritime transportation, progress will need to be made on first-generation reforms and to improve operational efficiency.

The measures suggested for the countries with the highest relative performance are expected to achieve greater efficiencies through the implementation of technology, intermodal connections, upgrading institutions and regulations, increasing investments and the use of more environmentally friendly technologies. Taking the above examples, in the case of road transportation, actions could be aimed at improving the quality and capacity of primary, secondary, and tertiary roads, promoting interconnection with ports and railroads, digitizing processes, and adopting traffic monitoring technology, and promoting the transition to clean technologies. In relation to rail transportation, the recommendations are aimed at strengthening the institutional management and financing model, along with investments in maintenance and/or expansion of the network from a multimodal perspective. In maritime transport, the world's leading countries (e.g. Germany, China, Singapore) define the steps to be followed in this sector in the region: the development of a strategic vision and integrated planning; progress in second-generation reforms and regulations update; greater investments with the participation of the private sector; inter-modal connection with the railroad; integration of port processes with logistics processes; technological modernization and promotion of the transition to clean technologies.

However, it is important to point out that, in cases such as the adoption of clean and digital technologies, sequencing may not be required —i.e., from dirty to clean technologies— but rather the level of development of both technologies may favor countries to **leapfrog** and directly include components with such characteristics in their investments and actions. Moreover, in the context of the Fourth Industrial Revolution and the growing impact of climate change, it will be crucial for relatively lower performing countries to consider technology and resilience variables from the very moment of planning investment in logistics-related infrastructure and services. Thus **Table 11.2** present actions regarding these dimensions for both levels of performance. Indeed, the early adoption of sustainability and technology criteria in transport infrastructure and services can contribute to improving their performance, optimizing their capacities, and reducing the need for future investments.

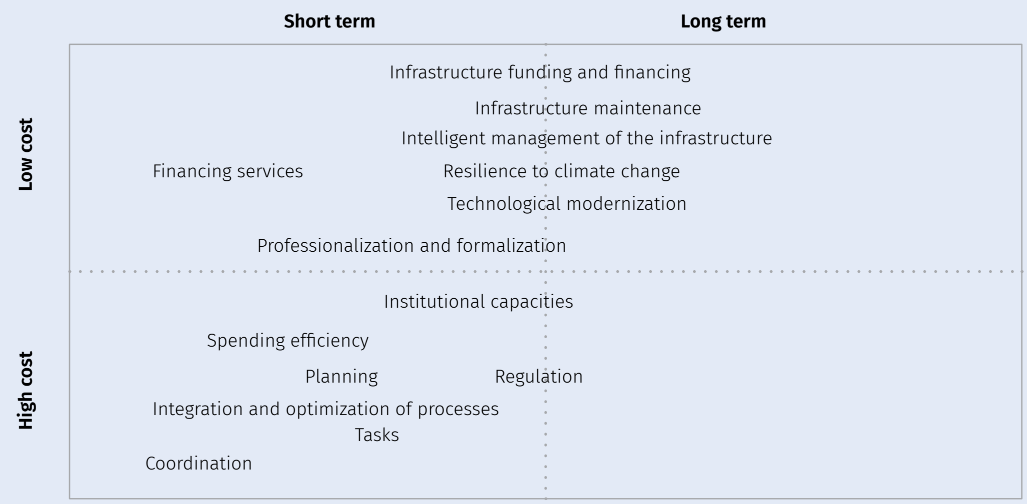
Table 11.2 Priorities for action according to the country's level of logistical performance

Priority areas for action	Priorities in countries with lower relative logistics performance	Priorities in the countries with higher relative logistics performance
Road	· Construction and maintenance of basic, backbone and rural infrastructure · Resilience to climate change. · Professionalization and formalization of motor transportation services (assets, processes, and technology). · Inter-institutional strengthening and coordination. · Regional coordination. · Creation of the institutional framework and planning instruments.	· Improving quality and capacity of primary, secondary, and tertiary roads. · Incentives for the establishment of logistics platforms. · Resilience of infrastructure to climate change. · Inter-modalism (e.g., with ports and railroads). · Technological modernization of infrastructure and services. · Adoption of clean technologies in services. · Consolidation of the current institutional framework.
Rail	· Multimodal planning. · First generation reforms. · Resilience of infrastructure to climate change. · Inter-institutional strengthening and coordination.	· Second generation reforms and regulations update. · Improved quality and capacity of the railroad network. · Inter-modalism (e.g., road and maritime) and configuration of logistics nodes.
Maritime	· First generation reforms. · Operational efficiency (assets, processes, and technology). · Resilience of infrastructure to climate change. · Inter-institutional strengthening and coordination.	· Strategic vision and integrated planning. · Second-generation reforms and regulatory updates. · Major investments, PPPs. · Inter-modalism (e.g., road and rail) and configuration of logistics nodes. · Integration of port processes with logistics processes. · Technological modernization. · Adoption of clean technologies. · Resilience of infrastructure to climate change.
Air	· Provision of infrastructure. · Risk management. · Operational efficiency.	· Integration of airport processes with logistics processes. · Technological modernization. · Adoption of clean technologies in services. · Resilience of infrastructure to climate change.
Trade facilitation	· Simplification of customs procedures. · Reduction of dispatch times. · Adequacy of border crossing infrastructure. · Risk management. · Transparency. · Inter-institutional coordination. · Regional coordination.	· Digitization of processes. · Integrated controls and unified inspection. · Technological infrastructure for cargo control. · Integration of logistics processes with control processes.
Urban logistics	· Integrated land use, mobility, and logistics planning. · Allocation of road and urban space (e.g., loading and unloading bays). · Professionalization and formalization of services. · Inter-institutional strengthening and coordination.	· Intelligent management of the allocated infrastructure and facilitation of multilevel logistics. · Adoption of clean technologies in services. · Pricing instruments.

Source: Own production.

Finally, it is important to take into account the **cost and time it takes to reap the benefits** of the actions that need to be implemented. Although the improvement of a country's logistics performance requires comprehensive actions to make progress in its different components, there are some actions that, due to their low cost and high impact, can be carried out with a greater degree of independence from budgetary restrictions, as well as actions that, due to their high impact in the short term, can generate significant gains for a country. In this sense **Figure 11.2** classifies the actions contained in the tables above, according to their costs and the timing of their impact.

Figure 11.2 Costs and timing of the impact of policy actions



Source: Own production.

For example, actions related to regulatory reforms typically require fewer fiscal resources and can have both short- and long-term positive impacts on logistics performance. Reforms related to improving competition fall into this category. Improving institutional capacity may have low to medium costs, given that they require a certain budget for, among other things, improving human resource training and modernizing information systems. However, they are much less costly when compared to infrastructure investments. Another example is the adoption of technologies in infrastructure and logistics asset management. Although a certain level of investment is required, it can be much lower and have a more immediate impact on the implementation of logistic flows, optimizing existing assets compared to the execution of new infrastructure projects. However, it should be emphasized that every project must be supported by an exhaustive cost-benefit analysis, in financial as well as economic and social terms, which serves as a tool for the public sector to prioritize the policies to be implemented in terms of time and budget.

Finally, it can be seen from the actions presented in this chapter that a strategy for improving logistics performance will include some actions that require **significant investments** —in many cases supported by public funding— **together with "soft" measures**, with low investment costs (Barbero, 2010). However, these measures may require strong political and institutional capacity to change business activities and deep-rooted attitudes among public and private actors. Therefore, any improvement in the logistics performance of a country must include the development of competent institutions capable of managing the many actors involved in logistics activities, with the appropriate technical skills and policies.

Throughout this document, we have seen that there are **success cases** in the region that demonstrate the feasibility of improving logistics performance if appropriate policy actions are implemented. An example of this is Colombia, a country that positioned logistics as a central area for its economic development more than 12 years ago, establishing guidelines for the improvement of its transportation infrastructure and business climate, and aligning its public policies in this regard. As the most recent result of these guidelines, it is worth noting that between 2016 and 2018 the country improved no less than 36 positions in the LPI. The same happened a decade ago with Panama when, taking advantage of its canal, the country sought to become a world-class logistics hub as one of its development priorities. The guidelines outlined under a broad public-private partnership included actions in all components of the logistics system, which allowed the country to rise from the 54th position in the LPI in 2007 to the 38th position in 2018. International experience also shows that the adoption of appropriate policies has allowed relatively less developed countries to make significant progress, reaping the benefits of improved logistics for their economies and populations. A globally cited example is Rwanda, which is a landlocked country, a factor that fundamentally limits its trade competitiveness. In order to counteract this obstacle and improve its logistics performance, the country has been implementing a series of reforms over the last 15 years aimed at simplifying and streamlining administrative processes, increasing the exchange of information between agencies involved in logistics processes, improving transport security, increasing the quality of its main road corridors, and strengthening collaboration with neighboring countries to facilitate the movement of Rwanda's international trade. As a result, Rwanda moved from the 148th place in the LPI ranking in 2007 to the 57th place in 2018.

The message of all these cases is that improving the logistics performance of a country is a **medium and long-term project** in which multiple actors and jurisdictions must be involved, transcending political cycles. Therefore, it is key to make logistics a **state policy objective**, based on a broad agreement among all related actors, regardless of their political and sectoral bases. Another aspect to highlight is the **comprehensiveness of the areas covered by the policy**, including the development of infrastructure and multimodal services, of the regulatory framework, sectoral capacities, and inter-sectoral collaboration. It is important for the policy to be **flexible** enough to incorporate aspects that were not considered —or were given less prominence— at the time it was drafted. This is fundamental in the context of the **technological and environmental changes** that will accelerate in the next decade, which will require a strong technological reconversion of the sector to increase its competitiveness —as well as to reduce the gap with leading countries that have already begun the transformation— and effective measures to reduce the impact of logistics on the environment, enabling progress to be made regarding the compliance of the sustainable development goals set for 2030.

References

AAR. (2020). *The Positive Environmental Effects of Increased Freight by Rail Movements in America*. Recovered from: https://www.aar.org/wp-content/uploads/2020/06/AAR-Positive-Environmental-Effects-of-Freight-Rail-White-Paper-62020.pdf

ACI. (2020, May 19). ACI Media Releases. *ACI Reveals Top 20 Airports for Passenger Traffic, Cargo, and Aircraft Movements*. Recovered from: https://aci.aero/news/2020/05/19/aci-reveals-top-20-airports-for-passenger-traffic-cargo-and-aircraft-movements/

Aggarwal, S. (2018). Do rural roads create pathways out of poverty? Evidence from India. *Journal of Development Economics*, *133*, 375–395. Recovered from: https://doi.org/10.1016/j.jdeveco.2018.01.004

Agro-proyectual. (2016). *Artículos técnicos*. El Costo de Transportar Granos En Argentina. Recovered from: https://www.agroproyectual.com/agro/index.php?option=com_content&view=article&id=662%3Ael-costo-de-transportar-granos-en-argentina&catid=25%3Aultimasnoticias&Itemid=125

Anderson, J. E., & Van Wincoop, E. (2003). Gravity with gravitas: A solution to the border puzzle. *American Economic Review*, *93*(1), 170–192. Recovered from: https://www.aeaweb.org/articles?id=10.1257/000282803321455214

ANDI. (2016). *Informe ejecutivo:piloto de cargue y descargue nocturno en empresas de la ciudad de Bogotá*. Recovered from: http://www.andi.com.co/Uploads/Informe%20Ejecutivo%20Piloto%20CD%20Nocturno.pdf

APAM. (2018). *Asociación Peruana de Agentes Maritimos*. Corredor Bioceánico Bolivia-Brasil Permitirá Reducir Tiempos de Traslado de Carga de 67 a 42 Días. Recovered from: https://www.apam-peru.com/web/corredor-bioceanico-bolivia-brasil-permitira-reducir-tiempos-de-traslado-de-carga-de-67-a-42-dias/

Aritua, B. (2019). *The Rail Freight Challenge for Emerging Economies How to Regain Modal Share*. Recovered from: https://openknowledge.worldbank.org/bitstream/handle/10986/31089/9781464813818.pdf?sequence=2&isAllowed=y

Argentinian Ministry of Environment and Sustainable Development & Ministry of Transportation. (2017). *Plan de acción nacional del transporte y el cambio climático*. Recovered from: https://www.argentina.gob.ar/sites/default/files/plan_de_accion_nacional_de_transporte_y_cc_1.pdf

Arvis, J.-F., Saslavsky, D., Ojala, L., Shepherd, B., Busch, C., Raj, A., & Naula, T. (2016). *Connecting to Compete 2016 : Trade Logistics in the Global EconomyThe Logistics Performance Index and Its Indicators*. Recovered from: http://hdl.handle.net/10986/24598

Arvis, J., Ojala, L., Wiederer, C., Shepherd, B., Raj, A., Dairabayeva, K., & Kiiski, T. (2018). *Connecting to Compete 2018 : Trade Logistics in the Global Economy*. Recovered from: https://openknowledge.worldbank.org/handle/10986/29971

Banister, D., & Berechman, Y. (2001). Transport investment and the promotion of economic growth. *Journal of Transport Geography*, *9*(3), 117–140. Recovered from: https://doi.org/10.1016/S0966-6923(01)00013-8

Barbero, J., & Guerrero, P. (2017). *El transporte automotor de carga en América Latina: soporte logístico de la producción y el comercio*. Recovered from: https://publications.iadb.org/es/publicacion/13969/el-transporte-automotor-de-carga-en-america-latina-soporte-logistico-de-la

Barbero, J., Fiadone, R., & Millán, M. F. (2020). *El transporte automotor de cargas en América Latina*. Recovered from: https://publications.iadb.org/es/el-transporte-automotor-de-cargas-en-america-latina

Barbero, J., (2010). *Freight logistics in Latin America and the Caribbean: An agenda to improve performance*. Recovered from: https://publications.iadb.org/publications/spanish/document/El_transporte_automotor_de_cargas_en_América_Latina.pdf

Barbero, J., Lordi, H., Polo, C., & Kohon, J. (2012). *Propuestas para una política nacional de transporte de ferroviario de cargas*. Recovered from: https://www.unsam.edu.ar/institutos/transporte/publicaciones/Propuesta%20para%20una%20Politica%20Nacional%20de%20Transporte%20Ferroviario%20de%20Cargas.pdf

Beck, A., Bente, H., & Schilling, M. (2013). *Railway Efficiency*. Recovered from: https://www.itf-oecd.org/sites/default/files/docs/dp201312.pdf

Behar, A., Manners, P., & Nelson, B. D. (2009). Exports and Logistics. *Social Research*, *439*.

