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White Paper

Supply Chain 4.0
Global Practices and Lessons Learned for Latin America and the Caribbean

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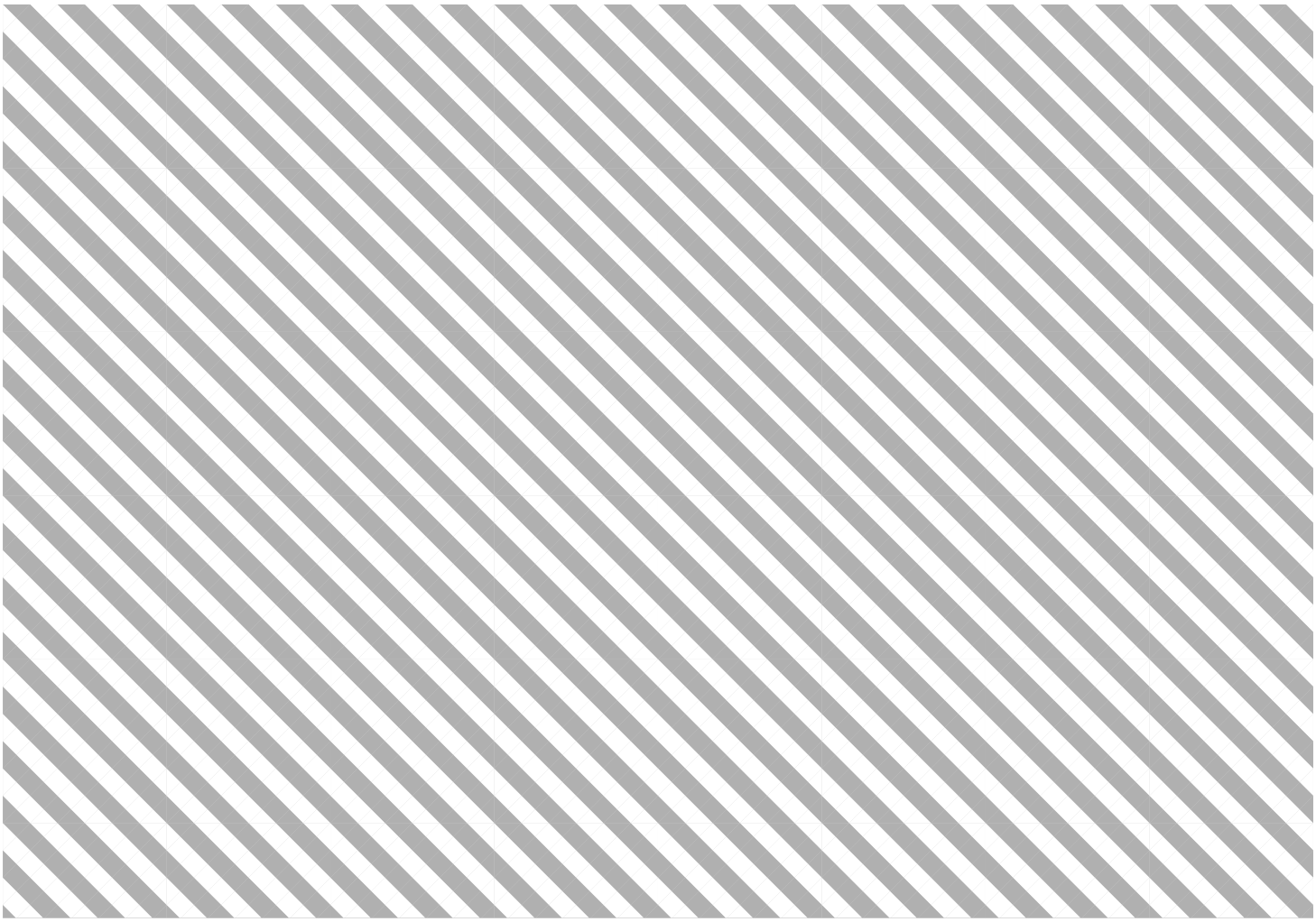

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Contents

Foreword 5

1. The supply chain in the Fourth Industrial Revolution 6

    1.1. Fourth Industrial Revolution technology and tomorrow's supply chains 7

    1.2. Evolution of Supply Chain 4.0 8

    1.3. Barriers and risks to Supply Chain 4.0 9

    1.4. Best practices in advanced economies 10

    1.5. The importance of coordinated Supply Chain 4.0 strategies and integrated policy frameworks 12

2. Analysing supply chains in Latin America and the Caribbean 15

    2.1. The state of supply chains in the region 15

    2.2. The regional context 15

    2.3. The level of awareness and readiness of the SME sector 17

    2.4. Supply chain enablers 18

    2.5. The integration of public-sector efforts within a single framework 20

3. Accelerating Supply Chain 4.0 in Latin America and the Caribbean 21

    3.1. Learning from the leading industry sectors 21

    3.2. Dealing with the challenges of the regional context 21

    3.3. Supporting the SME sector 22

    3.4. Accelerating the development of supply chain enablers 22

    3.5. Developing integrated policy frameworks 22

    3.6. The way forward 23

Appendices 24

    Appendix 1. The global supply chain landscape 24

    Appendix 2. The state of Supply Chain 4.0 in Latin America and the Caribbean – country profiles 26

Acknowledgements 41

Endnotes 44

Foreword

This White Paper is the product of a joint effort by the Inter-American Development Bank and the World Economic Forum's System Initiatives on Shaping the Future of Production and Shaping the Future of Mobility.[1] Its purpose is to capture current levels of awareness and adoption of Fourth Industrial Revolution (4IR) technologies across the supply chain and understand resulting business model and broader economic transformations. The 4IR transformation of the supply chain is also referred to in this paper as "Supply Chain 4.0". The document outlines the results of a 2018 study conducted in three phases to: (1) assess the state of 4IR technology adoption across supply chains in advanced economies; (2) understand current levels of awareness and adoption in Latin America and the Caribbean (LAC); and (3) outline a set of recommendations to accelerate the transition to Supply Chain 4.0 in the region, through strengthened public-private collaboration.

The first section of this White Paper presents a global overview and analysis of initiatives launched in advanced economies. The second section summarizes the results of a detailed examination carried out in six LAC countries – Argentina, Brazil, Colombia, the Dominican Republic, Mexico and Paraguay – on the state of four supply chains, namely appliances, automotive, food processing and textiles. The third section offers recommendations that the public sector, the private sector and both together can adopt to address the challenges and capitalize on the opportunities identified throughout the study.

An overarching finding is that three key requirements to be addressed stand out across all countries covered in the study, both in advanced economies and in the LAC countries: (1) the need for an integrated Supply Chain 4.0 policy approach and framework; (2) the need to learn from and build on leading sectors and companies in each country, to ensure inclusive development across the economy; and (3) the imperative to support small and medium-sized enterprises (SMEs) in their 4IR transformation efforts.

The findings and conclusions presented in this paper are based on the results of 95 interviews with policy-makers, business executives and researchers around the world and the LAC region, as well as on the review of more than 300 national plans, industry reports, documents and research papers. The outcome was validated and enriched by four workshops held in Buenos Aires, São Paulo, Bogota and Mexico City.

1. The supply chain in the Fourth Industrial Revolution

Production in modern economies is organized around supply chains, which involve business processes ranging from product design to customer delivery.[2] The performance of supply chains is driven by the efforts and behaviours of multiple stakeholders, such as manufacturers, logistics service providers and technology suppliers, and enabled by public policies for the development of a country's infrastructure and business environment.[3] The increasing interdependency of supply chain stakeholders is the result of a number of business trends that have emerged in the last three decades, including process and product specialization, outsourcing, off-shoring, just-in-time production and consumer-driven production. With design, production and distribution processes scattered among a variety of firms and parties, companies no longer compete in isolation, but rather as participants in interconnected supply chains.

Given process decentralization, the efficient performance of a supply chain requires a high degree of visibility – defined as the capability of sharing on-time and accurate data throughout the entire supply chain[4] – and coordination among supply chain partners. The technologies generated by the Fourth Industrial Revolution (4IR) – from big data analytics, the internet of things (IoT) and advanced robotics, to 3D printing, machine learning and artificial intelligence – can take supply chain visibility, coordination and performance to new levels. Potential benefits suggested in the literature include better inventory control; reduced friction, fewer barriers and less waste of resources on procedures that do not add value; increased functional and procedural synergy between participants; better monitoring of customer behaviour and faster response to changing market demands; shorter product realization cycles and lower product development costs; shorter order fulfilment lead times; greater logistics flexibility and improved delivery and logistics asset performance; and lower capital investment in excess capacity.[5]

Key technologies involved in Supply Chain 4.0

- **Big data/analytics** is defined as the capability of processing extremely large data sets to identify patterns of relationships (correlation, causality) among data to be used in detecting market trends, consumer behaviour and preferences. Most common applications in business operations range from demand forecasting to quality control and predictive maintenance.

- **The internet of things (IoT)** entails platforms that link multiple sensors and data devices in order to generate a complete vision of the behaviour of an organization, a system, a business operation or a phenomenon. The adoption of IoT is directly linked to vertical applications and, while these platforms are different from machine-to-machine applications, they are based on common components. An IoT system is a platform that interconnects a variety of discrete devices (including machine-to-machine sensors) to provide a holistic vision of certain phenomena.

- **Robotics** entails the application of digital technology to the performance of repetitive manual tasks, such as those required in car assembly, agricultural harvesting and exploration in dangerous environments.

- **3D printing** is a technology that allows the creation of objects by means of successive printing of adhesive materials, such as polymers. While applications of 3D printing are widespread, their use is fairly common in product design (medicinal prosthetics, architectural models, textile design) as well as in the development of spare parts (in consumer electronics and industrial products).

- **Artificial intelligence/machine learning** are two technologies that are not equivalent but that share some common concepts. Machine learning is an artificial intelligence application consisting in the development of programs that allow a computer to learn routines without necessarily being preprogrammed. In that sense, the machine learning program transforms itself once it starts processing information. The most common machine learning applications are self-driving cars, product recommendations, internet platforms like Amazon and Netflix and fraud detection in credit card usage. They are also used in the calculation of consumer credit profiles.

Source: Katz, R. et al., *Digital Ecosystems: Innovation and Disruption in Latin America*, gA Center of Digital Business Transformation, 2017.

The increasing interdependence of supply chain processes and the multiplicity of actors involved in them suggest that the full benefit of 4IR technology adoption, e.g. in terms of end-to-end visibility, flexibility and global optimization, can only be captured if all supply chain stakeholders are aligned and coordinated in their efforts towards digitally transforming the system. If this occurs, economic gains can be obtained for not only the actors that participate in a supply chain, but also the countries in which they operate. Indeed, since the modern economy is organized around supply chains,[6] their enhanced performance through the adoption of 4IR technology can become a key driver of competitiveness and economic growth.

The purpose of this White Paper is to outline best practices and lessons learned regarding the 4IR transformation of the supply chain in advanced economies. These perspectives are used to inform public-private discussions and policy and strategy development in countries across LAC, and to improve supply chain performance and competitiveness in a context of unprecedented technological change and disruption.

1.1. Fourth Industrial Revolution technology and tomorrow's supply chains

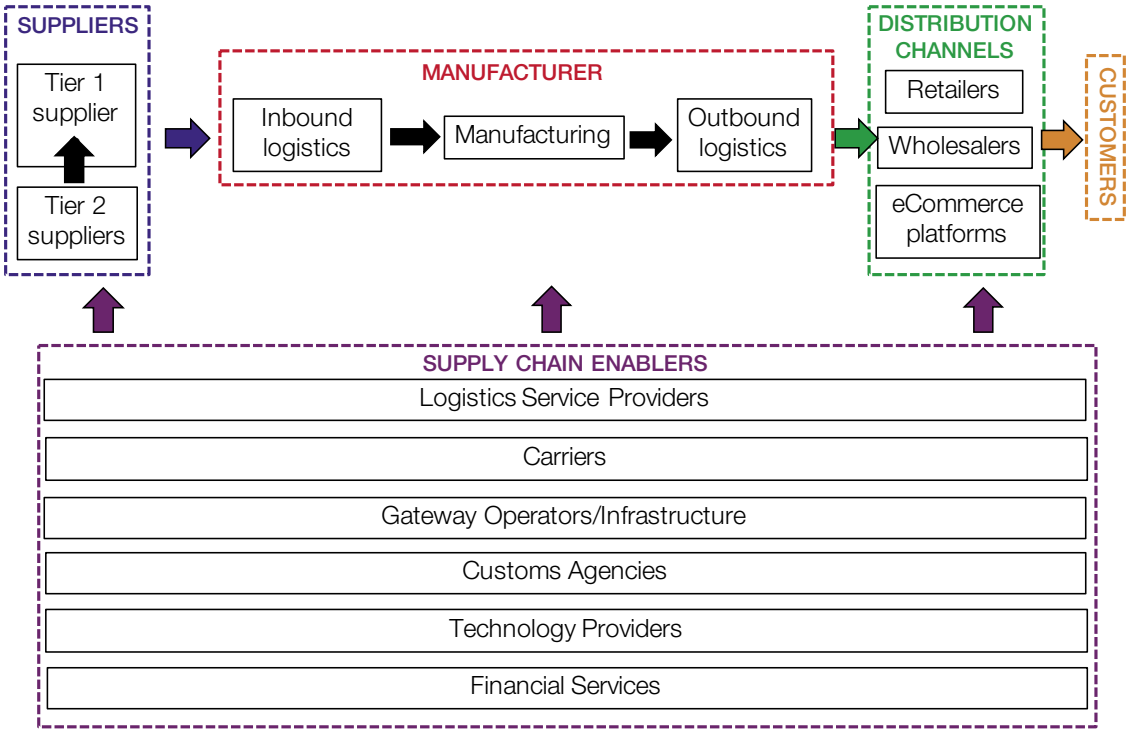
The supply chain represents a set of business processes and applied technologies that supports the flow of physical goods from suppliers to manufacturers and distribution channels serving consumers. The good functioning of supply chains requires interorganizational communication among a diverse set of stakeholders, including but not limited to suppliers, manufacturers, retailers, logistics service providers, transportation carriers and customs agencies. The resulting information flows verbally, manually (i.e. through information on paper), digitally (e.g. through emails), in an automated fashion (e.g. through robotic process automation) and through intelligent platforms.

