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Digital Transformation of Manufacturing

in Latin America and the Caribbean

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IDB Invest, a member of the IDB Group, is a multilateral development bank committed to promoting the economic development of its member countries in Latin America and the Caribbean through the private sector. IDB Invest finances sustainable companies and projects so that they achieve financial results and maximize economic, social, and environmental development in the region. With a portfolio of USD 15.340 billion in assets under management and 375 clients in 25 countries, IDB Invest provides innovative financial solutions and advisory services that respond to the needs of its clients in a variety of sectors.

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NTT DATA, part of the NTT Group, is an innovative global IT and business services company headquartered in Tokyo. The company helps clients in their transformation journey through consulting, industry solutions, business process services, digital and IT modernization, and managed services. NTT DATA enables them, as well as society, to confidently move into the digital future. The company demonstrates its commitment to the long-term success of its clients, combining global reach with local attention, to work with them in more than 50 countries around the world through a network of more than 140,000 professionals. To learn more, visit nttdata.com.

CONTENTS

CONTENTS

ACRONYMS

LAC - Latin America and the Caribbean

B2B - Business to Business

CAD - Computer-Aided Design

CEO - Chief Executive Officer

CFO - Chief Financial Officer

CIO - Chief Information Officer

CIP - Competitive Industrial Performance

CNC - Computer Numerical Control

COO - Chief Operating Officer

CTO - Chief Technology Officer

DMA - Digital Maturity Assessment

ERP - Enterprise Resource Planning

ESG - Environmental, Social and Governance

ACRONYMS

IIOT - Industrial Internet of Things

IoT - Internet of Things

IPI - Industrial Production Index

MES - Manufacturing Execution System

GDP – Gross Domestic Product

PLC - Programmable Logic Controller

QR - Quick Response

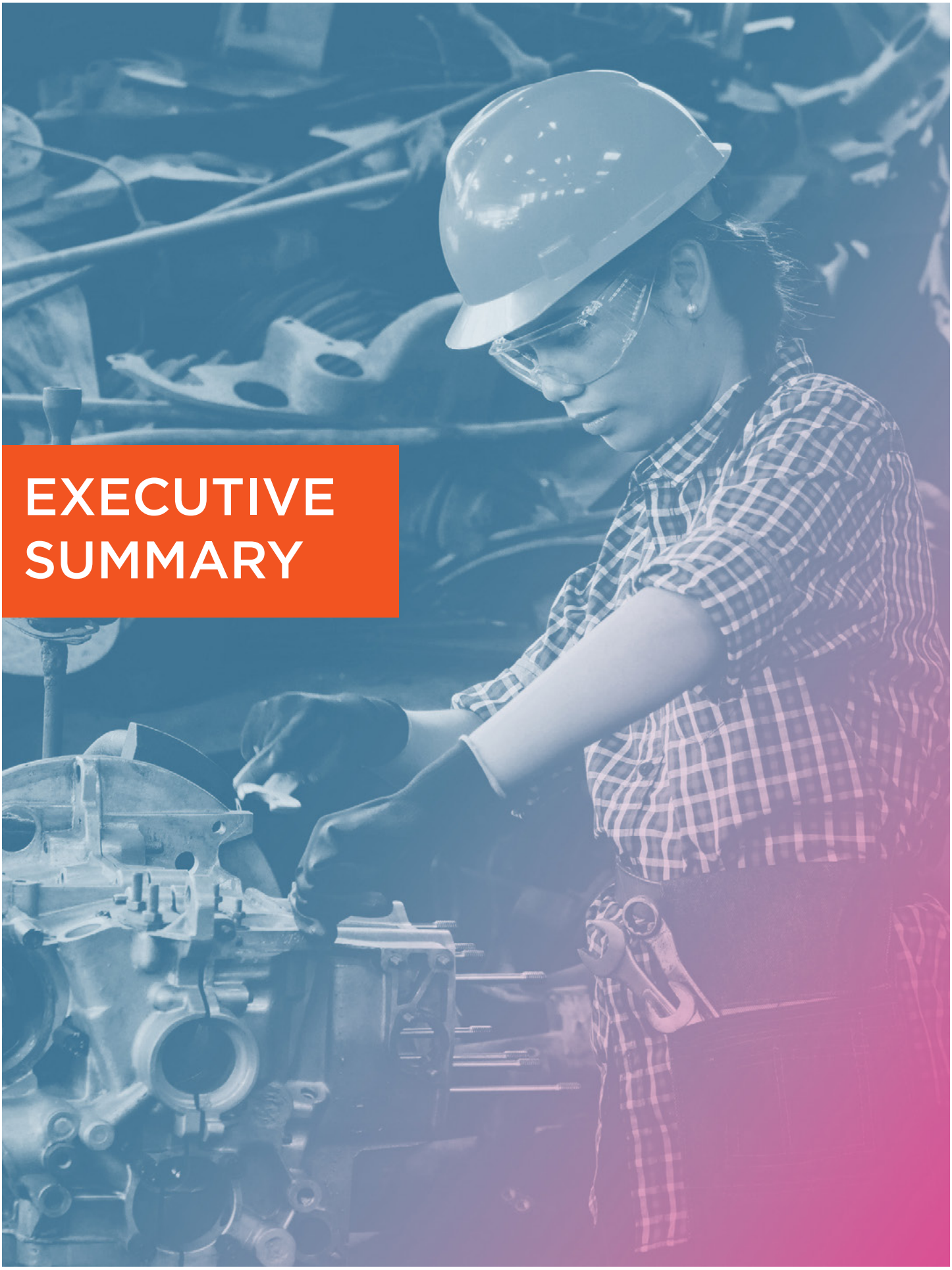
RPA - Robotic Process Automation

SCADA - Supervisory Control And Data Acquisition

TMS - Transport Management System

VAM - Value-added of Manufacturing

WMS - Warehouse Management System



EXECUTIVE SUMMARY

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Relevance of the manufacturing sector in Latin America and the Caribbean

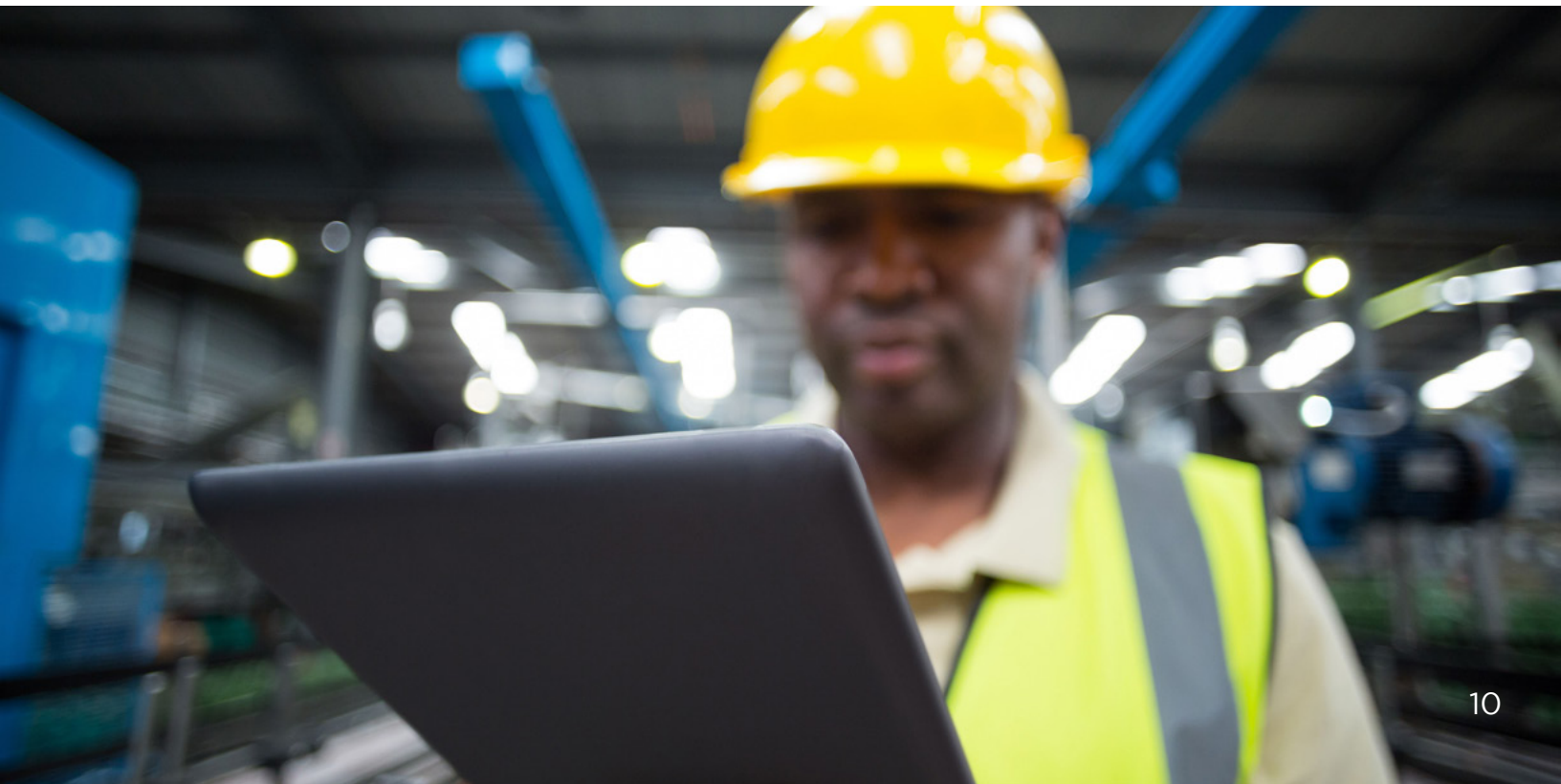
The relevance of the Digital Transformation of a sector is closely related to the contribution of that sector to the economy. In this sense, the manufacturing sector contributed to 15,7% (2020) of the gross domestic product of the countries in the region. Likewise, represents 20% of the total employees, which refutes its importance in being the main economic support of millions of families.

A factor that increases the need to speed up Digital Transformation in the industry is the redesign of the supply chains of large multinational companies which will result in a relocation of a large part of their productive capacity installed in China.

To attract the investment resulting from this movement, the manufacturing industry in Latin America must use digitization as a lever that increases its competitiveness.

The benefits of Digital Transformation in the industry are many and organizations have been increasingly using technology to improve their processes. Technologies such as automation, the use of switches, and algorithms with artificial intelligence have been used in the industry to gain accuracy and increase the productivity of operations. Other technologies, such as digital twins and additive manufacturing, have shown benefits in streamlining the use of resources and an ability to evidence enhancement in a faster way.

These tools combined with others such as the industrial internet of things (IIOT) and the advanced analytics models, enable enhancements in productivity and efficiency of processes with a cross-sectional view across the entire value chain. This, in turn, improves the responsiveness of organizations to meet the needs of their ecosystem.



State of digital maturity of the manufacturing industry

The starting point of Digital Transformation is the understanding of the level of maturity in the industry currently found through the analysis of a sample of companies from various manufacturing subsectors in the LAC region. The results of the analysis indicate a level of maturity that characterizes the industry in an intermediate position (called "follower" according to the studio's methodology) obtaining a rating of 2.97 on a scale of 5. There are some factors to consider to understand the state of maturity obtained. On the one hand, the result benefits from the advances in production efficiency as the manufacturing sector are one of the first to apply automation to part of its processes. On the other hand, filters were applied for the selection of participants who were supposed to have a sample of companies that had already started their digital journey.

Despite the existence of progress, opportunities must be addressed to meet the needs of the sector to remain competitive in a regional and global environment. To do this, the sector must continue to invest in integrating new digital solutions that include process automation and artificial intelligence capabilities and that leverage greater amounts of data obtained and interpreted in real-time to generate value oriented decision-making.

The key developments that characterize the current state of manufacturing are associated with the existence of transformation plans that in 74% of the companies analyzed, are not known to the entire organization, thus showing an opportunity to identify the digital transformation in the strategic agenda of companies.

Similarly, advances in the automation and digitization of specific tasks of the production process stand out, but without any integration with adjacent processes such as demand planning, supply, or digital channels for order capture. Other advances involve digital initiatives working in silos, or with the testing of more disruptive technologies such as digital twins or extended reality, as the solution that uses virtual reality and augmented reality technologies.

Another point to highlight is the opportunity for Digital Transformation to serve as an accelerator of organizations' environmental, social impact, and corporate governance (ESG) agendas. In addition to being important in the context of productivity and efficiency, it is relevant in considering challenges such as climate change and increasing the greater participation of underrepresented groups in the sector, such as women. Consequently, digital solutions will enable organizations to better measure their environmental and social impact and create jobs with new skills. The latter represents a great opportunity to incorporate more inclusive talent with greater gender equity.

To increase the adoption of digital transformation, some barriers must be overcome. Among the most important is the lack of long-term vision and the lack of mechanisms to evaluate, measure and monitor the return on investments required to enable the transformation. The attraction and training of digital talent are required, as well as the development of more tailored solutions that help organizations reduce the technological complexity of their business architectures. Finally, it is necessary to increase the connectivity infrastructure so that solutions such as 5G and WIFI-6 have greater coverage and enable the collection and remote access to data and the control of applications and equipment.

By overcoming these barriers, the manufacturing sector will be able to lay the foundations for a more accelerated transformation that allows differentiating itself and evolving to better serve its customers, and achieve optimal collaboration with its suppliers, in addition to generating more value in the ecosystems in which it participates and in society.

This report presents different solutions that enable Digital Transformation for the different links in the value chain, as well as the implicit benefits of applying these solutions in the sector.

Description of the methodological approach of the study

This study was designed to characterize the state of maturity of Digital Transformation by obtaining information taken directly from a sample of corporations belonging to various manufacturing subsectors in the LAC region.

To broaden the vision of the study, some transportation and retail companies that play an important role in the distribution of products to customers and final consumers were also included. In the case of the manufacturing sector, the sample of 35 companies includes organizations from the textile, chemical, plastic, paper, and derived products, non-metallic mineral products, manufactured metal products, machinery, electrical and electronic equipment, and automotive subsectors. Likewise, the seven countries with the greatest weight in the sector were included. The countries included were Mexico, Brazil, Argentina, Colombia, Peru, Chile, and Ecuador.

Each company was invited to answer a self-diagnosis of their digital maturity. Once evaluations were collected, interviews were conducted with executive directors to delve into the main aspects of the evaluation, its challenges, barriers, and projects in the context of transformation.

Additionally, interviews were conducted with representatives of five startups and six suppliers of companies participating in the study. In these interviews, the state of maturity of the industry was discussed from the point of view of third-party entities that collaborate with the sector.

Through this multidimensional approach, it was possible to identify the state of the Digital Transformation of the sector, and the main advances, challenges, and barriers that must be resolved to accelerate the process.

Key needs and challenges of the manufacturing sector

As a result of the study, a series of needs and challenges were identified that should be on the agenda of organizations in the sector and are listed below:

1. Increasing productivity and ensuring operating continuity.

Increase in productivity is a lever that enables greater control of the economic result. This factor is especially relevant in volatile environments such as those currently experienced by the sector. Achieving increased productivity involves integrating technology that allows improving the performance of processes, but also directing them towards approaches in which intelligent automation is applied selectively to integrate hybrid machine-system-human operations.

2. Increasing efficiency.

One of the competitive advantages of the sector is its ability to offer competitive products in the market from the point of view of price. In addition to automating activities, it is necessary to find solutions that simplify processes and guide them toward optimizing energy and resource consumption.

3. Enhancing traceability and decreasing operating and market risks.

The regulatory environment and consumer's demands increasingly require that companies take charge of the externalities that result from the manufacture or use of their products. Therefore, finding solutions for the traceability of the flow and consumption of energy, materials, and products throughout the value chains is an issue that, in addition to serving to optimize, inserts certainty and enables risk reduction.

4. Enhancing responsiveness of the value chain.

There are several elements not controlled by the organization with the potential to impact its operational continuity. Armed conflicts, trade frictions, and the scarcity of human and material resources require tools that allow planning the entire operation, as well as collaborating with customers, suppliers, and governments to establish systems to share information. As a result, the planning process will become more fluid, and the resources will be able to respond to unexpected events with greater flexibility.

5. Adapting to new talent management focuses.

Most of the large companies in the sector and their operating models were conceived by previous generations with less focus on digitization and collaboration. This generates a need to gradually change the management approach towards more collaborative and inclusive methods in which knowledge and experience are only one component.

6. Incorporating environmental goals into the operation.

The exploitation of natural resources and the resulting emissions are significant contributors to climate change. The Digital Transformation solutions must focus on enabling the measurement of the defined goals so that each organization can better monitor its environmental footprint and its orientation to government practices that ensure less polluting and more inclusive approaches to underrepresented groups.

7. Lack of digital culture and talent in the market.

It is presented as an additional challenge in which companies, in addition to transforming, must do so while finding better ways to attract, retain, retrain, and even train talent in increasingly remote or hybrid environments.

8. Technological complexity and need for tailor-made solutions.

The technological architectures of companies are complex and sometimes the result of decisions that did not have a long-term vision. The inclusion of new tools and technologies can influence decision processes, in addition to the technological dilemma, organizations and their executives must recognize adjustments to past decisions. The tool selection process is also a resource-intensive process and tools do not always achieve the desired level of customization to fit an organization and its technology architecture.

9. Understanding and measurement of the value of the transformation to justify the investment.

It is assumed that transformation requires resources to materialize and these resources must generate a future return. However, assigning value to a change in terms of operating is not easy. Especially when using traditional cost-benefit methods that do not use qualitative variables or consider the opportunity cost resulting from not transforming while others do. In this sense, it is important that business cases have the ability to be adressed under innovation scenarios and not just under scenarios of operational continuity.

INTRODUCTION

01

1.1 Study objectives

The main objective of the study is to publicize the current state of the Digital Transformation of the manufacturing industry in LAC, in order to provide key information about the main challenges, trends, and areas of opportunity that exist around the Digital Transformation. Of the private sector and propose a road map to accelerate the adoption of digital technologies that contemplate some of the innovative solutions that are currently applied in the industrial ecosystem of the region.

Since retail trade serves as one of the sales channels of the manufacturing industry, some companies in this sector are included in the study. Additionally, this study seeks to assess the perception of organizations regarding the value provided by ESG initiatives, together with their level of implementation in the aforementioned sectors.

As a starting point, the study seeks to delve into the current situation of Digital Transformation throughout the value chain of private sector companies, both of local origin and with a presence in countries of the region. In this way, a greater understanding of the needs and challenges that are faced in operational, organizational, financial, and regulatory terms is offered to address Digital Transformation.

With this study, the authors seek to provide a new perspective that promotes regional dialogue, emphasizing the need to improve the competitiveness and technological innovation capacity of the private sector in global markets, to prevent companies from being left behind.

Digital Transformation is presented as the key lever of change that promotes sustainable economic growth and the creation of new jobs in the region, while allowing the creation of more resilient economic sectors, with greater social inclusion, and that contributes to addressing the challenges of climate change on a global scale.

Understanding the current situation, the needs and opportunities of the private manufacturing and retail sector in the region allows us to identify the action points that organizations must address and delve into the appropriate digital solutions to face the challenges of Digital Transformation, to draw up a roadmap that allows scaling the digital capabilities of the sector and define a digital agenda that enables manufacturers and retailers to face the challenges of competitiveness, productivity, efficiency, and financial, social, and environmental sustainability, which the industry must resolve to meet new markets and maximize the economic and social growth of the region in the digital era.

1.2 Study framework

This study is divided into four sections: (1) Introduction, (2) Current Status of Digital Transformation of Manufacturing and Retail, (3) Digital Transformation Solutions, and (4) Conclusions.

This introduction chapter details the study objectives and the methodology used for their preparation, including both the criteria for the selection of the subsectors, countries, and companies under the scope, as well as the survey techniques and the analysis of information considered in the development of the study.

The second chapter, Current Status of Digital Transformation of Manufacturing and Retail, presents a detailed analysis of digital maturity levels of industries throughout the value chain, the needs, objectives and challenges faced by organizations in the sector and incorporates participants' vision of suppliers, startups and logistics actors in the supply chain adopting technological solutions and approaching both business and ESG strategies that can be driven by Digital Transformation.

The Digital Transformation Solutions section delves into the technological platforms that manufacturers and retailers are implementing in their operations as a tool to respond to the current challenges of the industry, as well as potential ways of collaborating with academic entities and startups to fuel the growth of the entire manufacturing ecosystem.

In the last section of the study, the conclusions are presented, and a series of recommendations to speed up Digital Transformation in LAC under the digital paradigm of Industry 4.0.

Finally, the document includes a section of Attachements, aimed at presenting complementary information or in greater detail to delve into the issues addressed by the study.

1.3 Methodology

For the elaboration of the study, field research was carried out with a total of 35 companies from the manufacturing and retail trade sectors that was complemented with secondary research. The field research was divided into two phases: (1) a digital questionnaire (Digital Maturity Assessment, DMA) to assess the level of current digital maturity of each of the organizations and (2) a process of interviews with different C-level executives to delve into the results of the DMA and understand their vision of the challenges they are facing and their perspective of Digital Transformation in the sector in the short, medium and long term.