Bergero, P., Calzada, J., Di Yenno, F., & Terré, E. (2020). *El Gran Rosario es el nodo portuario agroexportador más importante del mundo*. Recovered from: https://www.bcr.com.ar/es/print/pdf/node/80378

Bhattacharya, A., Contreras Casado, C., Jeong, M., Amin, A.-L., Watkings, G., & Silva, M. (2019). *Atributos y Marco para la Infraestructura Sostenible*. Recovered from: https://publications.iadb.org/publications/spanish/document/Atributos_y_marco_para_la_infraestructura_sostenible_es_es.pdf

Boeing. (2020). *World Air Cargo Forecast 2020-2039*. Recovered from: http://www.boeing.com/resources/boeingdotcom/market/assets/downloads/2020_WACF_PDF_Download.pdf

Bogart, D. (2007). *Private Ownership, Nationalization, and the Development of Transport Systems: Cross-Country Evidence from the Growth of Railroad Networks, 1860-1913*. Recovered from: http://www.socsci.uci.edu/~dbogart/bogart_railprivate_6_17_2007.pdf

Bureau of Infrastructure, & Transport and Regional Economics. (2009). *Road and rail freight : competitors or complements?* Recovered from: https://catalogue.nla.gov.au/Record/4695438

CAF. (2016). *Análisis de inversiones aeroportuarias en América Latina y el Caribe al horizonte 2040*. Recovered from: https://scioteca.caf.com/handle/123456789/1160?show=full

Calatayud, A., Sánchez-González, S., Bedoya-Maya, F., Giraldez, F., & Márquez, J. M. (2021). *Congestión urbana en América Latina y el Caribe: características, costos y mitigación*. https://publications.iadb.org/es/congestion-urbana-en-america-latina-y-el-caribe-caracteristicas-costos-y-mitigacion.

Calatayud, A. (2017). *The Connected Supply Chain: Enhancing Risk Management in a Changing World*. Recovered from: https://publications.iadb.org/publications/english/document/The-Connected-Supply-Chain-Enhancing-Risk-Management-in-a-Changing-World.pdf

Calatayud, A., & Katz, R. (2019). *Cadena de suministro 4.0: Mejores prácticas internacionales y hoja de ruta para América Latina*. Recovered from: http://dx.doi.org/10.18235/0001956

Calatayud, A., & Ketterer, J. A. (2016). *Gestión integral de riesgos para cadenas de valor*. Recovered from: https://publications.iadb.org/publications/spanish/document/Gestión-integral-de-riesgos-para-cadenas-de-valor.pdf

Calatayud, A., Mangan, J., & Palacin, R. (2017). Connectivity to international markets: A multi-layered network approach. *Journal of Transport Geography*, *61*, 61–71. Recovered from: https://doi.org/10.1016/j.jtrangeo.2017.04.006

Calatayud, A., & Millán, M. F. (2019). *ALC 2030: Construyendo las cadenas de suministro del futuro*. Recovered from: http://dx.doi.org/10.18235/0001969

Calatayud, A., Monsreal, M., Mangan, J., & Villa, J. (2020). Benefits of Technology Adoption for Enhanced Integration of Port–Hinterland Operations. *Transportation Research Record*, *2674*(11), 606–615. Recovered from: https://doi.org/10.1177/0361198120949251

Caldas, M., Carvalhal, R., & Gabriele, P. (2013). *The Efficiency of Freight Rail Transport: An Analysis from Brazil and United States*. Recovered from: http://www.wctrs-society.com/wp-content/uploads/abstracts/rio/selected/1567.pdf

CALSTART. (2020). *Drive to Zero's Zero-emission Technology Inventory (ZETI) Tool Version 5.9*. Recovered from: https://globaldrivetozero.org/tools/zero-emission-technology-inventory/

Canales Ewest, G., Sarria, A., Méndez, E., Castro, P., Alfaro, C., Libby, M. H., Castrillo, R., Aguirre, C., Castillo, M., & Castillo, S. (2019). *Guía Dinámica Como Gestionar un Proyecto de Puesto de Frontera*. Recovered from: http://dx.doi.org/10.18235/0002028

Carballo, J., Graziano, A., Schaur, G., & Volpe, C. (2016). *The Border Labyrinth: Information Technologies and Trade in the Presence of Multiple Agencies*. Recovered from: https://publications.iadb.org/publications/english/document/The-Border-Labyrinth-Information-Technologies-and-Trade-in-the-Presence-of-Multiple-Agencies.pdf

Cardenas, I., Bordon-Galvez, Y., Verlinden, T., Van de Voorde, E., Vanelslander, T., & Dewulf, W. (2017). City logistics, urban goods distribution and last mile delivery and collection. *Competition and Regulation in Network Industries*. Recovered from: https://doi.org/10.1177/1783591717736505

CBSA, & CSCB. (2016). *Supporting private sector engagement – the CBSA's stakeholder engagement model*.

Central Bank of Trinidad and Tobago. (2020). *Statistics*. Labour Force Annual. Recovered from: https://www.central-bank.org.tt/statistics/data-centre/labour-force-annual

Château, J., Dellink, R., & Lanzi, E. (2014). *An Overview of the OECD ENV-Linkages Model: Version 3* (No. 65; OECD Environment Working Papers). Recovered from: http://dx.doi.org/10.1787/5jz2qck2b2vd-en

Christopher, M. (2016). *Logistics & Supply Chain Management* (5th ed.). Financial Times/ Prentice Hall. Recovered from: https://www.martin-christopher.info/logistics-and-supply-chain-management-5th-edition

CIAT. (2016). *Historical GHG Emissions*. Historical GHG Emissions. Recovered from: https://www.climatewatchdata.org/ghg-emissions?end_year=2016&sectors=total-including-lucf&start_year=1990

CIIFEN. (2016a). *¿Qué es el cambio climático?* Recovered from: http://www.ciifen.org/index.php?option=com_content&view=category&layout=blog&id=100&Itemid=133&lang=es

CIIFEN. (2016b). *Adaptación y mitigación frente al Cambio Climático*. Adaptación y Mitigación Frente Al Cambio Climático. Recovered from: http://www.ciifen.org/index.php?option=com_content&view=category&layout=blog&id=102&Itemid=341&lang=es

LACAC. (2019). *Acuerdos multilaterales de cielos abiertos*. Acuerdo Multilateral de Cielos Abiertos Para Los Estados Miembros CLAC.

Clark, X., Dollar, D., & Micco, A. (2004). *Port Efficiency, Maritime Transport Cost and Bolateral Trade*. *March*, 55.

Corcuera-Santamaria, S. (2018). Integración y comercio. *Las Rutas Inteligentes Marcan El Paso En La Frontera*.

Cormagdalena. (2020). *Informe de gestión 2020 Cormagdalena*.

Cristea, A. D., Hummels, D., Puzzello, L., & Avetisyan, M. G. (2013). Trade and the greenhouse gas emissions from international freight transport. *Journal of Environmental Economics and Management*, *65*(1), 153–173. Recovered from: https://doi.org/10.1016/j.jeem.2012.06.002

Crucelegui, J. L. (2020). *Desafíos en la competencia y la regulación de infraestructuras y servicios portuarios y del sector del transporte marítimo*. Recovered from: https://unctad.org/system/files/official-document/ser-rp-2020d7_en.pdf

CSCMP. (2020). *CSCMP Supply Chain Management Definitions and Glossary*. CSCMP Supply Chain Management Definitions and Glossary.

Cuerca, S., & Moreno, M. (2020). Innovando en la Gestión Aduanera con Blockchain. *Integración y Comercio*, *46*, 72–86.

Da Silva Bahía, A. A., Pimentel de Freitas, V., & Almeida de Jesus, E. (2017). *La integración de la tecnología de rastreo con los documentos fiscales electrónicos.* Recovered from: https://idbg.sharepoint.com/:w:/r/teams/EZ-RG-ESW/RG-E1476/_layouts/15/Doc.aspx?sourcedoc=%7BDE3532D8-4C2D-49E9-AAA3-DE9E4B0BB07F%7D&file=Integración de tecnología de rasteabilidad con FE (Español) rev VPF%2C AB e EAJ 06.07.2017 (1).docx&action=default&mo

DANE. (2020). *Mercado Laboral*. Principales Indicadores Del Mercado Laboral. Recovered from: https://www.dane.gov.co

De Marco, A. (2019). "Las políticas de transporte en la Argentina: los años de la posconvertibilidad (2002-2015)", de José A. Barbero y Julián Bertranou (comps.). *Estado Abierto. Revista Sobre El Estado, La Administración Y Las Políticas Públicas*, 4(2), 201–204. Recovered from: https://publicaciones.inap.gob.ar/index.php/EA/article/view/153

Desarrollo logistico. (2018). *Desarrollo logístico*. Red Logística Gran Escala Nueva Generación de Puertos de Carga General. Recovered from: http://www.logistica.mtt.cl/proyectos/9/red-logistica-gran-escala

Desiderio, D. (2019). Data analysis techniques for enhancing the performance of Customs. *World Customs Journal*, *13*(2), 22. Recovered from: https://worldcustomsjournal.org/Archives/Volume 13%2C Number 2 (Sep 2019)/1886 01 WCJ v13n2 Desiderio.pdf?_t=1569889901

DHL. (2015). *Internet of Things in Logistics*. Recovered from: https://www.dhl.com/global-en/home/insights-and-innovation/thought-leadership/trend-reports/internet-of-things-in-logistics.html

DHL. (2020). *Logistic Trend Radar 5th edition*. Recovered from: https://www.dhl.com/global-en/home/insights-and-innovation/insights/logistics-trend-radar.html

Djankov, S., Caroline Freund, & Pham, C. S. (2010). Trading on Time. *Review of Economics and Statistics*, *91*(1), 166–173. Recovered from: www.jstor.org/stable/25651397

DNP. (2018). *Nueva Visión de la Política Nacional Logística*. Recovered from: https://onl.dnp.gov.co/es/Publicaciones/Documents/Nueva Visión de la Política Nacional Logística.pdf

DNP. (2019). *Departamento Nacional de Planeación*. Arranca Estrategia Para Reactivar El Transporte Ferroviario En Colombia. Recovered from: https://www.dnp.gov.co/Paginas/Arranca-estrategia-para-reactivar-el-transporte-ferroviario-en-Colombia.aspx

Dorosh, P., & Hyoung Gun Wang. (2011). Road connectivity, population, and crop production in SubSaharan Africa. *Agricultural Economics*, *43*(1), 89–103. Recovered from: https://doi.org/10.1111/j.1574-0862.2011.00567.