The search for greater efficiency in production processes has led businesses to employ various supply chain management strategies. Trends such as outsourcing, far sourcing, offshoring, just-in-time production and consumer-driven production have increased the complexity of supply chains. This complexity is evident at various levels: (1) network complexity, caused by the increase in the number of parties in the chain and the links between them; (2) process complexity, due to the increased number of processes and faster product development cycles; (3) product complexity, owing to the higher number of components and shorter product life cycles; (4) demand complexity, due to increased demand volatility and fragmentation; and (5) organizational complexity, due to the increasing number of entities involved and the tendency to work in silos.[7] While information systems have been applied in specific areas of the supply chain for half a century, big data/analytics, the IoT, robotics, 3D printing and artificial intelligence/machine learning are some of the 4IR technologies that are expected to further reshape supply chain design and improve communication flows, reduce complexity and enhance performance.

In the context of the 4IR, supply chains are characterized by a high degree of cyber-physical interconnection, enabled by sensors that collect big data for large-scale, real-time decisions to optimize supply chain performance.[8] The large-scale deployment of IoT sensors and big data analytics enables preventive maintenance, avoiding disruptions from unexpected failures. In addition, the use of IoT sensors together with artificial intelligence enables automated inventory management, thus diminishing human error, input shortages and the high cost of unnecessary inventory carrying. Likewise, the implementation of IoT, big data and artificial intelligence in transport operations and infrastructure management allows for real-time route and asset optimization, hence improving reliability and efficiency in logistics processes. Moreover, the deployment of advanced robotics and artificial intelligence allows for decisions and supply chain processes to be highly automated, while the length of supply chains is shortened through 3D printing. These are the key features of Supply Chain 4.0.

The 4IR transformation of the supply chain is driven by the combined undertakings of many stakeholders, including technology developers, logistics service providers, large manufacturers, small and medium-sized manufacturers, tier 1 and 2 suppliers, infrastructure and gateway operators, carriers and governments, who exercise their influence through public policies and regulations. An integrated and comprehensive framework depicts the multiple stakeholders involved in the 4IR transformation of the supply chain[9] (Figure 1).

Figure 1: Stakeholders along the supply chain



Source: Developed by the authors.

Due to process fragmentation and the multistakeholder nature of the supply chain, its full 4IR transformation requires a high level of collaboration. Such transformation needs to be addressed in a systemic manner, tackling technological and economic barriers and providing incentives for each group of stakeholders to take part in the change. The misalignment of stakeholder efforts to drive the 4IR transformation of the supply chain causes a coordination failure.[10] Public policy interventions can address this failure by putting in place mechanisms that help stakeholders to align. As an example, common IoT strategies and data standards, endorsed by all stakeholders, both public and private, facilitate connectivity and the flow of information among manufacturers, logistics service providers and customs agencies, and enable real-time monitoring of supply materials and spare parts.

1.2. Evolution of Supply Chain 4.0

The 4IR transformation of the supply chain is gradually taking place. Prompted by competitive pressure and disruption risks, large enterprises, primarily multinational corporations (MNCs) and large domestic firms in advanced economies, are transitioning towards Supply Chain 4.0. In the words of a large MNC executive, "The supply chain is a strategic component of our business model. This obliges us to be the best in terms of optimization and, consequently, in thinking about the 4IR transformation of the supply chain."

As MNCs advance in the adoption of 4IR technologies, their tier 1 suppliers face competitive pressure to join the transformation process, resulting in adopting 4IR technologies and ensuring interoperability with the systems put in place by MNCs. Large players recruit talent, experiment, run pilots and acquire firms that have developed new technologies, or reach out to top research centres for innovation. They are also investing in systems and facilities jointly with their suppliers. The rapid digitization of large manufacturers' supply chains becomes a driving force for tier 1 suppliers. This trend is being facilitated by the deployment of web-based and cloud-based technologies, and the adoption of new data standards for interorganizational connectivity, such as MT Connect developed by the Association for Manufacturing Technology in the United States.[11]

The rate of 4IR transformation is influenced by three factors: the industry level of globalization, the degree of vertical integration and the level of competitive intensity (Figure 2).

Figure 2: Variables affecting the readiness to tackle Supply Chain 4.0

Factors	Definition	Examples
Industry level of globalization	The enterprises that are part of global supply chains tend to be more advanced in terms of 4IR transformation than those that are focused on purely domestic markets.	In the automotive sector, subsidiaries tend to benefit from technology deployment at their headquarters and research centres. Likewise, MNCs' tier 1 suppliers tend to exhibit a higher level of 4IR technology adoption to support interorganizational linkages more efficiently.
Degree of vertical integration	The firms that occupy positions in more than one step or process in the supply chain tend to be more advanced in terms of 4IR transformation.	Firms that have internalized logistics processes (such as land transportation) are more likely to have a digital platform that enables the integrated management of manufacturing and logistics processes.
Level of competitive intensity	Industries under threat of disruption from nontraditional players show a higher likelihood of implementing 4IR transformation to better respond to the competitive threat.	Large logistics companies are creating or acquiring digital platforms that provide clients with increased visibility and, therefore, more value for the management of supply chain processes.

Source: Developed by the authors.

The combination of all these factors can accelerate the rate of 4IR transformation of the supply chain. Alternatively, their absence can act to delay the transformation.

1.3. Barriers and risks to Supply Chain 4.0

Among the most important obstacles standing in the way to Supply Chain 4.0 are the lack of a clear business case, limited access to human capital, the disparate nature of technologies (premature obsolescence, limited interoperability), internal organizational barriers (silos, fear of experimentation), the limited availability of transport infrastructure (from roads to ports to telecommunications), the low efficiency of transport services (due to highly fragmented sector organization), lagging information systems at gateways and borders, and cumbersome tax schemes and trade regulations. As an executive of a global supply chain of an electronics MNC said, "The key problem is how to show the economic value of the intended solutions." Similarly, a large logistics service provider mentioned that, "Manufacturers tend to see digital transformation as a golden bullet to solve whole business problems. It is common to see that if one digitizes a cumbersome and inefficient process, the results will be equally bad." A large MNC estimates that, "The big challenge is the lack of internal capability in state-of-the-art advanced digital technologies."

On the other hand, SMEs are lagging in their 4IR transformation of supply chains. The most important deterrents for these smaller firms to digitally transform are: (1) resource constraints, such as the lack of internal knowledge and human capital, as well as limited access to finance, and (2) limited technology availability, as information technology (IT) solutions and use cases focus primarily on large manufacturers' needs. This is leaving SMEs and tier 2 players underserved. Overall, less familiarity with new production and supply chain paradigms, and competing business priorities render SMEs less prone to invest in 4IR technologies. For example, a survey of US SME manufacturers conducted in June 2017 found that 77% had no plans to implement smart sensors or any type of IoT technology.[12] The primary adoption barriers cited in the survey were lack of awareness, limited expertise and lack of workforce digital skills.

SMEs are involved in supply chain processes along the chain, from sourcing to manufacturing, transportation and distribution. As the trend towards 4IR technology adoption is accelerating among large manufacturers and tier 1 suppliers, the SME lag is resulting in a "dual economy" effect, where everybody might lose. The risk for SMEs is to be left behind and outside the new digital economy, with undesired effects for governments in terms of employment

and economic growth. In turn, the risk for large companies is to indirectly rely on supply chain partners that, due to a low level of digitization, prevent them from fully grasping the benefits of the 4IR technologies.

1.4. Best practices in advanced economies

A review of the focus and experience of advanced economies to enable Supply Chain 4.0 provides valuable lessons and best practices:

- **Promoting 4IR transformation in all key industries**: Some advanced countries focus on bringing 4IR technology to traditionally "low technology" sectors. For example, Germany is modernizing traditional manufacturing industries, such as textiles, steel and electrical appliances, by introducing 4IR technologies (e.g. advanced materials/composites, advanced machining, nanotechnology, robotics systems, etc.).

- **Supporting 4IR transformation among SMEs**: SME support programmes play an important role in ensuring the viability of Supply Chains 4.0 – particularly since they include small tier 2 suppliers and smaller logistics services providers. These programmes target the specific challenges and needs of SMEs, including the next generation of engineering, product innovation and commercialization capacity. For example, in Japan, the government is subsidizing the creation of consortia of companies that have similar supply chain needs (e.g. raw materials or parts). They foster the creation of a shared logistics function, where companies collaborate and coordinate orders, which allows both the tighter management of the supply chain and reduced logistics costs. Additionally, governments are providing funding or tax deductions to support the adoption of 4IR technologies (e.g. IoT) in the supply chain. In South Korea, the Ministry of Small and Medium-Sized Enterprises is providing a variety of technology and innovation programmes, including support for start-up technology development, SME technology transfer, the joint utilization of research equipment, production-environment innovation technology, the joint development of industry-academia research institutes, and the establishment of research institutes attached to SMEs.

- **Extending SME 4IR technology adoption support programmes to the logistics sector**: In terms of the digitization of logistics service providers, three factors limit the process as in the case of SMEs: resource shortfalls, scepticism about sunk costs and low margins. These challenges constrain their ability to invest. While some European governments are supporting start-up initiatives to increasingly digitize logistics, a more advanced policy can be found in Singapore. Singapore's Logistics and Transportation Productivity Roadmap, launched in 2013, states that the adoption of technology is a key component to raise productivity in the logistics sector.

- **Focusing on addressing key bottlenecks in the transition to Supply Chain 4.0**: In many countries, the 4IR transformation of the supply chain suffers from structural impediments in the logistics sector, particularly in land transportation. These range from a reluctance to share information to systems incompatibility, business complexity and limited competitive intensity. Unless these constraints are addressed from a policy standpoint, they could become barriers to the transformation of the supply chain. While many countries recognize the impediments, as cited by subject-matter experts in Germany and Japan, among others, no concrete approaches have yet been identified to overcome them.

- **Acknowledging limited policy replicability**: While many industrial digitization efforts were initially developed by examining the German example, it is important to recognize that each country's industrial context is distinct. For example, the concept of SME cannot be easily assimilated to the German "Mittelstand". The leaders of the French *Alliance du Futur* and the Spanish *Industria Conectada 4.0* rapidly understood that, while looking at the German experience, each country's economic context is different and therefore requires a tailored approach to foster Supply Chain 4.0, grounded in its specific characteristics.

- **Strengthening public-private sector collaboration**: Governments need to reach out to large manufacturing companies and industry associations to harness and leverage their efforts, experience and spillover potential in the promotion of the 4IR transformation of the supply chain. The experience generated in the manufacturing sector needs to be extended to other supply chain stakeholders, such as logistics service providers and transportation carriers. The experience of 4IR transformation initiatives in advanced economies reveals numerous successful examples of public and private collaboration focused on specific digital transformation programmes (Figure 3).

Figure 3: Examples of public and private collaboration focused on Fourth Industrial Revolution transformation (with an impact on the supply chain)

Initiative	Example	Impact on the Supply Chain
4.0 Centres focused on SMEs	Italy: Fabbrica Intelligente	Cooperation of the public sector, private companies and academia for the promotion of innovative manufacturing platforms
	United States: Manufacturing USA, Manufacturing Extension Partnership	Policy that focuses on cross-cutting technology initiatives in the fields of additive manufacturing, robotics, energy and bio manufacturing The development of innovative methodologies and practices to integrate technology in the supply chain
	Japan: Industrial Value Chain Initiative	A collaborative forum promoting the development and adoption of "smart manufacturing" solutions, by bringing large and small enterprises together to develop a combination of manufacturing and ICT technologies to improve industrial operations The supply of advanced manufacturing IoT kits for SMEs
	Spain: Federación Española de Centros Tecnológicos	Centres that provide SMEs with R&D project assistance, technical assessment and advice, technology diffusion, standards and quality certification, training and international cooperation
SME advisory services	France: Advisory Programme - Industrie du Futur	Tools that assess SME digital transformation maturity Free consulting from SME peers
Use case development	Germany: Plattform Industrie 4.0	A database of over 300 use cases of opportunities for digitization production processes, 10 of which focus on the supply chain
4.0 Maturity indices	United States: Digital Compass (Digital Manufacturing Design and Innovation Institute)	A "Digital Compass" diagnostic tool to guide companies in their adoption of Industry 4.0 and evaluate the actual returns they are realizing from digital manufacturing implementations
	Germany: Industrie 4.0 Maturi-ty Index	An index that charts the evolution of firm capabilities, from simple digitization (adopting computers and connecting them online) to collecting data, to conducting diagnostics in real-time on the factory floor, to anticipating and predicting changes in demand, equipment maintenance and other operational variables, to self-optimizing factories
	Singapore: Smart Industry Readiness Index	A comprehensive tool for all companies regardless of size or the industry they are operating in, that covers all three core elements of Industry 4.0 (technology, process and organization) A specific pillar of the index that addresses the key components of Supply Chain 4.0
	Spain: Industria Conectada 4.0 Maturity Toolkit	A toolkit aimed at auto-evaluating a company's state of maturity in terms of its migration towards digital transformation; 16 pillars associated to enabling technologies
Data standards development	United States: MT Connect	A free, open standard that enables manufacturing equipment to provide structured, contextualized data with no proprietary format, used by manufacturers in the United States, Europe, Brazil and China
	Japan: e-F@ctory, Industry 4.1	A data standard providing a flexible approach to the interoperability of smart manufacturing equipment
	South Korea: Private-sector and KATS standards development	Interoperability standards defined by private companies within a sector (e.g. automotive companies define data standards for their own sector)

Source: Compiled by the authors.