1.3.1 Country and subsector prioritization criteria for the study

In order to define a representative sample of the manufacturing and retail sectors in LAC, a prioritization exercise was carried out to select the subsectors and countries that were finally included within the scope of this study.

For the prioritization of the countries, the following variables were considered: economic impact, labor force, level of competitiveness, infrastructure, and technology and innovation. For each of these variables, the parameters to be analyzed were defined with official data from public sources World Bank, United Nations, *The Global Economy,* , among others).

The parameters evaluated for each of the selected variables are the following:

Economic impact: (1) Manufacturing Value-added (VAM) to the country's GDP, (2) VAM as a percentage of the country's total GDP, (3) value of manufacturing exports, and (4) Industrial Production Index (IPI).

Labor force: Total number of employees in the manufacturing industry.

Level of competitiveness: Competitive Industrial Performance, CIP.

Infrastructure: Capital investment as a percentage of GDP.

Technology and Innovation: (1) Global innovation index (2021), (2) VAM of medium and high technology, as a percentage of total VAM, (3) research and development spending as a percentage of GDP.

Table 1: List of countries considered

Argentina	El Salvador	Panama
Brazil	Guatemala	Paraguay
Bolivia	Haiti	Peru
Chile	Honduras	Puerto Rico
Colombia	Jamaica	Dominican Republic
Costa Rica	Mexico	Trinidad and Tobago
Ecuador	Nicaragua	Uruguay

For the prioritization of subsectors, the VAM of the subsectors and its contribution to the total VAM of the sector in the main manufacturing countries of the LAC region were considered as the main analysis variable. Once the data was analyzed, a combination of manufacturing subsectors representing 84% of the total VAM of the region (Table 3) was selected, based on the International Standard Industrial Classification of All Economic Activities (ISIC), to establish the taxonomy. Classification of the study subsectors (See Attachements section).

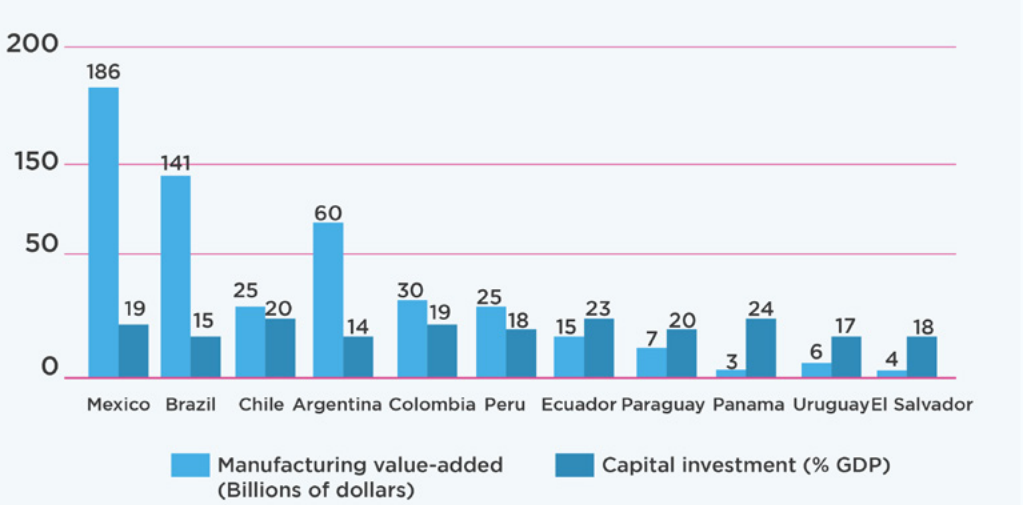
1.3.2 Results of the prioritization exercise

Based on the analysis of the variables mentioned in the previous section, complemented by expert criteria, and recommendations from the IDB Invest team specialized in the sector, the following countries and subsectors were selected as focuses for the study sample:

- **Selected countries** Mexico, Brazil, Chile, Argentina, Colombia, Peru, and Ecuador (see Figure 1).

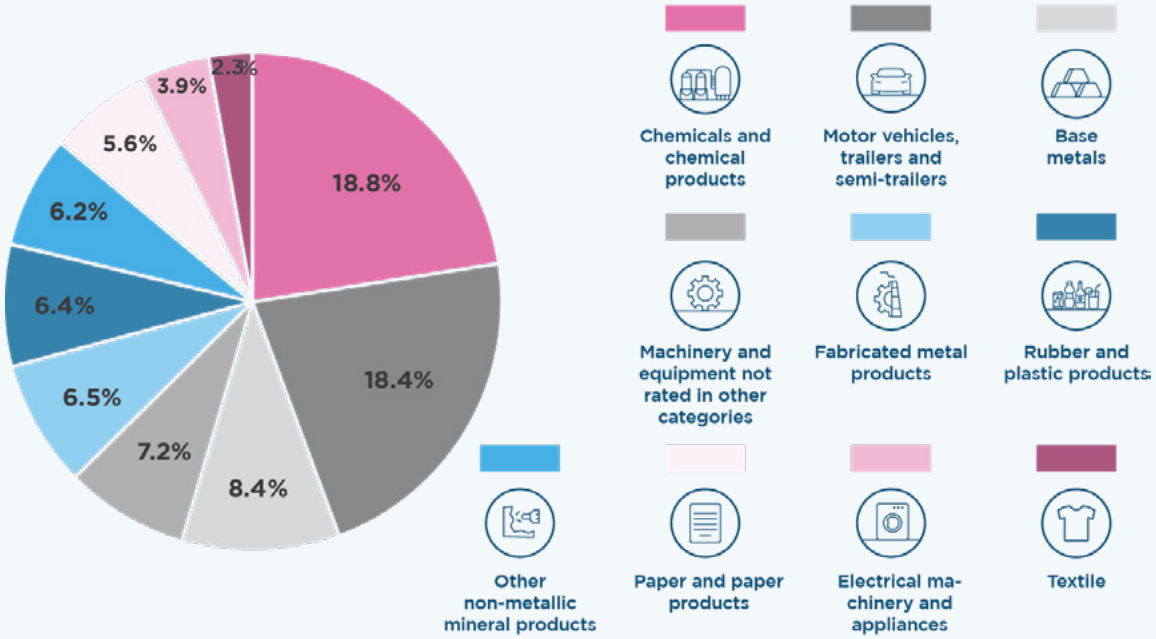
- **Selected subsectors** (1) Textile, (2) Paper and paper products, (3) Chemicals and chemical products, (4) Plastics, (5) Base metals, (6) Fabricated metal products, (7) Other non-metallic mineral products, (8) Machinery and electrical appliances, (9) Machinery and equipment not classified in another category and (10) Motor vehicles, trailers, semi-trailers. Additionally, the subsectors associated with basic pharmaceutical products and pharmaceutical preparations and the retail trade sector were incorporated into the study, to have a comprehensive vision of the value chain of production, distribution, and commercialization of products manufactured in the region (see Figure 2).

Figure 1: Ranking of countries based on their attractiveness for the present study.



Source: Own elaboration based on data collected from The World Bank, UNIDO, The Global Economy, Cornell University, INSEAD, WIPO and the United Nations.

Figure 2: Contribution to Manufacturing GDP, Selected Subsectors.



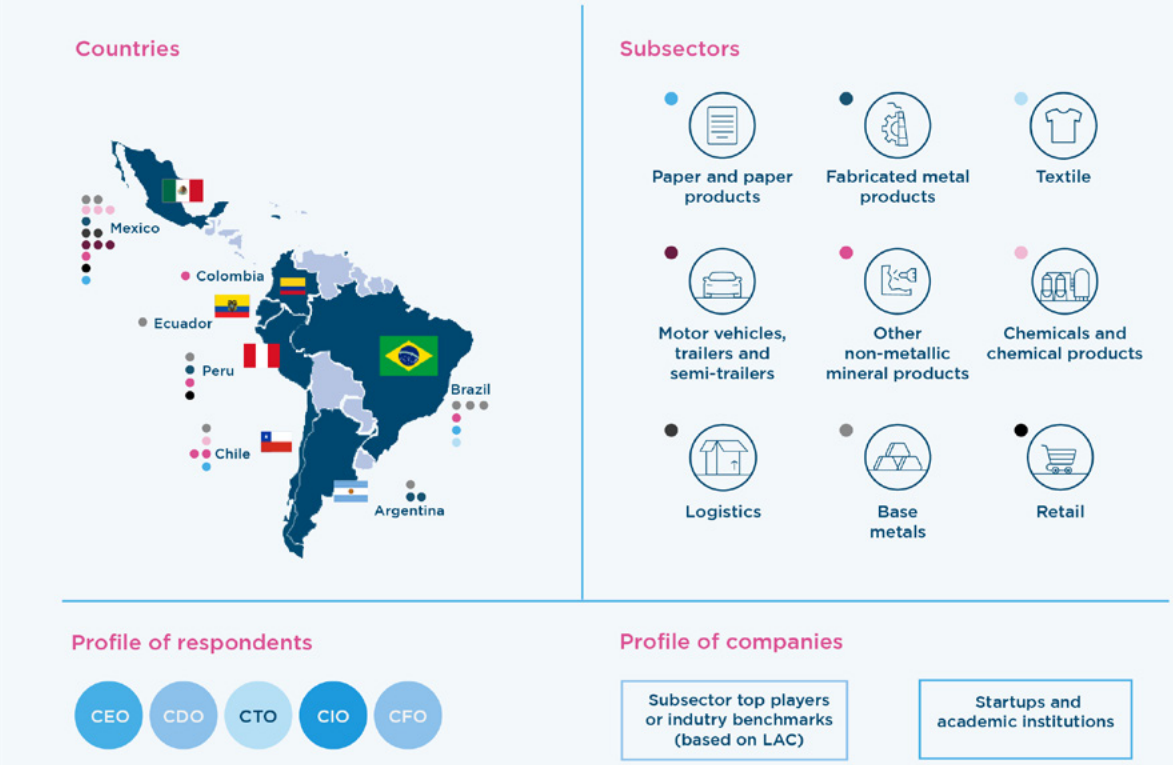
Source: Own elaboration from the UNIDO (United Nations Industrial Development Organization) database extracted on June 16, 2022.

1.3.3 Profile of participating companies

The study included the participation of 31 companies from the manufacturing sector, two from the retail trade, two players from the supply chain, six suppliers from the sector, and 6 startups focused on the industry. This combination of manufacturing and retail organizations with the participation of organizations that collaborate in the ecosystem, both traditional and emerging, made it possible to address the analysis of challenges and trends of Digital Transformation from the point of view of innovation in the sector and acquire a greater understanding of the bulk of the ecosystem.

The selected companies correspond to organizations with a turnover of more than $50 M USD and with C-Level executives willing to participate. These companies underwent a digital maturity assessment (DMA). In the case of additional companies belonging to startups and players in the manufacturing supply chain, only interviews were conducted and the findings of these were used as a complement to obtain complementary insight.

Figure 3: Geographic distribution of companies included in the study.



1.3.4 Structure of the Digital Maturity Assessment (EMD)

Digital Transformation is the process by which companies and organizations adopt and use digital technologies to improve their operations and achieve greater efficiency and competitiveness. Although there is a direct association with technology, there are several additional aspects that must be considered when embarking on initiatives or programs focused on Digital Transformation, and have to do with the ability of organizations to establish a strategy with a clear government that allows adjusting its operating model, its processes and its way of operating while integrating new talent.

As a starting point for understanding the current situation of Digital Transformation, a digital self-diagnosis questionnaire was applied to all the companies participating in the study. This Digital Maturity Assessment (DMA) considers the aspects that make up a complete vision to analyze the Digital Transformation capabilities of organizations that can be grouped into the following 9 domains:

1. Strategy and Business Model: Definition of a Digital Transformation strategy aligned with the corporate strategy and its business objectives. Relevance of digitization for the organization in terms of allocation of financial, human, and technological resources for the implementation of its digital agenda.

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2. Sustainability and Renewable Energies: Level of adoption of sustainable practices leveraged on digital tools for the optimization of the environmental impact in the organization. Relevance of sustainability in the strategic objectives and level of maturity in the transition to renewable energies in the operational processes.

3. Processes and Operation: Digital maturity in the operating model, including the current state of technological capabilities and the startup of digitization initiatives and automation of production, logistics, and administrative processes.

4. Governance: The Development level of the organization to implement and manage digital assets. It considers the maturity of the decision-making structure, the digital support in the management instances and the level of use or availability of strategic reports for decision-making.

5. Systems and Technology: Level of integration of technological assets, digital architecture and cybersecurity protocols that support the business. Maturity is assessed in terms of systems and digital platforms or disruptive technologies that support the operation.

6. New Businesses and Digital Products: Incorporation of digital components in the organization's products and/or services, level of digitization of the channels and maturity in the integration of new digital payment methods.

7. Organization: Level of technological adoption and digital culture of the organization. The ability to promote digitization from the management layer, the incorporation of training actions in digital skills, the use of systems in human resources management and the level of attraction and retention of specialized profiles are evaluated.

8. Big Data & Analytics: Information capture capabilities, data storage efficiency, master data management practices and processing capacity of these, from different levels of application of analytical models for the identification of behavior patterns and generation of predictions for decision making decisions.

9. Innovation: Ability to manage innovation in line with the organization's strategic and digitization objectives. The formality and transversality of innovation processes supported by methodologies, instances, or practices to promote and manage innovation using digital solutions are measured.

1.3.5 DMA maturity levels

The level of maturity of the participants was evaluated on a scale of 1 to 5 for each of the DMA domains. In addition, a calculation model was established that considers different values associated with the key aspects, to weigh the maturity level per domain and obtain the general digital maturity level of each organization.

The results of the DMA allowed companies to be classified into five categories based on their current state of digital maturity:

1. **Observer:** Organization characterized by its resistance to change, and therefore, carries out few Digital Transformation actions. These organizations usually have some digital initiatives; however, they are skeptical about the value that this process brings to the business and they are far from having structures that allow a digitized operation.

2. **Initiated:** Organization with limited or not formally assigned resources to address the Digital Transformation. Even though they use specific technological solutions for some stages of their value chain, they still have a high percentage of manual processes and do not have a culture of decision-making based on data.

3. Follower: An organization that has a strategic plan to address Digital Transformation and has incorporated roles, digital tools, and a government model dedicated to promoting and managing transformation. Although they have metrics to guide their decision-making, they have not yet been able to maximize business value from digitization.

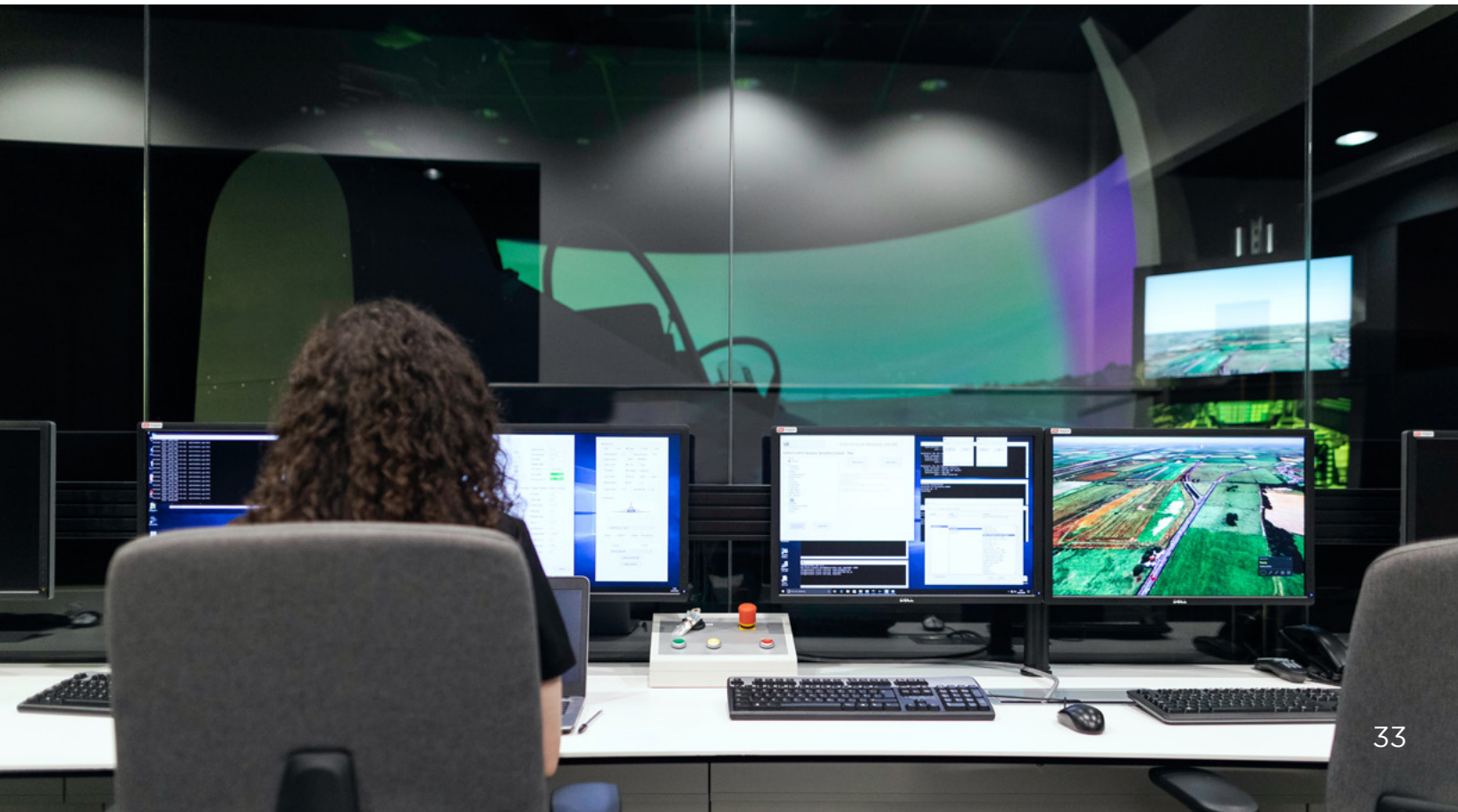
4. Leader: Organization that has a relevant and differentiating value offer based on personalization through digital tools. It is agile, strongly leveraged in the use of analytical models, automation, and digitization of its processes. He leads multiple transformation initiatives in the sector with the incorporation of disruptive technologies governed by a strategy and a long-term plan to manage Digital Transformation across the board.

5. Trailblazer: Organization with a fully integrated value chain through digital intelligence tools in real-time. It differentiates itself in the market by guiding the trends in Digital Transformation for the sector. It has predictive and integrated analytical capabilities to generate value collaboratively between the different areas. They use technological tools and standardized capabilities to manage and drive innovation in the organization.

1.3.6 Detail about the interview process

The qualitative analysis carried out from the interview process, complemented the information collected in the self-diagnosis of digital maturity with key information provided by C-level executives of the participating companies, focused on guaranteeing the correct diagnosis and broadening the understanding of the current state of each organization, in addition to having the individual vision of the executives about the market context, the regulatory framework, the challenges, the best practices, the strategies and the expectations about the future of Digital Transformation in the industry.

To obtain a comprehensive perspective of the state of Digital Transformation of the organizations, the interviews were carried out with different profiles of senior management: General Director (CEO), Operations Director (COO), Financial Director (CFO), Technology Director (CTO), Chief Information Officer (CIO).



Status of Digital Transformation of the manufacturing industry in LAC

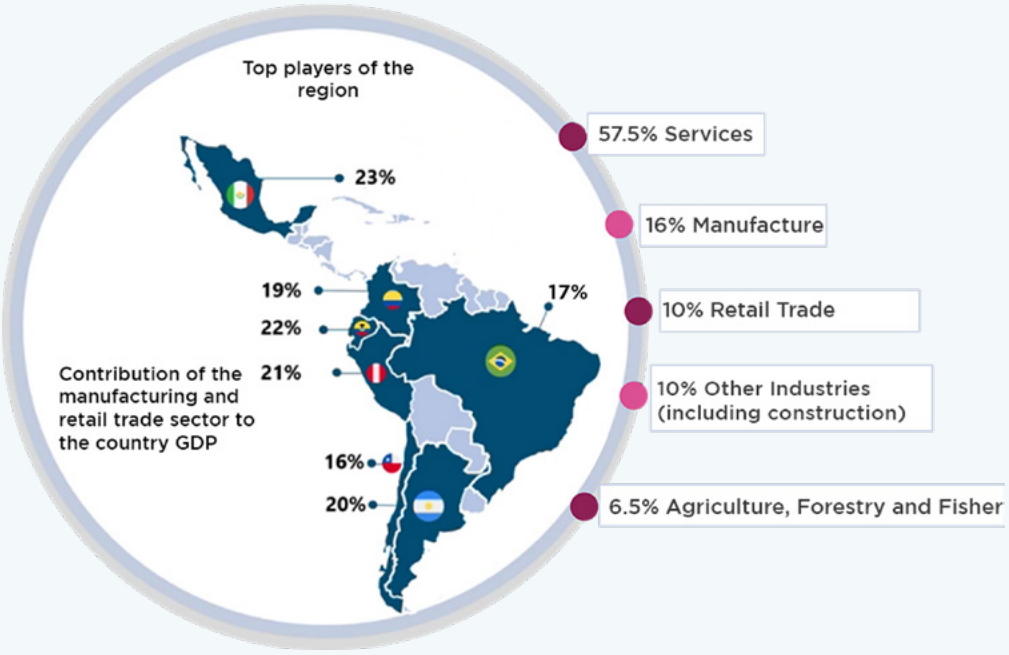
02

2.1 Context of the manufacturing industry in the LAC macroeconomy

The manufacturing sector in Latin America and the Caribbean is the second with the highest contribution to GDP in the region (15.7%), only behind the services sector (57.5%), with a tie for third place among the sector retail trade (10%) and other industries (including construction)[1].