Ducruet, C., & Notteboom, T. (2012). The worldwide maritime network of container shipping: spatial structure and regional dynamics. *Global Networks*, *12*(3). Recovered from: https://doi.org/10.1111/j.1471-0374.2011.00355.x

Economía Aplicada. (2019). *Actualidad sectorial*. ¿Cuántas Empresas Hay En Colombia? Recovered from: http://economiaaplicada.co/index.php/10-noticias/1493-2019-cuanta-empresas-hay-en-colombia

ECLAC. (2018). *La economía del cambio climático en América Latina y el Caribe*. Recovered from: https://repositorio.cepal.org/bitstream/handle/11362/42228/4/S1701215A_es.pdf

ECLAC. (2019). *Perspectivas del Comercio Internacional de América Latina y el Caribe 2019: el adverso contexto mundial profundiza el rezago de la región*. Recovered from: https://www.cepal.org/es/publicaciones/44918-perspectivas-comercio-internacional-america-latina-caribe-2019-adverso-contexto

ECLAC. (2020). *La calma antes de la tormenta: comportamiento del movimiento de contenedores en los puertos de América Latina y el Caribe en 2019 y de los principales puertos durante los primeros meses de 2020*. Recovered from: https://www.cepal.org/sites/default/files/news/files/2020_informe_portuario_2019_v.pdf

Euromonitor Internacional. (2019). *Digital Commerce in Latin America*. Recovered from: https://www.euromonitor.com/digital-commerce-in-latin-america/report

Falconí, F., Burbano, R., & Cango, P. (2016). *La discutible curba de Kuznets*. Recovered from: https://www.flacsoandes.edu.ec/en/node/62767

Feng, M., Shaw, S. L., Peng, G., & Fang, Z. (2020). Time efficiency assessment of ship movements in maritime ports: A case study of two ports based on AIS data. *Journal of Transport Geography*, *86*(May), 102741. Recovered from: https://doi.org/10.1016/j.jtrangeo.2020.102741

FEPSA. (2017). *Sistema Ferroviario de Cargas.*

FHWA. (2016). *2016 Freight Quick Facts Report*. Recovered from: https://ops.fhwa.dot.gov/publications/fhwahop16083/intro.htm

Floden, J., Barthel, F., & Sorkina, E. (2017). Transport buyers choice of transport service – A literature review of empirical result. *Research in Transportation Business and Management*, *23*, 35–45. Recovered from: https://doi.org/10.1016/j.rtbm.2017.02.001

Flyvbjerg, B. (2014). What You Should Know About Megaprojects, and Why: An Overview. *Project Management Journal*, *45*(2), 6–19.

Fransoo, J. C., Blanco, E. E., & Mejia-Argueta, C. (2017). *Reaching 50 million Nanostores: Retail Ditribution in Emerging Megacities* (1st ed.). Createspace Independent Publishing Platform.

Freightos. (2020). *The future of freight in 2020*. Recovered from: https://www.freightos.com/resources/download-the-future-of-freight-in-2020-study/

Fugazza, M., & Hoffmann, J. (2017). Liner shipping connectivity as determinant of trade. *Journal of Shipping and Trade*, *2*(1), 1–18. Recovered from: https://doi.org/10.1186/s41072-017-0019-5

Fundación Valenciaport. (2020). *Smart Port Manual, Strategy and Roadmap*. Recovered from: http://dx.doi.org/10.18235/0002384

Gani, A. (2017). The logistics performance effect in international trade. *The Asian Journal of Shipping and Logistics*, *33*(4), 279–288.

Ganne, E. (2018). *¿Pueden las cadenas de bloques revolucionar el comercio internacional?* Recovered from: https://www.wto.org/spanish/res_s/booksp_s/blockchainrev18_s.pdf

GB National Standar of China. (2018). *Fuel consumption limits for heavy-duty commercial vehicles*. Recovered from: https://theicct.org/sites/default/files/China Stage 3 Standards (GB30510-2018).pdf

Giordani, A. (2018). *Artificial Intelligence in Customs Risk Management for e-Commerce*. Recovered from: https://repository.tudelft.nl/islandora/object/uuid%3Ada9b9c93-eb5f-4954-bdbd-16d2bb61feb5

Giordano, P., Campos, R., & Michalczewsky, K. (2020). *Shock COVID-19 un impulso para reforzar la resilencia comercial tras la pandemia*. Recovered from: https://publications.iadb.org/publications/spanish/document/Monitor-de-Comercio-e-Integracion-2020-Shock-COVID-19-Un-impulso-para-reforzar-la-resiliencia-comercial-tras-la-pandemia.pdf

Government of Argentina. (2020). *Estudios y estadisticas laborales*. Encuesta de Indicadores Laborales. Recovered from: http://www.trabajo.gob.ar/estadisticas/eil/index.asp

Government of Buenos Aires. (2019). *Paseo del bajo*. Paseo Del Bajo. Recovered from: https://www.buenosaires.gob.ar/desarrollourbano/desarrollo/paseo-del-bajo

Gonzalez, J. A., Guasch, J. L., & Serebrisky, T. (2008). Improving Logistics Costs for Transportation and Trade Facilitation. In *Policy Research Working Paper; No. 4558*. Recovered from: https://openknowledge.worldbank.org/handle/10986/6566?locale-attribute=es

Grossman, G. M., & Krueger, A. B. (1995). Economic Growth and the Environment. *The Quarterly Journal of Economics*, *110*(2), 353–377. Recovered from: https://academic.oup.com/qje/article-abstract/110/2/353/1826336

Gudolle, M. F. (2016). *Os Custos Logísticos da Soja em Grãos: Estudo de Caso em uma Empresa Cerealista no Municipio de Cruz Alta-RS, Dissertação de Mestrado Profissional*. Recovered from: https://home.unicruz.edu.br/wp-content/uploads/2017/04/Marcos-Floriano-Gudolle-OS-CUSTOS-LOGÍSTICOS-DA-SOJA-EM-GRÃOS-ESTUDO-DE-CASO-EM-UMA-EMPRESA-CEREALISTA-NO-MUNICIPIO-DE-CRUZ-ALTA-RS.pdf

Halim, R. A., Kirstein, L., Merk, O., & Martinez, L. M. (2018). Decarbonization pathways for international maritime transport: A model-based policy impact assessment. *Sustainability*, *10*(7). Recovered from: https://doi.org/10.3390/su10072243

Hausmann, R., Hidalgo, C., Bustos, S., Coscia, M., Simoes, A., & Yildirim, M. (2013). *The atlas of economic complexity*. Recovered from: https://growthlab.cid.harvard.edu/files/growthlab/files/atlas_2013_part1.pdf

Herold, D. M., & Lee, K.-H. (2017). Carbon management in the logistics and transportation sector: an overview and new research directions. *Carbon Management*.

Hesketh, D. (2011). Seamless Electronic Data and Logistics Pipelines shift focus from import declarations to start of commercial transaction. *World Customs Journal*, *3*(1), 27–32. Recovered from: https://worldcustomsjournal.org/Archives/Volume 3%2C Number 1 (Apr 2009)/04 Hesketh.pdf

Hidalgo, C. A., & Hausmann, R. (2019). The building blocks of economic complexity. *Proceedings of the National Academy of Sciences of the United States of Americ*, *106*(26), 10570–10575. Recovered from: https://doi.org/10.1073/pnas.0900943106

Holguín-Veras, J., Encarnación, T., Gonzalez-Calderon, C. A., Winwbrake, J., Wang, C., Kyle, S., Herazo-Padilla, N., Kalahasthi, L., Adarme, W., Cantillo, V., Yoshizaki, H., & Garrido, R. (2018). Direct impacts of off-hour deliveries on urban freight emissions. *Transportation Research Part D*, *61*(Parte A), 84–103. Recovered from: /https://doi.org/10.1016/j.trd.2016.10.013

Holguín-Veras, J., Hodge, S., Wojtowicz, J., Singht, C., Wang, C., Jaller, M., Aros-Vera, M., Ozbay, K., Weeks, A., Replogle, M., Ukegbu, C., Ban, J., Brom, M., Campbell, S., Sanchez-Díaz, I., González-Calderón, C., Kornhauser, A., Simon, M., McSherry, S., … Allen, B. (2018). The New York city off-hour delivery program: A business and community-friendly sustainability program. *Journal on Applied Analytics*, *48*(1). Recovered from: https://doi.org/10.1287/inte.2017.0929

Hummels, D. (2001). Time as a Trade Barrier. In *GTAP Working Papers* (Vol. 1152). Recovered from: https://ideas.repec.org/p/gta/workpp/1152.html

Hummels, D., Lugovskyy, V., & Skiba, A. (2009). The trade reducing effects of market power in international shipping. *Journal of Development Economics*, *89*(1), 84–97. Recovered from: https://doi.org/10.1016/j.jdeveco.2008.05.001

Hummels, D., & Schaur, G. (2013). Time as a Trade Barrier. *American Economic Review, American Economic Association*, *103*(7), 2935–2959. Recovered from: https://www.jstor.org/stable/42920676?seq=1

Iansiti, M., & Lakhani, K. R. (2019). *Harvard Business Review*. The Truth about Blockchain. Recovered from: https://hbr.org/2017/01/the-truth-about-blockchain

IATA. (2020a). *Air Cargo Market Analysis: Robust end to 2020 for air cargo*.

IATA. (2020b). *Economics*. The Impact of COVID-19 on Aviation. Recovered from: https://www.airlines.iata.org/news/the-impact-of-covid-19-on-aviation

IATA. (2020c). *Guidance for Vaccine and Pharmaceutical Logistics and Distribution*. Recovered from: https://www.iata.org/contentassets/028b3d4ec3924cb393155c84784161ac/guidance-for-vaccine-and-pharmaceutical-logistics-and-distribution---extract.pdf

IATA. (2020d). *IATA*. Don't Make A Slow Recovery More Difficult with Quarantine Measures. Recovered from: https://www.iata.org/en/pressroom/pr/2020-05-13-03/

IATA. (2020e). *Press Release No:* 4. 2019 Worst Year for Air Freight Demand Since 2009. Recovered from: https://www.iata.org/en/pressroom/pr/2020-02-05-01/

ICAO. (2019). *Resoluciones adoptadas por la asamblea. Ver A40-17: Declaración consolidada de las políticas y prácticas permanentes de la OACI relativas a la protección del medio ambiente. Disposiciones generales, ruido y calidad del aire local*. Recovered from: https://www.icao.int/Meetings/a40/Documents/Resolutions/a40_res_prov_es.pdf

ICCT. (2019). *Ranking de eficiencia energética de aerolíneas de Estados Unidos y América Latina, 2017–2018*. Recovered from: https://theicct.org/sites/default/files/publications/Ranking_de_eficiencia_energetica_Latam_20191216.pdf

ICCT. (2020). *CO2 emissions from commercial aviation 2013, 2018, and 2019*. Recovered from: https://theicct.org/sites/default/files/publications/CO2-commercial-aviation-oct2020.pdf

IDB. (2010). *Risk Management for Cargo and Passengers A Knowledge and Capacity Product (TECHNICAL NOTES No. IDB-TN-294)*. Recovered from: https://publications.iadb.org/publications/english/document/Risk-Management-for-Cargo-and-Passengers-A-Knowledge-and-Capacity-Product.pdf

IDB. (2013). Muy lejos para exportar. *IDB*. Recovered from: https://publications.iadb.org/publications/spanish/document/Muy-lejos-para-exportar-Los-costos-internos-de-transporte-y-las-disparidades-en-las-exportaciones-regionales-en-América-Latina-y-el-Caribe-(Resumen-Ejecutivo).pdf

IDB. (2018). *Better spending for better lives: how Latin America and the Caribbean can do more with less*. Recovered from: https://publications.iadb.org/publications/english/document/Better-Spending-for-Better-Lives-How-Latin-America-and-the-Caribbean-Can-Do-More-with-Less.pdf

IDB. (2019a). *Building opportunities to grow in a challenging world*. Recovered from: https://publications.iadb.org/publications/english/document/2019_Latin_American_and_Caribbean_Macroeconomic_Report_Building_Opportunities_to_Grow_in_a_Challenging_World_en_en.pdf

IDB. (2019b). *De promesas a resultados en el comercio internacional. Lo que la integración regional puede hacer por América Latina y el Caribe* (M. Mesquita Moreira & E. Stein (eds.). Recovered from: https://publications.iadb.org/publications/spanish/document/De_promesas_a_resultados_en_el_comercio_internacional_Lo_que_la_integración_global_puede_hacer_por_América_Latina_y_el_Caribe.pdf

IDB. (2019c). *Documento de Marco Sectorial de Integración y Comercio*. Recovered from: https://www.iadb.org/es/acerca-del-bid/documentos-de-marco-sectorial

IDB. (2020a). *DE ESTRUCTURAS A SERVICIOS El camino a una mejor infraestructura en América Latina y el Caribe*. Recovered from: https://publications.iadb.org/publications/spanish/document/De-estructuras-a-servicios-El-camino-a-una-mejor-infraestructura-en-America-Latina-y-el-Caribe.pdf

IDB. (2020b). *Documento de marco sectorial de transporte*. Recovered from: https://www.iadb.org/es/sectores/transporte/marco-sectorial

IDB. (2021). *El mercado de transporte carretero de cargas en Uruguay (forthcoming)*.