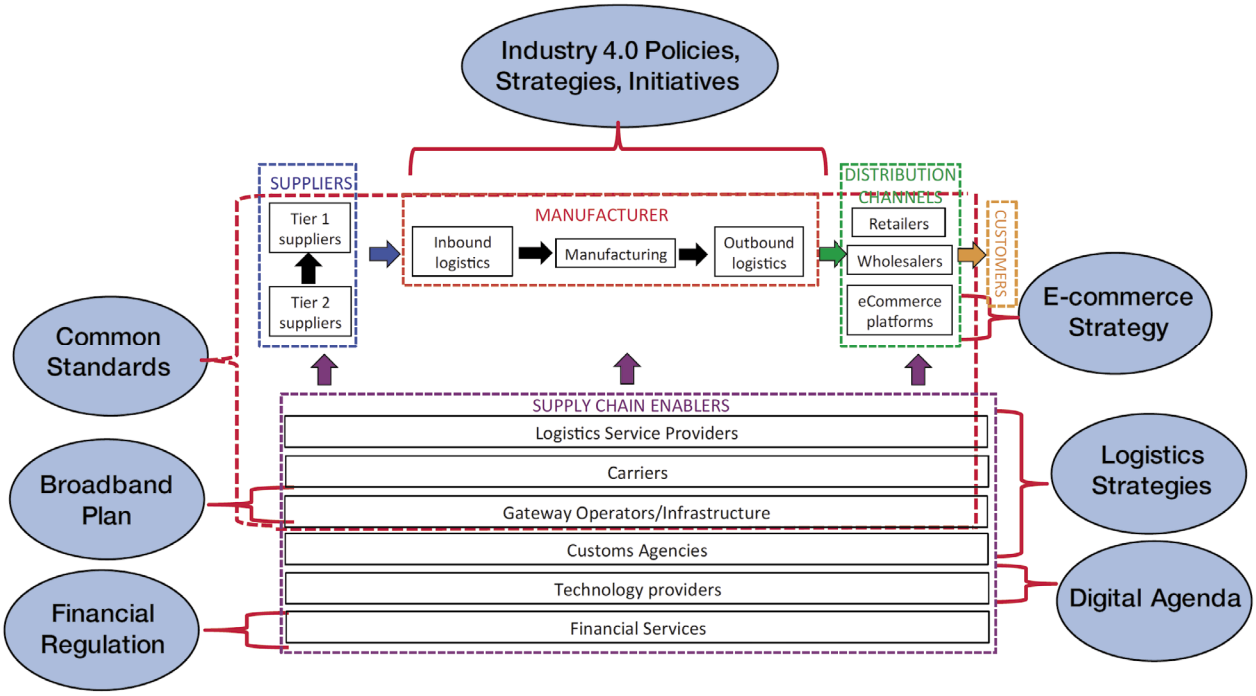
1.5. The importance of coordinated Supply Chain 4.0 strategies and integrated policy frameworks

Governments in advanced economies have launched multiple plans and programmes that contribute to the 4IR transformation of the supply chain. The promotion of shared communication standards, logistics strategies, transport infrastructure development and advanced manufacturing programmes are some examples of public policy intervention. However, each policy tends to focus on enhancing the digital transformation of only one specific supply chain node or enabler (Figure 4).

Governments are formulating national plans to support the transition to the future of production, such as *Industrie 4.0* in Germany, *Industria Conectada 4.0* in Spain and *Manufacturing Innovation 4.0* in South Korea. They are defining a set of targets, guidelines and implementation approaches to guide the economy's manufacturing sector in the direction of digitizing production processes. The public sector is involved in joint initiatives with the private sector to develop roadmaps or "how to" books to help private-sector companies launch their digital transformation journey, document examples of how to use 4IR technologies to address a supply chain business problem (around the concept of "use cases"), and create maturity indices and toolkits that allow companies to self-assess their level and progress of 4IR transformation. Industry 4.0 programmes are also targeting the digitization of SMEs, through training programmes, advisory services, test bed centre deployment and financial incentives.

At the same time, governments are exerting influence on the infrastructure enablers of the supply chain by preparing logistics development strategic plans, such as China's *Medium and Long Term Development Plan of Logistics Industry*, Italy's *Piano Strategico Nazionale della Portualità e della Logistica* and Singapore's *Logistics and Transportation Productivity Roadmap*. These programmes address the development of gateways (smart ports, multimodal terminals, etc.), logistics digitization and the streamlining of customs processes.

Figure 4: Public-sector initiatives that foster the development of Supply Chain 4.0



Source: Developed by the authors.

Complementing the logistics strategy, national broadband plans, such as France's *Très Haut Débit* and Italy's *Piano Nazionale Banda Larga*, provide the guidelines for the private-sector development of broadband and wireless networks critical to support the transformation of supply chains. More specifically, national broadband plans can entail not only high capacity networks but also IoT interoperability frameworks. France, for example, is actively fostering the migration to common data standards through the French Standardization Strategy.

Digital agendas, such as Germany's *Digitale Agenda*, are also driving transformation. This involves the funding or incubation of technology companies focused on the development of products or services that enhance the efficiency of the supply chain. By means of an e-commerce national strategy, governments impact the development of internet platforms and channels. Finally, the government regulation of financial services, data protection, digital economy policies (e.g. taxation) and cybersecurity influences transactions within supply chains.

Interestingly, while all these policies target the supply chain in one way or another, seldom are they implemented in an integrated fashion. In addition, they tend to be implemented by various government agencies with little interinstitutional coordination. Although sectorial initiatives are key to enact specific actions or reforms (e.g. related to maritime transport, customs, intellectual property), the 4IR transformation of the supply chain would benefit from an integrated and coordinated approach. See, as examples, the government entities in advanced economies involved in three of the public-sector initiatives that are influencing the migration to Supply Chain 4.0 (Figure 5).

Figure 5: Public-sector initiatives and entities involved in fostering Supply Chain 4.0

Country	Industry 4.0	Logistics Strategy	Data Standards
Germany	**Industrie 4.0** (Ministry of Economic Affairs and Energy, Ministry of Economics and Technology)	**Maritime Agenda 2025** (Ministry of Economic Affairs and Energy)	Ministry of Economic Affairs and Energy Ministry of Education and Research
Japan	**Industrial Value Chain Initiative** (Ministry of Economy, Trade and Investment) **Kohsetsushi Centers** (Ministry of Economy, Trade and Industry)	**Base Plan on Transport Policy** (Ministry of Land, Infrastructure, Transport and Tourism)	**Industrial Value Chains Initiative** (Ministry of Economy, Trade and Investment)
South Korea	**Manufacturing Innovation 4.0** (Ministry of Trade, Industry and Energy, Ministry of Science, ICT and Future Planning)	**National Logistics Master Plan 2011-2020** (Ministry of Land, Transport and Maritime Affairs)	Korean Agency for Technology and Standards (KATS) Ministry of Trade, Industry and Energy Ministry of Science, ICT and Future Planning National IT Promotion Agency Korea Institute for Industrial Economics and Trade
United States	**Manufacturing Extension Partnership** (Department of Commerce) **Manufacturing USA** (Departments of Commerce, Energy and Defense)	**National Strategy for Global Supply Chain Security** (Department of Homeland Security) Department of Transportation State governments	Industrial Internet Consortium Department of Transportation
Italy	**Piano Impressa 4.0** (Ministry of Economic Development) **Fabbrica Intelligente** (private sector)	**Piano Strategico Nazionale della Portualità e della Logistica** (Ministry of Infrastructure and Transportation)	Most standards efforts led by the European Commission
Spain	**Industria Conectada 4.0** (Ministry of Economy, Industry and Competitiveness) **Federación Española de Centros Tecnológicos**	**Estrategia Logística de España** (Ministry of Development)	Ministry of Education and Science
China	**Made in China 2025** (Ministry of Industry and Information Technology, Multilateral Investment Fund)	**Medium- and Long-Term Development Plan of Logistics Industry (2014-2020)** (Ministry of Communications and Transportation)	Ministry of Industry and Information Technology National Development and Reform Commission
France	**Industrie du Futur** (Ministry of Economy)	**France Logistique 2025** (Ministry of Economy, Ministry of the Environment, Energy and Seas)	**French Standardization Strategy 2016-2018** (Association Française de Normalisation)
Singapore	**Smart Nation** (Prime Minister, Government Technology Agency, Digital Government Office)	**Logistics and Transportation Productivity Roadmap** (Ministry of Trade and Industry)	Singapore Data Standards (Spring Singapore)

Note: Grey areas indicate private-sector involvement.
Source: Compiled by the authors.

Among the unintended consequences of limited interagency coordination and the resulting policy fragmentation is the risk of perpetuating coordination failures. For example, not foreseeing the need to eventually deploy sensing systems (enabled through wireless networks) when building new transport infrastructure may raise deployment costs at a later stage. Similarly, the benefits of automation in cargo handling at ports can be curtailed by the lack of integration with customs systems.

Taking into account the importance of supply chains in the modern economy and the international experiences reviewed, fostering Supply Chain 4.0 should encompass three key policy objectives:

– **Place the 4IR transformation of the supply chain among the main goals of the economic policy agenda**: Supply chains are a key driver of competitiveness and economic growth. Since the productivity of supply chains can be significantly improved through 4IR technologies, their adoption should be at the forefront of the economic policy agenda.

– **Develop an overarching and integrated strategy**: Driving the 4IR transformation of the supply chain in an integrated manner requires placing Industry 4.0 plans, logistics strategies and digital agendas, etc., within an overarching strategy, combining efforts from various government agencies.

– **Establish mechanisms to facilitate institutional coordination**: Institutional coordination must be addressed at two levels: 1) a single government entity should be in charge of formulating an overarching supply chain policy; and 2) policy implementation should result from the coordination between the ministries of transport, industrial development, communications and finance, among others.

2. Analysing supply chains in Latin America and the Caribbean

2.1. The state of supply chains in the region

In the aggregate, the 4IR transformation of supply chains in LAC is still embryonic. However, MNCs and large "multilatinas" are at a higher implementation level than other enterprises. Large companies are aware of the key 4.0 concepts and the potential of 4IR technologies; a survey conducted in Brazil by the National Confederation of Industries in 2017 indicated a high level of awareness of Industry 4.0. This includes the 4IR transformation of the supply chain: 46.6% of surveyed executives chose high probability when asked whether 4IR technologies will improve relationships with suppliers through the real-time monitoring of orders and logistics via web services. Similarly, according to a 2017 study among C-level executives in Argentina, 76% of respondents answered that the evolution towards Industry 4.0 is part of the discussion within senior management. Among the key topics of interest, the executives mentioned smart manufacturing, real-time performance management and digital performance dashboards.[13]

All over the world, the LAC automotive supply chain is consistently more advanced in its transformation than that of other sectors. For an automotive MNC executive, the implementation of 4IR technologies in the supply chain is strategic: "The company has a worldwide strategy that each subsidiary adapts to the country requirements." When the automotive industry is analysed by country, Mexico is ahead (due to its close geographic integration with US original equipment manufacturers), followed by Brazil. Trailing behind are Argentina (with lagging implementation due to the adverse economic context) and Colombia (because of the country's smaller market size).

At the other end of the spectrum, the textile supply chain is consistently at a low stage of digital transformation. However, Mexico and the Dominican Republic are somewhat ahead as a result of the economic importance of the "maquiladora" sector[14] in both countries.

The appliances supply chain is progressing in terms of its 4IR transformation, driven by integration needs with Asian manufacturers. The strategic importance of Brazil and Argentina indicates that the appliances supply chain will make progress on its 4IR transformation in the near future.[15]

The food processing supply chain is lagging the appliance supply chain. Figure 6 shows that the food processing sector exhibits a homogeneous level of 4IR transformation across countries, while the automotive sector depicts variances across geographies. A similar effect can be identified in the case of textiles and appliances.

Country size plays a role in driving the 4IR transformation of supply chains. In relative terms, all sectors in the Dominican Republic and Paraguay depict a consistent lag, although there is some degree of technology adoption in the maquiladora sector and the auto-parts industry of both countries.

Four factors explain LAC countries' embryonic stage of development of 4IR transformation:

- Challenges related to the regional context
- The low level of awareness and readiness of the SME sector
- The limitations of supply chain enablers
- A lack of integration of public-sector efforts within a single policy framework

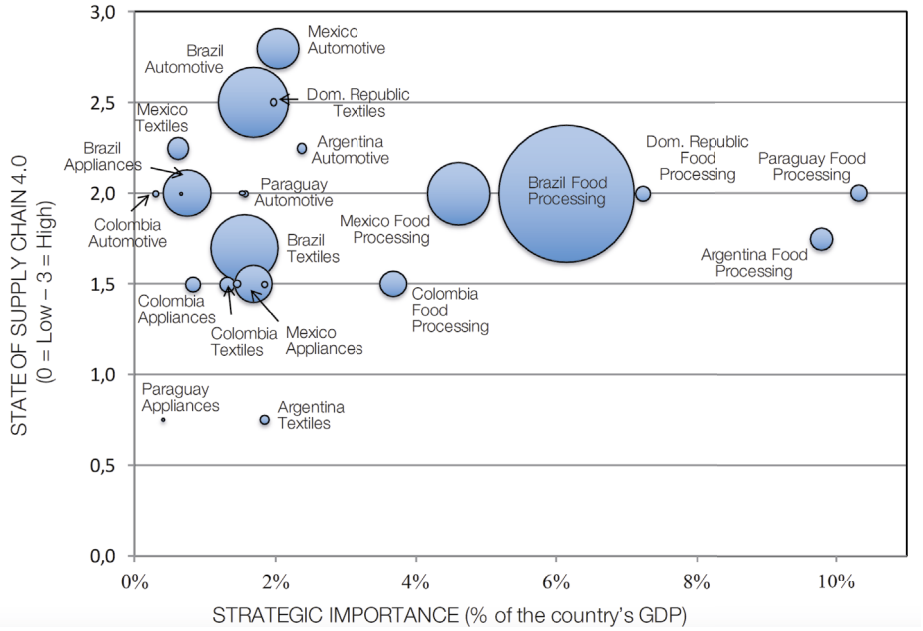
2.2. The regional context

Some of the challenges and barriers to the 4IR transformation of the supply chain in LAC countries are similar to those encountered in more advanced nations. Enterprises in the region mention a few specific barriers:

- Low labour costs, which compete with the potential benefits of 4IR technology adoption
- The limited local availability of region-specific technology, which compels companies to seek and acquire advanced solutions overseas, resulting in higher costs and lower returns on investment (ROI)
- A skills gap and shortage of qualified workers; according to interviewees, managers and shop floor engineers are not sufficiently prepared to implement 4IR technologies and solutions
- Cultural resistance caused by the fear of job losses and unemployment

Low labour costs in the region typically compete with the potential economic benefits of investing in 4IR technologies. Especially in Mexico, companies report that the benefits produced by technology adoption across many areas of the supply chain, such as automation in distribution centres and packaging, still cannot rival with low labour costs. Macro indicators support this assessment: Mexico's average labour costs are the equivalent of $6.36 per hour, while Brazil's are $11.20, and Argentina's are $18.87. Comparatively, the hourly labour cost in the United States is $38.0, while in Canada it is the equivalent of $30.60.[16] In the words of a MNC executive in LAC, "When the Mexican ROI of technology investment is compared with that of other countries, the time horizon required to break even is much longer."

Figure 6: Latin America and the Caribbean: State of Supply Chain 4.0 (by sector)



Notes: The state of the 4IR transformation is based on interviews and secondary market research; the size of the bubble depicts the percentage of the total GDP share of the four sectors in the six countries under study.
Source: Authors' analysis.