Due to its contribution, the sector plays a strategic role in regional development, which is accentuated in the current context where many multinational companies are repositioning their production footprint to relocate it or move closer to their demand or countries, aligning their global values and agendas. Manufacturing is a sector that also contributes to the generation of local jobs with a level of training and qualification, an important component on the agenda of regional governments.

Figure 4: Contribution of the sectors to the GDP of the region.

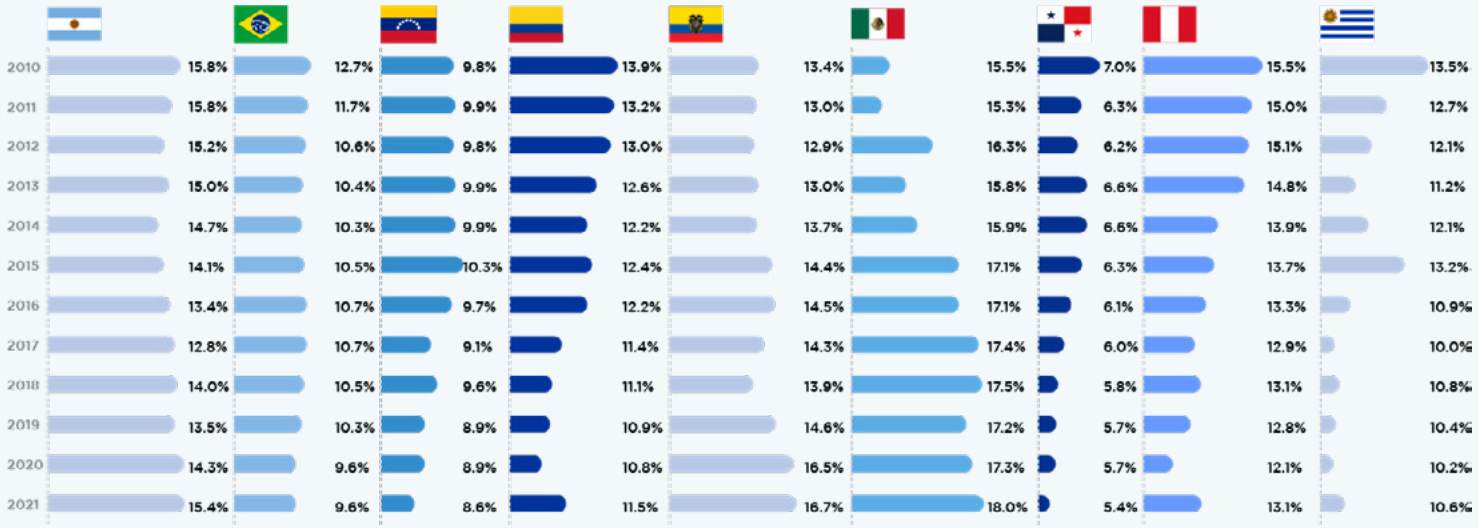


Source: Own elaboration based on the World Bank 2021 database.

1 (World Bank, 2021)

In the last decade, the sector's participation in Latin American GDP increased slightly from 14.3% to 15.7%. However, such growth has been mainly driven by Mexico given the unique integration of its value chains with the United States and its position as a manufacturing hub for inputs ranging from electronic components to automobiles. In the case of Brazil, despite having a focus on industrialization and logistics infrastructure, the weight of the manufacturing sector has decreased. The same has happened in most of the geographies of Latin America where the same indicator of sector participation has been reduced. The lower weight of manufacturing also occurs in a context in which the weight of other sectors such as agriculture and, above all, services, have increased their representativeness.

Figure 5. Annual evolution of the contribution of the manufacturing sector to the country's GDP (%).



Source: Own elaboration based on data from World Bank & OECD, 2021.

The decrease in the weight of the manufacturing sector in the economy for certain LAC countries is also due, among other reasons, to the impact of the commodity boom and the growing sophistication of Chinese and Asian manufacturing, which explains the contraction of the sector's share manufacturing in the LAC region as a percentage of GDP.

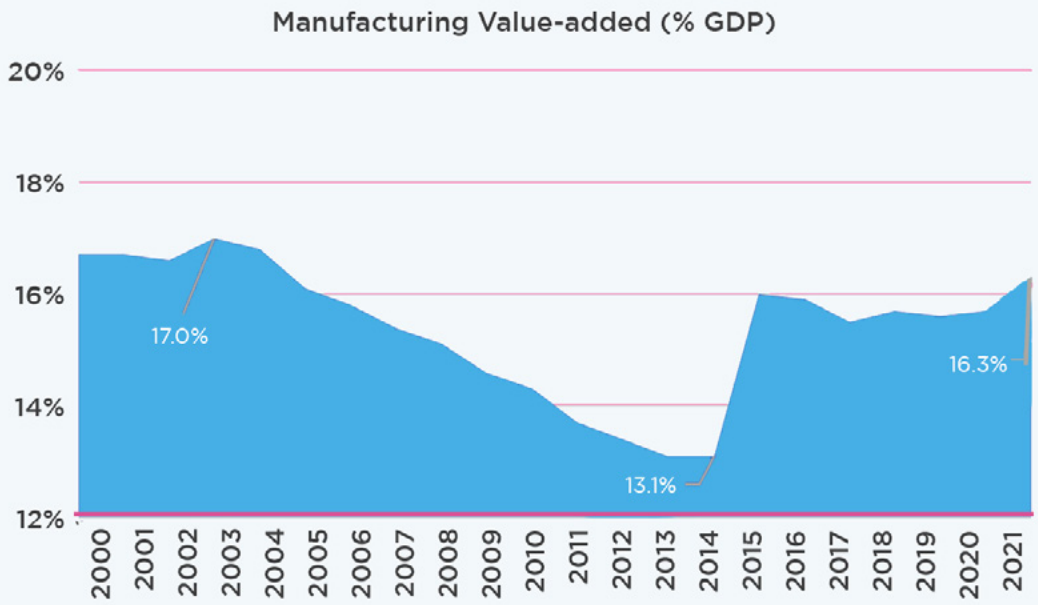
This is especially relevant in the case of South America since much of the focus was on investing in the export of goods with little value-added, but at substantial prices, which increased the terms of trade and resulted in wage improvements that negatively impacted competitiveness in the face of decisions to establish or maintain manufacturing hubs in those countries. This, combined with the chronic deterioration of some economies such as Argentina and Venezuela, and the persistent ascendancy of China, also accelerated the migration of a part of manufacturing to other countries[2].

Figure 6 shows the contribution of the manufacturing industry in Latin America and the Caribbean to GDP from the year 2000. It shows two trends, the first downward until 2014 due to unfavorable scenarios such as falling prices in commodity exports, the economic crisis in Brazil, the depreciation of the Argentine peso, and the recession in Venezuela.

Starting in 2015, there was a substantial recovery in the contribution of manufacturing to GDP, followed by relative stability starting in 2017. The recovery observed in 2015 is mainly explained by the growth of said proportion in Mexico, Ecuador, Chile, and Uruguay.

2 (Commodity Cycle in Latinamerica, Mirages and Dilemmas World Bank)

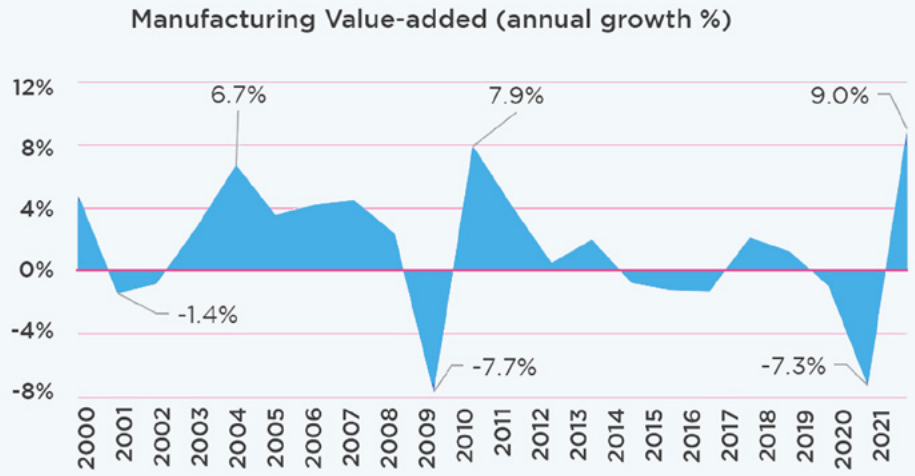
Figure 6: Contribution of the manufacturing sector to LATAM GDP since 2000.



Source: Own elaboration based on data from World Bank & OECD, 2021.

When analyzing the growth of the manufacturing industry in the region, it has been inconsistent in recent years. The falls associated with the effects of the global economic crises of 2001 (-1.4%) associated with the *dot-com bubble crisis,* 2008 (-7.7%), the H1N1 swine flu pandemic and the mortgage crisis and in 2020 (-7.3%) the pandemic caused by COVID. On the other hand, the positive peaks that arise after the aforementioned periods respond to the return of economic growth promoted thanks to the strategies of governments and financial entities to return to economic stability.

Figure 7: Annual growth of the manufacturing industry in LATAM since the year 2000.



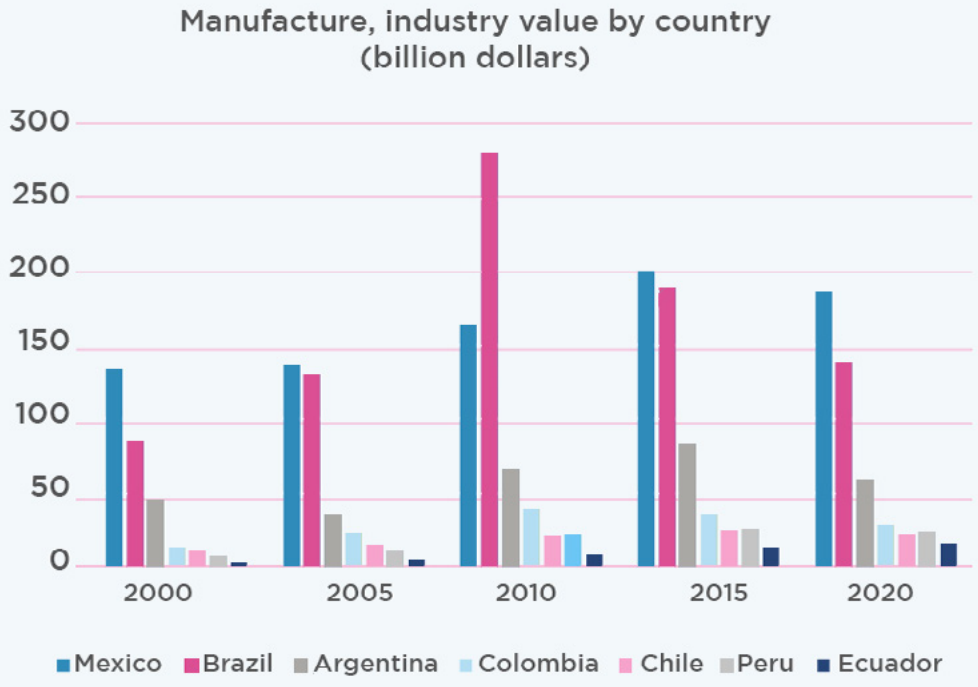
Source: Own elaboration based on the World Bank & OECD database, 2021.

Despite low consistency in growth, the sector currently contributes $878 billion USD to the region's GDP, representing ~13% of the labor force and ~45% of total exports. Among other things, the contributions of Mexico and Brazil which contribute 43% of the total value of the sector, which represents ~USD 378 billion, stand out[3].

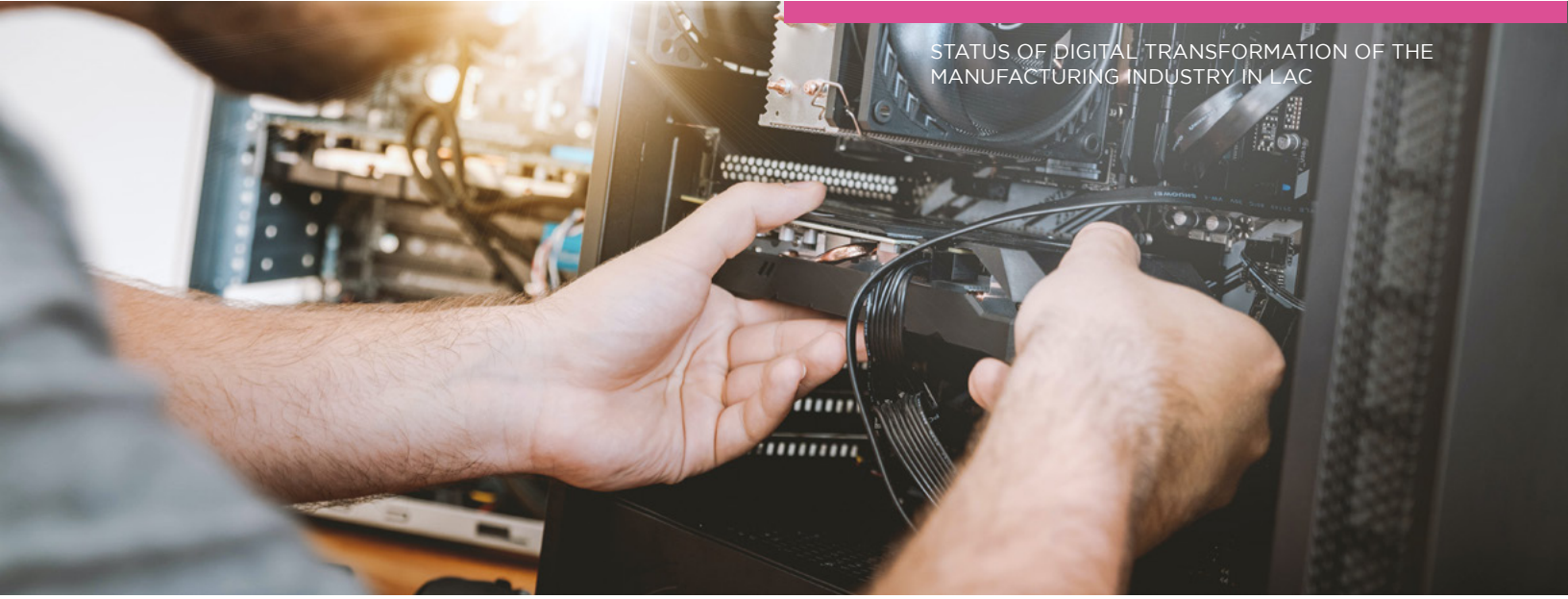
3 (World Bank & OECD, 2021)

In the case of Mexico, the resilience of the sector in the 2010-2020 period also stands out since, despite having decreased slightly in real terms, its decrease is significantly less than that of the rest of the Latin American geographies. Focusing on the case of Brazil, the sector had its peak in 2010 due to the solid inertia experienced during the previous years in terms of foreign investment and economic growth. However, it had a notable decrease in 2015, which is explained by the strong economic crisis that took place from 2014 to 2016, which caused a sharp decline in consumption and the consequent decrease in production and demand for Brazilian products. Also, the devaluation of the Brazilian real affected the value of the industrial production.

Figure 8: Value of manufacturing industry by country (top 7 countries in the region).



Source: Own elaboration based on World Bank & OECD, 2021.



2.2 Structure of the manufacturing value chain

2.2.1 Characterization of the value chain in the region

To understand the current situation of the value chain in the manufacturing sector in Latin America and the Caribbean, it is necessary to go back to the period 1950-1990, in which an important part of the Latin American economies based their development on import substitution policies. These policies were in turn accompanied by tariffs and subsidies to encourage local production and consumption.

As of 1990, many different economies in the region, led by Chile and Mexico, began a process of integrating global value chains motivated by mainly political, economic, and social factors. Political, under a free-market logic to improve the economy and attract investment. Economic, since it was intended to increase income through exports, thus reducing dependence on the domestic market and imports. Social, since both countries sought to improve the life quality of their citizens to create new and greater sources of employment[4]. Evidence of this phenomenon is that Chile and Mexico are among the TOP 5 countries with the largest free trade agreements.

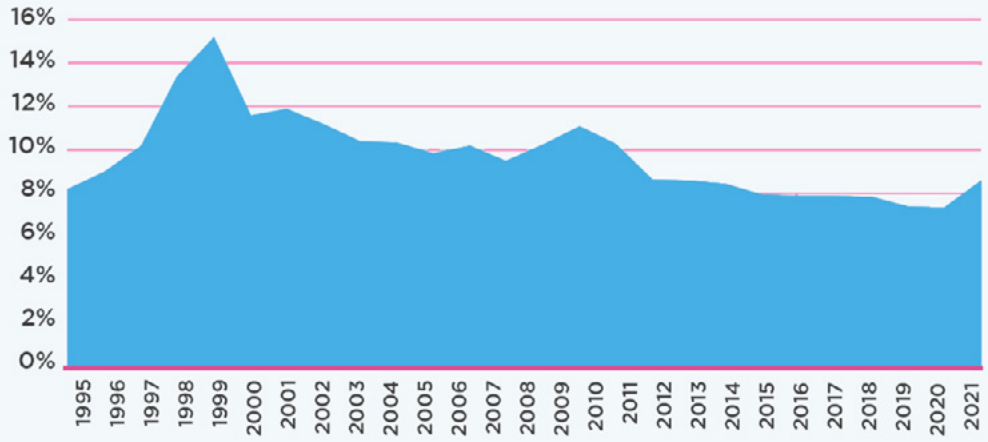
4 (Río Sánchez & Javier, 2009).

This change of focus led to the current structure of the manufacturing industry. As the transformation towards global trade intensified, Latin America and the Caribbean created a sector based on the specialization of productive activities of low complexity, on competitive advantages associated with the exploitation of abundant natural resources and on the low cost of labor[5]. With some exceptions, manufacturing in the region maintains to date, a low level of technological maturity relative to other latitudes in the world.

As shown in Figure 9, at the beginning of export-oriented industrialization the percentage of manufacturing exports with technological content increased temporarily. However, this percentage has consistently decreased since the beginning of the 21st century due to a series of factors such as: global economic changes, production efficiency, and the increase in cheap labor in other parts of the world such as China and, trade protectionism by some powers and the lack of investment in the region.

5 (Lauxmann et al., 2020).

Figure 9: Evolution of the percentage of exports of manufactures with technological content from Latin America and the Caribbean (1995-2020).



Source: Own elaboration based on World Bank data supplemented with Lauxmann et al., 2020.

The paradigm shift of the last decades -led by a strategy of global integration of value chains in the region- has generated, with some exceptions, there is a lag in the digitization and adoption of technologies in the sector at the regional level[6], mainly due to the ability of the industry to generate economic profit from products of low productive complexity or low value-added.

6 (Masera, 2022).

In recent years, the global COVID-19 pandemic and events such as the war between Russia and Ukraine have highlighted the risks in global supply chains of excessive external dependence associated with the high concentration of sophisticated manufacturing in some specific geographies, such as the factories of technological devices, electronic components, and automobiles in Asia and the United States.

This denotes the need for a change in strategy that points towards models focused on regional productive poles, with trusted partners and that ensure more resilience and response capacity. The foregoing seeks to reduce dependence on third economies to satisfy the demand for inputs or finished products and to integrate with logistics flows of shorter duration and with less propensity to be affected by external factors that cause an interruption in value chains.

Finally, climate change has also encouraged transformation and shifted the focus to preserving the environment. Compliance with the Paris Agreement signed in 2015 is a clear example of the importance for countries and, therefore, organizations, of acting to mitigate climate change, since the industrial sector is characterized by high energy consumption and a high environmental impact.

The latter is relevant in the case of Latin America and the Caribbean given the high proportion of manufacturing activities related to the extraction and processing of natural resources. Thanks to the agreement, organizations are beginning to move towards a more sustainable value chain, adapting or anticipating both regulatory and market requirements, with a high focus on the transition from carbon-dependent energies to operational models supported by renewable energies and that involve principles of circular economies.