IDB, & CNC. (2018). *Plan nacional de logística de cargas 2020-2032 PNLOG República Dominicana*. Recovered from: http://cnc.gob.do/phocadownload/Publicaciones/Estudios/PNLOG%20RD-VE-.pdf

IDB, & PRONACOM. (2017). *Plan nacional de logística*. Recovered from: http://www.pronacom.gt/contenido/proyectos_plan_nacional_de_logistica/

IEA. (2017). *The Future of Trucks - Implications for energy and the environment*. Recovered from: https://doi.org/10.1787/9789264279452-en

IEA. (2019a). *CO2 Emissions from Fuel Combustion*. Recovered from: https://www.iea.org/subscribe-to-data-services/co2-emissions-statistics

IEA. (2019b). *The Future of Rail Opportunities for energy and the environment*. Recovered from: https://doi.org/10.1787/9789264312821-en

IEA. (2020a). *Aviation*. Recovered from: https://www.iea.org/reports/aviation

ILOS. (2017). *Custos logísticos no Brasil*. Recovered from: https://www.ilos.com.br/web/analise-de-mercado/relatorios-de-pesquisa/custos-logisticos-no-brasil/

IMO. (2019). *Reducing greenhouse gas emissions from ships*. Reducing Greenhouse Gas Emissions from Ships. Recovered from: https://wwwcdn.imo.org/localresources/en/MediaCentre/HotTopics/Documents/IMO ACTION TO REDUCE GHG EMISSIONS FROM INTERNATIONAL SHIPPING.pdf

INEC. (2020). *INEC Costa Rica*. Empleo. Recovered from: https://www.inec.cr/empleo

INEGI. (2019). *Colección de estudios sectoriales y regionales*. Recovered from: http://internet.contenidos.inegi.org.mx/contenidos/Productos/prod_serv/contenidos/espanol/bvinegi/productos/nueva_estruc/702825187798.pdf

INEI. (2018). *Indicadores de Empleo e Ingreso por departamento*. Recovered from: https://www.inei.gob.pe/media/MenuRecursivo/publicaciones_digitales/Est/Lib1537/libro.pdf

Infralatam. (2017). *Inversión en Transporte*. Transporte. Recuperado: http://es.infralatam.info/dataviews/252248/transporte/

Infralatam. (2020). *Infratalam*. Transporte.

INRIX. (2019). *INRIX 2019 Global Traffic Scorecard*. Recovered from: https://inrix.com/scorecard/

Mexican Transportation Institute. (2016). *Productividad y eficiencia en los ferrocarriles, una estimación aplicando una técnica de productividad total de los factores*. Recovered from: https://imt.mx/archivos/Publicaciones/PublicacionTecnica/pt477.pdf

INVIAS. (2020). *Manual de capacidad y niveles de servicio para carreteras de dos carriles. Tercera versión*. Recovered from: https://www.invias.gov.co/index.php/archivo-y-documentos/documentos-tecnicos/11026-manual-de-capacidad-y-niveles-de-servicio-para-carreteras-de-dos-carriles-2020/file

IPCC. (2018). *Annex I: Glossary*. Recovered from: https://www.ipcc.ch/sr15/chapter/glossary/

iProUP. (2020). *Cuando la suerte llama a tu puerta: la historia de Rappi, o de una empresa que nació de un buzón de sugerencias*. Recovered from: https://www.iproup.com/economia-digital/10801-cuando-la-suerte-llama-a-tu-puerta-la-historia-de-rappi-o-de-una-empresa-que-nacio-de-un-buzon-de-sugerencias

IRF. (2019). *IRF world road statistics 2019 Database*. Recovered from: https://irfnet.ch/world-road-statistics/

IRU. (2020). *COVID-19 Impacts on the Road Transport Industry*. Recovered from: https://www.iru.org

ITF. (2017). *ITF Transport Outlook 2017*. https://doi.org/10.1787/9789282108000-en.

ITF. (2018). *Decarbonising Maritime Transport*. Recovered from: https://www.itf-oecd.org/sites/default/files/docs/decarbonising-maritime-transport-2035.pdf

ITF. (2019a). *Efficiency in Railway Operations and Infrastructure Management*. Recovered from: https://www.itf-oecd.org/sites/default/files/docs/efficiency-railway-operations-infrastructure_1.pdf

ITF. (2019b). *ITF Transport Outlook 2019*. Recovered from: https://doi.org/10.1787/transp_outlook-en-2019-en.

ITF. (2019c). *The role of private investment in transport infrastructure*. Recovered from: https://www.itf-oecd.org/sites/default/files/docs/role-private-investment-transport-infrastructure.pdf

ITF. (2020a). *Decarbonising Air Transport EXPERT WORKSHOP*.

ITF. (2020b). *Decarbonising Argentina's Transport System*. Recovered from: https://www.itf-oecd.org/decarbonising-argentina-transport-system

Iwan, S., Kijewska, K., Johansen, G., Eidhammar, O., MAlecki, K., Konicki, W., & Thomsom., R. (2018). Analysis of the environmental impacts of unloading bays based on cellular automata simulation. *Transportation Research Part D: Transport and Environment*, *61*(Part A), 104–117. Recovered from: https://www.sciencedirect.com/science/article/abs/pii/S1361920916303881

Jacobs, G. D., & Greaves, N. (2003). Transport in developing and emerging nations. *Transport Reviews*, *23*(2), 133–138. Recovered from: https://doi.org/10.1080/01441640309895

Jaimurzina, A., & Wilmsmeier, G. (2017). La movilidad fluvial en América del Sur. *CEPAL: Recursos Naturales e Infraestructura*.

Kang, T. Il. (2019). WCO Magazine. *Korea Pilots Blockchain Technology as It Prepares for the Future*. Recovered from: https://mag.wcoomd.org/magazine/wco-news-88/korea-pilots-blockchain-technology-as-it-prepares-for-the-future/

Kiprono, P., & Matsumoto, T. (2018). Roads and farming: the effect of infrastructure improvement on agricultural intensification in South-Western Kenya. *Agrekon*, *57*(3–4), 198–220. Recovered from: https://doi.org/10.1080/03031853.2018.1518149

Kohon, J. (2014). *IDB*. Competencia Desigual Entre El Ferrocarril y El Camión. Recovered from: http://logisticsportal.iadb.org/node/5638

Kohon, J. (2021). *25 años de concesiones ferroviarias de cargas en América Latina: ¿Qué anduvo bien? ¿Qué anduvo mal?* Recovered from: https://publications.iadb.org/es/25-anos-de-concesiones-ferroviarias-de-cargas-en-america-latina-que-anduvo-bien-que-anduvo-mal

Kunst, R., & Nuroglu, E. (2017). Kuznets and Environmental Kuznets Curves for Developing Countries. In Murat Yülek (Ed.), *Industrial Policy and Sustainable Growth Part of the series Sustainable Developmen* (1st ed., pp. 1–14). Springer Nature Singapore Pte Ltd. Recovered from: https://doi.org/10.1007/978-981-10-3964-5_12-1

Kurosaki, F., & Singh, M. (2016). Comparison of Three Models for Introducing Competition in Rail Freight Transport. *Transportation Research Procedia*, *14*, 2820–2829. Recovered from: https://doi.org/10.1016/j.trpro.2016.05.348

Lacerda Coutinho, G., & Shoucair Jambeiro, F. (2018). Panorama. *Brazil's New Integrated Risk Management Solutions*. Recovered from: https://mag.wcoomd.org/magazine/wco-news-86/brazils-new-integrated-risk-management-solutions/

Lall, S. (2000). The technological structure and performance of developing country manufactured exports, 1985-98. *Oxford Development Studies*. Recovered from: https://doi.org/10.1080/713688318

Letnika, T., Alessandro Farina, Matej Mencinger, Marino Lupi, & Božičnik, S. (2018). Dynamic management of loading bays for energy efficient urban freight deliveries. *Energy*, *159*, 916–928. Recovered from: https://doi.org/10.1016/j.energy.2018.06.125

Limão, N., & Venables, A. J. (2001). Infrastructure, Geographical Disadvantage, Transport Costs, and Trade. *The World Bank Economic Review*, *15*(3), 451–479. Recovered from: https://www.jstor.org/stable/3990110?seq=1

Liotta, G., Stecca, G., & Kaihara, T. (2015). Optimisation of freight flows and sourcing in sustainable production and transportation networks. *International Journal of Production Economics*, *164*, 351–365. Recovered from: https://doi.org/10.1016/j.ijpe.2014.12.016

López-Bermúdez, B., Freire-Seoane, M. J., & Nieves-Martínez, D. J. (2019). Port efficiency in Argentina from 2012 to 2017: An ally for sustained economic growth. *Utilities Policy*. Recovered from: https://doi.org/10.1016/j.jup.2019.100976

Mangan, J., Chandra C. Lalwani, & Calatayud, A. (2020). *Global Logistics and Supply Chain Management* (4th ed.).

Manners-Bell, J. (2019). *Future of Logistics*. Recovered from: http://dx.doi.org/10.18235/0001729

Márquez-Ramos, L., Inmaculada Martínez-Zarzoso, Eva Pérez-García, & Gordon Wilmsmeier. (2011). "Special Issue on Latin-American Research" Maritime Networks, Services Structure and Maritime Trade. *Netw Spat Econ*, *11*(3), 555–576. Recovered from: https://link.springer.com/article/10.1007/s11067-010-9128-5

Márquez, L. (2017). El ferrocarril colombiano: 4 temas recurrentes en la literatura. *Estudios Gerenciales*, *33*, 187–194. Recovered from: http://dx.doi.org/10.1016/j.estger.2017.04.003

Marti, L., Puertas, R., & García, L. (2014). Relevance of trade facilitation in emerging countries' exports. *The Journal of International Trade & Economic Development*, *23*(2), 202–222.

Martínez-Zarzoso, I., & Wilmsmeier, G. (2010). International Transport Costs and the Margins of Intra-Latin American Maritime Trade. *Swiss Institute for International Economics and Applied Economics Research*, *65*(1).

McCann, P. (2005). Transport costs and new economic geography. *Journal of Economic Geography*, *5*(3), 305–318.

McKinsey. (2018). *Distraction or disruption? Autonomous trucks gain ground in US logistics*. Distraction or Disruption? Autonomous Trucks Gain Ground in US Logistics. Recovered from: https://www.mckinsey.com/industries/travel-logistics-and-infrastructure/our-insights/distraction-or-disruption-autonomous-trucks-gain-ground-in-us-logistics

McKinsey. (2020). *Risk, resilience, and rebalancing in global value chains*. Recovered from: https://www.mckinsey.com/~/media/McKinsey/Business Functions/Operations/Our Insights/Risk resilience and rebalancing in global value chains/Risk-resilience-and-rebalancing-in-global-value-chains-full-report-vH.pdf

McLeod, F., & Cherrett, T. (2011). Loading bay booking and control for urban freight. *International Journal of Logistics Research and Applications*, *14*(6), 385–397. Recovered from: https://doi.org/10.1080/13675567.2011.641525

MEIC. (2019). *Estudio Situacional de la PYME*. Recovered from: http://reventazon.meic.go.cr/informacion/estudios/2019/pyme/INF-012-19.pdf

Mejia Rivas, I., & Maday, M. (2019). *IDB*. Así Conectó La Alianza Del Pacífico Sus Ventanillas Únicas de Comercio Exterior. Recovered from: https://blogs.iadb.org/integracion-comercio/es/conecto-alianza-del-pacifico-ventanillas-unicas-comercio/

Mendes Constante, J. (2019). *International Case Studies and Good Practices for Implementing Port Community Systems*. Recovered from: http://dx.doi.org/10.18235/0001665

Merchán, D., & Blanco, E. (2016). *Desafíos para la movilidad de carga en zonas de alta congestión*. Recovered from: https://www.mincotur.gob.es/Publicaciones/Publicacionesperiodicas/EconomiaIndustrial/RevistaEconomiaIndustrial/400/MERCHAN y BLANCO.pdf

Mesquita-Moreira, M., Volpe, C., & Blyde, J. S. (2008). Unclogging the Arteries. The impact of transport costs on Latin American and Caribbean Trade. *Journal of Globalization, Competitiveness & Governability*, *2*(3), 126–140.