Beyond labour costs, other microeconomic factors also disincentivize 4IR technology adoption by LAC companies:

- **Structural factors**: Investment in certain 4IR technologies is scale dependent, becoming economically attractive when implemented in large manufacturing and distribution centre facilities (for example, sorters and robots). Many LAC companies with large distribution networks tend to operate in decentralized structures based on multiple small fulfilment and dispatching centres to mitigate security risks. Along these lines, the technology investment required to support the 4IR transformation becomes less attractive due to diseconomies of scale.

- **Siloed 4IR transformation approach**: Technology adoption in LAC companies is typically approached within a single business function, without taking into account the need for broader business process reengineering or change management.[17] This tends to create integration challenges, interoperability problems and fragmented information sharing, which lead to higher technology implementation costs.

- **Unfulfilled promises of technology benefits**: According to certain subject-matter experts, the LAC market is influenced by information technology providers and management consultants who herald over-optimistic and somewhat unrealistic economic benefits related to the 4IR transformation. This raises management scepticism regarding the 4IR promise.

- **Innovators dilemma**: It is often the case in LAC that, based on industry benchmarks, the most innovative companies have higher operating costs than less automated firms. In light of this, their competitors shy away from the 4IR transformation without taking into consideration that the innovators set new standards in consistency and quality and build the foundation for the next step of evolution in the industry.

Beyond these generic factors, each LAC country must address particular barriers. Argentinian companies must confront adverse macroeconomic conditions. In Brazil, companies are currently focusing on managing short-term challenges derived from the business environment, which is taking a toll on investment strategies. In the case of Colombia, the integration of territories that until recently were affected by violent conflict poses the challenge of bringing local economies up to speed. In Mexico, security

concerns oblige companies to increase transportation expenditures and insurance, which reduces the availability of resources to invest in 4IR technologies. The low safety levels of roads and railways significantly increase logistics costs.

2.3. The level of awareness and readiness of the SME sector

Although they recognize the need to innovate, LAC SMEs have limited knowledge of the impact of 4IR technologies and even less of the benefits they can enjoy. They often lack the financial resources to innovate. Additionally, technological solutions are regularly designed for MNCs in more mature markets and thus are not suited to the scale and requirements of SMEs in LAC countries.

In Colombia, the only country that has surveyed 4IR technology adoption, the data reveal a gap between large enterprises and SMEs in this area (Figure 7).

This gap is particularly important given the key role that SMEs play in the economies of LAC countries (Figure 8).

Figure 7: Colombia: Adoption of advanced digital technologies (%, 2017)

Technology	Nation (*)		Secondary Sector (**)		Tertiary Sector (**)	
	Large Enterprises	SMEs	Large Enterprises	SMEs	Large Enterprises	SMEs
IoT	17.7	9.9	17.1	12.8	20.0	11.1
Robotics	8.2	1.4	2.4	0.3	12.2	2.0
3D Printing	6.3	3.0	4.9	2.4	6.7	3.6
Virtual Reality	3.2	1.3	2.4	0	4.4	2.3
Artificial Intelligence	4.4	2.4	0	0.3	7.8	4.3

Notes: (*) Sample of 2,141 enterprises; (**) Sample of 551 enterprises; (***) Sample of 1,090 enterprises.
Source: Katz, R., M.-C. Duarte, F. Callorda, D. Durán and C. Meisl, *Observatorio de la Economía Digital de Colombia*, Ministry of ICT/Bogota Chamber of Commerce, 2018.

Figure 8: Latin America and the Caribbean: Distribution of companies by size (number of employees)

	Argentina (2018)		Brazil (2014)		Colombia (2017)		Dominican Republic (2013)		Mexico (2016)		Paraguay (2011)	
	Total	%	Total	%	Total	%	Total	%	Total	%	Total	%
Large	3,451	0.64	13,854	0.30	5,942	0.5	513	1.98	10,461	0.19	1,497	0.67
Medium	14,934	2.77	66,305	1.45	18,734	1.6	1,712	6.61	47,724	0.84		
Small	70,594	13.09	524,393	11.51	71,366	6.3	6,445	24.90	263,041	4.65	6,457	2.88
Micro	450,401	83.50	3,952,859	86.73	1,045,477	91.6	17,216	66.51	5,332,788	94.32	216,288	96.45
Total	539,380	/	4,557,411	/	1,141,519	/	25,886	/	5,654,014	/	224,242	/

Notes (by number of employees):
- Argentina: Large (>200); Medium (50-200); Small (10-49); Micro (<9)
- Brazil: Large (>250); Medium (50-250); Small (10-49); Micro (<9)
- Colombia: Large (>100); Medium (51-100); Small (11-50); Micro (<10)
- Dominican Republic: Large (>250); Medium (50-250); Small (10-49); Micro (<10)
- Mexico: Large (>250); Medium (51-250); Small (11-50); Micro (<10)
- Paraguay: Large and Medium (50+); Small (10-49); Micro (<10)

Sources: Compiled by the authors based on Argentina (Ministerio de Producción, 2018, GPS de Empresas Argentinas); Brazil (IBGE, Diretoria de Pesquisas, Coordenação de Metodologia das Estatísticas de Empresas, Cadastros e Classificações, Cadastro Central de Empresas, 2014); Colombia (DANE, Registro Mercantil de la Cámara de Comercio de Bogotá); Dominican Republic (Directorio de Empresas y Establecimientos, 2013, Oficina Nacional de Estadísticas); Mexico (INEGI, Censo Económico 2014 y Cuentas Nacionales, 2016); Paraguay (DGEEC, Censo Nacional Económico, 2011).

2.4. Supply chain enablers

LAC countries face important deficits in key supply chain enablers, such as inadequate road and railway infrastructure, congestion in the access to ports, uneven technology adoption among logistics service providers and cumbersome customs agency operations. However, for the past decade, they have enhanced the performance of certain supply chain enablers, in particular in port and airport infrastructure, as evidenced by their improvement in international rankings.

Ports

Despite improvement, the inefficiencies and cost disadvantage of the region's ports persist, mainly caused by external factors primarily related to transportation challenges in the hinterland and in port access. Colombian ports have undertaken a modernization programme (mechanized storage, scanners for non-intrusive inspection, a virtual port management system, paperless processing), which has increased port efficiency. In Paraguay, traceability via GPS, radio frequency identification for container tracking and advanced space management systems have been implemented at certain river ports. Likewise, some of the more advanced terminals in Argentina have introduced IoT solutions to verify the condition of grain in silos to avoid contamination, drones for inventory management and artificial intelligence to respond to customer inquiries.

Despite these technological upgrades, however, a primary bottleneck remains. Many Latin American ports are more efficient in interactions "from the ship to the berth" than "between the yard and the trucks". Along these lines, a major challenge involves the assignment of turns to loading trucks.[18] Port development has not advanced in sync with city planning, resulting in physical constraints for cargo processing. Beyond this fact, investments in technology have mainly been focused within the port rather than within the "port community". In addition, certain inefficiencies in cargo handling have resulted from the terminals' need to deal with multiple government authorities.

Transportation infrastructure

In general, Latin America's road infrastructure is underdeveloped. Only 13% of Brazil's road network of 1,596,683 km is paved.[19] Argentina has approximately 3,000 km of two-way roads, although the country's needs are for approximately 6,000 km.[20] In Colombia, the recent intercity transport network's modernization has created bottlenecks at city road access points. This situation, added to the existing congestion within cities, negatively affects the effectiveness of the country's supply chain. For example, when transportation vehicles enter Colombia's metropolitan areas, their average speed decreases from 50 km/h to 10 km/h.[21] In Paraguay, the 8,000 km of paved roads are well under the required 23,000 km.[22] Finally, with just 60% of paved roads within its 5,400 km network of primary and secondary roads,[23] the Dominican Republic's road infrastructure remains underdeveloped with poor connectivity between the north and south of the country and congestion to access the main urban centres and ports.[24]

Once the main mode of transport for freight in many LAC countries, the railway system has been neglected over past decades in favour of road development. While some LAC countries have improved the quality of railroad infrastructure over the past five years, the railway network is still unable to meet the demand.

Brazil's national rail network of only 29,817 km is mostly deployed within the southern part of the country.[25] Similarly, of the 3,515 km of tracks in Colombia, only 51% are in service; the poor condition of the rest of the network does not allow operation.[26] In Argentina, the railroad infrastructure is outdated and in bad condition. This significantly impacts the performance of the transportation industry and the productivity of the supply chain, particularly affecting the country's agribusiness. On average, sugar from a manufacturing plant in the north of Argentina reaches a port by train in 15 days, compared to three days by truck. Schedules are unpredictable and safety conditions are insufficient.[27]

Logistics service providers

The performance of logistics service providers in LAC is uneven across segments. The international operators, such as FedEx, UPS and DHL, are advanced in their 4IR transformation, and certain local logistics service providers are deploying 4IR technologies as well. For example, the Mexican logistics industry is using 4.0 technologies, such as automated industrial processes using supervisory control and data acquisition (SCADA), big data, electric trucks and autonomous collaborative robots. In an approach similar to that of the logistics service providers of advanced economies, Mexican logistics players are acquiring small start-up companies to gain access to new technologies. But the large majority of logistics service providers, mainly the smaller local companies, exhibit a high level of technological obsolescence. Most small players tend to have systems that cannot interoperate with those of manufacturers. This impedes traceability and smooth processing along the supply chain.

With its low level of digitization, the trucking industry represents a major bottleneck towards the 4IR transformation of the supply chain in LAC, limiting end-to-

end traceability and real-time decision-making. Multiple factors are causing this barrier. First and foremost, the trucking industry in the region is extremely fragmented and comprises a majority of small companies with the typical digitization barriers of SMEs: low investment capacity, limited capabilities and limited access to finance. As an illustration, of the approximately 150,000 trucking companies in Mexico, only 10 have sufficient scale to carry out a 4IR transformation initiative.[28] In Colombia, of around the 3,500 land transportation carriers,[29] the government estimates that no more than 100 companies have sufficient scale to adopt 4IR technologies.[30] Furthermore, interviewees report a reluctance to deploy technologies that would provide higher visibility of transportation delays.

Two trends are emerging from this logjam. First, logistics service providers are increasingly integrating trucking operations into their services, thus facilitating the deployment of digital technologies. Second, technology-based start-ups are entering the market, positioning themselves as matching platforms between logistics service providers (and exporters) and drivers. These include, for example, CargoX, Fretebras, Busca Cargas and Truckpad in Brazil,[31] and Humber, Circular and Avancargo in Argentina. They provide digitization capabilities and are attempting to solve the coordination failure between logistics service providers and the trucking sector.

Customs agencies

Some progress has been made to implement single window service and simplify trade procedures. Nevertheless, LAC countries still lag in the adoption of international best practices. This is evident, for example, in the time needed for foreign trade documentary compliance procedures (Figure 9).

Telecommunications networks

Fixed broadband provides the infrastructure needed to link manufacturing facilities, suppliers, distribution centres and gateways. However, access (service coverage) must be accompanied by broadband speed, which is critical to downloading and uploading information onto the network.[32] Wireless broadband (at a reasonable speed, such as supplied by 4G technology) is needed to provide supply chain stakeholders with access to information at any location, for instance allowing logistics providers and shippers to monitor cargo flows. The lack of wireless broadband connectivity in remote areas hinders supply chain visibility.

Although LAC countries have reached an important level of wireless broadband coverage, they trail OECD member countries in the key indicators of telecommunications infrastructure development.

Figure 9: Comparative time required for foreign trade documentary compliance procedures (2018, in hours)

Country	Export	Import
Argentina	30	192.0
Brazil	12	48.0
Colombia	60	64.0
Dominican Republic	10	14.0
Mexico	8	17.6
Paraguay	24	36.0
BENCHMARKS		
Netherlands	1	1.0
Singapore	2	3.0

Source: Country data in World Bank, *Doing Business 2018*, 2018.

2.5. The integration of public-sector efforts within a single framework

Although no country is focusing specifically on Supply Chain 4.0, several related government programmes and plans have been launched (Figure 10).

The lack of a holistic national strategy matches the limited institutional coordination between the multiple government entities whose policies influence the transformation of the supply chain. Furthermore, private-sector awareness of government policies and initiatives that have been created to enhance technology adoption in sectors or processes related to supply chain operations is limited. This finding, in and of itself, is particularly striking, considering some governments' level of effort so far to develop programmes intended to enhance the 4IR transformation.

Figure 10: Public-sector initiatives in Latin America and the Caribbean that affect key aspects of Supply Chain 4.0

Initiatives	Argentina	Brazil	Colombia	Dominican Republic	Mexico	Paraguay
Industry 4.0	National Innovation Digital Industry 4.0 Plan R&D Innovation Clusters	National Strategy for Industry 4.0 Brazilian Strategy for Digital Transformation	Production Transformation Programme	Competitiveness Improvement Plan SME Digital Economy Projects	Industry 4.0 Prosoft 4.0	Vision Paraguay 2030
Logistics		National Plan for Logistics and Transportation	National Logistics Policy	National Logistics and Cargo Transportation Plan	National Plan of Transport and Logistics 2014-2018	National Logistics Plan
Transportation	Belgrano Plan Infrastructure PPPs		Transportation Master Plan 2010-2032	Port Authority Strategic Plan	Transportation Investment Programme 2013-2018	Transportation Master Plan
Telecommunications	Federal Fibre Optic Network	National Broadband Plan National IoT Plan	Vive Digital	Digital Agenda 2016-2020	National Digitization Strategy	National Telecommunications Plan
Financial Transactions	National Cyber-security Strategy	Information, Communications and Cybersecurity Strategy	Sectorial Strategic Plan		Financial Reform	National Cybersecurity Plan
Customs	Single window for foreign trade Secretariat of Production Simplification		Customs Strategic Plan		Customs Modernization Plan	Customs Strategic Plan

Source: Compiled by the authors.

3. Accelerating Supply Chain 4.0 in Latin America and the Caribbean

The 4IR transformation of the supply chain is critical for the economic growth of LAC countries. Supply chain efficiency determines the competitiveness of companies and industries, as well as the attractiveness of countries. The adoption of 4IR technologies can significantly improve supply chain performance. Therefore, the 4IR transformation of the supply chain should be at the top of the economic policy agenda.