2.2.2 Specificities of the region within selected countries

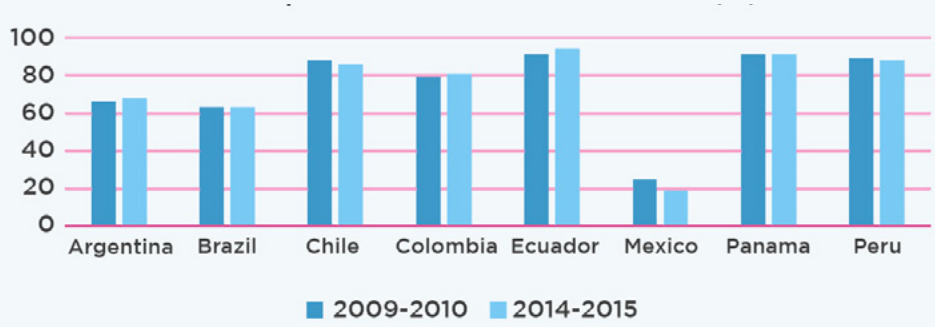
Although in general terms a large part of the region has focused on the exploitation of resources or the production of low-value-added in comparison with other economic zones, there are particularities at the value chain level associated with the different geographies within the region.

In order to understand the logic of the development of the manufacturing sector, it is necessary to understand the economic foci in productive terms, where beyond manufacturing, most countries sustain their economy from abundant raw materials, without having natural incentives to develop value-added manufacturing capacities.

As for the countries considered, Mexico has the lowest percentage of exports of raw materials with respect to its total export of merchandise with 19%, followed by Brazil and Argentina where this indicator rises to 63% and 68%, respectively. Meanwhile, Chile, Colombia, Ecuador, and Peru complete the top six in the ranking with more than 80% of their exports associated with raw materials, which implies a high level of dependency and productive focus oriented to products without value-added. In summary, with the exceptions of Mexico and to a lesser extent, Brazil and Argentina, most of the countries in this region are highly dependent on primary activities[7].

7 (Cabrera Valencia, 2019).

Figure 10: Percentage of exports of raw materials with respect to total merchandise (%).



Source: Own elaboration based on data from Cabrera Valencia, 2019.

It should be noted that most of the countries in the region are not only dependent on the export of raw materials but that their exports are concentrated in a small number of products[8]. The manufacturing of Chile, Colombia, Ecuador, and Peru is concentrated in subsectors with low complexity: those that consider copper mining, nitrates, and lithium, non-metallic extraction products such as cement and glass, or mining activities production associated with paper and wood. In all cases being products of a basic character with little differentiation.

8 (Cabrera Valencia, 2019).

In the case of Mexico, the high participation of vehicle manufacturing, machinery and equipment, electronic components, and computer equipment stands out. On the other hand, Argentina and Brazil, although they are highly dependent on primary activities, are also experts in the manufacture of vehicles, equipment machinery, and other finished products derived from metals, plastic, and wood. In the case of Brazil, the production of electronic components and computer equipment also stands out.

Based on their current productive developments, Argentina, Brazil, and Mexico could become the region's main productive poles, which allow for mitigating the risk of shortages observed by the economic conditions and global events of recent years.

In the case of the automotive industry, Argentina, Brazil, and Mexico are strategic points where large companies have installed capacity, together with their suppliers, to satisfy local demand. Another example is the paper industry and its derivatives in which, given the logic of consumer goods, it makes sense to install capacity to minimize transportation costs associated with products such as diapers and toilet paper. In the same way, products focused on the construction industry, such as cement, concrete, and lime, are produced in the region to satisfy its demand, mainly due to the availability of raw materials for local production and the efficiency generated by reducing the transfer of goods of high weight and volume.

2.3 Potential impact of the current geopolitical scenario

Recent geopolitical events created a window of opportunity for Latin America and the Caribbean to benefit from the reimportation of manufacturing located in geographies such as China. The Phenomena associated with the COVID-19 pandemic and the armed conflict between Russia and Ukraine evidenced the effects that supply disruption can have on complex value chains. Another relevant factor that contributes to this opportunity is the change in political relations between Western countries and China, due to the trade frictions that began in 2018 and increased from the pandemic and recent armed conflicts, with an effect on the perception and relationship of other Western countries with the Asian country and some of its allies. With the latter, a new wave of relocation is encouraged, but with a Friendshoring logic, in which the alignment of values is equally important in the decision of the geographies to prioritize.

On the one hand, the pandemic and the war slowed down value chains and demonstrated the disadvantages of excessive dependence on specific geographies, which also translate into long distances, travel times, and increased cost of maritime transport. To give an example: China represented, until 2020, 20.7% of the region's import operations[9].

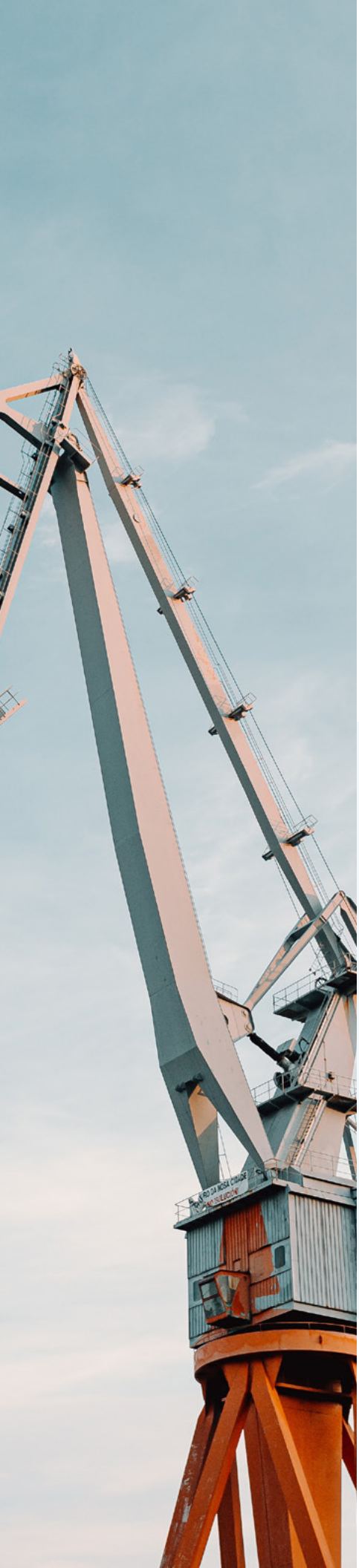
9 (World Bank, 2022) reviewed November 10, 2022.

Another factor that influences this phenomenon is that several of the competitive advantages of geographies such as China have been diluted over time. Labor costs have increased over the last decades, ceasing to be low-cost production centers, as a result of improvements in working conditions. Additionally, the recent change in internal policy in China and the regulatory "harassment" of multiple industrial sectors, combined with the zero covid policy have reduced the attractiveness and certainty of investments in that geography. Lastly, the trade tensions of the last decade and the bloc alignment with Russia have positioned China as a less suitable partner for trade in goods.

These and other factors have caused China to lose relevance in the world of global manufacturing in recent years[10], moving these operations to new productive poles closer to the final destinations of the goods. Some countries in Latin America and the Caribbean, such as Mexico and Brazil, position themselves as natural candidates to attract part of these investments.

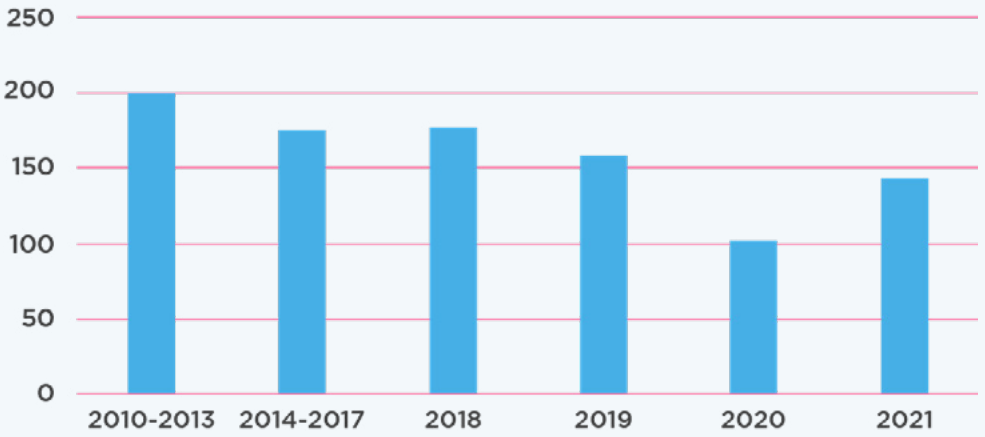
The global geopolitical and economic environment favors the deconcentration of manufacturing. However, to materialize the opportunity, the Latin American countries must guarantee environments that provide certainty and stability to the region. In this sense, it is important to increase legal certainty and avoid excessively interventionist policies that, in the past, have resulted in expropriation movements that make the region less attractive.

10 (CNBC & LaRocco, 2022).



Another area recommended to attract the establishment of manufacturing centers is the development of long-term structured policies that guarantee incentives for this type of investment. The challenge is no less since, in the last decade, Latin America has experienced social and political instability that has often spilled into the economic sphere. This can be seen in the decrease in foreign direct investment (FDI) in the LAC region in the past decade, where the only growth peak was from 2017 to 2018 with 1%, experiencing the strongest contraction of the period in 2020, due to the COVID pandemic[11].

Figure 11: Foreign direct investment flows in the LAC region in billion dollars.



Source: Own elaboration based on data obtained from the United Nations, 2022.

11 (United Nations & Zhan, 2020).

2.4 Current situation of manufacture and retail trade in LAC

This section depicts the status of Digital Transformation in manufacturing and retail companies in Latin America and the Caribbean. Starting from an initial understanding of the main business challenges that these organizations are facing, the section delves into the level of digitization in which companies are when addressing these business challenges and the barriers in their Digital Transformation process.

To provide a comprehensive vision of digitization throughout the value chain of the sectors, a series of interviews with SMEs and startups that provide products and services within the industrial ecosystem were also included in the study.

2.4.1 Current needs of organizations in the manufacturing industry

Derived from the macroeconomic context and the market situation after the pandemic (see details in sections 2.1-2.3), companies in the manufacturing sector are facing significant challenges in order to ensure business continuity and maintain their competitiveness in the market.

Among the most relevant impacts of the current socioeconomic context of the LAC region in these sectors, the following stand out:

- Increased price of products and services due to inflation.
- Shortages of products and components due to production and supply chain shutdowns.
- Changes to customer consumption habits towards products from organizations with a reputation for social responsibility.
- Lack of legal certainty and governance for long-term investments.
- Changes to demand and processes resulting from environmental regulation and tariff regulations.
- Shortage of skilled labor.

This new reality has important implications for the business and operating models of organizations, which are being forced to adapt their products and restructure their operations to maintain margins and be able to cope with new market dynamics.

Based on the analysis carried out, the main needs faced by organizations in the sector were identified:

1. Increasing productivity and ensuring operational continuity.
2. Increasing efficiency.
3. Improving traceability and reducing operational and market risks.
4. Improving the responsiveness of the value chain.
5. Adapting to new talent management approaches.
6. Incorporating environmental goals into the operation.

Each need is detailed as follows.

Increasing productivity and ensuring operational continuity

To increase productivity and ensure operational resilience, process continuity is a critical factor. Seventy-three percent of organizations consider it essential to have flexible operating processes to avoid interruptions in the operation, either due to external factors such as contingency periods or adverse market conditions or internal factors such as failures in production systems or poor planning in the acquisition of inputs.

Although these interruptions can generate significant losses in the results of the manufacturers, the analysis shows a lack of digital solutions with analytical capabilities among organizations that enable timely management of operational risks, mainly among companies in the subsectors of heavy industry.

In the case of the most digitally advanced companies, their main challenge is to achieve convergence between information technologies (IT - Systems) and operation technologies (OT - Machines and switches) to integrate the events of the physical process with the information collected in systems and data processors. The convergence of these technologies occurs in the intelligent automation of processes but also in their monitoring and is necessary to enable the application of technologies in order to operate the processes and have real-time information analysis for early detection of deviations or red flags in production.

The case of a company in the metallurgical sector in Argentina is identified, which seeks to reduce, even, production losses associated with unplanned maintenance interventions by implementing monitoring models and prescriptive analysis for the proactive maintenance of the equipment of their processing plants.

Increasing efficiency.

According to the results of the interviews carried out, 94% of the manufacturing companies have mentioned that one of their main strategic focuses is to increase their efficiency to improve the performance of their processes and reduce production costs without affecting the quality of the products manufactured.

In the manufacturing sector, the search for efficiencies focuses on the productivity of manufacturing processes. The pressure to maintain operating margins is leading companies to seek solutions that allow optimizing the use of resources and improving inventories through digitization and process automation. Eighty-eight percent of study participants state they have automated or semi-automated production plants supported by manufacturing execution systems MES (Manufacturing Execution System).

In the case of retail, the ability of organizations to reduce operating costs is critical to ensure their profitability. In this case, operational efficiency is more focused on supply chain planning processes and store operations.

Improving traceability and reducing operational and market risks

The series of recent events such as the COVID-19 pandemic or the war in Eastern Europe have impacted the shortage of raw materials and inputs for production and marketing in the region. According to 78% of the companies interviewed, improving traceability in the supply chain and increasing its resilience against adverse events, such as temporary closures or government restrictions, is key to facing periods of uncertainty in the supply of products.

In this sense, one of the priorities of companies is to have the appropriate digital tools to be able to monitor their production processes in real-time and identify potential risks throughout the supply chain in advance. This covers the entire chain from suppliers of raw materials and inputs to logistics operators.

Likewise, having resilient operations allows organizations from both sectors to speed up the transformation and restructuring times of their activities in the face of any unforeseen event in the market.

Improving the responsiveness of the value chain.

In addition to the existing challenges in production activities, the industry presents significant challenges in business planning and management processes. For 78% of the companies interviewed, changes in customer consumption patterns and supply problems for certain inputs are creating a significant challenge when it comes to balancing supply and demand.

In order to adequately respond to changes in demand that may affect production processes and plans, organizations need to improve integration and proximity with their distributors and direct customers. Understanding in real-time the behavior of all the agents that participate in the value chain would help manufacturing companies to anticipate potential changes in the market and speed up the adaptation times of their processes and products.

In the case of retail, marketplace platforms have generated advantages in terms of automation of commercial attention, visibility of inventories, and the ability to reach a greater number of customers, enabling new lines of income. However, the challenge of implementing advanced analytics solutions to take advantage of business, consumer, and customer behavior data to anticipate changes in demand and improve results remains.

Adapting to new talent management approaches.

In the current context of Industry 4.0, where digitization is generating constant and increasingly accelerated changes in the market environment, talent management represents a huge challenge for companies, which must find the formula to adapt to this new context to ensure the attraction, growth, and retention of the best talent.

Among the most relevant difficulties when attracting and managing talent by companies in the manufacturing and retail trade sector in the region, the following stand out:

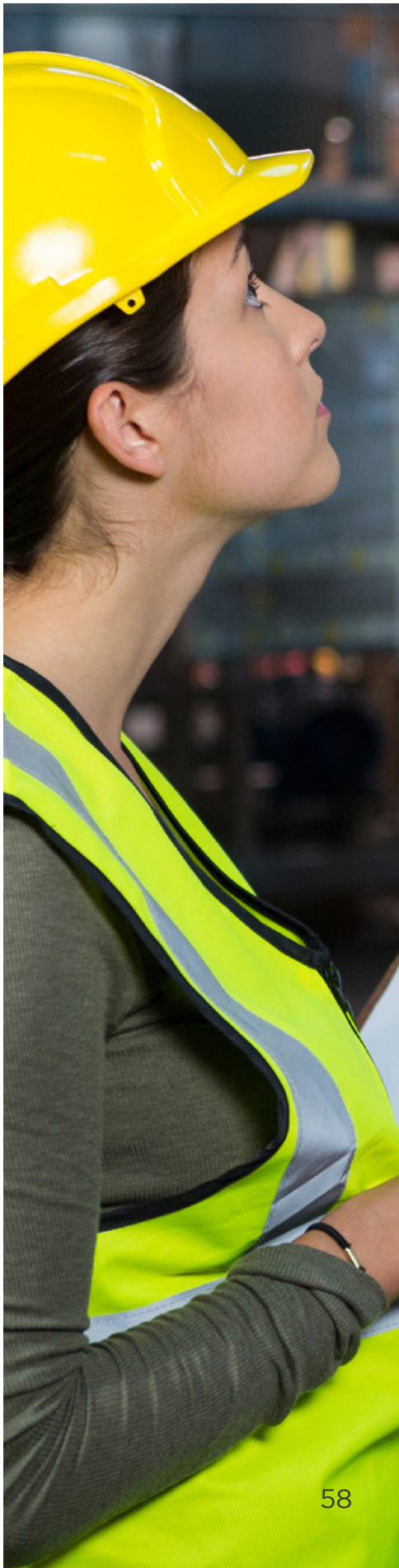
- Shortage of labor and talent specialized in digital solutions.
- High turnover of new digital profiles.
- Lack of digital knowledge in leadership positions.
- Inefficiencies in the management of hybrid operations.

The need for hybrid talent, with specialized knowledge of the business and strong digital skills, is mainly identified in tactical and operational positions but has a high impact in all areas of the organization.

Although it has been identified that 85% of the study participants have incorporated specialized profiles for tasks of a digital nature, there is still a significant gap in the incorporation of digital skills for management positions and middle managers. In the case of managers, such knowledge is needed to generate more robust visions of transformation in which there is clarity about the risks and benefits of such programs. In the case of middle managers and operational profiles, the need is associated with acquiring or updating the digital skills necessary to enable the transformation.

Incorporating environmental goals into the operation.

In recent years, governments in the region have a greater sensitivity for including initiatives associated with sustainability and reducing the impact of climate change in their agendas. The inclusion of environmental objectives in organizations can occur due to existing regulations or as a result of the intention to enter more regulated markets. Despite this, in the manufacturing sector, there is still a long way to go in this matter, since only 48% of the companies interviewed mentioned sustainability as a priority issue on the senior management agenda in the short term.



So far, environmental goals in the region have been driven mainly by regulatory changes associated with compliance with emission levels and waste management, responding to or anticipating future regulations. For example, in terms of emissions, the region has made progress in the transition from carbon-dependent energies to the use of renewable energies. In some cases, there are even investments to produce their energy from "cleaner" mechanisms such as the use of panels to reduce energy consumption and the replacement of fossil fuels with alternative fuels such as waste.

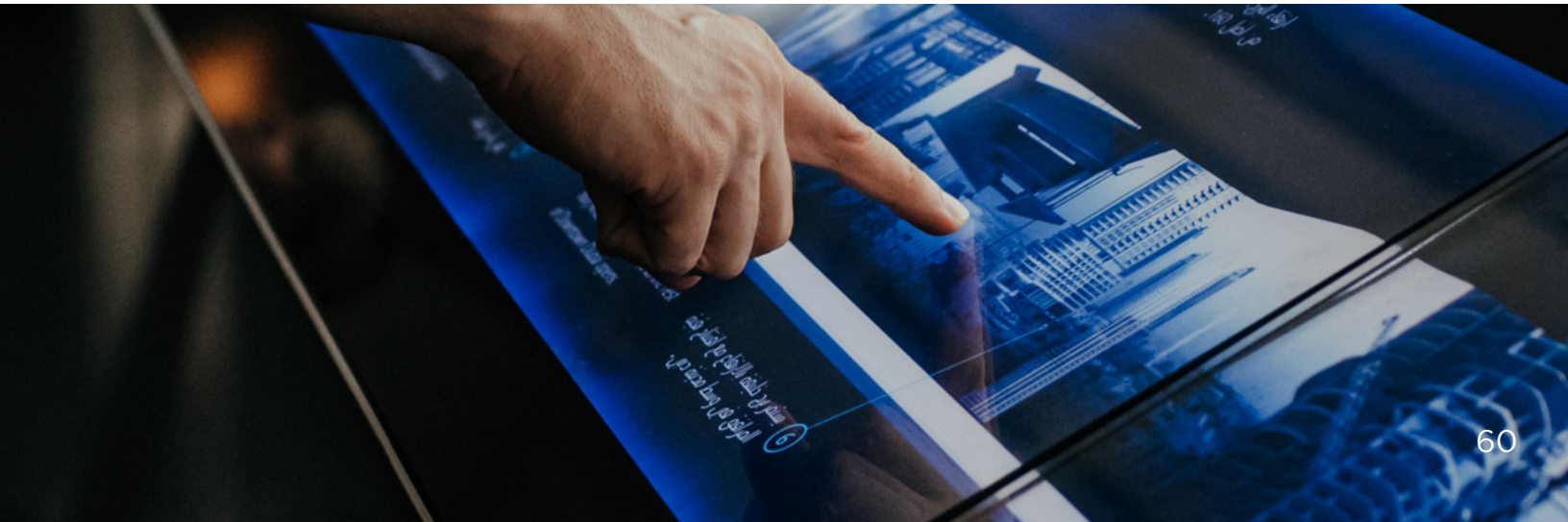
The results of the study indicate that the sector has a growing awareness of the relevance of adopting a more developed culture of sustainability. Only 6% of the participating companies stated that they did not have a performance management model for practices focused on the environment. In the same sense, 14% stated that they have advanced practices to monitor and optimize the emissions they generate. It was also possible to identify 11% of companies with initiatives associated with adjusting their operating models towards a circular economy vision.