Mexican Government. (2019). *Autotransporte federal*. Estadistica Básica 2019. Recovered from: https://www.sct.gob.mx/transporte-y-medicina-preventiva/autotransporte-federal/estadistica/2019/

Miami Airport. (2018). *Miami International Airport*. MIA Cargo HUB. Recovered from: https://www.miami-airport.com/home-cargo.asp

Ministry of Production. (2018). *Las Mipyme en Cifras 2017*. Recovered from: https://issuu.com/patacalata/docs/libro_-_mipyme_en_cifras

Ministry of Transportation. (2019). *Análisis de derivabilidad de carga del modo vial al modo ferroviario*. Recovered from: https://www.argentina.gob.ar/modelo-de-transporte/analisis-de-derivabilidad-de-carga-del-modo-vial-al-modo-ferroviario

Ministry of Transportation, Government of Colombia, & IDB. (2018). *Sistema logístico nacional: una estrategia para la competitividad*. Recovered from: https://plc.mintransporte.gov.co/Portals/0/Estudios IDB/Libro Blanco.pdf?ver=2018-12-14-113134-343

Ministry of Economy, & Trade and Industry. (2019). *New Fuel Efficiency Standards for Trucks and Buses Formulated. Retrieved from New fuel efficiency standards for heavy vehicles targeting fiscal year as FY2025 formulated*. New Fuel Efficiency Standards for Trucks and Buses Formulated. Retrieved from New Fuel Efficiency Standards for Heavy Vehicles Targeting Fiscal Year as FY2025 Formulated. Recovered from: https://www.meti.go.jp/english/press/2019/0329_003.html

Ministry of Transport New Zealand. (2010). *Understanding transport costs and charges*.

Minnesota DOT. (2013). *Freight rail economic development*. Recovered from: http://www.dot.state.mn.us/ofrw/fred/PDF/final.pdf

Miranda-Moreno, L., Calatayud, A., Riobo Patino, J. A., & Jamali, B. (2020). *Proceedings of the 99th Annual Meeting of the Transportation Research Board*.

Mesquita Moreira, M., Stein, E., & IDB. (2019). *De promesas a resultados en el comercio internacional. Lo que la integración regional puede hacer por América Latina y el Caribe.*

Mozo Sánchez, J. (2012). *Análisis de Capacidad y Nivel de Servicio de Segmentos Básicos de Autopistas, Segmentos Trenzados y Rampas de acuerdo al Manual de Capacidad de Carreteras HCM2000 aplicando MathCad. Capítulo 3*.

Mundo Marítimo. (2018). Mundo Marítimo. *Corredor Bioceánico Bolivia-Brasil Permitirá Reducir Tiempos de Traslado de Carga de 67 a 42 Días*. Recovered from: https://www.mundomaritimo.cl/noticias/corredor-bioceanico-bolivia-brasil-permitira-reducir-tiempos-de-traslado-de-carga-de-67-a-42-dias?platform=hootsuite

Mundo Marítimo. (2020, May 25). Mundo Marítimo. *Chile Aprueba Plan de Inversión Ferroviaria de US$1.900 Millones Para El Período 2020 - 2022*. Recovered from: https://www.mundomaritimo.cl/noticias/chile-aprueba-plan-de-inversion-ferroviaria-de-us1900-millones-para-el-periodo-2020-ndash-2022

NAS. (2019). *Renewing the National Commitment to the Interstate Highway System: A Foundation for the Future*. Recovered from: https://www.nap.edu/catalog/25334/renewing-the-national-commitment-to-the-interstate-highway-system-a-foundation-for-the-future

New Zealand Customs Service. (2011). *Risk management: New Zealand's experience*. Recovered from: https://www.wto.org/english/tratop_e/tradfa_e/case_studies_e/risk_m_nzl_e.doc

Notteboom, T. (2006). The Time Factor in Liner Shipping Services. *Maritime Economics & Logistics*, *8*, 19–39. Recovered from: https://doi.org/10.1057/palgrave.mel.9100148

NYT. (2019). *1.5 Million Packages a Day: The Internet Brings Chaos to N.Y. Streets*. 1.5 Million Packages a Day: The Internet Brings Chaos to N.Y. Streets. Recovered from: https://www.nytimes.com/2019/10/27/nyregion/nyc-amazon-delivery.html

OECD/UN, & ECLAC/CAF. (2014). *Latin American Economic Outlook 2014 - Logistics and Competitiveness for Development*. Recovered from: http://dx.doi.org/10.1787/leo-2014-en

OECD. (2014). *The Competitiveness of Global Port-Cities*. Recovered from: https://dx.doi.org/10.1787/9789264205277-en

OECD. (2015). *Globalisation, Transport and the Environment*. Recovered from: https://www.oecd.org/greengrowth/greening-transport/45095528.pdf

OCHOA. (2020). *Tropical Storm Eta & Hurricane Iota: Humanitarian Snapshot*. Recovered from: https://vosocc.unocha.org/GetFile.aspx?file=104858_Tropical_storm_Eta__Hurricane_Iota__Humanitarian_Snapshot.pdf

Oliveira, L. K. de, Matos, B. A., Dablanc, L., Ribeiro, K., & Isa, S. S. (2018). *Distribuição urbana de mercadorias e planos de mobilidade de carga: Oportunidades para municípios brasileiros*. Recovered from: http://dx.doi.org/10.18235/0001169

Oliveira, L. K. de, Odirley, R. dos S., & Renata Lúcia, Nóbrega Magalhães de Rodrigo Affonso., O. de A. (2018). Is the Location of Warehouses Changing in the Belo Horizonte Metropolitan Area (Brazil)? A Logistics Sprawl Analysis in a Latin American Context. *Urban Science*, *2*(2). Recovered from: https://doi.org/10.3390/urbansci2020043

WCO. (2016). *Coordinated border management*. Recovered from: http://www.wcoomd.org/-/media/wco/public/global/pdf/topics/facilitation/instruments-and-tools/tools/safe-package/cbm-compendium.pdf?la=end

WCO. (2019). *Study Report on disruptive technologies.* Recovered from: http://www.wcoomd.org/-/media/wco/public/global/pdf/topics/facilitation/ressources/permanent-technical-committee/223-224/pc_0541_annex_e.pdf?la=en

Ortega, M.-A. (2018). Conectando mercados: vías rurales y producción agrícola en el contexto de una economía dual (Connecting markets: rural roads and agricultural production in a dual economy). *Documento CEDE No. 2018-44*, 37. Recovered from: http://dx.doi.org/10.2139/ssrn.3265330

National Logistics Plan. (2018). *Plano Nacional de Logística PNL - 2025*. Plano Nacional de Logística PNL - 2025. Recovered from: https://www.epl.gov.br/plano-nacional-de-logistica-pnl

Port Strategy. (2012). *A Collective Voice*. Intelligent Port Community Systems Can Give Hubs the Edge When Chasing Cargo. Recovered from: https://www.portstrategy.com/news101/port-operations/planning-and-design/pcs-part-one

Rave, C., Cañete, S., & Landaverde, O. (2020). *Mapeo estratégico de oportunidades para las cadenas logísticas en el cono sur*.

Rietveld, P. (1994). Spatial economic impacts of transport infrastructure supply. *Transportation Research Part A: Policy and Practice*, *28*(4), 329–341. Recovered from: https://doi.org/10.1016/0965-8564(94)90007-8

Rodas, R., Pérez Fiaño, J. E., Cañete, S., & Landaverde, O. (2019). *Estudio de Plan Operativo para el Corredor Pacífico.*

Rodríguez, R., & Montes, L. (2017). *IDB*. Cómo Lograr Pasos Fronterizos Más Eficientes (y Que Tengan En Cuenta a Las Comunidades Locales). Recovered from: https://blogs.iadb.org/transporte/es/como-lograr-pasos-fronterizos-mas-eficientes/

Sánchez Abril, H. M. (2011). Descripción de la Infraestructura Ferroviaria. *L'esprit Ingénieux*, *2*(1).

Sánchez, R. J., Hoffmann, J., Micco, A., Pizzolitto, G. V., Sgut, M., & Wilmsmeier, G. (2003). Port efficiency and international trade: Port efficiency as a determinant of maritime transport costs. *Maritime Economics and Logistics, 5, 199-218*. Recovered from: https://doi.org/10.1057/palgrave.mel.9100073

Schwab, K. (2016). *The Fourth Industrial Revolution*.

Serebrisky, T., Sarriera, J. M., Suárez-Alemán, A., Araya, G., Briceño-Garmendía, C., & Schwartz, J. (2016). Exploring the drivers of port efficiency in Latin America and the Caribbean. *Transport Policy*, *45*, 31–45. Recovered from: https://doi.org/10.1016/j.tranpol.2015.09.004

Serebrisky, T., Brichetti, J. P., Blackman, A., & Mesquita Moreira, M. (2020). *Infraestructura sostenible y digital para impulsar la recuperación económica post COVID-19 de América Latina y el Caribe: Un camino hacia más empleo, integración y crecimiento*. Recovered from: http://dx.doi.org/10.18235/0002571

Serebrisky, T., Schwartz, J., Pachón, M., & Ricover, A. (2011). *Making a Small Market Thrive: Recommendations for Efficiency Gains in the Latin American Air Cargo Market*. Recovered from: http://hdl.handle.net/10986/17490

Statista. (2019). *Infographics*. The Growing Weight of Amazon's Logistics Costs. Recovered from: https://www.statista.com/chart/12893/amazon-fulfillment-and-shipping-costs/

Statista. (2020). *Change in e-commerce revenue during the COVID-19 outbreak in selected countries in Latin America in April 2020*. Recovered from: https://www.statista.com/statistics/1116604/change-e-commerce-revenue-coronavirus-latin-america/

Suárez-Alemán, A., Gastón Antesiano, & Oscar Ponce de León. (2020). *Perfil de las asociaciones público-privadas en puertos de América Latina y el Caribe: principales cifras y tendencias del sector*. Recovered from: http://dx.doi.org/10.18235/0002196

Suárez-Alemán, A., Morales Sarriera, J., Serebrisky, T., & Trujillo, L. (2016). When it comes to container port efficiency, are all developing regions equal? *Transportation Research Part A: Policy and Practice*, *86*, 56–77. Recovered from: https://doi.org/10.1016/j.tra.2016.01.018

Suárez-Alemán, A., Serebrisky, T., & Ponce de León, O. (2019). *Competitividad portuaria en América Latina y el Caribe: Un análisis de la regulación, gobernanza, y competencia en el sector portuario de la región*. Recovered from: https://publications.iadb.org/es/competitividad-portuaria-en-america-latina-y-el-caribe-un-analisis-de-la-regulacion-gobernanza-y

Suárez-Alemán, A., Serebrisky, T., & Ponce De León, O. (2018a). Port competition in Latin America and the Caribbean: the role of concessions and competition policy. *Maritime Policy and Management, 45(5), 665-683*. Recovered from: https://doi.org/10.1080/03088839.2017.1418538

Suárez-Alemán, A., Serebrisky, T., & Ponce De León, O. (2018b). Port competition in Latin America and the Caribbean: the role of concessions and competition policy. *Maritime Policy and Management, 45(5), 665-683*, Recovered from: https://doi.org/10.1080/03088839.2017.1418538

Suk Park, J., Seo, Y. J., & Ha, M. H. (2019). The role of maritime, land, and air transportation in economic growth: Panel evidence from OECD and non-OECD countries. *Research in Transportation Economics*, *78*(February), 100765. Recovered from: https://doi.org/10.1016/j.retrec.2019.100765

Svetlana Angert, S. (2019). *"Blockchain Technology Implementation in the U.S. Customs Environment" Submitted in Partial Fulfillment of the Requirements for the Degree of Master of Arts in Security Studies (Homeland Security and Defense) From the Naval Postgraduate School (September)*.

Taddia, A., Montes, L., Hollnagel, J., Navas, C., & Monter, E. (2021). *Transporte bajo en carbono en América Latina y el Caribe. Monografía del Banco Interamericano de Desarrollo (forthcoming)*.

Teter, J. (2020). *Trucks and buse*. Recovered from: https://www.iea.org/reports/trucks-and-buses

TFL. (2019). *Evaluation of Freight Consolidation Demonstrator Projects*. Recovered from: http://content.tfl.gov.uk/steer-assessment-of-demos-report-oct-2019.pdf

Thompson, L. (2013). *Recent Developments in Rail Transportation Services*. Recovered from: http://www.oecd.org/daf/competition/Rail-transportation-Services-2013.pdf

Tongo, F. (1982). *Ferrocarriles* (2nd ed.). Representaciones y Servicios de Ingeniería.

Transport Scotland. (2017). *Delivering Your Goods Benefits of using Rail Freight*. Recovered from: https://www.transport.gov.scot/media/33630/transport-scotland-rail-freight-guide-web.pdf

Transport. (2020, June 16). Transporte.MX. *¿Qué Es El Proyecto Gran Visión Sistema Ferroviario Mexicano?* Recovered from: https://www.transporte.mx/que-es-el-proyecto-gran-vision-sistema-ferroviario-mexicano/

UK Government Office for Science. (2019). *A time of unprecedented change in the transport system*. Recovered from: https://www.gov.uk/government/publications/future-of-mobility

UNASUR/COSIPLAN. (2017). *Cartera de Proyectos 2017*. Recovered from: http://www.iirsa.org/admin_iirsa_web/Uploads/Documents/CARTERA_DIGITAL.pdf

UNComtrade. (2018). *International Trade Statistics Database*. Recovered from: https://comtrade.un.org

UNComtrade. (2019). *International Trade Statistics Database*. Recovered from: https://comtrade.un.org/

UNCTAD. (2020a). *Global transport costs for international trade, 2016.* Data Center.