LAC countries can benefit from the list of recommendations emerging from this study, structured according to five action areas identified in the assessment of the current situation as described above:

- The various stages of supply chain transformation by sector
- The challenges related to the regional context
- The limited awareness and readiness of the SME sector
- The limitations of supply chain enablers
- The lack of integration of public-sector efforts within a single framework.

3.1. Learning from the leading industry sectors

The assessment of the differences in sectors' implementation of the 4IR transformation of the supply chain reveals some sectors are more advanced than others. Subsidiaries of MNCs learn from the experience of their operations in advanced economies. In addition, "multilatinas" are ahead of local companies. What lessons can be learned from the leaders?

First, a holistic approach to the 4IR transformation of the supply chain is critical. In LAC countries, most 4IR transformation efforts have been concentrated within factories and at the company level, without taking into consideration the interrelationship with suppliers, distributors or logistics service providers.

Second, companies need a clear roadmap for Supply Chain 4.0. The 4IR transformation of the supply chain, particularly for companies in such "traditional" industries as textiles, steel and heavy manufacturing, requires not just the adoption of 4IR technologies but also a fundamental change in mindset and operating model. Accountability for the transformation's implementation must come from the top level of the enterprise.

Third, "sitting on the fence" is a risky strategy. Companies should experiment and seek joint pilots and implementation opportunities with partners in the supply chain in order to assess the broader potential of the transformational changes.

Fourth, in conducting technology experimentation, companies should monitor local start-up environments to identify new technologies, applications and innovative business models. Start-ups and research labs are catalysts synthesizing knowledge. Partnerships or outright acquisitions are ways to acquire cutting-edge knowledge and talent. LAC has a vibrant start-up community in the fields of e-commerce and logistics.

Fifth, companies should also explore technology applications that are adapted to the region's infrastructure conditions. If telecommunications networks are insufficiently developed to provide ultra-broadband or high-speed wireless, companies can consider low technology approaches.

Public policy can also fulfil a role in fostering the 4IR transformation of the supply chain among large enterprises. For example LAC governments should support the development of data standards for interorganizational communications and, importantly, once defined, accept the standards and adopt the digital tools in governmental processes. Private-sector reports disclose that, despite digital processing, government agencies regularly still request paper versions of documents. In view of the idiosyncrasies of Latin America, the German and South Korean approach to standards development, in which the private and public sectors collaborate, is advisable. In these countries, the government assumes a leading role in driving the migration to common standards but includes the private sector in its definition and implementation. Supranational standardized efforts, such as the agreement concluded between Germany, France and Italy, can supplement the effort.

3.2. Dealing with the challenges of the regional context

The region faces a number of specific barriers to the 4IR transformation of the supply chain, including low labour costs, the limited availability of knowledge and technology locally, and cultural resistance.

Technology costs are falling, such that emerging country and cheap labour is losing its competitive advantage. Three years ago, radio frequency identification costs were three to four times more expensive than human labour for a major Mexican distribution company, but that gap has narrowed today to 40%. A similar trend can be observed pertaining to robots performing specific, automated tasks. Also, even if the ROI is not positive in the short run, over time, 4IR enabled supply chain processes will become less expensive, particularly when derived effects, such as zero quality defects, start reducing costs (as has been shown in the manufacturing sector in Germany). In addition, the disruption risk of companies that do not transform is very high.

The technological knowledge and talent needed can be enhanced through collaborative agreements with universities and research institutions. Governments can also play a role, as witnessed by the Manufacturing USA network in the United States, the Fraunhofer Society in Germany and the Industrial Value Chain Initiative in Japan.

Companies should work with labour unions to mitigate any labour force disruption risks that could result from efforts to implement the digital transformation of supply chains. Mitigation measures include ensuring open and continuous communication, and offering training programmes to address skills mismatches, which could be rolled out in coordination with governments.

3.3. Supporting the SME sector

Many LAC governments have programmes that focus on upgrading the capabilities and technology infrastructure of SMEs. Examples include the digital economy projects aimed at SMEs established by the Ministry of Industry, Commerce and SMEs of the Dominican Republic, the National Institute of Industrial Technology in Argentina, and the digital transformation support centres deployed by the Ministry of ICT of Colombia. However, their primary emphasis is on the adoption of mature technologies, rarely addressing the 4IR transformation of the supply chain.

The lessons that can be learned are, first, governments should emphasize the deployment of technology centres that concentrate on specific sectors aimed at providing training and test beds for SMEs to develop capabilities in support of 4IR transformation. Industry, academia and government agencies need to collaborate to develop roadmaps or "how to" books for small private-sector companies. An example of such an initiative is the toolkit developed by the Digital Manufacturing and Design Innovation Institute in the United States. Joint technology centres should also be created, like the Italian Intelligent Factory Cluster (*Fabbrica Intelligente*) for the promotion of innovative manufacturing platforms. This activity could leverage technology vendors for workforce training and use case development.

Second, LAC governments can partner with innovative companies to develop digital capabilities within SMEs – leveraging their spillover power. Examples are the Spanish partnership model between the public sector and private companies that served to launch the *Industria Conectada 4.0* effort, and the peer network of private-sector executives enrolled within France's *Industrie du Futur*.

Third, policy initiatives can be deployed to stimulate innovation in the area of Supply Chain 4.0. The need to reduce federal and state taxes and import duties and to simplify the levy structure is critical to provide the right incentives. Governments should support the development of start-ups that are focusing on specific supply chain use cases, in particular for SMEs. Assistance should include financial support and the development of facilitating environments.

3.4. Accelerating the development of supply chain enablers

Most governments in the region are already engaged in programmes to upgrade the transportation and gateway infrastructures.

Some lessons in this area are, first, governments need to make a concerted effort to upgrade the technological capability of customs agencies. Progress has already been made through the implementation of single window clearance and non-intrusive cargo controls.

Second, the lack of 4IR transformation within the trucking sector is a fundamental bottleneck. Government, industry associations and chambers of commerce have a key role to play in building awareness and knowledge across small enterprises. Academia can provide use cases and benefit metrics that could help convince transportation SMEs of the digital transformation payoff. Digital transformation champions can help to propel the benefits among their peers (through the "demonstration" effect). Subsidizing programmes aimed at facilitating the purchase and installation of equipment, for example combined with low-emission policies, can complement these efforts.

Third, governments can consider creating a technology position with policy capability (e.g. a Chief Information Officer/Chief Technology Officer position) within infrastructure-focused ministries to increase sensitivity to 4IR transformation needs. Such a position can be created within ministries of transportation with responsibility to design a technology transformation policy for the transport sector (as is the case in Colombia). A similar institutional change could be made in the ministries of industry to develop policies aimed at the 4IR transformation of the supply chain.

3.5. Developing integrated policy frameworks

Like in Singapore's Industry 4.0 and China's 2035 vision, the Supply Chain 4.0 policy strategy needs to be integrated. Industry 4.0 and logistics strategy efforts are deployed in some countries (e.g. in Brazil and Mexico) but they need to be integrated within a national infrastructure plan that targets all transportation modes. Germany's 2030 Federal Transport Infrastructure Plan and Maritime Agenda 2025 serve as references as the programmes link logistics to digitization. National infrastructure and logistics plans should address the 4IR transformation. Industry 4.0 plans should include the 4IR transformation of the supply chain as a key axis.

These plans appear to be most effective when enacted as state policy. The political electoral cycle and the volatile business environment in many LAC countries influence the pace of investment in technology, which needs a more stable long-term horizon to reap the benefits of investment efforts. High-level policy endorsements by representatives from the public and private sectors can introduce a certain level of certainty within economic policies. An example of how to involve the private sector can be found in the development of the Dominican Republic's logistics and transportation plan.

Once this strategy is formalized, it is important to define an institutional setting that fosters collaboration among various government agencies to achieve policy integration. Coordination at the federal/national level should be complemented by linkages to state and local governments. In turn, the highest levels of the executive branch of government (e.g. the presidential cabinet) should foster interagency collaboration. Elements of institutional leadership can be seen in Germany's Federal Ministry for Economic Affairs.

Finally, the development of policies oriented towards fostering Supply Chain 4.0 needs to be supported by up-to-date information on the state of the 4IR transformation at the different supply chain nodes and processes, especially where the public sector intervenes so that enhancement actions can be implemented if needed. This could be facilitated by creating a 4IR transformation observatory, or assigning this mandate to an existing institution, supported by digital transformation measurement indices.

3.6. The way forward

The analysis of practices in advanced economies and the examination of lessons learned, as well as the assessment of the situation in LAC, have led to defining a range of initiatives grouped along five action areas with respective implementation responsibilities (Figure 11).

The future development of LAC is contingent upon governments, the private sector and civil society confronting this challenge and building the necessary coordination mechanisms to make the 4IR transformation of the supply chain a reality.

Figure 11: Initiatives to accelerate the development of Supply Chain 4.0 in Latin America and the Caribbean

Action area	Public Sector	Private Sector	Public-Private Collaboration
1. Learning from the leading sectors	Implement cybersecurity frameworks to prevent supply chain disruptions Drive the development of supranational standards for a digitized supply chain	Expand the internal focus of digital transformation to addressing supply chain interrelationships Develop a roadmap for the digital transformation of the supply chain Assign roadmap responsibility to senior management Promote technology experimentation through limited pilots Monitor local start-ups to identify potential applications and technologies Develop cyber-prevention capability	Accelerate the work aimed at developing data standards for intercorporate supply chain communications Establish public-private cybersecurity prevention mechanisms
2. Dealing with the challenges of the regional context	Develop training programmes to address human capital limitations and labour skills mismatches	Consider low technology approaches feasible to implement in the Latin American environment	Consider the local environment in the development of national plans
3. Supporting the SME sector	Address supply chain digital transformation in existing SME support programmes Deploy technology centres focused on specific sectors aimed at providing training and test beds for SMEs to develop capabilities in support of their digital transformation Reduce federal and state taxes and import duties, and simplify the levy structure to provide the right incentives to digitally transform the supply chain Support the development of start-ups that are focusing on specific supply chain use cases with advanced technologies	Establish test beds and capacity building centres to support suppliers Develop inclusive training programmes and open them up to the employees of suppliers Build consortia to increase negotiating power when it comes to the acquisition of technology	Develop roadmaps or "how to" books to help small private-sector companies launch their digital transformation journey Partner with leading private companies to create joint technology centres Enrol large and innovative companies to partner with government to develop digital capabilities within SMEs Leverage technology providers for training programmes
4. Accelerating the development of supply chain enablers	Put in place a subsidization programme aimed at facilitating the acquisition and implementation of digital technologies among trucking companies Develop an aggressive programme to upgrade the technology and operational capability of customs	Develop start-ups aimed at addressing coordination failures in the supply chain (transportation matching networks, AI port applications)	Implement a communications campaign targeted at trucking companies to explain the benefits to be derived from digital transformation Consider identifying champions that could help to propel the transformation benefits among their peers (through the "demonstration" effect)
5. Developing integrated policy frameworks	Address the issue of digital transformation in the recommendations and programmes of national infrastructure and logistics plans Include the digital transformation of the supply chain as a key axis in Industry 4.0 plans Build an IT policy function within the ministries of transportation with responsibility to design a technology transformation policy for the transport sector Make a similar institutional change in the ministries of industry to develop policies aimed at the digital transformation of the supply chain In developing plans for all supply chain nodes (gateways, transportation infrastructure, customs), consider the contribution of digital and advanced technologies Create a digital transformation observatory	Establish long-lasting mechanisms (beyond electoral cycles) to exchange information and lessons learned with the government on a regular basis, and to inform the devel-opment of future policies	Involve the private sector in the development of national plans aimed at digitally transforming the supply chain

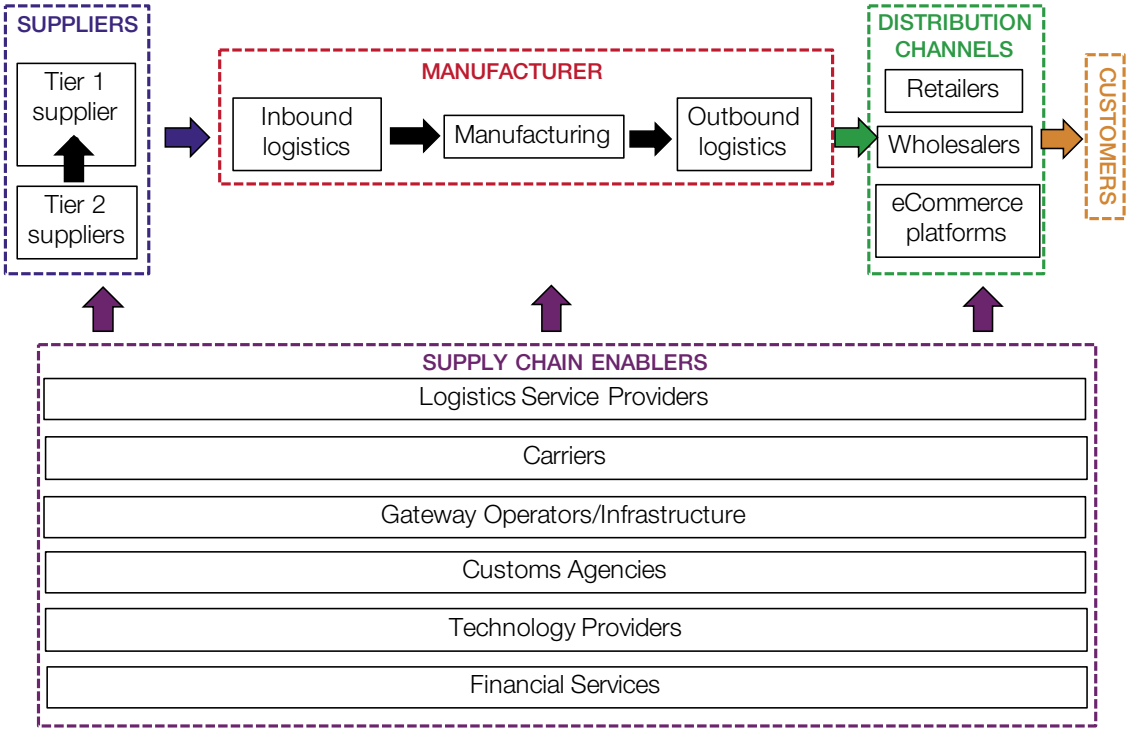
Source: Compiled by the authors.

Appendices

Appendix 1. The global supply chain landscape

The supply chain comprises all business processes ranging from inbound logistics, to manufacturing, outbound logistics, distribution channels and customer care. These processes are either conducted and/or enabled by multiple stakeholders (Figure A).