2.4.2 Current scenario of Digital Transformation

Digital Transformation has become a fundamental element to address challenges faced by businesses throughout the industrial ecosystem. However, as is the case in other industries, in the manufacturing and retail sectors in LAC, Digital Transformation lags behind when compared to regions in the United States, Europe, and some Asian countries.

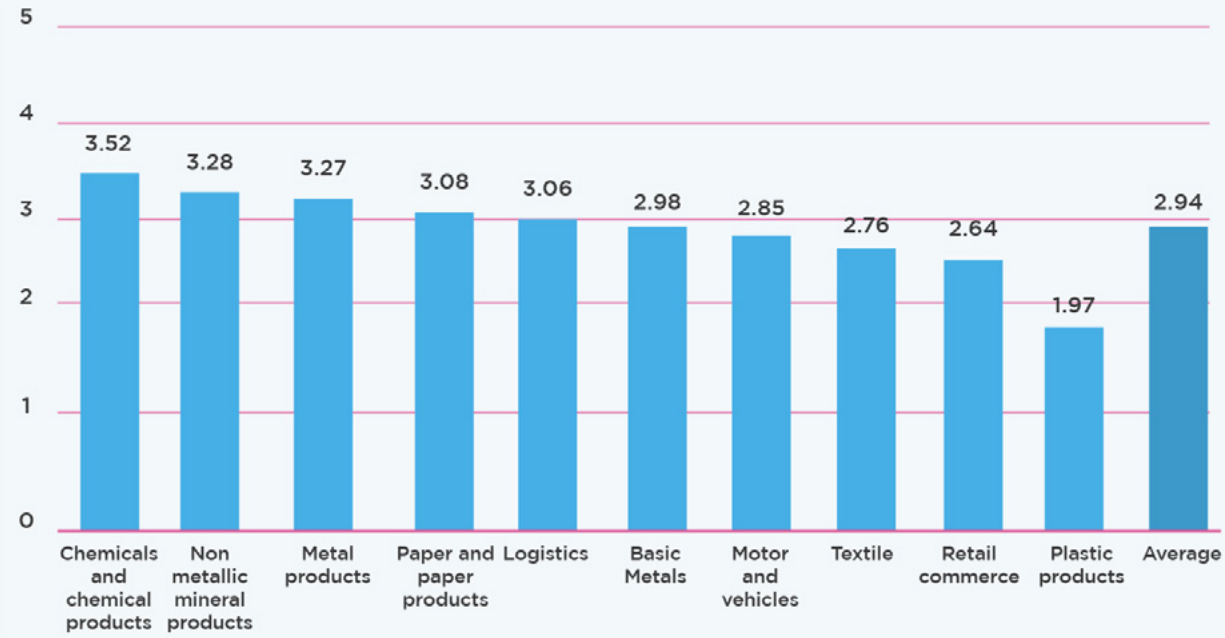
In the digital ranking of the *International Institute of Management*, In the most advanced economies in LAC, Chile, and Mexico, are in positions 41 and 55, respectively. Based on the analysis carried out, an opportunity is identified in terms of digitization and process automation. Addressing this gap and promoting investment in Digital Transformation is a necessary lever to improve the competitive position of Latin America and the Caribbean as a regional production hub that stands out for its productivity, efficiency, and response capacity to meet local demand on time and from other economies such as the United States and Europe.

The results of the analysis carried out on the sample of participating companies show that, in the LAC region, the Manufacturing (2.97) and Retail Trade (2.64) sectors present an intermediate level of digital maturity, placing 90% of the subsectors analyzed within an average digital maturity range of 2.5 - 3.5 out of a maximum of 5 points.



These results are expected considering that, according to the selection criteria, the participating companies must meet a minimum size threshold, which in turn implies that they had already embarked on their *digital business journey*. In any case, the state of maturity observed is insufficient to take advantage of the benefits of Digital Transformation and ensure the competitive position of corporations in the future.

Figure 12: Self-assessment results with the digital maturity tool (by subsector).



Source: Own elaboration based on the results of the DMA.

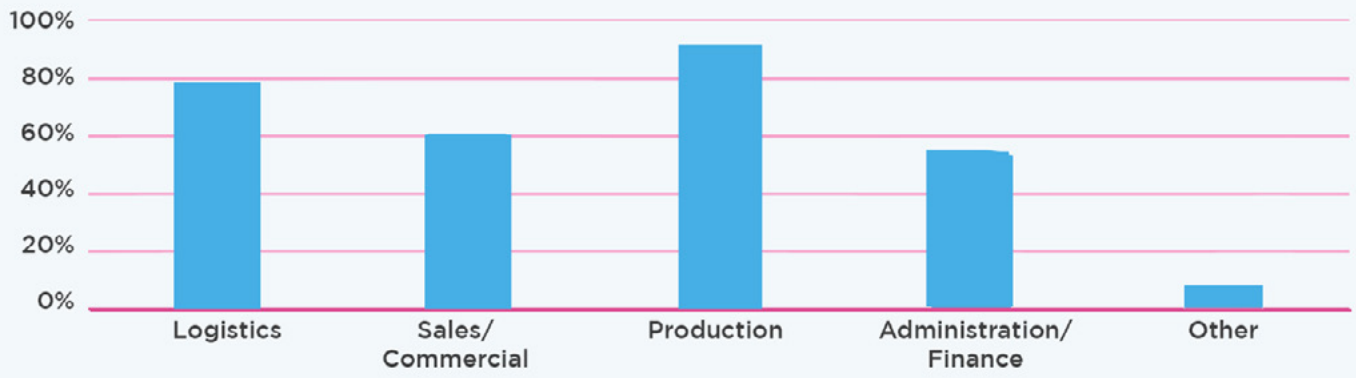
Although the results of the digital maturity self-assessment offer a perspective on the level of maturity, it is important to consider the influence of the sample of participating companies. Despite having subsectors with higher evaluations, no great differences in maturity are perceived when the results of the qualitative analysis are integrated. A common factor of the organizations and industries with the highest scores is having a digital vision that is relatively aligned with the business challenges and grounded in a strategic Digital Transformation plan that considers the needs of the entire organization.

This data contrasts with the fact that in 77% of the manufacturing companies interviewed, Digital Transformation is addressed in silos or without a cross-sectional vision. Digital initiatives are identified separately by each business unit and prioritized by the information technology area based on their individual return on investment, without considering synergies between business units, production plants, or countries.

The absence of a global vision regarding Digital Transformation not only prevents companies from maximizing the value of digitization in their supply chain but also has a direct impact on business objectives such as a) An increase in sales expenses due to duplication of software licenses, b) Inefficiencies in the operation due to problems in the integration between the systems, c) Bottlenecks due to different levels of digitization in the units and d) Delays in deliveries due to lack of visibility of real inventories.

At the operational level, the most digitally advanced processes are logistics and production and there are more areas of opportunity in administrative processes, including finance, human resources, and legal functions.

Figure 13: Digitization in the links of the value chain (% of responses)



Source: Own elaboration based on data collected from the DMA and interviews

We analyze below the current digital maturity in the different functions of the value chain and how organizations are using new technologies to address their business challenges.

Logistics.

Digital Transformation has become an essential element in the logistics sector for companies to achieve their objectives of faster delivery speed, order traceability, and cost control.

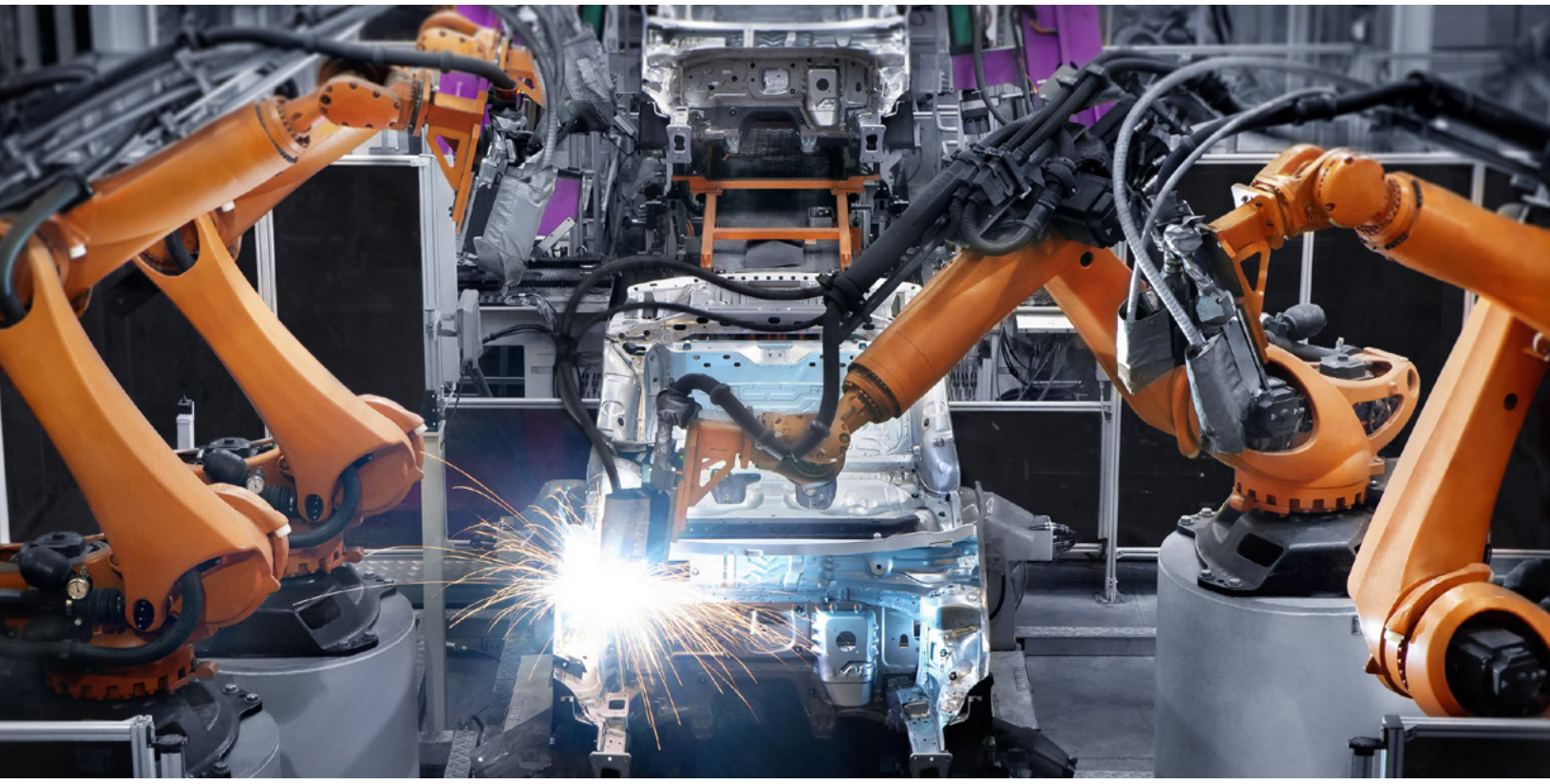
In the storage and logistics processes of companies in the region, there is a high integration of warehouse management systems (*Warehouse Management Systems*, WMS) and transport (*Transport Management Systems,* TMS) that are combined with technologies such as radio frequency identification (*Radio Frequency Identification,* RFID), barcodes and mobile devices such as *tablets* or *smartphones*. These technologies allow companies to have greater visibility and reliability in the management of their inventories, as well as the implementation of *paperless processes*, electronic payments, and the digital signature itself.

Although these technologies are beginning to offer significant benefits to organizations in terms of efficiency, service quality, or sustainability, the following areas of opportunity are also identified to continue taking advantage of the benefits offered by Digital Transformation in logistics operations. For example:

- **Leveraging data usage.** The data collected in logistics activities have a high value for decision-making in production and sales processes. However, to make the most of this information and carry out real-time analysis, all logistics management devices and systems must be connected and perfectly integrated with the resource planning system (*Enterprise Resource Planning, ERP*) and the rest of the organization systems. For this, it is key to leverage the use of *data-warehouse* and/or *data-lakes* solutions that serve as the basis for the implementation of advanced analytics capabilities.

- **Automation of logistics processes.** Logistics processes are a natural area of application for solutions such as artificial intelligence, autonomous vehicles, and the use of *Big Data* combined with switches connected to the Internet of Things (IoT) for real-time monitoring of activities. Seventy-five percent of the participating companies stated that they were implementing initiatives focused on logistics optimization through this type of technology with different degrees of advancement and sophistication.

In transportation and distribution activities, the use of geolocation systems in the vehicle fleet stands out, as well as route planning and merchandise traceability systems. These systems are allowing organizations to optimize loads on the transportation network, routes according to orders, available vehicles, weather conditions, road conditions, or traffic, and offer customers the ability to track their orders in real-time.



Production.

With the advent of 5G networks and advances in cutting-edge technologies such as Big Data, artificial intelligence, or the Internet of Things (Internet of Things, IoT), production processes are evolving in the most digitally advanced countries[12] towards a new concept of Smart Manufacturing, where all the elements of the plants are connected and interact with each other as a network, maximizing productivity, and giving more flexibility and resilience to the processes.

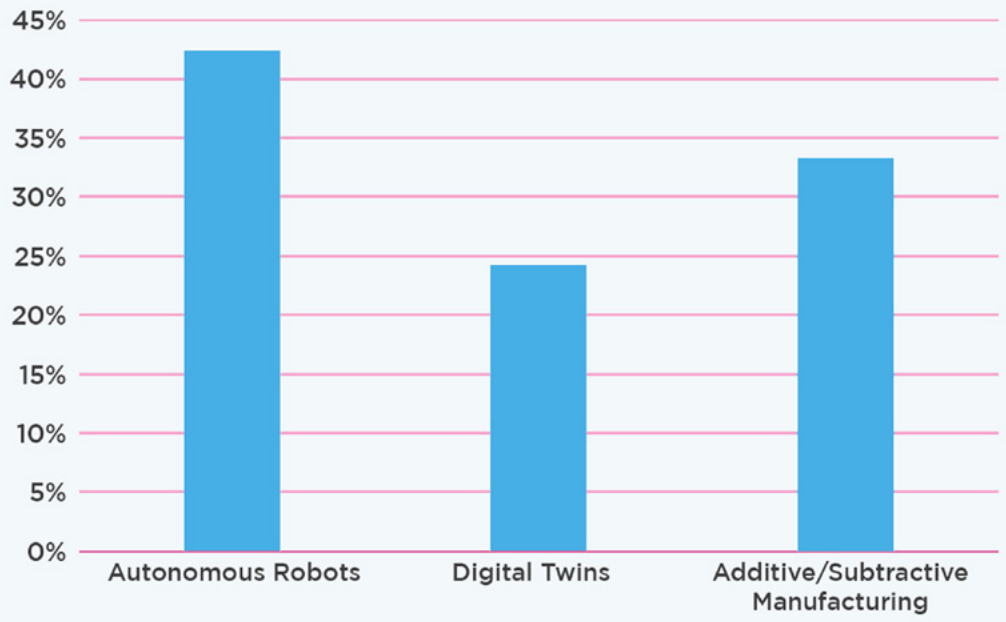
According to the results of the analysis, in LAC it is considered that the sector is currently in a state of follower since the process of evolution towards a smart production model is being slower than in other regions, which could represent a threat to the competitiveness of the region's industry in the medium term.

One of the factors that is influencing when it comes to providing factories with intelligence is the delay in the deployment of 5G networks in most of the countries of the region. In the main cities of countries such as Mexico, Brazil, Peru, or Chile, the availability of 5G networks is already a reality. However, in certain more rural areas where some industrial parks and production plants are located, the necessary infrastructure for the development of smart factories is not yet available.

12 (IMD WORLD DIGITAL COMPETITIVENESS RANKING 2022, s/f).

Regarding the integration of technologies in the factories of the region, wide differences are identified between the companies participating in the study. Although 43% of the manufacturing companies interviewed claim to have automated assembly lines with robots, only 24% of them are making use of new technologies (IoT switches, Digital Twins, additive/subtractive manufacturing...) to make processes more efficient, optimize the use of assets and energy resources, optimize the production rate and improve the quality of your products. For example, an automotive organization in Mexico can monitor the entire production line of its vehicles in an integrated control center, with quality monitoring in real-time to identify deviations and execute corrective actions on the production line.

Figure 14: Percentage of adoption of production technologies.



Source: Own elaboration based on data collected from the DMA and interviews.

In production lines, there is a clear trend toward the incorporation of switches and other measurement devices to monitor the performance of machines and make long-distance decisions associated with planning, production, and asset maintenance, among others.

However, as in the case of logistics processes, there is still an area of opportunity in the use of the data collected even though 66% of the companies declare that they have technological capabilities and internal knowledge to carry out analyses that trigger predictive maintenance decisions, this was not concluded in the results of the interviews where many of the initiatives were in the process of being implemented or were in isolated links of the process itself.

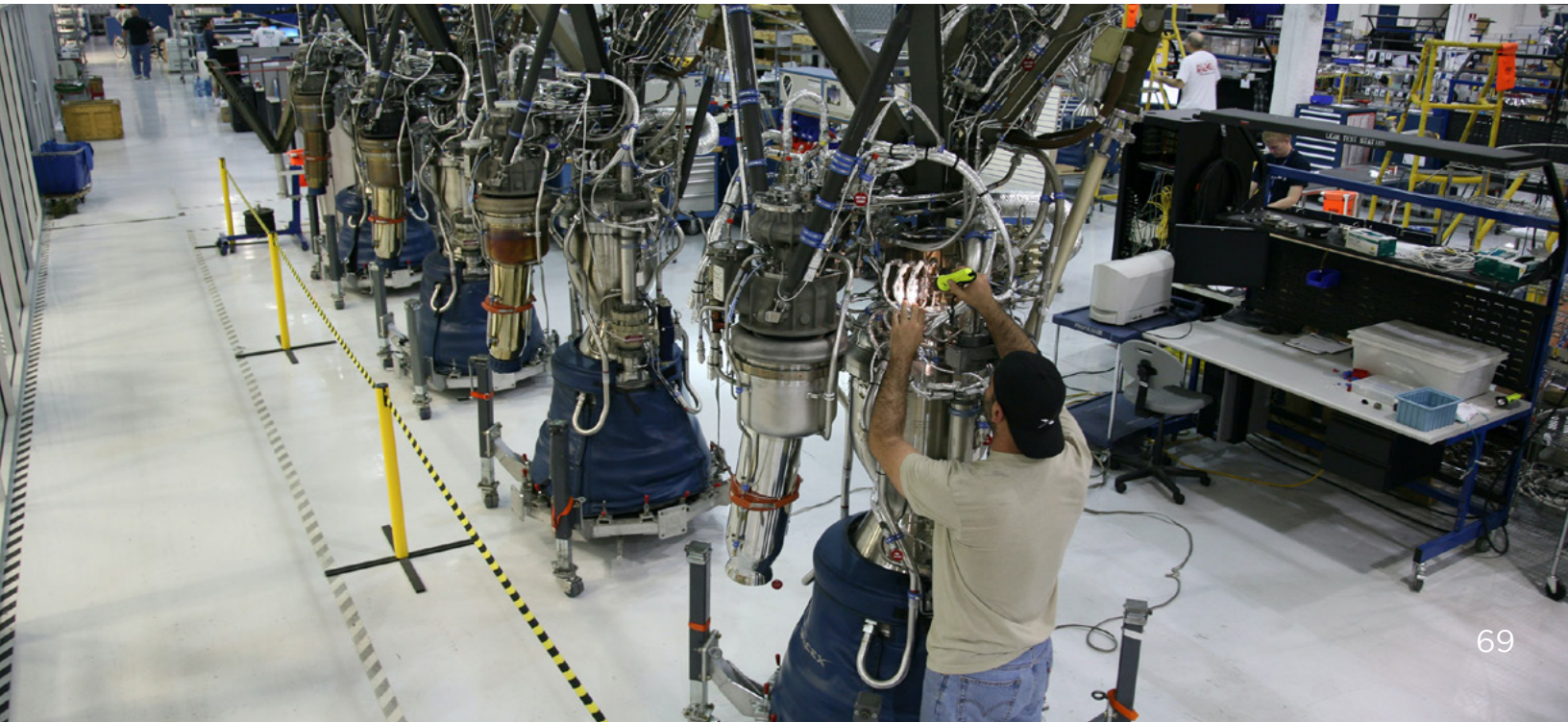
In this sense, one of the main challenges to achieve is the convergence between operation technologies and information technologies to share data between the organization's machines, devices, and systems and integrate said analysis into decision-making.