UNCTAD. (2020b). *Review of Maritime Transport 2019*. Recovered from: https://unctad.org/system/files/official-document/rmt2019_en.pdf

UNECE, & UN/CEFAT. (2018). *White Paper Data Pipeline*. Recovered from: https://unece.org/fileadmin/DAM/cefact/GuidanceMaterials/WhitePaperDataPipeline_Eng.pdf

UNFCCC. (1992). *Convención marco de las naciones unidad sobre el cambio climático*. Recovered from: https://unfccc.int/files/essential_background/background_publications_htmlpdf/application/pdf/conveng.pdf

UNIDO. (2020). *In China, robot delivery vehicles deployed to help with COVID-19 emergency*. In China, Robot Delivery Vehicles Deployed to Help with COVID-19 Emergency. Recovered from: https://www.unido.org/stories/china-robot-delivery-vehicles-deployed-help-covid-19-emergency

United Nations. (2015). *Sustainable Development Goals*. Objetivos de Desarrollo Sostenible. Recovered from: https://academicimpact.un.org/es/content/objetivos-de-desarrollo-sostenible

Van Stijn, E., Phuaphanthong, T., Kerotho, S., Pikart, M., Hofman, W., & Tan, Y.-H. (2011). *Single window implementation framework*. Recovered from: https://unece.org/DAM/cefact/publica/SWImplementationFramework.pdf

Vickerman, R., Spiekermann, K., & Wegener, M. (1999). Accessibility and Economic Development in Europe. *Regional Studies*.

Volpe, C. (2017). *Como Salir del laberinto fronterizo. Una evaluación de las iniciativas de facilitación del comercio en América Latina y el Caribe. El Semáforo de la Frontera, Sistemas Aduaneros de Gestión de Riesgo*. Recovered from: https://publications.iadb.org/publications/spanish/document/Cómo-salir-del-laberinto-fronterizo-Una-evaluación-de-las-iniciativas-de-facilitación-del-comercio-en-América-Latina-y-el-Caribe.pdf

Volpe, C. (2018). *IDB*. ¿Cómo Responde El Comercio Cuando Se Simplifica Mediante Una Ventanilla Única? Recovered from: https://blogs.iadb.org/integracion-comercio/es/el-proceso-de-la-frontera-como-responde-el-comercio-cuando-se-simplifica-mediante-una-ventanilla-unica/

WEF. (2018). *The Global Competitiveness Report 2018*. Recovered from: https://www.weforum.org/reports/the-global-competitveness-report-2018

WEF. (2019a). *The Global Competitiveness Report 2019*. Recovered from: http://www3.weforum.org/docs/WEF_TheGlobalCompetitivenessReport2019.pdf

WEF. (2019b). *Windows of Opportunity: Facilitating Trade with Blockchain Technology*. Recovered from: http://www3.weforum.org/docs/WEF_Windows_of_Opportunity.pdf

Wilmsmeier, G., Hoffmann, J., & Sanchez, R. J. (2006). The Impact of Port Characteristics on International Maritime Transport Costs. *Research in Transportation Economics*, *16*, 117–140. Recovered from: https://doi.org/10.1016/S0739-8859(06)16006-0

Wilson, J. S., L. Mann, C., & Otsuki, T. (2005). *Assessing the Benefits of Trade Facilitation: A Global Perspective*. Recovered from: https://doi.org/10.1111/j.1467-9701.2005.00709.x

WCO. (2020). *What Customs can do to mitigate the effects of the COVID-19 pandemic - Highlights of WCO Members' practices*. Recovered from: http://www.wcoomd.org/-/media/wco/public/global/pdf/topics/facilitation/activities-and-programmes/natural-disaster/covid_19/covid_19-categorization-of-member-input_may-29-2020_edition-4_en.pdf?la=en

World Bank, & IRU. (2019). *Road Freight Transport Services Reform : Guiding Principles for Practitioners and Policy Makers*. Recovered from: https://openknowledge.worldbank.org/handle/10986/25853?show=full

World Bank. (2009). *Air Freight: A Market Study with Implications for Landlocked Countries*. Recovered from: https://www.worldbank.org/en/topic/transport/publication/air-freight-study

World Bank. (2011). *Freight transport for development toolkit: rail freight*. Recovered from: http://documents1.worldbank.org/curated/pt/119711468149677258/pdf/563590WP0rail11Box3494502B01PUBLIC1.pdf

World Bank. (2018a). *Logistics Performance Index*. Logistics Performance Index. Recovered from: https://doi.org/10.1787/eco_surveys-svn-2017-graph37-en

World Bank. (2018b). *World Development Indicators (WDI)*. World Development Indicators (WDI). Recovered from: https://doi.org/10.4135/9781412952613.n571

World Bank. (2019a). *World Development Indicators (WDI)*. World Development Indicators (WDI). Recovered from: https://doi.org/10.4135/9781412952613.n571

World Bank. (2020a). *Accelerating digitalization. Critical actions to strengthen the resilience of the maritime sector.*

World Bank. (2020b). *Doing Bussines 2020*. Recovered from: https://www.doingbusiness.org/content/dam/doingBusiness/media/Profiles/Regional/DB2020/LAC.pdf

World Bank. (2019b). *Doing Business 2019*. Recovered from: https://espanol.doingbusiness.org/es/reports/global-reports/doing-business-2019

World Maritime University. (2019). *Transport 2040: Automation, Technology, Employment - The Future of Work*. Recovered from: http://dx.doi.org/10.21677/itf.20190104

WSJ. (2018, October 15). How Robots and Drones Will Change Retail Forever. *How Robots and Drones Will Change Retail Forever*. https://www.wsj.com/articles/how-robots-and-drones-will-change-retail-forever-1539604800

WSJ. (2019, January 5). *Why Your Ice Cream Will Ride in a Self-Driving Car Before You Do*. Recovered from: https://www.wsj.com/articles/why-your-ice-cream-will-ride-in-a-self-driving-car-before-you-do-11546664589

WSJ. (2020, March 23). *Coronavirus Rattles Shipping Industry as Supply Shock Moves to Demand Decline*. Recovered from: https://www.wsj.com/articles/coronavirus-rattles-shipping-industry-as-supply-shock-moves-to-demand-decline-11585249552

Zeybek, H. (2019). Analysis of freight mode choice decisions of shippers and forwarders: pre-liberalisation survey. *World Review of Intermodal Transportation Research*, *8*(3), 209-221. Recovered from: https://doi.org/10.1504/WRITR.2019.102357.

ANNEXES

Annex I

Table I-I Descriptive statistics of the variables used in the analysis					
Variable	**N**	**Mean**	**Std. dev.**	**Min.**	**Max.**
Quality of logistics services (score)	127,490	2.83	0.63	1.25	4.32
Quality of transportation infrastructure (score)	127,490	2.75	0.71	1.10	4.44
Total trade (millions of US$)	101,856	907,757	7,525,354	0	563,203,136
Primary sector trade (millions of US$)	83,362	104,520	728,802	0	38,218,184
Secondary sector trade (millions of US$)	96,616	649,562	6,295,435	0	543,846,528
Trade in low-technology goods (millions of US$)	86,410	145,329	1,723,026	0	185,401,680
Trade in medium technology goods (millions of US$)	82,395	273,800	2,447,673	0	164,944,240
Trade in high-technology goods (million US$)	76,236	212,627	2,601,260	0	217,166,064
Distance (Weighted - Km)	127,183	7,267	4,306	106	19,650
Importer's GDP (millions of US$)	125,534	515,129	1,779,159	149	20,544,343
Exporter's GDP (millions of US$)	125,370	515,829	1,780,277	149	20,544,343
Common currency (dummy)	127,183	0	0	0	1
Free Trade Agreement (FTA)	127,183	0	0	0	1
Common colony (dummy)	127,183	0	0	0	1
Common language (dummy)	127,183	0	0	0	1
Shared border (dummy)	127,183	0	0	0	1
Landlocked (dummy)	127,183	0	0	0	1

Source: Own production.

Annex II

Table II.I Examples of types of TAC Regulations in selected LAC countries									
	Regulation	Argentina	Brazil	Chile	Colombia	Costa Rica	El Salvador	Mexico	Uruguay
Economic	Table of freight rates / minimum or reference rates endorsed by the public sector	▪ Referential tariff schemefor the RFT of cereals, oilseeds, related products, by-products and derivatives of national jurisdiction of cereals, oilseeds, related products, by-products and derivatives(Ministerial Resolution 8 of 2016) ▪ Referential tariff scheme (CATAC freight table for 2021)	▪ Creation of the national policy of minimum floors for road freight transportation (Law 13.703 of 2018). ▪ Methodology for calculating minimum prices for road freight transportation (Technical Note 1139 of 2021)	▪ There are no reference tariffs (costs and competitiveness analysis of land transportation of interurban freight transport modes in 2011)	▪ Efficient cost information system for motor freight transportation SICE TAC (SICE TAC 2021)	▪ No reference	▪ No reference	▪ Autotransport Price Index 2014) ▪ No examples are identified in this category (Autotransport price index of 2014).	▪ No reference
	Operator entry/ exit permissions	▪ National Register of Road Freight Carriers (Road Freight Transport Act of 2007)	▪ National Registry of Land Freight Transportation (Ley de transporte de mercancías por carretera de 2007)	▪ Law 19,872 of 2003 (Law 19,872 of 2003)	▪ Register of the Public Service of Road Freight Transport (Decree 173 of 2001, productivity in road freight transport in Colombia of 2019)	▪ Permit of Weights and Dimensions (Regulation 31363 of Road Traffic on the Basis of Weight and Dimensions of Cargo Vehicles, 2003)	▪ Land Freight Transport Regulations (Land Transport, Transit and Road Safety Law of 1995, Description of the Application for National Freight Transport Registration of 2009)	▪ Permit for the service of federal trucking of general cargo (Ley de Caminos, Puentes y Autotransporte Federal de 1993, Reglamento de Autotransporte Federal y Servicios Auxiliares de 1994)	▪ Classification of land cargo transportation (Decree 349/001 of 2001) ▪ Control of land cargo transport vehicles (Decree Control of land cargo transportation vehicles (Decree 378/005 of 2005) ▪ National registry of loaders, takers and givers of cargo. (Decree 184/016 of 2016)

Table II.I Examples of types of TAC Regulations in selected LAC countries

	Regulation	Argentina	Brazil	Chile	Colombia	Costa Rica	El Salvador	Mexico	Uruguay
Technical / operative	Transport of hazardous substances	■ General Regulations for the Transport of Dangerous Goods by Road (Resolution 195/97 of 1997)	■ Instructions for the transport of dangerous goods and other measures (Resolution 5.232 of 2016) ■ Regulations for the the transport of dangerous goods by road (Resolution 5.848 of 2019)	■ Regulations for the transport of hazardous cargo on roads and highways (Decree 298 of 1994)	■ Regulations for the handling and transportation of dangerous goods by road (Decree 1609 of July 31, 2002)	■ Regulations for the Land Transportation of Hazardous Products (24715-MOPT)	■ Requirements for the transport of dangerous goods (Road Freight Transport Act 2013) ■ Regulations for the Land Transportation of Hazardous Products (24715-MOPT)	■ Land Transportation of Hazardous Materials and Wastes Regulations (1993 Regulations)	■ National regulations on the transport of dangerous goods by road (Decree 560/003 of 2003)
	Specifications of weights, dimensions and maximum capacity	■ Agreement on weights and dimensions for road transport vehicles for passengers and cargo (Resolution 197/2010) ■ Update to the dimensions and admitted load (Decree 32/2018)	■ Weight and dimensional limits for road transport vehicles (Resolution 210 of 2006)	■ Maximum dimensions for vehicles (Resolution 1 of 1995 and updates)	■ Limits of weights and dimensions dimensions for motor freight vehicles (Resolution 4100 of 2004, Resolution 2888 of 2005)	■ Road traffic regulations based on the weight and dimensions of cargo vehicles (Regulation 31363-MOPT of 2003)	■ Weight, dimensions and capacity requirements for freight vehicles (Road Freight Transport Act 2013)	■ Mexican Official Standard on the maximum weight and dimensions with which motor transport vehicles that travel on general communication roads of federal jurisdiction may circulate (NOM- 012-SCT-2-2008) ■ Freight transport regulation review (OECD, 2017).	■ Weight limits for vehicles circulating on national roads (Decree 311/007 of 2007) ■ Prices to be charged to cargo transportation companies, with special circulation permits for excess dimensions or weight (Decree 483/008 of 2008) ■ Application of penalties for vehicles with total gross weight exceeding 24 tons (Decree 270/011 of 2011) ■ Harmonization of reference values for load capacity and total gross weight that may affect the road transport regime (Decree 2/015 of 2015)