Figure A: Stakeholders along the supply chain



Source: Developed by the authors.

The main stakeholders conducting the aforementioned business processes comprise the suppliers of inputs and services, manufacturers and distribution channels. The interaction between these key players is influenced and/or facilitated by a number of enablers, including logistics service providers,[33] gateway operators/infrastructure providers (ports, terminals, telecommunications), carriers (air, maritime freight, trucking companies), customs agencies, technology suppliers and financial intermediaries. The performance of supply-chain enablers has a direct impact on the efficiency with which the supply chain operates.

The assessment of supply-chain trends and digitization adoption dynamics by stakeholder has yielded a number of enablers and barriers to implementation. Its review indicates that, while the economic benefit of a digitized supply chain is obvious, as explained in sections 1 and 2, a number of challenges remain within each supply chain node and group of stakeholders (Figure B).

Figure B: Enablers and barriers to Supply Chain 4.0

Stakeholders	Enablers of Supply Chain 4.0	Barriers to Supply Chain 4.0
Tier 1 suppliers	Co-location of systems and facilities with large manufacturers Co-investment of infrastructure upgrades	Lack of internal knowledge and human capital, and limited access to investment funds
Tier 2 suppliers	Supplier discounts and co-investments: Cognizant of the limited resources of small manufacturers, the information technology supplier provides them with substantial discounts, even co-investing with them	IT solutions and use cases focused primarily on large manufacturers, leaving SMEs and tier 2 players underserved Limited investment capacity Lack of human capital
Large manufacturers	New technologies, such as application programming interfaces (APIs) and web-calling, are replacing the older electronic data interface (EDI) technologies to interface with all suppliers of transport, distribution and manufacturing services in a supply chain Standards for inter-organizational connectivity developed within vertical communities of interest (with or without government stewardship) Consumer pressure for more transparency that can only be established through the use of advanced technology Start-up acquisition for sourcing innovative applications and technology	Unclear return on investment Organizational barriers to supply-chain innovation (fear of experimentation, innovator's dilemma) Technological immaturity (e.g. technological instability) Low technology adoption at gateways, less favourable zones for location of distribution centres, limited flexibility of taxation, interface complexity with customs agencies, and high trade regulations Limited access to human capital Disparate nature of technologies (premature obsolescence, limited interoperability) Underdeveloped national infrastructure (from roads to ports to telecommunications) Dependence upon inefficient transport industry structures (either highly fragmented or monopolistic)
Small and medium-sized manufacturers	Government policies clearly focused on upgrading SME capabili-ties and providing low-cost solutions	Limited financial and human capital resources, less familiarity with advanced technologies, and competing priorities
Logistics service providers	Customer pressure to provide a response to growing digitization needs of manufacturers and their tier 1 suppliers Industry competition and/or disruption by internet platforms Co-development with large manufacturers to foster the digitization of logistics service providers	Reliance on subcontractors, which are not really capable of connecting to the platforms Low margins constraining technology investment
Small and medium-sized logistics service providers	Interface with large logistics players acting as an incentive to digitize	Resource shortfalls, scepticism about recovery of sunk costs, and low margins
Carriers	Competitive pressure, particularly in air and maritime transport	Trucking companies (particularly SMEs) less prone to respond to the needs emerging from large manufacturers due to concerns about enhanced transparency, interface and business complexity, and limited access to capital and human resources
Gateway/infrastructure providers	Gateways actively investing in robotics, streamlining operational flows, and automated carrier handling, digital tools and information flows, leading to the smart gateway concept	National telecommunications infrastructure is not up the level required by current supply chains, e.g. to ensure end-to-end traceability (limited geographic coverage, low signal strength) Lack of coordination and harmonization of digital strategies implemented by gateways (especially ports) No specific policies to improve technology adoption in infrastructure, plans lack coordination with other Fourth Industrial Revolution or technology plans
Technology suppliers	Interoperability among different systems allowing improved functional integration Large technology providers offering implementation support	
Governments	Investments: Infrastructure investment (airports, ports, terminals, corridors, free trade zones) having a spillover impact throughout the supply chain Governments provide financial stimulus, ranging from tax credits for applications piloting to workforce and management training, to SMEs and tier 2 suppliers' incentives to tackle the digital transformation of their value chain Government development of industry maturity roadmaps Government definition of standards and protocols to support interoperability across platforms and systems Governments setting up regulatory sandboxes where companies can test new technologies at lower risk for the society (e.g. regarding UAV, truck platooning)	Limited coordination of government programmes and policies across supply chain nodes Infrastructure and gateway investments not articulated within a master plan that takes into consideration the needs of supply chains Regulatory constraints regarding UAVs, driverless vehicles, and data protection are also barriers to the digital transformation Lack of specific supply chain transformation policies No technology policy function within ministries of transport or industrial development

Source: Developed by the authors.

As Figure B indicates, the barriers to achieve a transformation of the supply chain are numerous. Large manufacturers actively tackle some of them through internal efforts. For example, potential bottlenecks by carriers or mid-size logistics service providers are dealt with by selecting those players that are more responsive to their requirements and deploying bypassing technologies that enable full chain visibility.

Additionally, standards for inter-organizational connectivity are being developed within manufacturers vertical communities of interest (with or without government sponsorship). Streamlined relationships between large manufacturers and tier 1 suppliers ensure adequate support on the part of the latter group. Finally, if large manufacturers need advanced technology access, they are ready to procure it through acquisition of start-ups, outsourcing with systems integrators and agreements with research centres and universities.

In sum, large manufacturers are actively transitioning towards the Fourth Industrial Revolution transformation of their supply chains. In doing so, they still face some exogenous challenges in areas where public policy can foster such transformation, including trade policies, customs controls, and taxation of imported equipment needed to deploy digital applications. Importantly, as shown in Figure B, other supply chain actors such as small manufacturers, tier 2 suppliers and small and medium-sized logistics service providers and carriers face a number of challenges that are delaying the end-to-end transformation of the supply chain.

Appendix 2. The state of Supply Chain 4.0 in Latin America and the Caribbean – country profiles

1. Argentina

1.1. Country's competitiveness position

– The Argentinian economy ranks 92nd in terms of its competitiveness,[34] having improved 14 positions in recent years, boosted by a better institutional performance, technological adoption, business sophistication, and innovation, indicating a reconversion process and reflecting new sources of growth.

– Argentina ranks 50/100 in terms of its structure of production (complexity and ubiquity of its manufacturing base) and 75/100 in terms of current levels of readiness across a series of drivers of production (from technology and innovation to human capital and sustainability). This means the country needs to increase its investment when it comes to laying the foundations to successfully transition towards the future of production.[35]

– The country exhibits a relatively advanced digitization level when compared to its Latin American peers, but lags considerably with regard to OECD countries.

1.2. Key government initiatives with impact on Supply Chain 4.0

– Digital Industrial Innovation 4.0: spearheaded by the Ministry of Modernization with the objective of fostering the digitization of SMEs
– R&D development hubs: national network of 51 clusters specialized in food and beverages; textiles, fabrics and leather products; aeronautics and space; quality, design and development of products; construction, materials and processes
– Secretariat of Production Simplification: Agency in charge of streamlining government processes
– Fibre Optic Federal Network: Lighting up of 20,000+ km of state-owned fibre-optic backbone
– Single Window for Foreign Trade: Single point of contact for foreign trade processes
– Software promotion Law: Incentives for the development of software industry
– Belgrano Plan: Modernization of railway system in the North-West region
– Infrastructure PPPs: $26.5 billion programme in public-private partnership investment, of which $12 billion is focused on 2,800 km in highways and 4,000 km in safe road projects
– National cybersecurity strategy

Argentina - Ranking in terms of competitiveness and digitization

/	Argentina		First Latin American Country	Average OECD
	Position in Latin America	Index		
ICT Development Index (UIT) – 2017	Second	6.79	Uruguay (7.16)	7.74
Network Readiness Index (World Economic Forum) – 2016	Seventh	3.80	Chile (4.60)	5.24
E-Government Development Index (UN) – 2018	Second	0.7335	Uruguay (0.7858)	0.84
Digitization Index (TAS) – 2018	Seventh	55.18	Chile (61.34)	67.25
Digital Ecosystem Development Index (CAF) - 2015	Sixth	51.12	Chile (59.81)	64.94
B2C E-commerce index (UNCTAD) – 2016	Fourth	51.90	Uruguay (62.6)	75.05
Knowledge Economy Index (World Bank) – 2012	Fourth	5.65	Chile (7.25)	8.20
Global Innovation Index (Cornell-WIPO) – 2017	Seventh	32.00	Chile (38.7)	52.91
Broadband development Index (BID) – 2014	Fourth	4.73	Chile (5.76)	6.13
Ease of Doing Business (World Bank) – 2018	Sixteenth	58.11	Mexico (72.27)	78.00
Logistics performance Index (World Bank) – 2018	Fifth	2.93	Chile (3.32)	3.74
World Competitiveness Ranking (IMD) – 2018	Fourth	57.986	Chile (75.107)	

Source: Analysis based on data from ITU, World Economic Forum, UN, TAS, CAF, UNCTAD, World Bank, WIPO and IADB.

1.3. State of Supply Chain 4.0 – Selected sectors

Automotive	Food Processing	Textiles	Appliances
Automotive companies and tier 1 suppliers have digital transformation strategies developed in head offices and progressively deployed to the subsidiaries; however, Argentina is likely to implement transformation strategies after Brazil and Mexico High-end car producers exhibit a more advanced level of Fourth Industrial Revolution transformation; local vehicle manufacturers are less developed Tier 1 Argentinian suppliers that are part of global supply chains also depict a high level of transformation	Fourth Industrial Revolution transformation is driven by the degree of integration to global supply chains: sub-sidiaries of foreign MNCs have a clear digital trans-formation strategy; how-ever, deployment rate is behind other countries	Companies lack a Fourth Industrial Revolution transformation strategy, and lag significantly in terms of technology adoption in their supply chain. The erosion in competitiveness has not favoured the investment required to upgrade manufacturing capacity The sector exhibits a high SME preponderance, less prone to adopt Fourth Industrial Revolution technologies	Current changes in competitiveness dynamics, combined with the macro-economic context, have forced companies to a "low intensity" Fourth Industrial Revolution transformation strategy

Source: Interviews.

Argentina - Adoption and challenges to the implementation of Supply Chain 4.0

Sector	Strategic Importance (% of country's GDP)	Implementation in Argentina (0: low – 3: high)[1]	Supply Chain Challenges								
			Transport infrastructure	Human capital limita-tions	Labour union resistance	Telecommunications infrastructure	Limited integration with suppliers and distributors	Limited integration with logistics service providers	Internal organization silos	Limited technology availability	Norms and standards
Automotive	2.37	2.25	M	L	L	L					
Food processing	9.79	1.75	H	H		L	H	L	L	L	M
Textiles	1.84	0.75	H		L	L	H	H	L	L	L
Appliances	1.45	1.50	H	H	L		M		H		M

Notes: H: High; M: Medium; L: Low.
[1] Defined based on interviews and secondary market research.
Source: Authors.

1.4. State of development of supply chain enablers
(number in brackets is world ranking)

- **Infrastructure (roads, railways and telecommunications)**
  - Infrastructure Quality Index 2018 (World Bank): 2.77 (62)
  - Efficiency of seaport services 2018 (World Economic Forum): 3.7 (81)
  - Efficiency of air transport services 2018 (World Economic Forum): 4.3 (83)

- **Logistics service providers**
  - Logistics quality and competence indicator 2018 (World Bank): 2.78 (68)
  - Tracking and tracing indicator 2018 (World Bank): 3.5 (58)

- **Customs**
  - Customs Efficiency Index 2018 (World Bank): 2.42 (98)
  - Time required for foreign trade documentary compliance (World Bank 2018): 192 hours (Import); 30 hours (Export)

- **Telecommunications networks**
  - 4G coverage of population 2018 (GSMA): 98%
  - Average fixed broadband speed 2018 (Akamai) (Mbps): 6.45

2. Brazil

2.1. Country's competitiveness position

- The Brazilian economy ranks 80th in terms of its competitiveness,[36] having declined five positions in the last four years as a result of a lower institutional performance and worsening macroeconomic conditions; this decline was somewhat cushioned by technological adoption, business sophistication and innovation.

- Brazil ranks 41/100 in terms of its structure of production (complexity and ubiquity of its manufacturing base) and 47/100 in terms of current levels of readiness across a series of drivers of production (from technology and innovation to human capital and sustainability); this means the country needs to increase its investment when it comes to laying the foundations to successfully transition towards the future of production.[37]

- The country exhibits an intermediate digitization level when compared to its LAC peers, but lags considerably with regard to OECD countries.

Brazil - Ranking in terms of competitiveness and digitization

/	Brazil		First Latin American Country	Average OECD
	Position in Latin America	Index		
ICT Development Index (UIT) – 2017	Fifth	6.12	Uruguay (7.16)	7.74
Network Readiness Index (World Economic Forum) – 2016	Sixth	4.00	Chile (4.60)	5.24
E-Government Development Index (UN) – 2018	Fourth	0.7327	Uruguay (0.7858)	0.84
Digitization Index (TAS) – 2018	Eighth	49.23	Chile (61.34)	67.25
Digital Ecosystem Development Index (CAF) - 2015	Fifth	50.55	Chile (59.81)	64.94
B2C E-commerce index (UNCTAD) – 2016	Third	56.20	Uruguay (62.6)	75.05
Knowledge Economy Index (World Bank) – 2012	Second	6.14	Chile (7.25)	8.20
Global Innovation Index (Cornell-WIPO) – 2017	Seventh	33.10	Chile (38.7)	52.91
Broadband development Index (BID) – 2014	Third	5.22	Chile (5.76)	6.13
Ease of Doing Business (World Bank) – 2018	Fourteenth	56.45	Mexico (72.27)	78.00
Logistics performance Index (World Bank) – 2018	Fourth	2.99	Chile (3.32)	3.74
World Competitiveness Ranking (IMD) – 2018	Sixth	55.80	Chile (75.107)	83.79

Source: Analysis based on data from ITU, World Economic Forum, UN, TAS, CAF, UNCTAD, World Bank, WIPO and IADB.