Sales and Customer Service.

In the sales and customer service areas, it is worth noting the relevance that digital channels are acquiring as a result of the pandemic. In the retail sector, all companies interviewed have digital channels for both sales and customer service, while in the manufacturing sector, the declared presence is barely 60%.

The digitization of service channels is taking place in two directions: (1) enabling 100% digital channels such as e-commerce platforms and social networks, and (2) deployment of new digital solutions in traditional channels, such as strengthening sales with electronic devices to capture orders (manufacturing) and inclusion of devices that emit signals for their identification *(beacons)*, QR codes or augmented reality in physical stores in the case of retail trade.

A pending subject is associated with customer service platforms where the main methods characterized in manufacturing continue to be *call centers,* calls, and emails. This contrasts with retail, where much more progress has been made in customer self-management platforms that involve the use of digital channels to manage requests and claims.



Digitally transforming business processes has provided great benefits among the companies interviewed. In addition to an increase in sales and greater customer satisfaction, the digitization of the commercial channel allows us to considerably reduce the marginal cost of sale per customer, enabling lower prices and, therefore, allowing organizations to serve a much larger market.

Regarding the challenges when digitizing their sales and customer service processes, organizations have mentioned the following:

- **Omnichannel and multichannel.** An omnichannel strategy requires synchronization that allows a client to start a sales process in any channel and continue it through another without losing traceability. Although, in the case of retail trade, the trend is towards omnichannel, in the case of manufacturing, most companies are still in the early phase of development of their digital channels (multichannel). Both trends represent a significant challenge in relation to systems integration, data governance, and the implementation of tools such as *Customer Engagement Centers* (CEC). Additionally, the introduction of new channels implies addressing challenges among which are the possible cannibalization of sales, the adjustment of business processes, and the eventual need to reinforce the organization with new profiles. The latter is of particular importance in the case of industries that decide to directly attack the final consumer (*Business to Consumer*, B2C).

- **Return on investment.** In subsectors or companies with a low number of customers or a low level of demand for products, the cost of investing in the deployment of digital channels makes it difficult to justify the financial investment. This situation is more common in corporations that do not have a comprehensive Digital Transformation strategy and therefore manage digitization as initiatives in silos, which prevents them from capturing synergies between them and promoting transformative changes that enable access to new markets or models of business. In the case of manufacturing, the composition of the demand translates into customers mainly from the B2B *(Business to Business)* segment who are accustomed to traditional methods for capturing orders, which implies digital channel initiatives with a different logic from that it is required in the case of the B2C channel and that requires change management to increase adoption so that the investment can be justified in the long term.

Despite the above, in the case of the manufacturing sector, 26% of the companies stated that they have robust digital channels oriented towards omnichannel that seek to integrate the concept of customer self-management as an efficiency lever.

Support functions.

In support areas such as Finance, Human Resources, or Purchasing, the digitization of companies in the sector in LAC focuses on the systematization of tasks and the automation of processes, mainly through Robotic Process Automation technologies. Automation, RPA) and tools for process management (Business Process Management, BPM) that serve to automate and monitor workflows.

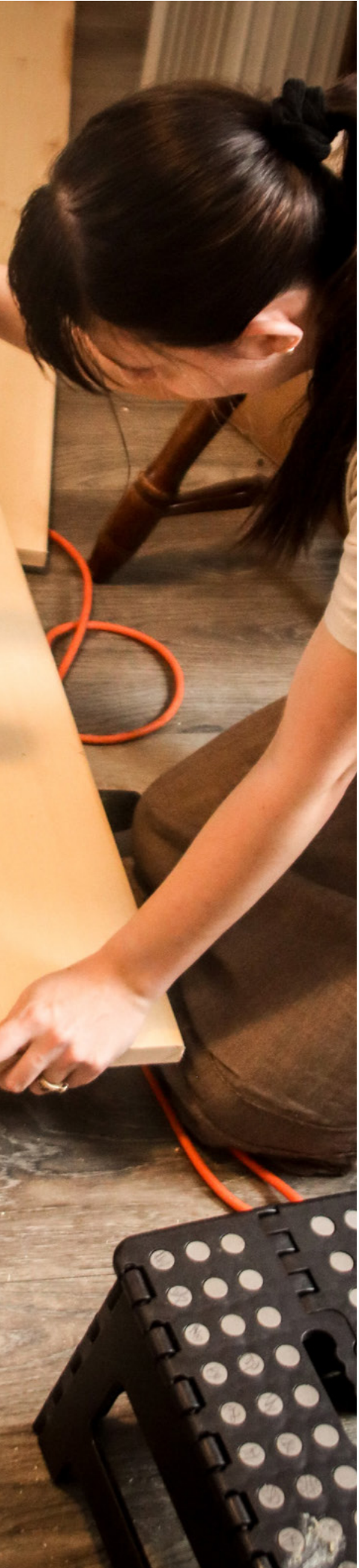
Among the companies interviewed in the region, there is still a strong presence of manual administrative processes and high use of tools such as Excel for the generation of reports and spreadsheets, order tracking, and accounting operations at all levels, but especially between smaller suppliers and manufacturing companies.

In this regard, 85% of companies are prioritizing the automation of transactional processes where automation complexity is low and investment returns are high (for example, invoice processing), compared to 14% of companies that declare be implementing initiatives to digitize more robust activities and associated with back-office processes that involve interacting with more systems and require the combination of more sophisticated technologies with advanced analytics capabilities and, on occasions, supported by artificial intelligence.

It is important to contextualize that regardless of the degree of sophistication of the automation, they tend to occur in certain activities of a process and rarely not in the entire process. In this sense, it is common to maintain manual activities either to review, validate or connect some tasks with others.

Among the main challenges for the automation of processes or parts thereof, the following have been identified:

- Alignment of interests between *stakeholders* and prioritization of initiatives.
- Standardization and degree of maturity of the processes.
- Technological architecture and integration between systems.
- Availability of technical capabilities for the development of more complex automation solutions.
- Structuring the governance of automation.



Sustainability

In terms of sustainability, a basic level is observed in which digitization is mainly used for monitoring emissions data and optimizing the consumption of resources. Participating organizations reported a tendency to prioritize sustainability initiatives when they are linked to an additional benefit of operational efficiency.

In this line, there is a greater presence of solutions focused on addressing the economic and environmental dimension of sustainability seeking to increase the performance of raw materials through substitution or reuse, which in turn impacts cost reduction. Something similar occurs with solutions focused on reducing emissions or energy consumption.

Another important factor why organizations decide to venture into this type of initiative is the reputational aspect that is increasingly present in the mind of the consumer and if not addressed, can mean risks whose consequence is greater than the costs of implementing solutions to mitigate them.

In the case of the social field of sustainability, there was less focus on inclusion initiatives beyond those related to gender where, although there are efforts, most companies recognize a significant gap in the participation of women in the sector.

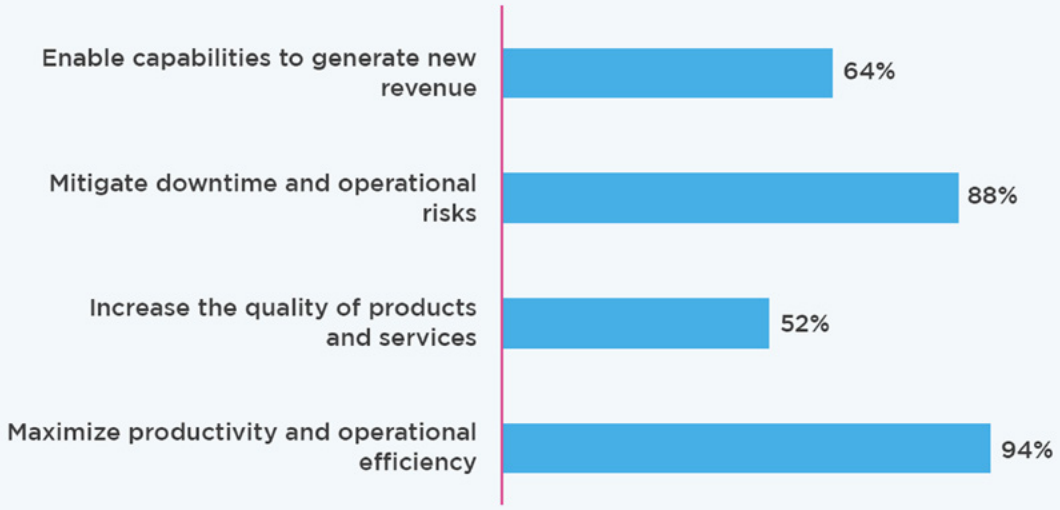
Among the most mentioned solutions, the incorporation of paperless operation models or the use of switches to capture environmental and resource management data stands out. At more advanced levels, the use of management systems to control environmental impact metrics integrated with operation data and the generation of reports in real-time to monitor sustainability goals is identified.

For example, the case of a company in the metals and metal products sector in Chile that uses switches in production plants to monitor emissions and generate high-precision reports on environmental impact stands out.

2.5 Objectives and strategic focuses of the Digital Transformation

Despite the difference between the particularities and the level of maturity of the subsectors in the region, the Senior Management of the organizations converges on certain Digital Transformation goals that are cross-sectional to address business challenges in the industry such as maximizing productivity and operational efficiency, increase the quality of products and services, mitigate downtime and operational risks, and enable capabilities to generate new revenue.

Figure 15: Objectives of Digital Transformation – Responses from organizations.



Source: Own elaboration based on data collected from the DMA and interviews.

Each of these objectives and their relevance in the digitization of the industry are deepened as follows.

Maximize productivity and operational efficiency.

One of the main objectives of Digital Transformation in the industry is to deploy automation initiatives and advanced data analytics linked to the Internet of Things (IoT) and artificial intelligence to improve productivity and operational efficiency as a catalyst for cost reduction.

In this regard, manufacturing companies are focusing on the digitization of their production processes to simplify processes, optimize the use of resources, and maximize the performance of their assets. On the other hand, retail companies are more focused on achieving efficiencies associated with their logistics infrastructure, in order to have greater control and visibility over the supply chain, which is key to satisfying consumer demand.

The case of a cement company that assured that it is using Digital Twins for the analytical simulation of scenarios associated with its production processes is highlighted, allowing the optimization of mixtures in the development of its concrete products, an initiative with estimated savings of more than $10 million USD annually.

Increase the quality of products and services.

Another digitization objective most mentioned during the study is to improve the quality of the products and services offered. In this sense, several initiatives have been identified in the transformation plans that involve the integration of new technologies in different areas of the organization. For example:

- Integrate artificial intelligence solutions, machine learning, and IoT devices in production lines to provide machines with intelligence, improving their precision and allowing them to anticipate certain events to minimize failures or errors in manufacturing.

- Deploy additive/subtractive manufacturing technology to create custom parts and prototypes at low cost and with fewer design defects.

- Digitize products or services to increase the value perceived by the customer. In some subsectors such as the automobile, retail trade, or the paper industry and its derivatives, digital solutions are beginning to be incorporated (mobile applications, QR codes, augmented reality, among others) that allow adding value to products and services.

- Use advanced analytics capabilities to better understand customer needs and behaviors and identify trends to help tailor products or offer more personalized service.

- Increase traceability through technologies such as quality management systems, radio frequency identification (RFID), and, more recently, the *blockchain*.

Although these initiatives, among others, are part of the strategic transformation plan of several companies in the sector, the reality is that the sector in the region is currently lagging in terms of the implementation of cutting-edge technologies and many of these companies are facing difficulties, in order to capitalize on their transformation projects. This is due to the high presence of legacy systems, difficulties in integration between systems, lack of *in-house* technical knowledge and errors in the definition of work plans and business cases.

Ensure operational continuity and reduce downtime.

Various external factors affect both demand and supply and the operational continuity of manufacturing companies. To mitigate this uncertainty, companies have focused on implementing solutions focused on reducing the impacts that natural disasters, pandemics, and geopolitical conflicts cause in their supply chains. These solutions are oriented towards the use of data to improve decision-making and increase the visibility of your supply chain.

In this regard, 85% of the participants state they have purchasing platforms integrated with their inventories that allow access to key information on suppliers and supplies to anticipate potential stock-outs.

Another relevant factor is the early identification of possible sudden failures in the assembly lines due to breakdowns in the machines, which cause stoppages in the operation or work accidents. For example, a company in the metallurgical sector with a presence in several LAC markets is implementing maintenance models supported by *machine learning* to monitor its equipment, identify possible failures, and carry out preventive maintenance actions. Likewise, this same company is using a real-time video analytics solution to identify risk scenarios in the field and avoid accidents at work.

Increase sales and generate new revenue.

Although the main strategic focus of Digital Transformation for companies is productivity, 64% of corporations have seen digitization as a good opportunity to improve their business performance and enable new revenue lines.

In the manufacturing sector, some companies in the study have mentioned that they are generating new sources of income through the following initiatives: (1) the use of advanced analytics tools in their demand analysis to identify trends and enter new markets (2) generation of strategic alliances with providers of digital solutions to evolve their portfolio of products and/or services and serve new customer segments.

For example, a coating company derived from the wood sector, with a presence in Brazil and Colombia, implemented a subscription model for frequent orders through a digital portal.

On the other hand, some subsectors that did not have B2C sales models are opting to expand their role within the value chain and incorporate direct sales to consumers through the development of their e-commerce platforms or with a presence in *marketplaces*.

The implementation of this type of platform requires reviewing various aspects of the business strategy, such as the operating and support model, digital marketing capabilities, and the review of remuneration schemes for the sales force. This is necessary to ensure that new segments are properly served. A company in the paper industry with a presence in Mexico, Colombia, Argentina, and Peru claims to have increased its sales by 24% and the average value of the products and services sold by 9% by enabling a B2C digital sales channel.

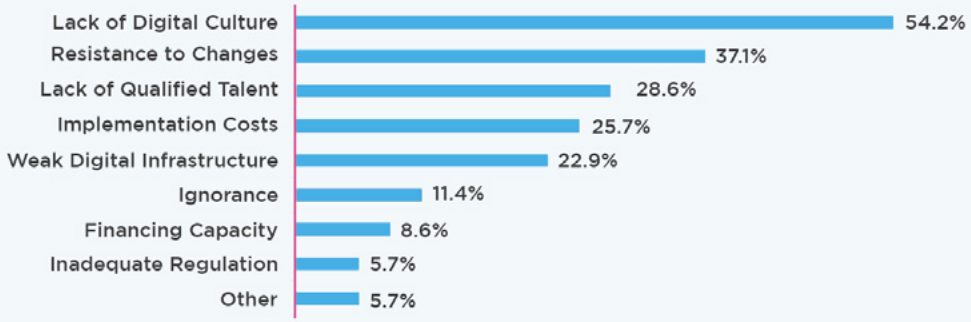
In the case of retail, the need of the sector to offer a closer and more personalized service to its customers has focused the companies on the development of omnichannel capabilities, analytical capabilities for customer segmentation, and dynamic digital marketing strategies. In this scenario, a retail company with a presence in Chile and Peru stands out for the integration of a commercial strategy aimed at becoming a *marketplace* platform to connect other sellers with their customers.

2.6 Barriers to Digital Transformation

Companies in the manufacturing and retail sector in the region are facing multiple barriers to bringing their Digital Transformation plans to reality.

When analyzing the results, common themes were identified such as the lack of culture and digital talent, technological complexity, the need for customized solutions, and the lack of capabilities to evaluate, size, and monitor the return on investment.

Figure 16: Challenges of Digital Transformation – Responses from organizations (%).



Source: Own elaboration based on the results of the study.

Lack of culture and digital talent in the market.

Digital Transformation involves a change in business with a high impact on the culture and organizational model of companies. For this reason, the absence of digital culture, the resistance to change from employees and the lack of knowledge about the benefits of digitization by senior executives are the main barriers on the path to the Digital Transformation of the sector.

One of the main obstacles to implementing Digital Transformation programs is the absence of a robust digital culture in 75% of the participating organizations.

Along the same lines, a great resistance to change is identified on the part of collaborators at different levels of the organization as they are used to carrying out their activities systematically and traditionally. Getting out of their comfort zone and adapting to new digital work schemes is a challenge, especially for employees with more seniority. For this reason, in a sector where the processes are highly mechanical, with a very productive approach and little value-added, organizations are having difficulties in promoting a change of mentality in the organization, which represents a significant barrier to the adoption of digital or hybrid operations, where human-machine collaboration is key to maximizing process performance.

Another prominent barrier is the lack of talent trained in digital skills such as programming, advanced analytics, and technology architecture. This is a common denominator in the countries of the region, and it is accentuated by the recent phenomenon of competition for scarce talent. It is common to find digital specialists with little or no knowledge of the business or technical experts with vast experience but without the specific knowledge of the business that needs to be transformed. This situation has generated high competition among companies in the sector to attract and retain the best talent.

One solution that some companies are implementing to try to tackle this problem is to promote the training of their internal teams in digital skills. For example, a steel-producing company in Mexico has created an internal education platform to transmit digital skills to the entire organization.

Technological complexity and the need for customized solutions in the industry.

Due to the technological advances of the last 5 years, the portfolio of possible digital solutions available in the market is increasingly broad. However, despite the existence of a wide range of technological tools, they have been developed without a sector vision and their adaptation to specific needs in some cases is complex.

Derived from the particularities of the manufacturing sector, where production processes, assets, and resources are different depending on the characteristics of the subsector, the type of product, or even for the same product in different production plants, the implementation of a technological solution requires high parameterization and adaptation of the solution.

In addition, these solutions must be deployed in technological architectures that have legacy systems and solutions developed within the same organization, which makes integrations of the technological infrastructure difficult. Additionally, there is an opportunity to develop local providers that specialize in technological solutions, as well as to encourage collaboration with the *startup* ecosystem. The latter, to expand the offer of available solutions.

This complexity, combined with a lack of strategic vision and previous bad experiences breeds resistance, causes delays in decision-making, and sometimes incurs additional costs caused by rework resulting from poor sizing.

Ability to evaluate, size, and monitor the return on investment.

The high investment required for the implementation of certain digital solutions and the lack of mechanisms to measure and manage the value of Digital Transformation by organizations are barriers that prevent the execution of many digitization projects.

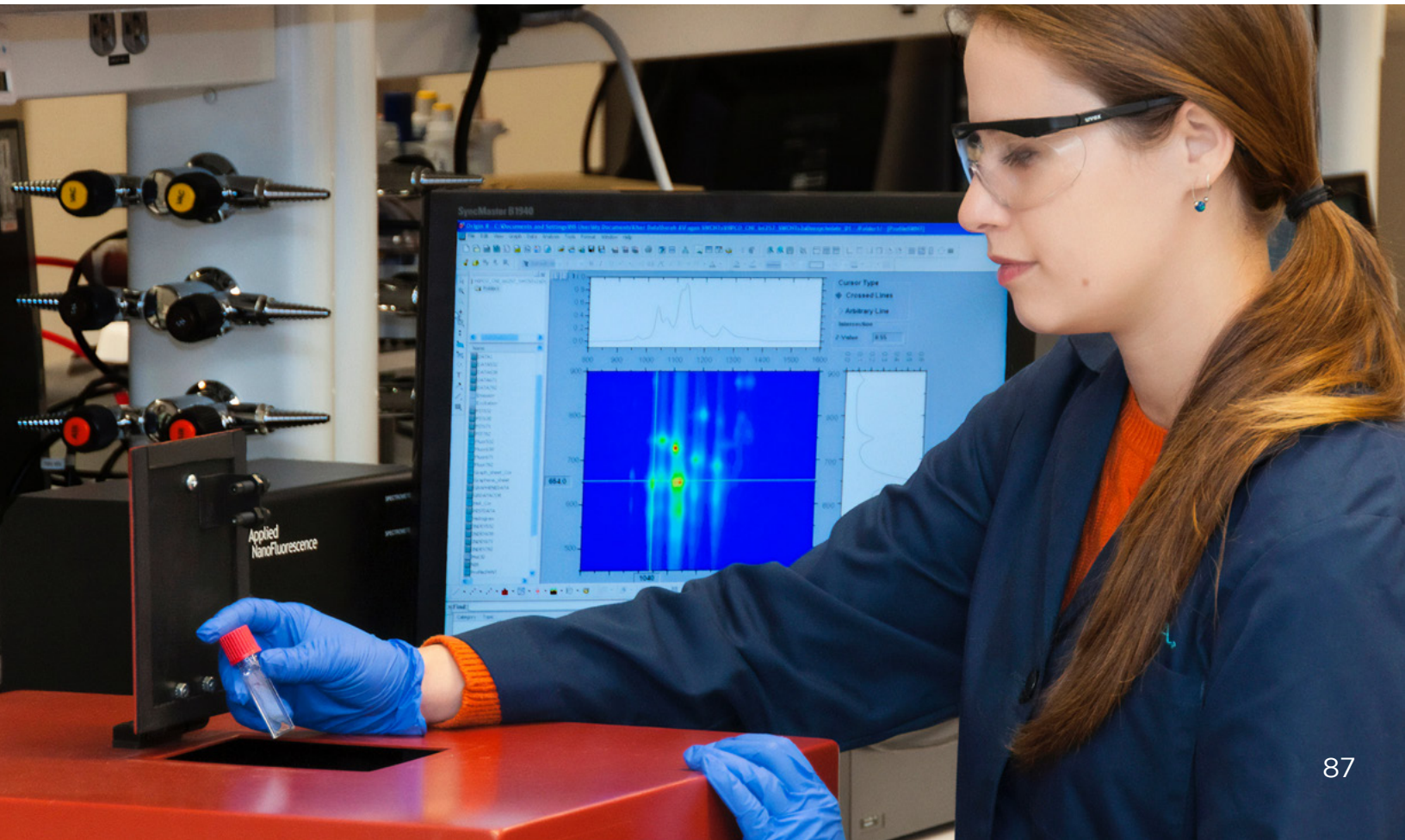
One of the main challenges of Digital Transformation plans is to demonstrate the return on the investment required for its implementation.