Table II.I Examples of types of TAC Regulations in selected LAC countries									
	Regulation	**Argentina**	**Brazil**	**Chile**	**Colombia**	**Costa Rica**	**El Salvador**	**Mexico**	**Uruguay**
Technical / operative	Road safety strategy	▪ Speed limit (80km/h) for vehicles over 3,500 kg (Law 1751 of 2005). ▪ National mandatory technical inspection system (Law 24,449 of 1995, Decree 779/95 of 1995, Decree 1716/2008 of 2008) ▪ Comparative study of the periodicity of the technical vehicle inspection in the world (ASOCDA, 2017)	▪ Speed limit (90km/h) for heavy load vehicles (Brazilian traffic code) ▪ No regulation of maximum working hours (General description of road freight transport in Brazil 2013) ▪ Technical vehicle inspection (Brazilian traffic code, DENATRAN Resolution of 2017) ▪ Comparative study of the periodicity of the technical vehicle inspection in the world (ASOCDA, 2017)	▪ Speed limit (90km/h) for vehicles over 3,500 kg (Decree 75 of 1997). ▪ Technical requirements for safety devices and safety systems for new trucks and tractor-trailers (Supreme Decree 45 of 2017). ▪ Technical revisions and the authorization and operation of revision plans (Decree 156 of 1990 and its updates) ▪ Comparative study of the periodicity of technical vehicle inspection in the world (ASOC- DA, 2017)	▪ Speed limit (60-80km/h) for cargo vehicles (National Traffic Code). ▪ Creation of the Integral Transit and Transportation System (SITRA) in 2018 (Description of Technological Development) ▪ Mechanical and Gas Vehicle Revision (Decree 019 of 2012) ▪ Comparative study of the periodicity of the technical vehicle inspection in the world (ASOCDA, 2017)	▪ Speed Limit (60km/h) (Regulation 31363-MOPT of 2003) ▪ Law of Transit by Public Roads and Road Safety (Law No. 9078) ▪ Vehicle Technical Review Procedures Manual (Executive Decree 30184-MOPT of 2002)	▪ Speed limit (40-70km/h) (Ley de transporte terrestre, tránsito y seguridad vial of 199) ▪ General Regulation of Traffic and Road Safety (Decree 61) ▪ Technical vehicular (Procedure of 2009)	▪ Emerging official Mexican standard for land transportation with maximum speed limits for cargo vehicles (75-90 km/h) traveling on roads and bridges under federal jurisdiction (NOM-EM-033-SCT-2-2000) ▪ Norma Oficial Mexicana para remolques y semirremolques. Safety specifications and test methods (NOM-035-SCT-2-2010) ▪ There is no regulation of maximum driving and resting time. ▪ Revision of cargo transport regulation (OECD, 2017).	▪ Speed limit (80km/h) for cargo vehicles (National Road Traffic Regulation) ▪ Technical inspection manual for cargo and passenger transport vehicles - technical aptitude certificates (Decree 451/994 of 1994) ▪ Vehicular technical inspection for passenger and cargo transport (Decree 72/996 of 1996, Decree 246/000 of 2000 and Decree 49/009 of 2009) ▪ Homologation of types of motor vehicles for collective transport of passengers and cargo by road(Decree 603/008 of 2008) ▪ Integral Cargo Transportation Control System (Decree 155/018)

Table II.I Examples of types of TAC Regulations in selected LAC countries									
	Regulation	Argentina	Brazil	Chile	Colombia	Costa Rica	El Salvador	Mexico	Uruguay
Technical / operative	Limitation of emissions and fuel consumption (clean transportation and fleet renewal).	▪ Facilities for importing CNG and LNG vehicles ▪ Modification of deadlines to validate vehicle approvals imported from Europe	▪ Environmental projects to rationalize the use of fuel: Project TransportAR and Project EconomizAR.	Emission Standards for New Heavy Vehicle Engines (Euro V). (Resolution 2321 of 2008)	▪ Law 697 of 2001: National Program for the Rational and Efficient Use of Energy (PROURE as per its Spanish acronym) ▪ CONPES 3759: Policy for modernization of the road freight sector	▪ Regulations for the control of emissions from motor vehicles (N° 39724 -MOPT). ▪ Law on Public Road Traffic and Road Safety – emission control (Ley No. 9078).	No reference	▪ Mexican Official Standard with fuel quality specifications (NOM-EM-005-CRE-2015). ▪ Mexican Official Standard with maximum permissible limits of emissions generated by motor vehicles (NOM-044-SEMAR-NAT-2017).	▪ Tax benefits related to VAT on the acquisition of new motor vehicles for road transportation. (Decree No. 210/010). ▪ Optimization of gas and noise emission levels by heavy-duty vehicles (Decree No. 111/008).

Source: Own production based on the literature review.

Annex III

AIS database processing

From the AIS data, toconstruct port traffic and efficiency indicators, two data tables have been used, constituted as follows:

- **Position:** This data table contains the spatial information of the ship once it enters the port area. This table reports the navigation status, speed, course,and location.
- **Called at Port:** This table contains the vessel's historical information, i.e., the ports at which it has arrived.

The information contained in these databases has been combined and arranged on a time spectrum. Thus, port entrances and exits have been determined according to the following criteria:

Where: $if\ \ t\_exit^{pc}_{i,c,p} \geq t^{pos}_{i,p} \geq t\_entry^{pc}_{i,c,p}$ → this observation pertains to the port call made at *c*.

Meanwhile, $if\ \left|t^{pos}_{i,p} - t\_entry^{pc}_{i,c,p}\right| \leq \left|t^{pos}_{i,p} - t\_exit^{pc}_{i,c-1,p}\right|$ → such observation pertains to the entry in the port call at the port of the moment *c*.

If on the other hand $\left|t^{pos}_{i,p} - t\_entry^{pc}_{i,c,p}\right| > \left|t^{pos}_{i,p} - t\_exit^{pc}_{i,c-1,p}\right|$ → such a remark belongs to the port call that was made earlier.

Where the superscripts *pos* and *pc* refer to observations from the Position and Port Calls table respectively; the subscript *i* refers to the vessel, *p* refers to the port where the vessel is located and *c* refers to the n^{th} port call; the variable t^{pos} is the moment of time reported in the position table; t_entry^{pc} and t_exit^{pc} refer to the time of entry and exit from the port of interest. Consequently, under this framework, it is possible to organize the calls to the ports under a criterion of temporal distance.

Subsequently, based on this information, the data has been filtered toclean the data of capture errors:

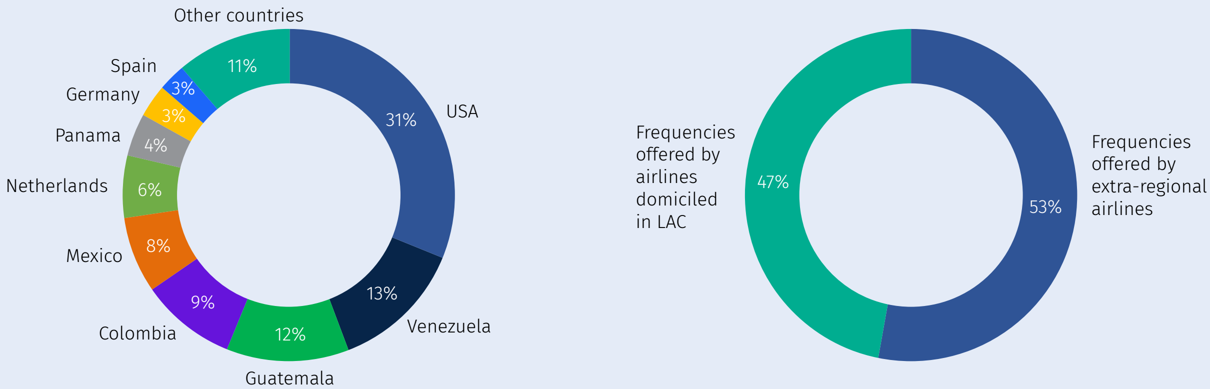
- **Complete information:** Vessels must make a complete trajectory upon arrival at the port area. Thosevessels that have no information prior or subsequent to mooring at the berth; or never moored at the berth to load/ unload, but only made one passage through the port area, have been excluded.
- **Temporal:** Vessels whose mooring time has been less than 5 minutes have been eliminated. In addition, toavoid double counting of vessel arrivals, calls to port that took place less than 5 days apart have been considered as unique. Likewise, lack of information onposition for 5 days has been considered as a different call to port.

These criteria have been implemented to get rid of information that is poorly captured and consequently, creates noise fortheconstruction of the indicators. Based on this, the spatiotemporal trajectory of the vessel is constructed following Feng et al, (2020):

$$T_{i,c,s} = \{(x_0, y_0, t_0, s_0, c_0), \ldots (x_N, y_N, t_N, s_N, c_N)\}$$

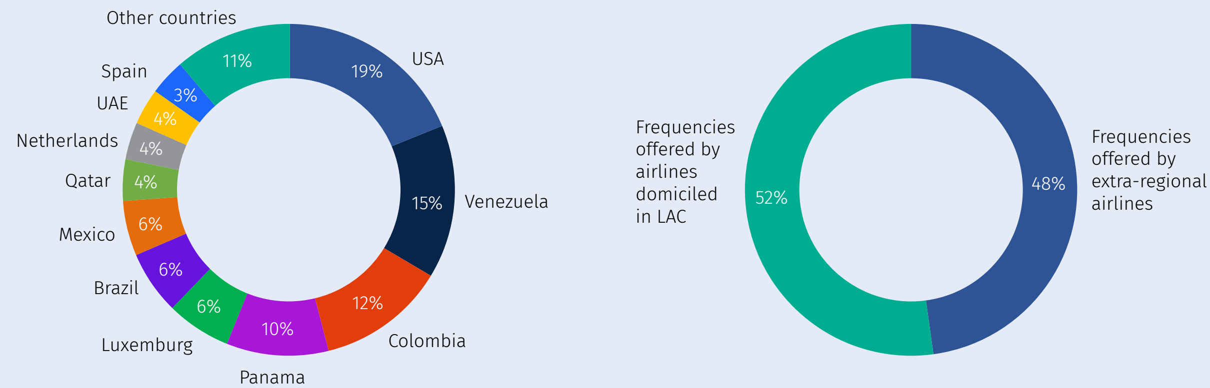
Where the subscripts *c* and *s* refer to the port call and state within the port respectively; x_n and y_n are the vessel coordinates; t_n is the time of data capture in UTC with seconds precision; s_n is the state of the vessel at the time of data capture; and c_n is the n^{th} port call. Finally, from this processing, information is obtained for each vessel in which, in addition to the variables previously mentioned, the type and size of the vessel, start and end date of the current state, speed, and course are reported.

Figure IV.I Scheduled cargo services provided from different points in LAC, by airline domicile country (yearly frequencies, 2010)



Source: Prepared by the authors, based on OAG data.
Notes: 1. The cargo frequencies referring to Guatemala and Panama correspond to the operation of DHL's local subsidiaries (DHL de Guatemala in Guatemala and DHL Aero Expreso in Panama).
2. 70% of the frequencies referring to Venezuela correspond to the operation of DHL's local subsidiary (Vensecar Internacional).

Figure IV.II Scheduled cargo services offered from points in LAC, by airline domicile country (yearly frequencies, 2019)



Source: Prepared by the authors, based on OAG data.
Notes: 1. All frequencies from Venezuela correspond to DHL's local subsidiary (Vensecar Internacional).
2. All frequencies from Panama correspond to DHL's local subsidiary (DHL Aero Expreso).

Annex IV

Table IV-I Main LAC airports and their destinations (Metric tons, 2018)		
Origin	**Destination**	**Metric tons**
El Dorado International Airport (BOG) - Bogota	Miami	199,977
	Panama	21,934
	Amsterdam	16,878
	Lima	10,277
	Mexico	10,081
	Santiago	9,803
	Luxembourg	9,395
	Madrid	8,342
	Sao Paulo	6,906
	Quito	5,968
Benito Juarez International Airport (MEX) – Mexico City	Los Angeles	35,941
	Frankfurt	12,765
	Amsterdam	10,468
	Bogota	10,112
	Miami	9,407
	Madrid	9,309
	Doha	9,271
	Covington	8,235
	Paris	8,100
	Hong Kong	7,531
André Franco Montoro International Airport (GRU) - Sao Paulo/Guarulhos	Miami	27,721
	New York	14,532
	London	12,126
	Paris	11,207
	Frankfurt	10,286
	Madrid	9,772
	Mexico City	8,991
	Santiago	7,517
	Zurich	6,790
	Orlando	5,538

Source: The Civil Aviation Authority of Colombia – "Aeronautica Civil"(Colombia)[67]; Ministry of Communications and Transport – as per its Spanish acronym SCT (Mexico)[68]; and the Brazilian National Civil Aviation Agency – as per its Portuguese acronym ANAC (Brazil)[69].