2.2 Key government initiatives with impact on Supply Chain 4.0

– National Strategy for Industry 4.0: Developed by the Ministry of Industry, Trade and Services; programme is managed by the Brazilian Agency of Industrial Development to provide support to test new products in technology companies; additionally, the entity is currently working to define robotics standards and precision agriculture strategy

– Brazilian Strategy for Digital Transformation: Developed by the Ministry of Science and Technology, this initiative sets the guidelines for the digitization of the Brazilian economy, through the acceleration of digitization of production processes in agriculture, commerce, finance, manufacturing, and transport and logistics services

– Route 2030: Developed jointly by the Ministry of Finance and the Ministry of Industry, Trade and Services, this programme is focused on a specific industrial policy and incentives to bring innovation to the automotive supply chain, including suppliers of auto parts and car manufacturers

– National IoT Plan

– National Plan for Logistics and Transport: Developed by the Ministry of Transport, the programme's primary objective is to develop a more balanced transport matrix with a significant participation of rail and water modes

– National Plan of Port Logistics

– Information, Communications and Cybersecurity Strategy

2.3. State of Supply Chain 4.0 – Selected sectors

Automotive	Food Processing	Textiles	Appliances
Among the selected sectors, this is the most advanced in terms of Fourth Industrial Revolution transformation of the supply chain However, this is not consistent across companies The subsidiaries of MNCs are lagging in Fourth Industrial Revolution technology adoption when compared with operations of same companies in Europe, US and China	The Fourth Industrial Revolution transformation of the supply chain is more advanced in companies that have multi-country subsidiaries (either MNCs or "multi-Latinas") Some sub-sectors lag given that slim margins constrain investments in new technologies	Relatively advanced inter-relationship with distribution channels (Real time control of inventory management at the retailer in order to manage production batches) Digital development of design to be shared with retailers before sent to production Systems to track production orders status for completion	MNCs are more advanced, mainly in manufacturing processes; however, interviewees report investments to be constrained by tax duties on imported technologies

Source: Interviews.

Brazil - Adoption and challenges to the implementation of Supply Chain 4.0

Sector	Strategic Importance (% of country's GDP)	Implementation in Brazil (0: low – 3: high)[1]	Supply Chain Challenges								
			Transport infrastructure	Human capital limitations	Labour union resistance	Telecommunications infra-structure	Limited integration with sup-pliers and distributors	Limited integration with logis-tics service providers	Internal organization silos	Limited technology availabil-ity	Norms and standards
Automotive	1.68	2.5	M	H	H	H	M	H			H
Food processing	6.15	2.0	H	M	L		M			H	H
Textiles	1.56	1.7	H	M	L		M				
Appliances	0.74	2.0	H	M	L		M				H

Notes: H: High; M: Medium; L: Low.
[1] Defined based on interviews and secondary market research.
Source: Authors.

2.4. State of development of supply chain enablers
(number in brackets is world ranking)

- **Infrastructure (roads, railways, and telecommunications)**
  - Infrastructure Quality Index 2018 (World Bank): 2.93 (50)
  - Efficiency of seaport services 2018 (World Economic Forum): 3.1 (105)
  - Efficiency of air transport services 2018 (World Economic Forum): 4.4 (73)
- **Logistics service providers**
  - Logistics quality and competence indicator 2018 (World Bank): 3.09 (46)
  - Tracking and tracing indicator 2018 (World Bank): 3.11 (51)
- **Customs**
  - Customs Efficiency Index 2018 (World Bank): 2.41 (102)
  - Time required for foreign trade documentary compliance (World Bank 2018): 12 hours (Export); 48 hours (Import)
- **Telecommunications networks**
  - 4G coverage of population 2018 (GSMA): 95%
  - Average fixed broadband speed 2018 (Akamai) (Mbps): 6.96

3. Colombia

3.1. Country's competitiveness position

- The Colombian economy ranks 66th in terms of its competitiveness, having improved three positions in the last five years,[38] boosted by human capital development, infrastructure enhancement and technological readiness.

- Colombia ranks 56/100 in terms of its structure of production (complexity and ubiquity of its manufacturing base) and 65/100 in terms of current levels of readiness across a series of drivers of production (from technology and innovation to human capital and sustainability) This means the country needs to increase its investment when it comes to laying the foundations to successfully transition towards the future of production.[39]

- The country exhibits a moderate digitization level when compared to its LAC peers, but lags considerably with regard to OECD countries.

Colombia - Ranking in terms of competitiveness and digitization

/	Colombia		First Latin American Country	Average OECD
	Position in Latin America	Index		
ICT Development Index (UIT) – 2017	Ninth	**5.12**	Uruguay (7.16)	7.74
Network Readiness Index (World Economic Forum) – 2016	Sixth	4.10	Chile (4.60)	5.24
E-Government Development Index (UN) – 2018	Seventh	0.6871	Uruguay (0.7858)	0.84
Digitization Index (TAS) – 2018	Sixth	55.77	Chile (61.34)	67.25
Digital Ecosystem Development Index (CAF) – 2015	Third	55.03	Chile (59.81)	64.94
B2C E-commerce index (UNCTAD) – 2016	Eleventh	44.60	Uruguay (62.6)	75.05
Knowledge Economy Index (World Bank) – 2012	Seventh	5.37	Chile (7.25)	8.20
Global Innovation Index (Cornell-WIPO) – 2017	Fifth	34.78	Chile (38.7)	52.91
Broadband development Index (IDB) – 2014	Fourth	5.13	Chile (5.76)	6.13
Ease of Doing Business (World Bank) – 2018	Third	69.41	Mexico (72.27)	78.00
Logistics performance Index (World Bank) – 2018	Fourth	2.94	Chile (3.32)	3.74
World Competitiveness Ranking (IMD) – 2018	Fifth	57.357	Chile (75.107)	83.79

Source: Analysis based on data from ITU, World Economic Forum, UN, TAS, CAF, UNCTAD, World Bank, WIPO and IADB.

3.2. Key government initiatives with impact on Supply Chain 4.0

- Programme of Transformation of Production
- National Logistics Policy
- Strategic Plan for National Customs Agency
- Transportation Master Plan 2010-2032
- Sectorial Strategic Plan

3.3. State of Supply Chain 4.0 – Selected sectors

Automotive	Food Processing	Textiles	Appliances
The sector is the most advanced with regard to a vision and implementation of Supply Chain 4.0 However, most of the digital transformation efforts occur within the manufacturer functions with less effort at the interface with either suppliers or distributors	Large companies share a similar level of awareness as the automotive sector Differences in level of transformation exist within sub-sectors (wherever the industry structure is more fragmented – fresh fruits, dairy, cocoa – the level of awareness is lower; in case the industry is more export-oriented, a higher level of digital transformation is registered)	The textile sector, with the exception of export-oriented maquiladoras, is a laggard when it comes to the digital transformation of the supply chain, primarily due to the lack of available technology spend-ing capacity	The appliances sector is behind the other three sectors in terms of industry 4.0 and digital transformation of the supply chain Large distribution retailers of appliances have already implemented fairly advanced electronic distribution channels and inventory management systems

Source: Interviews.

Colombia - Adoption and challenges to the implementation of Supply Chain 4.0

Sector	Strategic Importance (% of country's GDP)	Implementation in Colombia (0: low – 3: high)[1]	Supply Chain Challenges								
			Transportation infrastructure	Human capital limitations	Labour union resistance	Telecommunications infra-structure	Limited integration with sup-pliers and distributors	Limited integration with logis-tics service providers	Internal organization silos	Limited technology availabil-ity	Norms and standards
Automotive	0.29	2.0		L			H			L	H
Food processing	3.68	1.5	H	H		H	H				H
Textiles	1.32	1.5	M	M			H				H
Appliances	0.83	1.5	H	H			H				H

Notes: H: High; M: Medium; L: Low.
[1] Defined based on interviews and secondary market research.
Source: Authors.

3.4. State of development of supply chain enablers
(number in brackets is world ranking)

- **Infrastructure (roads, railways, and telecommunications)**
  - Infrastructure Quality Index 2018 (World Bank): 2.67 (72)
  - Efficiency of seaport services 2018 (World Economic Forum): 4.0 (72)
  - Efficiency of air transport services 2018 (World Economic Forum): 4.4 (80)
- **Logistics service providers**
  - Logistics quality and competence indicator 2018 (World Bank): 2.87 (56)
  - Tracking and tracing indicator 2018 (World Bank): 3.08 (53)
- **Customs**
  - Customs Efficiency Index 2018 (World Bank): 2.61 (75)
  - Time required for foreign trade documentary compliance (World Bank 2018): 60 hours (Export); 64 hours (Import)
- **Telecommunications networks**
  - 4G coverage of population 2018 (GSMA): 88 %
  - Average fixed broadband speed 2018 (Akamai) (Mbps): 5.63

4. Dominican Republic

4.1. Country's competitiveness position

- The Dominican Republic ranks 104th in terms of its competitiveness, having improved one position since 2013.[40] However, its ranking in macroeconomic environment, infrastructure and higher education improved significantly.

- The Dominican Republic ranks 71/100 in terms of its structure of production (complexity and ubiquity of its manufacturing base) and 80/100 in terms of current levels of readiness across a series of drivers of production (from technology and innovation to human capital and sustainability). This means the country needs to increase its investment when it comes to laying the foundations to successfully transition towards the future of production.[41]

- The country exhibits a transitional digitization level when compared to its LAC peers, although its ICT connectivity scores exhibit more developed levels.

Dominican Republic - Ranking in terms of competitiveness and digitization

/	Dominican Republic		First Latin American Country	Average OECD
	Position in Latin America	Index		
ICT Development Index (UIT) – 2017	**4.51**	**Fifth**	Uruguay (7.16)	7.74
Network Readiness Index (World Economic Forum) – 2016	3.60	Sixth	Chile (4.60)	5.24
E-Government Development Index (UN) – 2018	0.57	Tenth	Uruguay (0.7858)	0.84
Digitization Index (TAS) – 2018	46.14	Ninth	Chile (61.34)	67.25
Digital Ecosystem Development Index (CAF) – 2015	39.60	Thir-teenth	Chile (59.81)	64.94
B2C E-commerce index (UNCTAD) – 2016	39.90	Eleventh	Uruguay (62.6)	75.05
Knowledge Economy Index (World Bank) – 2012	4.12	Eleventh	Chile (7.25)	8.20
Global Innovation Index (Cornell-WIPO) – 2017	31.20	Ninth	Chile (38.7)	52.91
Broadband development Index (BID) – 2014	4.43	Ninth	Chile (5.76)	6.13
Ease of Doing Business (World Bank) – 2018	60.93	Ninth	Mexico (72.27)	78.00
Logistics performance Index (World Bank) – 2018	2.66	Eleventh	Chile (3.32)	3.74

Source: Analysis based on data from ITU, World Economic Forum, UN, TAS, CAF, UNCTAD, World Bank, WIPO and IADB.

4.2. Key government initiatives with impact on Supply Chain 4.0

- Strategic Plan of Ministry of Industry, Commerce and SMEs: Among its action plans, the programme identifies improvement of production processes, support for technology innovation in enterprises and workforce training
- Digital Economy Projects for SMEs: Implemented by the Ministry of Industry, Commerce and SMEs, the initiatives focus on transferring technology to SMEs, providing training and consulting services, fostering the development of electronic commerce and promoting the development of the software industry
- National Logistics and Cargo Transportation Plan: Developed by the Ministry of Industry and Commerce, the programme proposes the development of a National Logistics System (comprising regional highways, customs, port development, and foreign trade processes) and creating institutional accountability for plan implementation
- Strategic Plan of the Port Authority: With the goal of becoming the Caribbean shipping logistics hub, the plan is focused on upgrading and modernizing port management processes and infrastructure
- Digital Agenda 2016-2020: The agenda focuses on increasing broadband coverage, integrated e-government services, and promotion of ICT development industries
- Software Industry Development Program

4.3. State of Supply Chain 4.0 – Selected sectors

Automotive	Food Processing	Textiles
In the past five years, some companies have established global design centres and logistics hubs for regional distribution of finished products; however, Fourth Industrial Revolution technology adoption is at a very early stage	The Fourth Industrial Revolution transformation of the supply chain is more advanced in companies that have multi-country subsidiaries (either MNCs or "multi-Latinas") Some sub-sectors lag given that slim margins constrain investments in new technologies	The textile sector, with the exception of export-oriented maquiladoras, is a laggard when it comes to the digital transformation of the supply chain, primarily due to the lack of available technology spend-ing capacity

Source: Interviews.

Dominican Republic - Adoption and challenges to the implementation of Supply Chain 4.0

Sector	Strategic Importance (% of country's GDP)	Implementation in Dominican Republic (0: low – 3: high)[1]	Supply Chain Challenges								
			Transport infrastructure	Human capital limitations	Labour union resistance	Telecommunications infra-structure	Limited integration with sup-pliers and distributors	Limited integration with logis-tics service providers	Internal organization silos	Limited technology availabi-ity	Norms and standards
Automotive	1.56	2.0	M	L		L					
Food processing	7.23	2.0	M	L		L					
Textiles	1.97	2.5	M	L		L					
Appliances	1.84	1.5	M	L		L					

Notes: H: High; M: Medium; L: Low.
[1] Defined based on interviews and secondary market research.
Source: Authors.

4.4. State of development of supply chain enablers
(number in brackets is world ranking)

- **Infrastructure (roads, railways, and telecommunications)**
  - Infrastructure Quality Index 2018 (World Bank): 2.36 (135)
  - Efficiency of seaport services 2018 (World Economic Forum): 4.6 (43)
  - Efficiency of air transport services 2018 (World Economic Forum): 4.7 (60)
- **Logistics service providers**
  - Logistics quality and competence indicator 2018 (World Bank): 2.44 (108)
  - Tracking and tracing indicator 2018 (World Bank): 2.97 (65)
- **Customs**
  - Customs Efficiency Index 2018 (World Bank): 2.41 (103)
  - Time required for foreign trade documentary compliance (World Bank 2018): 1 hour (Export); 14 hours (Import)

– **Telecommunications networks**
  – 4G coverage of population 2018 (GSMA): 90%
  – Average broadband speed 2018 (Akamai) (Mbps): 4.54

5. Mexico

5.1. Country's competitiveness position

– The Mexican economy ranks 51st in terms of its competitiveness, having improved 10 positions in the last three years,[42] boosted by technological adoption, business sophistication and innovation, indicating a reconversion process and reflecting new sources of growth.

– Mexico ranks 22/100 in terms of its structure of production (complexity and ubiquity of its manufacturing base) and 46/100 in terms of current levels of readiness across a series of drivers of production (from technology and innovation to human capital and sustainability). This means the country still has a relatively solid manufacturing base but needs to continue strengthening its investments in the drivers of production to stay relevant.[43]

– The country exhibits a moderate digitization level when compared to its LAC peers, but lags considerably with regard to OECD countries.