In this sense, many of the companies in the study prioritize their digital initiatives individually based on the return on investment, without considering a holistic vision of transformation that considers both quantitative and qualitative benefits, including the cost of not implementing the changes.

NOTE: High value of the investment is a term relative to each company based on its capacity.

On many occasions, this problem is derived from the lack of vision on the part of the management layer to understand and evaluate the potential value of the solutions and initiatives that they want to implement, concentrating only on their direct profitability in the short term. Of the sample of companies participating in the study, 77% point to the lack of digital culture as one of the main impediments to moving forward with their transformation agendas.

Having a strategic vision of digitization allows organizations to understand the real benefits that innovation can enable in the long term and the risks that you may face if you fall behind digitally. In this sense, business strategy and Digital Transformation must be addressed jointly and in coordination as a way to keep organizations current through investments focused on evolving their processes with clarity of the benefits to be obtained. Otherwise, organizations face risks associated with the loss of competitiveness in the market due to the obsolescence of the operating model itself.



Digital solutions for identified needs

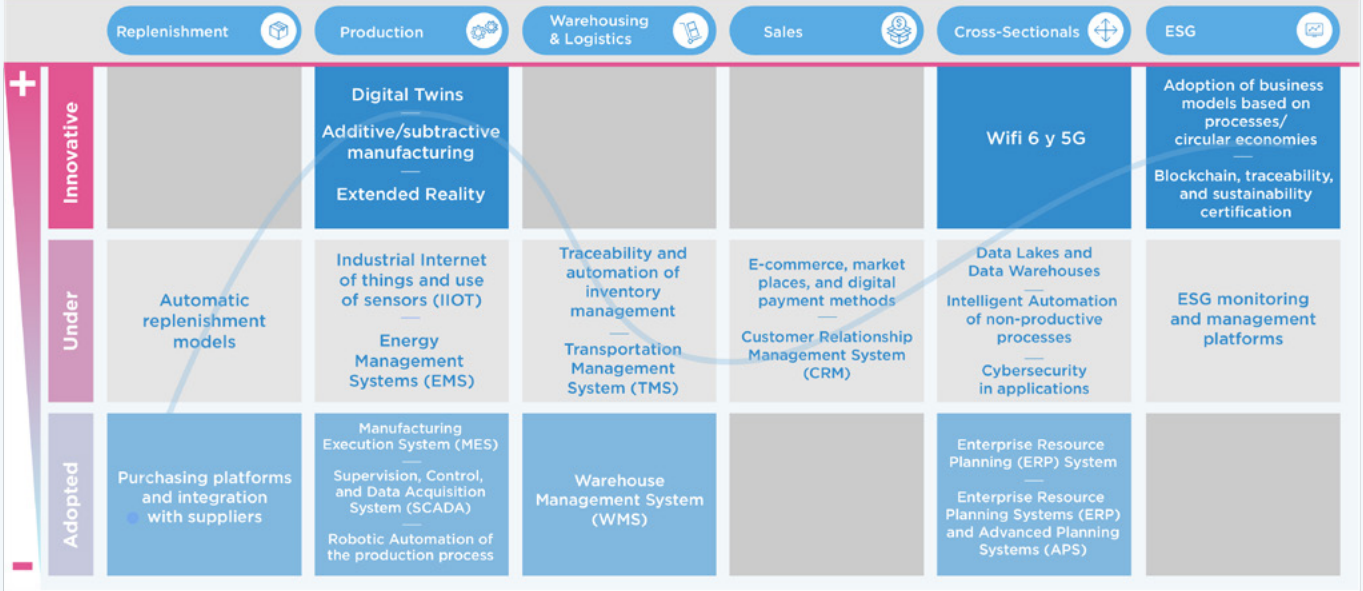
03

3.1 Digital solutions by link

The manufacturing and retail industry in Latin America and the Caribbean has been experiencing a wave of transformation for some years now, which is driving it to adopt new business models enabled by technology. This wave, commonly known as *Industry 4.0*, is accompanied by technologies associated with interconnectivity, process automation, analytical machine learning, and management based on real-time data that serve to integrate physical operations with a digital operating model integrated into an ecosystem.

The integration of these technologies into the operating models of organizations arises in response to the transformation needs of the different links in the value chain, which in the case of manufacturing include: supply, production, storage and logistics, sales, and channels. The level of adoption of the solutions in the sector depends on the digital maturity of said link and the need that the link itself has to transform itself to address challenges such as those included in chapter 2 of this study. There are also cross-sectional solutions that apply to processes that support the business along several or all of the links in the chain.

Figure 17: Rating of Solutions.



Source: Own elaboration result of the study.

3.1.1 Solutions for replenishment

The replenishment link consists of processes and technologies whose objective is to ensure the continuous and efficient flow of supplies of goods and services necessary for the manufacture of products.

The solutions in this link are mainly aimed at tackling challenges such as increasing productivity and operational efficiency. To respond to these needs, companies have focused on implementing solutions such as purchasing platforms and integration with suppliers and automatic replenishment models based on demand profiles.

These platforms seek to increase the level of standardization and the integration of data sources as a lever to grant greater visibility and thereby give certainty to the flow of inputs required in the production process. In this way, the aim is to increase the assertiveness of planning.

Predictive replenishment models use analytical algorithms that allow characterizing the optimal quantities of specific inputs that must be purchased to satisfy demand. Both solutions are complementary, although there are purchasing platforms that can parameterize this type of collaborative replenishment algorithm.

Purchasing platforms and integration with suppliers

The purchase-to-pay process *(Purchase-to-Pay, P2P)* covers all activities related to the acquisition, receipt, and settlement of the goods or services required for the operation. It is a critical process that requires being synchronized with the demand profile of each product or service.

Supplier purchasing and integration platforms focus on digitizing and optimizing the entire flow from the generation of a purchase request, the selection of suppliers, the generation of the purchase order, the receipt of the good or service, validation, approval, and payment of the invoice. Aspects such as the evaluation of suppliers and the comprehensive management of purchasing categories are also covered with functionalities such as the structured analysis of spending.

The benefits of implementing this type of tool are associated with offering greater visibility on relevant parameters for planning which, in turn, allows facing the challenges associated with the productivity and resilience of supply chains. On the other hand, by digitizing the process, operational efficiency is also achieved resulting from the reduction of manual activities.

On the company side, purchase decisions can be enabled that consider parameters on supply capacity and consumption, which reduces the probability of breaks in the replenishment chain. For suppliers, this presents an opportunity to increase sales by allowing them to take proactive action with access to diverse information such as production plans, publications, and stock quantities. This, in turn, enables *just-in-time* replenishment models that seek to reduce the time spent on supplies and materials at the facilities of manufacturing companies.

According to the study, 80% of companies have implemented this type of solution. However, only 40% state that they have an end-to-end integration of the process. The barriers to the adoption of this type of tool have to do with the implementation costs and the lack of digital capacities of a significant part of the providers to integrate this type of technology in their processes since it is required to have information in real-time on stocks and other parameters such as delivery times and purchase and production batches.

Defining these parameters is a task that requires a high investment of time, especially in organizations with less mature planning and purchasing processes.

As an example of this type of technology, the case of a multinational automotive company with operations in Mexico stands out. To ensure the availability of inputs and synchronize its production chain with those of its suppliers, it implemented a purchasing platform in which its suppliers have access to production information, inventory levels, and production plans.

Automated replenishment models.

The elimination of manual and low-value tasks is a need that is increasingly addressed by the manufacturing sector. In the field of purchasing, automatic replenishment models that use demand parameters (e.g. orders per period per product) and others from the supply chain (delivery times, batch sizes, batches of production) seek to reduce response times, minimize costs, avoid stock breaks and facilitate the provision of inputs and/or merchandise necessary to comply with production plans.

Automatic replenishment models use an organization's inventory data, production plans, and demand estimates to optimize routine tasks and automate order generation. This allows users to focus on planning and higher value-added tasks like strategic contract negotiation and spend analysis.

Additionally, more advanced models can be generated with analytics to incorporate factors that affect demand such as seasonality, prices, product shortages, promotions, and other variables that may impact demand modeling.

With the adoption of these models, operational efficiency is improved by giving greater visibility to the organization to evolve towards more strategic management of the purchasing process focusing on reducing the total cost of the purchase. This enables productive and efficient operations purchases are optimized and working capital is reduced without jeopardizing the availability of raw materials and the level of customer service.

Despite its advantages, the level of adoption of this type of tool is relatively low, since less than 40% of the companies contacted purchase solutions that incorporate automatic replenishment models with some level of use of analytics and that also integrates with other planning tools.

The main barriers that affect the adoption of these tools are related to the lack of digitization of important parts of the process and the absence of an operating model in which there are inventory policies linked to demand for all families of inputs. In this sense, there is also little availability of reliable historical data on supply parameters that feed analytical models and a lack of data science profiles to deploy the implementation of these practices as part of a continuous process.

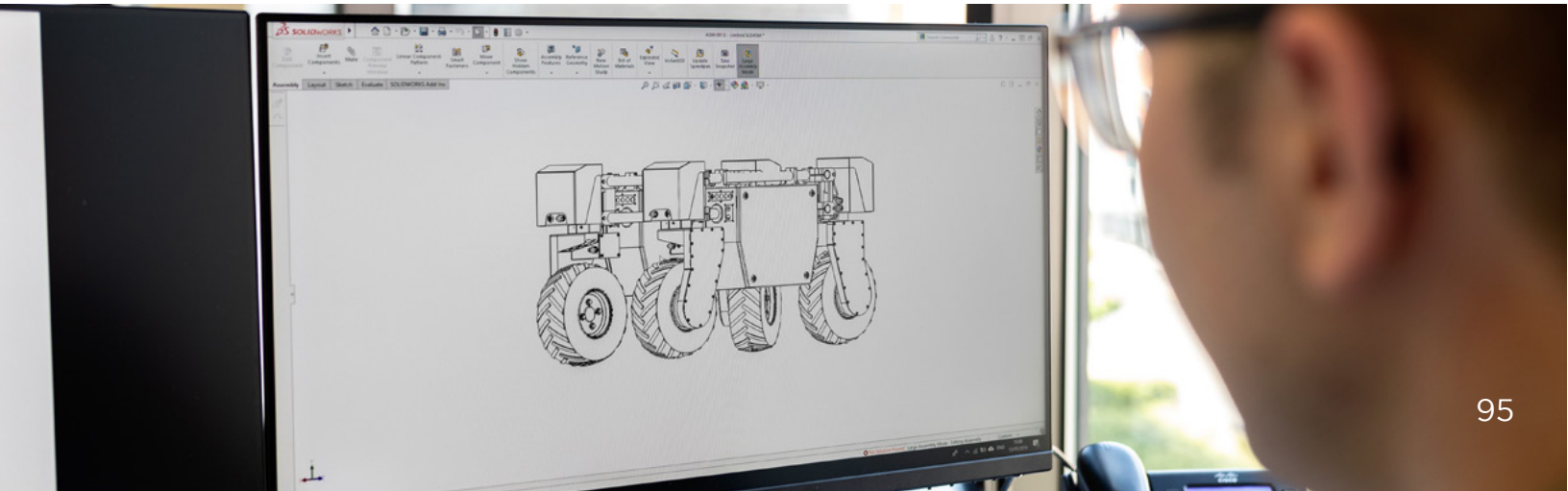
A case identified in the study is a multinational cement company that, in order to avoid shortages of its critical spare parts, incorporated replenishment algorithms based on goals or reorder points.

These algorithms generate suggested orders automatically. The parts shortage with long delivery times is anticipated. The algorithms generate alerts in the supplier itself, so a signal anticipates the eventual need to supply the set of required parts.

3.1.2 Solutions for Production

The cornerstone of the manufacturing sector is the production link and for this reason, it has been one of the main focuses of the transformation of the sector. According to the study, all the organizations interviewed have implemented at least some technology to digitize and automate this link. This is due, to a large extent, to the fact that part of the differentiation of the sector has to do with what allows them to optimize their production process.

In this line, it was identified that more than 90% of the companies consulted state they have production lines supported by manufacturing execution systems (MES) with different levels of automation that are also combined with SCADA (*Supervisory Control and Data Acquisition)* and the implementation of switches and telemetry to monitor operations and make decisions based on data.



On the other hand, less than 20% of participants use technologies such as Digital Twins or additive/subtractive manufacturing for the physical part testing, packaging, or products. This occurs primarily in the non-metallic mineral products and basic metals and automotive subsectors, as they are capital-intensive industries where component precision is critical. In this sense, simulating and prototyping add value by characterizing in advance the operation of the product in a controlled environment without incurring costs.

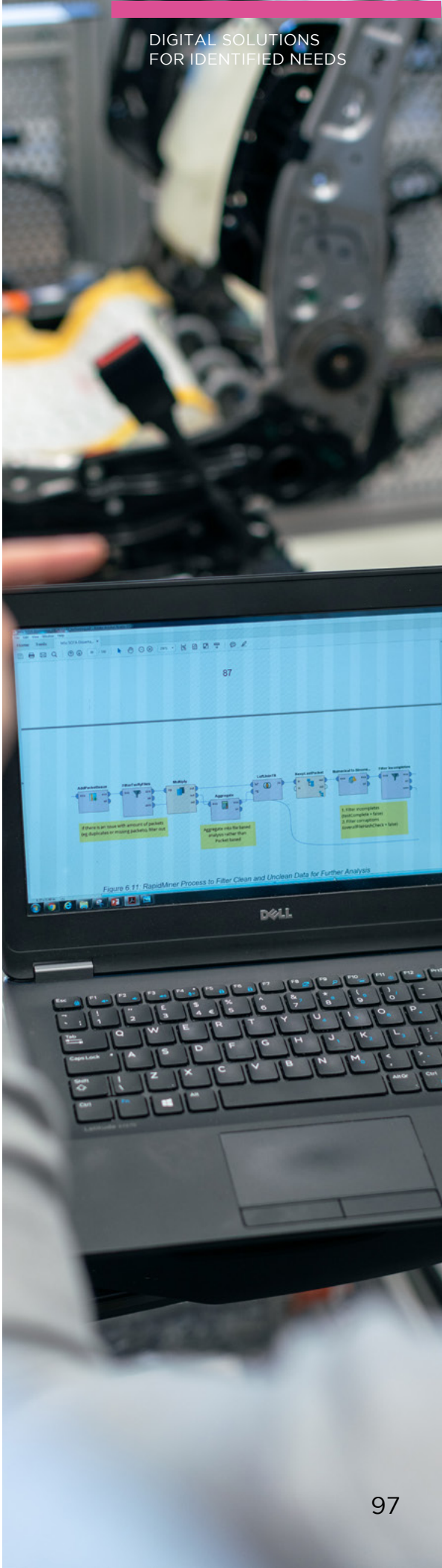
One of the findings of this study is that participants belonging to international corporations have an advanced level of digital maturity since they to have a higher level of implementation of different technologies by having more access to internal benchmarks and the synergy of taking advantage of implementations already tested in other geographies.

Manufacturing Execution Systems (MES) and Supervision, Control, and Data Acquisition Systems (SCADA).

A *Manufacturing Execution System* (MES) is a system focused on the planning and execution of production orders using of real-time data from the production process, machines, and workstations in a plant.

MES has functionalities that cover the administration of production steps, product traceability, labor management, quality control and maintenance planning, and data recording. These types of solutions are complemented by supervision, control, and data acquisition (SCADA) systems that monitor the equipment to provide a real-time map of the production process through interaction with switches and programmable logic controllers.

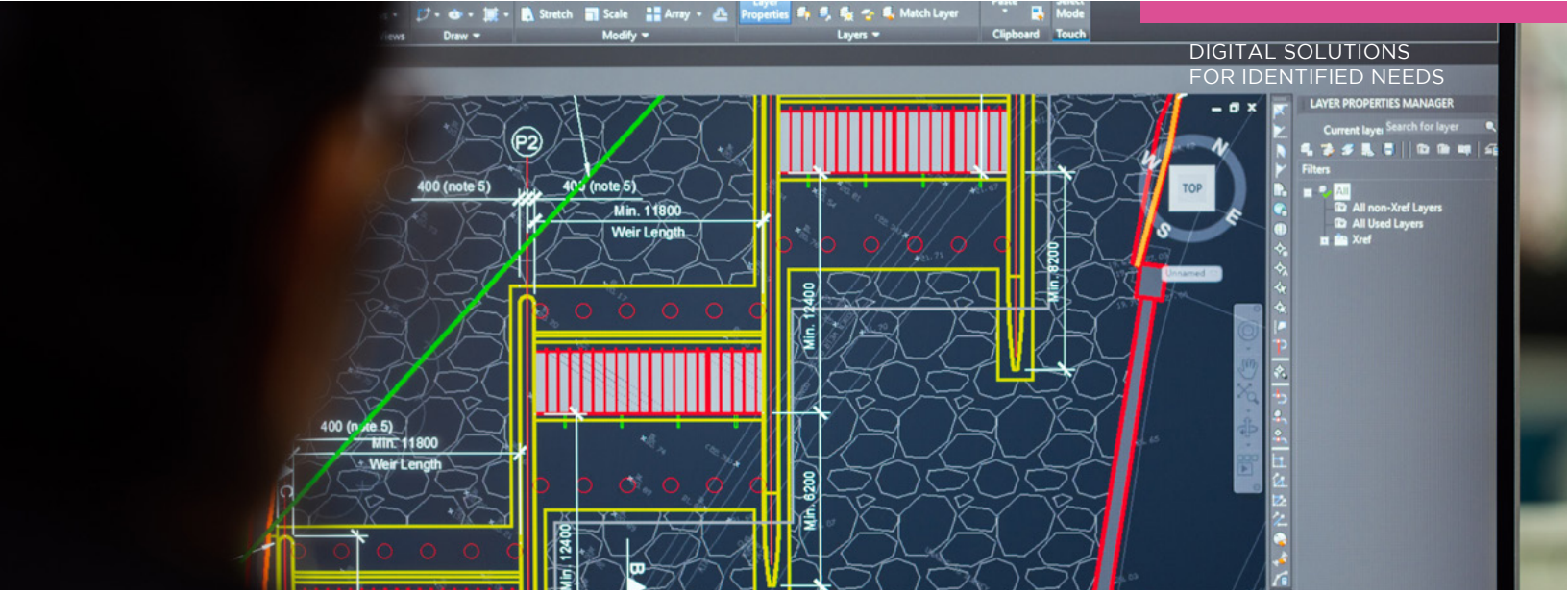
The main difference between both systems is MES' focus on the planning and management of production orders and SCADA on monitoring and control of factory processes. It is common for both systems to be integrated with resource planning (ERP) systems.



The benefits of these tools are linked to increased productivity and increased efficiency. This is achieved with real-time visibility and control of the status of the production process, the flow and stocks of raw materials, the availability of machines, and cycle times. Monitoring these parameters allows implementing improvements and reacting quickly to unplanned incidents.

Only 6% of the participants do not have this type of technology. In such cases, the declared barriers have to do with implementation costs, the level of obsolescence of some equipment in production plants, and the manual nature of important parts of some of the processes in some subsectors. These barriers are associated with a low level of digital and technological maturity, the lack of an integrated vision of Digital Transformation, and the low budgets dedicated to it.

An example of the implementation of this technology is the case of a steel company in Colombia, which uses this type of system to manage parts of its production processes, centrally configuring production and quality parameters and actively managing lead times to optimize progress in the process stages.



Digital Twins.

Digital Twins are virtual representations of a real system, such as an assembly line or factory production line, as well as its various stations and technologies such as robotic arms or Computer Numerical Control (CNC) equipment. Its main advantage is observing the process under simulated conditions without incurring the mobilization of physical resources so that adjustments in the real process required to optimize the result can be anticipated.

Using Digital Twins, it is possible to explore events and scenarios in a model that faithfully simulates the physical system that is being replicated. This validates adjustment hypotheses in variables and characterizes their impact at a low cost and with greater agility.

The benefits of this technology are associated with increased productivity since it is possible to design and test without having to perform tests on the production line. On the other hand, these solutions make it possible to identify improvements to reduce costs and thereby respond to the need to increase efficiency, generate savings and ensure operational continuity.