67. Aeronáutica Civil, 2020. Stadistics of Aviation activities – Data base.
68. SCT, 2020. Historical Statistics 1992-2019.
69. ANAC - Agência Nacional de Aviação Civil, 2020. Dados e Estatísticas.

Table IV-II Miami Airport's main trade flows with LAC by product category (Metric tons, 2018)

Miami's airport main trade flows with LAC			
Tons exported		**Tons imported**	
Industrial Machinery / Parts	25,987	Flowers	225,196
Computers / Peripherals	24,934	Fish / Crustaceans	181,544
Telecommunications Equipment	19,538	Vegetables & Roots	81,268
Vehicle Parts / Tires	18,845	Fruits & Juices	36,371
Metals and Metal Products	13,180	Clothing	10,504
Total LAC exports	**284,033**	**Total LAC imports**	**607,133**

Source: Miami International Airport (2018)[70].

Table IV-III Percentage of authorized capacity in use, by airline domicile (full year – 2019)

Flying to (columns) / Airline domiciles (rows)	Argentina	Brazil	Chile	Colombia	Costa Rica	Ecuador	El Salvador	Guatemala	Honduras	Mexico	Panama	Peru	Venezuela
Argentina													
Brazil	152%		unltd	unltd		unltd						4%	14%
Chile	unltd	unltd											
Colombia		unltd			unltd	unltd		unltd			unltd		
Costa Rica													
Ecuador													
El Salvador													
Guatemala													
Honduras													
Mexico					unltd			29%					
Panama				unltd	unltd		unltd	unltd	N/A*				32%
Peru													
Venezuela				unltd							35%		

Source: Prepared by the authors based on OAG data.
Notes: 1. Blank cells indicate the non-existence of services.
2. Only services offered by airlines domiciled in LAC are considered for this analysis, and only for international services to / from points within the region.
3. A conservative approach is assumed for the Brazil - Peru relation, since only those frequencies with extra-regional fifth freedom rights are considered for the capacity calculation. For services within the region, the carrying capacity is unlimited.
4. For the Mexico - El Salvador relation, it is assumed that the limit of 14 weekly frequencies for mixed services specified in the ASA also applies as maximum capacity for dedicated cargo flights.
5. or the Mexico - Guatemala relation, the capacity limit assumed for cargo services is that specified for the main Mexico City - Guatemala City route (maximum capacity of 7 weekly cargo frequencies).
6. For the Venezuela - Panama relation, it is assumed that the 35 weekly frequencies limit for mixed services specified in the ASA also applies as maximum capacity for dedicated cargo flights.
7. *N/A: information not available.

70. Miami Airport, 2018. MIA Cargo Hub.

Table IV-IV Traffic rights (freedoms of the air) in Air Services Agreement (in July/2020), for the transportation of cargo only, in selected LAC countries

Flying to (columns) / Airline domiciles (rows)	Argentina	Brazil	Chile	Colombia	Costa Rica	Ecuador	El Salvador	Guatemala	Honduras	Mexico	Panama	Peru	Venezuela
Argentina							n/a	n/a	n/a				
Brazil							n/a		n/a				
Chile									n/a				n/a
Colombia									n/a				
Costa Rica								n/a	n/a				
Ecuador											n/a		n/a
El Salvador												n/a	
Guatemala												n/a	n/a
Honduras										n/a	n/a		n/a
Mexico													
Panama													
Peru													n/a
Venezuela													

Legend: Traffic rights[71].

	3rd and 4th freedoms		3rd, 4th 5th and 6th freedoms		3rd, 4th, 5th, 6th and 8th freedoms
	3rd, 4th and 5th freedoms		3rd, 4th, 5th, 6th and 7th freedoms		Information not available

Source: Own production from consultations with ASAs in LAC countries.

71. Traffic rights are established by freedoms of the air, which are the rights granted to air carriers of one country to operate in the territory of another country, which may include territories of countries in between and beyond. For existing types of freedoms of the air, Access ANAC (2017).

Table IV-V Airline survey: Diagnosis of the quality of infrastructure and processes at LAC airports

Question 1: Infrastructure On a scale from 1 to 5 (1: very poor, 2: poor, 3: fair, 4: good, 5: very good), how would you assess the quality of cargo facilities at these airports?

Country - Airport	Infrastructure														
	Imp./Exp.			Export					Import						Additional comments on the quality of the infrastructure
	On the apron at the foot of the aircraft	Customer service areas	Interface areas with inland transportation	Normal cargo warehouses	Hazardous cargo facilities	Facilities for valuable cargo	Refrigerated and perishable goods facilities	Security control facilities	Normal cargo warehouses	Hazardous cargo facilities	Valuable cargo facilities	Refrigerated and perishable goods facilities	Specific areas for customs control	Other (specify)	
Ministro Pistariri (EZE), Ezeiza - Argentina															
Lynden Pindling (NAS), Nassau - Bahamas															
Grantley Adams (BGI), Bridgetown - Barbados															
Philip S. W. Goldson (BZE), Belize - Belize															
Viru Viru (VVI), Santa Cruz de la Sierra - Bolivia															
Viracopos (VCP), Campinas - Brazil															
Galeao (GIG), Rio de Janeiro - Brazil															
Guarulhos (GRU), Sao Paulo – Brazil															
Arturo Merino Benitez (SCL), Santiago - Chile															
El Dorado (BOG), Bogota - Colombia															
Jose Maria Cordova (MDE), Medellin, Colombia															
Juan Santamaria, San Jose - Costa Rica															
Jose Joaquin de Olmedo (GYE), Guayaquil - Ecuador															

Table IV-V Airline survey: Diagnosis of the quality of infrastructure and processes at LAC airports

Question 1: Infrastructure On a scale from 1 to 5 (1: very poor, 2: poor, 3: fair, 4: good, 5: very good), how would you assess the quality of cargo facilities at these airports?

Country - Airport	Infrastructure														
	Imp./Exp.			Export					Import						Additional comments on the quality of the infrastructure
	On the apron at the foot of the aircraft	Customer service areas	Interface areas with inland transportation	Normal cargo warehouses	Hazardous cargo facilities	Facilities for valuable cargo	Refrigerated and perishable goods facilities	Security control facilities	Normal cargo warehouses	Hazardous cargo facilities	Valuable cargo facilities	Refrigerated and perishable goods facilities	Specific areas for customs control	Other (specify)	
Mariscal Sucre (UIO), Quito - Ecuador															
Oscar Arnulfo Romero (SAL), San Salvador – El Salvador															
La Aurora (GUA), Guatemala – Guatemala															
Cheddi Jagan (GEO), Georgetown, Guyana															
Toussaint Louverture (PAP), Port-au-Prince - Haiti															
Ramon Villeda Morales (SAP), San Pedro Sula-Honduras															
Norman Manley (KIN), Kingston - Jamaica															
Benito Juarez (MEX), Mexico City - Mexico															
Augusto C. Sandino (MGA), Managua - Nicaragua															
Tocumen (PTY), Panama City – Panama															
Silvio Pettirossi (ASU), Asuncion - Paraguay															

Table IV-V Airline survey: Diagnosis of the quality of infrastructure and processes at LAC airports

Question 1: Infrastructure On a scale from 1 to 5 (1: very poor, 2: poor, 3: fair, 4: good, 5: very good), how would you assess the quality of cargo facilities at these airports?

Country - Airport	Infrastructure														
	Imp./Exp.			Export					Import						Additional comments on the quality of the infrastructure
	On the apron at the foot of the aircraft	Customer service areas	Interface areas with inland transportation	Normal cargo warehouses	Hazardous cargo facilities	Facilities for valuable cargo	Refrigerated and perishable goods facilities	Security control facilities	Normal cargo warehouses	Hazardous cargo facilities	Valuable cargo facilities	Refrigerated and perishable goods facilities	Specific areas for customs control	Other (specify)	
Mariscal Sucre (LIM), Lima - Peru															
Las Americas (SDQ), Santo Domingo – Dominican Republic															
Johan Adolf Pengel (PBM), Paramaribo, Suriname															
A.N.R. Robison (POS), Port of Spain -Trinidad and Tobago															
Carrasco (MVD), Montevideo - Uruguay															
Simon Bolivar (CCS), Caracas - Venezuela															
Add others that you consider relevant															

Source: Prepared by the consultant.

Table IV.V Airline survey: Diagnosis of the quality of infrastructure and processes at LAC airports

Question 2: Processes On a scale of 1 to 5 (1: very poor, 2: poor, 3: fair, 4: good, 5: very good), how would you assess the quality of the cargo processes at these airports in terms of availability and efficiency of services?

Country - Airport	Processes													
	Processes (Imp./Exp.)				Import					Export				Additional comments on the quality of the processes
	ling on the apron and transport to warehouses	Storage computer systems	Customs computer systems	Invoicing computer systems	Phytosanitary controls	Customs	Deconsolidation	Transportation of cargo to cargo terminal	Clearance of clients	Security screening (AVSEC)	argo consolidation/ palletization	Transportation of cargo to cargo terminal	Other (specify)	
Ministro Pistariri (EZE), Ezeiza - Argentina														
Lynden Pindling (NAS), Nassau - Bahamas														
Grantley Adams (BGI), Bridgetown - Barbados														
Philip S. W. Goldson (BZE), Belize - Belize														
Viru Viru (VVI), Santa Cruz de la Sierra - Bolivia														
Viracopos (VCP), Campinas - Brazil														
Galeao (GIG), Rio de Janeiro - Brazil														
Guarulhos (GRU), Sao Paulo – Brazil														
Arturo Merino Benitez (SCL), Santiago - Chile														
El Dorado (BOG), Bogota - Colombia														
Jose Maria Cordova (MDE), Medellin, Colombia														
Juan Santamaria, San Jose - Costa Rica														
Jose Joaquin de Olmedo (GYE), Guayaquil - Ecuador														

Table IV.V Airline survey: Diagnosis of the quality of infrastructure and processes at LAC airports

Question 2: Processes On a scale of 1 to 5 (1: very poor, 2: poor, 3: fair, 4: good, 5: very good), how would you assess the quality of the cargo processes at these airports in terms of availability and efficiency of services?

Country - Airport	Processes													
	Processes (Imp./Exp.)				Import					Export				Additional comments on the quality of the processes
	ling on the apron and transport to warehouses	Storage computer systems	Customs computer systems	Invoicing computer systems	Phytosanitary controls	Customs	Deconsolidation	Transportation of cargo to cargo terminal	Clearance of clients	Security screening (AVSEC)	argo consolidation/ palletization	Transportation of cargo to cargo terminal	Other (specify)	
Mariscal Sucre (UIO), Quito - Ecuador														
Oscar Arnulfo Romero (SAL), San Salvador – El Salvador														
La Aurora (GUA), Guatemala – Guatemala														
Cheddi Jagan (GEO), Georgetown, Guyana														
Toussaint Louverture (PAP), Port-au-Prince - Haiti														
Ramón Villeda Morales (SAP), San Pedro Sula-Honduras														
Norman Manley (KIN), Kingston - Jamaica														
Benito Juarez (MEX), Mexico City - Mexico														
Augusto C. Sandino (MGA), Managua - Nicaragua														
Tocumen (PTY), Panama City – Panama														
Silvio Pettirossi (ASU), Asuncion - Paraguay														

Table IV.V Airline survey: Diagnosis of the quality of infrastructure and processes at LAC airports

Question 2: Processes On a scale of 1 to 5 (1: very poor, 2: poor, 3: fair, 4: good, 5: very good), how would you assess the quality of the cargo processes at these airports in terms of availability and efficiency of services?

Country - Airport	Processes													
	Processes (Imp./Exp.)				Import					Export				Additional comments on the quality of the processes
	ling on the apron and transport to warehouses	Storage computer systems	Customs computer systems	Invoicing computer systems	Phytosanitary controls	Customs	Deconsolidation	Transportation of cargo to cargo terminal	Clearance of clients	Security screening (AVSEC)	argo consolidation/ palletization	Transportation of cargo to cargo terminal	Other (specify)	
Mariscal Sucre (LIM), Lima - Peru														
Las Americas (SDQ), Santo Domingo - Dominican Republic														
Johan Adolf Pengel (PBM), Paramaribo, Suriname														
A.N.R. Robison (POS), Port of Spain -Trinidad and Tobago														
Carrasco (MVD), Montevideo - Uruguay														
Simon Bolivar (CCS), Caracas - Venezuela														
Add others that you consider relevant														

Source: Prepared by the consultant.

LOGISTICS
IN LATIN AMERICA AND THE CARIBBEAN:

OPPORTUNITIES, CHALLENGES, AND COURSES OF ACTION

Agustina Calatayud and Laureen Montes (Eds.)

TRANSPORT DIVISION

IDB