Mexico - Ranking in terms of competitiveness and digitization

/	Mexico		First Latin American Country	Average OECD
	Position in Latin America	Index		
ICT Development Index (UIT) – 2017	Eleventh	4.87	Uruguay (7.16)	7.74
Network Readiness Index (World Economic Forum) – 2016	Eighth	4.00	Chile (4.60)	5.24
E-Government Development Index (UN) – 2018	Eighth	0.6818	Uruguay (0.7858)	0.84
Digitization Index (TAS) – 2018	Ninth	45.78	Chile (61.34)	67.25
Digital Ecosystem Development Index (CAF) – 2015	Ninth	45.70	Chile (59.81)	64.94
B2C E-commerce index (UNCTAD) – 2016	Sixth	49.10	Uruguay (62.6)	75.05
Knowledge Economy Index (World Bank) – 2012	Sixth	5.61	Chile (7.25)	8.20
Global Innovation Index (Cornell-WIPO) – 2017	Third	35.79	Chile (38.7)	52.91
Broadband development Index (BID) – 2014	Eighth	4.72	Chile (5.76)	6.13
Ease of Doing Business (World Bank) – 2018	First	72.27	Mexico (72.27)	78.00
Logistics performance Index (World Bank) – 2018	Fourth	2.94	Chile (3.32)	3.74
World Competitiveness Ranking (IMD) – 2018	Second	63.733	Chile (75.107)	83.79

Source: Analysis based on data from ITU, World Economic Forum, UN, TAS, CAF, UNCTAD, World Bank, WIPO and IADB.

5.2. Key government initiatives with impact on Supply Chain 4.0

– Industry 4.0: Programme organized around three axes: Deployment of R&D centres focused on Industry 4.0 technologies applied to key strategic sectors; creation of innovative ecosystems; and organization of competitiveness clusters

– National Plan of Transportation and Logistics (2014-18): The strategy is composed of four axes: Optimization and homologation of normative and operative frameworks in customs offices; standardization and certification programme for the national logistics industry; creation of an ecosystem that will enable the design of collaborative sectorial strategies; and design of a national strategy for Logistics 4.0

– Customs Modernization Plan

– National Digital Strategy: One of the five axes of the strategy is focused on technology adoption to transform the government; this comprises building the basis for interoperability within the government to improve the delivery of public services

– Transportation and Communications Infrastructure Investment Program 2013-2018: Defined a roadmap to upgrade the country's road and railroad network, including modernization of seven airports, building two new ports, enhancing three existing ones, and building 15 new highways, among several objectives

5.3. State of Supply Chain 4.0 – Selected sectors

Automotive	Food Processing	Textiles	Appliances
All automotive companies and tier 1 suppliers have a digital transformation strategy, developed in head office and progressively being deployed by subsidiaries Local market conditions dictate a prudent investment approach for digital transformation in Mexico There is no difference in digital transformation level between companies focused on mid-range cars relative to those that manufacture high-end cars	Fourth Industrial Revolution transformation is driven by the degree of integration to global supply chains Subsidiaries of foreign MNCs and "multi-Latinas" have a clear Fourth Industrial Revolution transformation strategy focused on supplier and distributor integration, while SMEs are lagging significantly	According to interviews, the dependence on US exports and on government regulations, combined with a low labour cost did not set the appropriate rules to incentivize investments in new technologies	The industry is primarily focused on potential impact of the outcome of free trade agreements; in this context, the Fourth Industrial Revolution transformation is not a sector priority; however, it would benefit from the improved performance of transport operations and reduction of transport costs derived from the adoption of digital technologies

Source: Interviews.

Mexico - Adoption and challenges to the implementation of Supply Chain 4.0

Sector	Strategic Importance (% of country's GDP)	Implementation in Mexico (0: low – 3: high)[1]	Supply Chain Challenges								
			Transport infrastructure	Human capital limitations	Labour union resistance	Telecommunications infra-structure	Limited integration with sup-pliers and distributors	Limited integration with logis-tics service providers	Internal organization silos	Limited technology availabil-ity	Norms and standards
Automotive	2.03	2.80	H	M	L	M	M	M	M	H	H
Food processing	4.62	2.00	H	H	L	M	H	L	M		H
Textiles	0.61	2.25	M	M	L		H		M	M	H
Appliances	1.68	1.50	H		L			H	M	H	H

Notes: H: High; M: Medium; L: Low.
[1] Defined based on interviews and secondary market research.
Source: Authors.

5.4. State of development of supply chain enablers
(number in brackets is world ranking)

- **Infrastructure (roads, railways, and telecommunications)**
  - Infrastructure Quality Index 2018 (World Bank): 2.85 (57)
  - Efficiency of seaport services 2018 (World Economic Forum): 4.3 (60)
  - Efficiency of air transport services 2018 (World Economic Forum): 4.5 (70)
- **Logistics service providers**
  - Logistics quality and competence indicator 2018 (World Bank): 3.02 (52)
  - Tracking and tracing indicator 2018 (World Bank): 3.00 (62)
- **Customs**
  - Customs Efficiency Index 2018 (World Bank): 2.77 (53)
  - Time required for foreign trade documentary compliance (World Bank 2018): 8 hours (Export); 18 hours (Import)
- **Telecommunications networks**
  - 4G coverage of population 2018 (GSMA): 85 %
  - Average fixed broadband speed 2018 (Akamai) (Mbps): 7.68

6. Paraguay

6.1. Country's competitiveness position

- Paraguay ranks 112th in terms of its competitiveness, having improved 8 positions since 2014,[44] propelled by improvements in technological readiness, higher education and institutional performance.

- The country exhibits a moderate to low digitization level when compared to its LAC peers, but lags considerably with regard to OECD countries.

Paraguay - Ranking in terms of competitiveness and digitization

/	Paraguay		First Latin American Country	Average OECD
	Position in Latin America	Index		
ICT Development Index (UIT) – 2017	Thirteenth	4.18	Uruguay (7.16)	7.74
Network Readiness Index (World Economic Forum) – 2016	Fourteenth	3.40	Chile (4.60)	5.24
E-Government Development Index (UN) – 2018	Fourteenth	0.53	Uruguay (0.7858)	0.84
Digitization Index (TAS) – 2018	Thirteenth	41.83	Chile (61.34)	67.25
Digital Ecosystem Development Index (CAF) – 2015	Thirteenth	35.23	Chile (59.81)	64.94
B2C E-commerce index (UNCTAD) – 2016	Tenth	43.80	Uruguay (62.6)	75.05
Knowledge Economy Index (World Bank) – 2012	Thirteenth	3.87	Chile (7.25)	8.20
Global Innovation Index (Cornell-WIPO) – 2017	Tenth	30.30	Chile (38.7)	52.91
Broadband development Index (BID) – 2014	Thirteenth	3.84	Chile (5.76)	6.13
Ease of Doing Business (World Bank) – 2018	Tenth	59.18	Mexico (72.27)	78.00
Logistics performance Index (World Bank) – 2018	Eighth	2.78	Chile (3.32)	3.74
World Competitiveness Ranking (IMD) – 2018			Chile (75.107)	

Source: Analysis based on data from ITU, World Economic Forum, UN, TAS, CAF, UNCTAD, World Bank, WIPO and IADB.

6.2. Key government initiatives with impact on Supply Chain 4.0

- National Development Plan 2030: Includes two action clusters related to digital transformation (Competitiveness and Innovation, Regionalization and Production Diversification)
- Paraguay Digital Agenda: Includes, among other objectives, the quality improvement of government services, ICT usage in enterprises and enhancement of broadband connectivity
- National Logistics Plan: Guided by three objectives: Build efficient regional supply chains; reduce transaction costs; and increase export opportunities
- National Telecommunications Plan 2016-2020
- National Customs Agency Strategic Plan 2015-2018: Digitize services, provide better security in the supply chains, strengthen logistics chains with security and transparency
- ICT National Plan
- Transport Master Plan: Near- and mid-term development of transport infrastructure
- National Cybersecurity Plan: Comprises six actions related to security in the supply chain (SME adoption of cybersecurity protocols, promotion of cybersecurity standards, regional coordination with other nations, etc.)

6.3. State of Supply Chain 4.0 – Selected sectors

Automotive	Food Processing	Textiles
Sector linked to Brazilian automotive companies, leveraging close geography and low labour costs Beyond integration with Brazilian sector, companies serving the local are beginning to digitize basic operations Facing barriers in local human capital, and low availability of technology suppliers	On average, technology investment to improve tracing Technology adoption hampered by lack of standards Some industry leaders implementing integrated systems for manufacturing control, quality monitoring, and vehicle handling Low level of workforce with digital capability Low availability of local technology providers	Digitization based on ERP implementation and adoption of GPS tracking Facing obstacles in availability of technical human resources and limited telecommunications infrastructure

Source: Interviews.

Paraguay - Adoption and challenges to the implementation of Supply Chain 4.0

Sector	Strategic Importance (% of country's GDP)	Implementation in Paraguay (0: low – 3: high)[1]	Supply Chain Challenges								
			Transport infrastructure	Human capital limitations	Labour union resistance	Telecommunications infrastructure	Limited integration with suppliers and distributors	Limited integration with logistics service providers	Internal organization silos	Limited technology availability	Norms and standards
Automotive	1.52	2.00	H	H	L	H	H	H	H	H	H
Food processing	10.32	2.00	H	H	M	H	H	H		H	M
Textiles	0.66	2.00	H	H	L	H	H	M		H	
Appliances	0.40	0.75	H	H	L	H	H	M			

Notes: H: High; M: Medium; L: Low. [1] Defined based on interviews and secondary market research Source: Authors.

6.4. State of development of supply chain enablers
(number in brackets is world ranking)

- **Infrastructure (roads, railways, and telecommunications)**
  - Infrastructure Quality Index 2018 (World Bank): 2.55 (80)
  - Efficiency of seaport services 2018 (World Economic Forum): 3.4 (95)
  - Efficiency of air transport services 2018 (World Economic Forum): 3.3 (119)
- **Logistics service providers**
  - Logistics quality and competence indicator 2018 (World Bank): 2.72 (74)
  - Tracking and tracing indicator 2018 (World Bank): 2.61 (101)
- **Customs**
  - Customs Efficiency Index 2018 (World Bank): 2.64 (68)
  - Time required for foreign trade documentary compliance (World Bank 2018): 24 hours (Export); 36 hours (Import)
- **Telecommunications networks**
  - 4G coverage of population 2018 (GSMA): 88 %
  - Average fixed broadband speed 2018 (Akamai) (Mbps): 1.43

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Endnotes

1. The effort was sponsored by the Inter-American Development Bank.
2. The concept of supply chain is different from value chain. A value chain is used either as a set of interrelated activities a company relies upon to create value and build competitive advantage (see Porter, M., *Competitive Strategy*, New York: Simon and Shuster, 1995) or a combination of different industry players to meet a market requirement (see Stigler, G., "The Division of Labor is Limited by the Extent of the Market", *The Journal of Political Economy*, vol. 59, no. 3, 1951, pp. 185-193).
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6. International evidence indicates that: (1) firms that participate in supply chains are more productive; and (2) countries that participate in supply chains and in segments of higher added value demonstrate greater economic development. Calatayud, A. and J. A. Ketterer, "Integrated Value Chain Risk Management", Technical Note No. 922, Washington DC: Inter-American Development Bank, 2016.
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9. Appendix 1 includes a more detailed framework description.
10. A coordination failure is a specific kind of market failure where the increase of a firm's productivity depends not only on macroeconomic conditions, but also on the actions of other firms, infrastructure, regulation and the availability of public goods.
11. MT Connect, a free, open standard that enables smart manufacturing equipment to provide structured, contextualized data with no proprietary format, is currently being used by manufacturers not only in the United States, but also in Europe, Brazil and China.
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13. Boston Consulting Group, *Acelerando el desarrollo de Industria 4.0 en Argentina*, 2018.
14. A "maquiladora" is a manufacturing plant that imports and assembles duty-free components for export. The arrangement allows plant owners to take advantage of low-cost labour and to pay duty only on the "value added" – that is, on the value of the finished product minus the total cost of the components that were imported to make it.
15. More details on the implementation of Supply Chain 4.0 by sector is available in Appendix 2.
16. The average hourly labour costs for Mexico's peers (Argentina, Brazil and Colombia) is $18.70 (according to Deloitte's 2016 Global Manufacturing Competitiveness Index).
17. Katz, R., P. Dougal, S. de Urquiza and R. Fisch, *Digital Ecosystems: Innovation and Disruption in Latin America*, gA Center of Digital Business Transformation, 2017.
18. The impact on processing time is highly seasonal.
19. For the data, see Baptista da Costa, F., "Transport Sector Emissions in Brazil: A Brief Overview", Presentation to the International Transportation Forum, Berlin, Germany, September 2012.
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21. Colombia National Planning Department, *Documento técnico, Misión de Logística y Comercio Exterior*, p. 30.
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27. This situation is not common to all goods. An analysis conducted by the Ministry of Transport of Argentina showed that the transportation network’s distance to the port of exit is the longest for regional products (e.g. sugar), while distance to the port for grains (soybeans, corn, barley, etc.) is 166 km on average (National Cargo Study, *Subsecretaría de Planificación de Transporte de Cargas y Logística* (2012 data), Ministry of Transport, 2017).
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32. Rohman, I. and E. Bohlin, “Does broadband speed really matter as a driver of economic growth? Investigating OECD countries”, *International Journal of Management and Network Economics*, vol. 2, no. 4, 2012, 336-356.
33. Logistics service providers refer to third party logistics (3PL) and fourth party logistics (4PL), including not only transportation but also companies offering other logistics processes, such as distribution, fulfilment, etc. 3PL firms specialize in integrated logistics services. They address the logistics needs of their clients by integrating transportation, warehousing, inventory control, order processing, customs brokerage and other logistics activities in a comprehensive and seamless supply chain management system. Firms in the 3PL sub-sector provide a set of customized logistics services, tailored to the exact needs and specifications of their clients. 4PL goes one step further than 3PL and involves the integration of all companies involved in the supply chain. This guarantees that the planning, steering and verification of all logistics procedures will be performed by a single service provider with a long-term strategic objective.
34. World Economic Forum, *The Global Competitiveness Report 2017-2018*, 2017.
35. World Economic Forum, *Readiness for the Future of Production Report 2018*, 2018.
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