Digital Twins are also used to train personnel in the use of machinery, so they can acquire the necessary skills to operate the real machine, in a safe and controlled environment, without incuring high costs associated with training errors. The use of this technology speeds up the learning process and mitigates the risk, due to lack of experience, of damage to the machine or the operator.

The level of adoption of this solution in the sector is low. Only 17% of organizations declared to use this technology. The main barriers to implementation are cost to develop the model, cultures that are resistant to use the model results as representations of the real process, and the limited availability of historical data that allows to correctly characterize the impact of known variables on the process.

A company in the metal sector in Brazil implemented a Digital Twins system to simulate the production processes of one of its factories. Thanks to this simulation, the company generates production scenarios that facilitate the identification of the configuration that maximizes the volume produced. The model analyzes the main variables that impact the consumption and performance of raw materials and machines for the different scenarios and compares them to select those that offer the highest productivity and efficiency.

Industrial Internet of Things and Use of Switches (IIoT).

The Industrial Internet of Things (IIoT) refers to the interconnectivity of physical objects through switches and software in order to exchange and collect data. The application of the IIoT, together with the use of switches, makes it possible to collect information on the production process or the logistics operation in real-time and in a massive way to monitor the operation of machines, detect events and trigger automatic corrections.

The IIoT can be combined with the application of analytical models based on artificial intelligence and machine learning to identify patterns or anomalies, predict conditions or prescribe corrective actions. To implement an IIoT platform, it is also necessary to have high-speed connectivity solutions such as WI-FI 6 or 5G, as well as large cybersecurity patterns and tools for the protection of high volumes of information.

IIoT benefits are primarily associated with maximizing productivity and operational efficiency. These benefits arise from the ability to obtain information and make decisions about the process remotely. Additionally, this type of technology improves the response capacity of value chains and enables the measurement of environmental impact indicators such as energy consumption.

The level of adoption of this solution is medium/high. More than 60% of the participants apply this technology at some point in their production or logistics processes. Among the adoption barriers that were identified are implementation costs, the lack of a data infrastructure to integrate physical technology with processing systems, and the absence of robust connectivity solutions.

An example of the application of this technology is a Chilean company in the chemical products subsector, whose programmable logic controllers (PLCs) have switches that feed centralized databases, making production variables visible, such as temperature or processing speed to make decisions about equipment configurations in the production line.

CASE STUDY

MONITORING CENTER: A PARADIGM SHIFT IN MAINTENANCE

Location: Argentina, Brazil, Central America, Colombia, Mexico and USA.

Products: Flat steels, coated steels, pipes, profiles, long steels and tinplate.

About:

Ternium is a steel company with production levels that reach up to 12.4 million tons of crude steel annually in its 18 production centers, distributed in 6 countries in America. It has over 20,000 employees throughout its service and/or distribution centers, and its production plants. Its value chain aims to prioritize the development of small and medium enterprises, encouraging global competitiveness in the long term. It is characterized by having an integrated and efficient production system from the extraction of the mineral to the making of the product, obtaining as a result the delivery of a quality and guarantee service.

Problem to solve:

In a context in which the demand and consumption for the different steel products is constantly increasing, **Ternium** explored different alternatives to improve and consolidate its production process. The shutdown of production lines due to equipment failure is a latent challenge in production operations. **Ternium** has been challenged by the inaccuracy of the software of its equipment when having to report a problem, which generates the need for manual analysis of the machines and unexpected interventions that affect productivity.

Some inefficiencies generated:

- Production detention.
- Longer emergency maintenance times.
- Craftsmanship in analysis procedures for repair.
- Low anticipation capacity against equipment failures.

Solution implemented:

The collaborative work between maintenance and IT areas has allowed **Ternium** to detect the main variables associated with problems in production equipment, which triggered the implementation of production lines that have beyond 6,000 sensors that let on monitoring operating parameters and detect possible failures. They also implemented a Maintenance Center that stores the information and grants them to view the status of their equipment on 8 monitoring screens. This is done through two platforms called APM *(Asset Performance Management)* and Orion. These platforms allow the detection of inadequate vibrations in motors and pumps, unusual behaviors in the temperature of machines and lead to the correct use in communication networks.
Although data capture and monitoring are relevant, the greatest value is achieved by incorporating advanced analytics models that consider the historical behavior of the variables associated with the operation of the equipment to compare with failure scenarios and predict when and why they could have a possible failure, favoring interventions to be anticipated or operating parameters to be adjusted to avoid emergency stops with greater impact on productivity.

Results:

The APM platform has made it possible to standardize procedures and actions between different areas of the company, which has resulted in spending fewer hours solving the different problems. This solution has generated an irruption in the market, which changes the concept of maintenance and has led **Ternium** to position itself as a benchmark in the industry. With this, the company has managed to have a more efficient and safe process for a more profitable production.

Improvements identified:

- Increased productivity.
- Reduction of emergency stops.
- Less craftsmanship in the process of detecting faults.
- Approach to a prescriptive maintenance that indicates the best solution against possible errors.
- Greater control and visibility of the productive process.

Additive/Subtractive Manufacturing.

Additive manufacturing and subtractive manufacturing refer to two methods for producing complex solid components from digital designs.

Additive manufacturing is a method of manufacturing objects by adding successive layers of material that adhere to the previous layers until the designed part is complete. With this technology, the pieces are created from models made in computer-aided design (CAD) software to later be worked on through 3D printers in which powder, liquid, resins, and metals are deposited, melted, and/or melted, or carbon fiber to create parts.

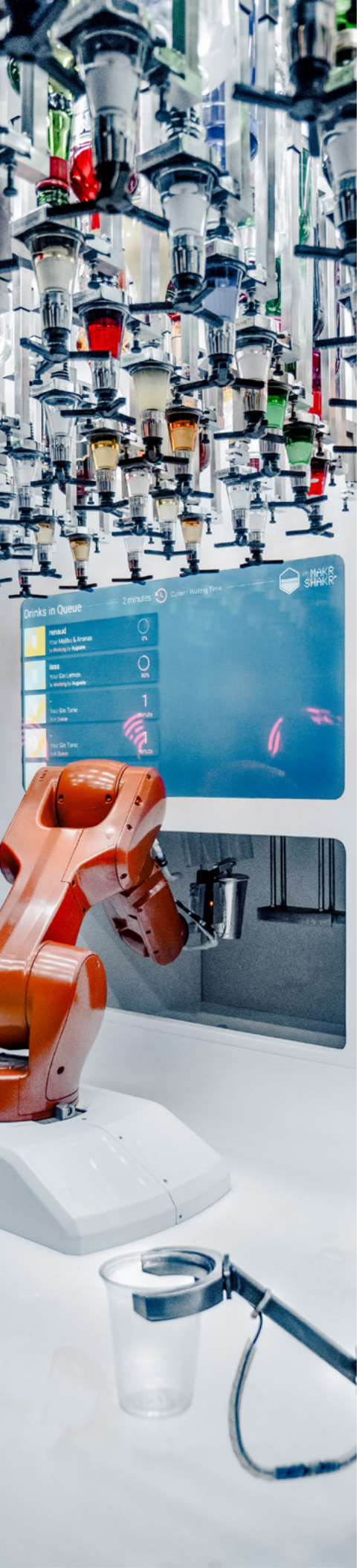
Unlike the additive process, subtractive manufacturing consists of manufacturing solid objects through the removal or elimination of layers. The layers are removed by means of cuts, perforations, and molding or adaptations with Computerized Numerical Control (CNC) technologies, where the virtual model previously designed in the CAD software provide instructions to generate the path that guides the tool. In general, the creation of the pieces is done in wood or metal for precise geometries and that are difficult to produce with traditional methods.

Both manufacturing processes are used in the manufacture of prototypes of tools and molds that are required in production lines for components such as gauges, clamping parts, and other accessories. The ability to manufacture this type of part in a short period allows rapid validation of its operation in the production line.

The benefits obtained with this type of solution are associated with productivity and operational efficiency that results from the greater speed and precision that they have compared to traditional methods. In the case of additive manufacturing, there are additional benefits as it is a method that generates less material waste, which contributes to a greater reduction in costs.

The level of adoption of additive manufacturing is moderate despite its potential. According to the study, 22% of companies use this technology for prototyping their packaging or parts as part of their innovation process. Using this technology in a massive way in the manufacturing process is not observed. The reminder of organizations consulted state do not implemented this type of technology. The main barriers to adoption have to do with the perception of requiring a high effort to redesign existing production processes, with the lack of specialist knowledge within organizations to characterize the feasibility and cost of implementation.

An example of the application of this technology in the study participants is the case of a company that produces glass containers in Chile that designs these items using 3D printing to perform usability tests.



Robotic automation of the production process.

Robotization is one of the most widely used solutions in the manufacturing sector and its use has increased and has become more sophisticated over time, mainly due to the influence of multinational companies originating in countries such as the US, Germany, Japan, and South Korea. This type of solution has been widely disseminated in different subsectors with the clear objective of increasing the productivity of their lines, being more flexible when faced with fluctuations in demand and improving the precision of components.

Some of the advantages that companies acquire by implementing robotic automation in the production process are increased productivity, cost reduction, quality control, time savings, and reduction of accidents at work.

In line with these benefits, robots are increasingly replacing less-skilled labor, especially in industries with high-precision production processes and with routine and/or dangerous tasks. In principle, substitution occurs in repeatable activities where process flexibility is not required. According to The Future of Jobs Report 2020 issued by the World Economic Forum, approximately 30% of the tasks in the industry are carried out by some type of robot and it is expected that by 2025, 85 million additional jobs will be performed by machines[13].

13 (The Future of Jobs Report 2020)

This introduces a double challenge while jobs are replaced, new needs arise that are associated with the configuration, monitoring, and control of automated lines and the retraining a large part of the workforce is required.

In this sense, a large part of the use cases of this technology deals with collaborative robots or co-bots, in which the robot performs part of the process and a person must complete it. The latter also facilitates the increase in the participation of women in the sector since the strength of the person is no longer a determining factor for the movement of objects. With this type of solution, hybrid systems are created to gain productivity without incurring the elimination of jobs. The level of adoption of this technology is high.

It is estimated that 87% of participants have some kind of automated production process in place. However, some organizations report barriers such as high implementation costs and resistance to change from employees.

An example of this type of solution is a multinational automotive company using robotics in its manufacturing processes to increase production speed and accuracy by automating repetitive tasks such as component assembly, sorting, and part counting.

Energetic Management Systems.

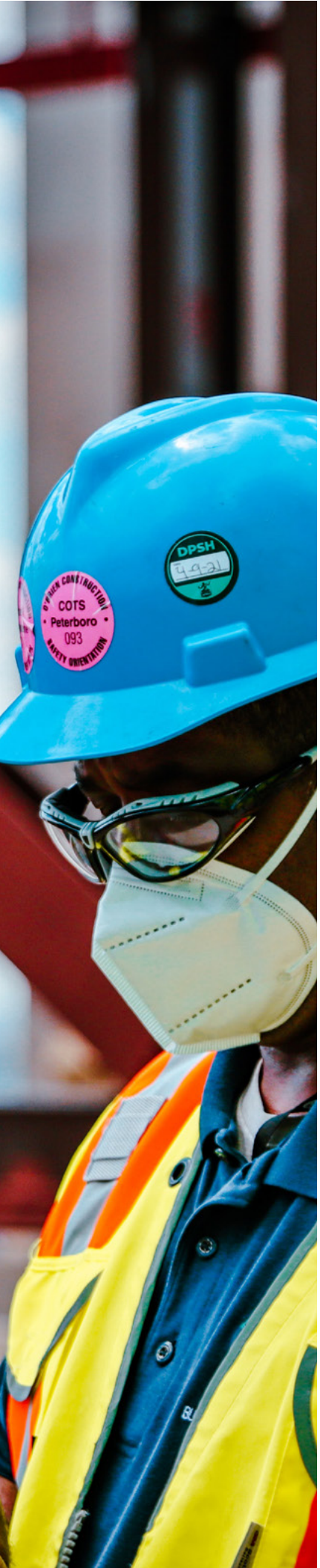
An *Energy Management System* (EMS) allows monitoring in real-time of the status of the electrical network and the energy consumption data of the machines, equipment, and storage systems of the production plants. This is achieved thanks to the installation of switches in the production lines where the tool collects data from the electrical system and stores it on a server for processing.

From these data, it is possible to generate a historical and real-time analyses of consumption, failure, and voltage stability, among others. This, in combination with the analysis of other production factors, enables the identification of opportunities to maximize energy efficiency.

An EMS can work independently or in addition to a SCADA system, performing an integration between the two so that switches are used and synergies are generated during installation. Having both systems integrated allows simultaneous control of the production processes performance and the use of electrical energy.

The benefits of EMS systems are associated with efficiency, particularly those related to energy consumption. Additionally, these solutions contribute to reducing the environmental footprint in line with the social and corporate governance agenda, which is an increasingly important point for the manufacturing sector.

Despite being a solution with the potential to contribute to the declared objectives of the sector, only three companies participating in the study declared that they were in the process of implementing initiatives associated with this type of tool.



Extended Reality (XR).

Extended reality encompasses a set of technologies that focuses on combining physical elements of the real world with digitally generated environments and objects. The concept comprises virtual reality (VR), augmented reality (AR), and mixed reality (MR).

In virtual reality, a user is immersed in a completely digital environment in which real conditions are simulated with a high level of accuracy. Augmented reality consists of introducing some superimposed virtual elements in a real environment. Mixed reality is a mixture of both concepts.

In the manufacturing sector, these types of solutions are used mainly to increase productivity and efficiency by providing additional tools that increase the speed that a task can be performed. Other benefits are mitigating the risk of accidents and improving finished products quality.

In the study, 23% of companies stated they use this type of technology within their processes. These companies were mainly concentrated in the metal products and cement sectors. He highlighted the case of a metal products company in Argentina that uses virtual reality as part of the training of crane operators. With this, the goal is to reduce the accident rate, which in turn has an impact on the productivity of its operations.

3.1.3 Solutions for storage and logistics

The warehousing and logistics links are important components of the sector, not only because of their integration with the production links but they also concentrate a non-negligible part of the organization's costs.

Currently, the manufacturing sector has several solutions to digitize storage and logistics seeking synchronization and efficiency in the supply chain. Some of the main solutions identified for the sector are: warehouse management software (WMS), transportation management systems (TMS), and inventory and cargo control technology.

Warehouse Management System (WMS)

A *Warehouse Management System* (WMS) is a software that is used to optimize the control and administration of all the operations that are carried out within a distribution center, from the reception to the dispatch of the material. The objective of this type of system is to achieve traceability of the movement and location of each stored object.

These types of systems provide visibility into an organization's inventory at any time and location, whether at a facility or in transit. This allows managing supply chain operations from suppliers to the warehouse and the distribution center. WMS systems, in addition to serving to optimize operations, enable automation, the application of robots and controls to drive equipment such as material handlers, conveyor belts, and storage stations.

By implementing a WMS system, manufacturing organizations respond to the need to improve operational efficiency and responsiveness in the value chain. This occurs through benefits such as planning improvements, reduced use of paper in warehouses, synchronization of the materials workflow, workforce productivity, increased flexibility in order management, and inventory optimization.

The tracking and management of warehouse operations in the sector is a critical process and susceptible to error, which is why organizations are gravitating towards digitization by implementing this type of system. A WMS is often integrated into a transportation management system (TMS).

The level of adoption of this technology is high since practically all participating companies have it. Despite this, some barriers to the successful implementation of this type of solution have been observed, such as the complexity to integrate with other management systems, as well as the adequacy of the processes and the training required to extract the maximum performance from these tools.

One case identified in the study is from a metallurgical company in Brazil that implemented a WMS to improve its warehouse management processes. The system allows you to better monitor inventory levels resulting from a definition of optimal locations according to the rotation and relevance of products and supplies. This has translated into significant cost savings, and an improvement in their service as they have managed to optimize their inventory levels and better synchronization according to their demand profiles.

Transport Management System (TMS).

A Transport Management System (TMS) is a supply chain management system that allows you to manage distribution operations. These systems are used to establish parameters for the characteristics of the load, the vehicles, and the orders, to optimize factors that directly affect distribution costs such as the level of occupation of the vehicles, the size of the deliveries, the frequency of travel, and cargo consolidation.

It is important to mention that the TMS can be applied to any mode of transport and thereby provide visibility, control, and the ability to optimize the process. A well-implemented TMS system enables the identification of inefficiencies from planning so companies can take proactive measures to mitigate them. On a more operational level, the TMS can provide real-time shipment tracking, giving visibility to compliance with delivery promises and allowing action to be taken in case of delays.

In that sense, it is common for TMS to be combined with GPS technology to always know the location of the load.

In general, a TMS system supports key processes of the transport activity such as planning and decision-making, execution and monitoring of activities, and events such as the allocation of orders, vehicles, and cargo location. These types of platforms also make it possible to generate KPIs for distribution operations such as the level of vehicle utilization and the percentage of orders delivered on time and on time (OTIF).

The benefits that organizations achieve by implementing TMS technology are enhanced by integrating it with a WMS tool and with the order management system itself. Data on orders (outputs), stocks, and inputs to the logistics flow are synchronized with the logistics optimization tools and configurations in the TMS.

These solutions reduce operating costs, avoid product losses, optimally manage staff tasks and record the traceability of the entire logistics cycle. The adoption of these solutions encourages operational efficiency through robust and parameterized planning that can also be fed back over time.

This technology has a medium level of adoption since 56% of the participants report having implemented this type of tool. Among adoption barriers, the complexity of implementation was highlighted as intensive in human and financial resources, the difficulty in defining the ideal tool to integrate it with other systems, and the lack of technical knowledge within the company and suppliers to achieve a successful implementation.

The study, highlighted a case of a company in the logistics subsector in Chile, where they use TMS to manage the delivery of packages and track shipments. In addition, initiatives are underway to improve their current system and replace it with world-class software that also optimizes last-mile distribution operations.

Traceability and automation of inventory management.

Inventory management is a critical element of the supply chain, which encompasses the tracking of inputs and finished products throughout the supply chain, to generate location traceability and trajectory of each specific item, product or batch.

Given its importance, peripheral solutions have been developed for the systems that enable better management of the product flow throughout the chain. One technology that stands out is radio frequency identification (RFID) integrated with WMS and TMS.

This technology enables the identity of stock to be transmitted wirelessly in the form of a unique serial number for tracking purposes. It works by storing the information of an object or product in the chip of the label that is printed with an RFID printer, which allows the label to be read through terminals or readers to consult the information, execute records of the state or initiate movement or distribution processes.

With traceability solutions, companies obtain benefits associated with increasing productivity, increasing efficiency, reducing risks, and increasing the response capacity of their value chain. This is done by being able to know the status of stocks and their location in real-time, which helps to improve the accuracy of inventory calculations and to minimize losses/waste.

The level of adoption of this technology is low. Only 10% of the participants claimed to use it due to barriers such as the lack of awareness of the solution, the high costs of RFID tags that are up to 20 times higher compared to alternatives such as barcodes, and the difficulty of integrating the technology into existing systems.

A steel-producing company in Argentina uses RFID in conjunction with other solutions such as IoT and QR codes to track and supervise product movements to collect data in real-time about inventory levels and their location to improve its inventory and logistics management processes.

Although the level of adoption in the case of the manufacturing sector is low, this technology is more widespread in the case of retail trade and its adjacent industries. This is due to the greater number of products managed in this type of industry, as well as the need to have traceability of specific product characteristics such as expiration dates and production batches.

3.1.4 Solutions for the Sales area

The sales area is the driving force for organizations to generate income, through the commercialization of the goods produced. This link is responsible for the generation of demand through the understanding of market requirements, the relationship with customers, and on a more operational horizon, to capture orders. To better enable this link, there are technological tools that organizations in the sector have incorporated. Among them are customer relationship management (CRM) systems, digital channels such as e-commerce and marketplace platforms for order fulfillment, and other tools such as chatbots to fill customer requests.

Customer relationship management system (CRM).

A customer relationship management system (CRM) is a solution that allows centralizing, in a single source of information, all the interactions that occur between a company and its customers. These tools are aimed at managing three basic functions: the commercial area, marketing, and after-sales or customer service.

CRM systems have various modules in which the information is centralized. The most used are sales, marketing, customer service, reports, and contact registration.

Through these modules, companies can enable actions such as digitizing the capture of orders, establishing interaction campaigns with customers, monitoring the status of requests, monitoring indicators, and having a record of all the contact points of a customer over the length of the time. In the manufacturing sector, these systems are mainly used to digitize the process of prospecting for sales or capturing orders. These are two process components where accuracy is important for demand planning and product delivery, respectively.

In the case of demand planning, knowing the level of maturity or phase in which a sales opportunity is located serves as an input generating forecasts, enables the synchronization of the chain, and allows the generation of efficient scenarios on how to address said future demand.

In the more operational horizon, digitizing the capture of orders gives reliability to the process and ensures that everything enters a common flow regardless of the channels. The latter can be physical or digital and be represented by a web portal or a mobile application.

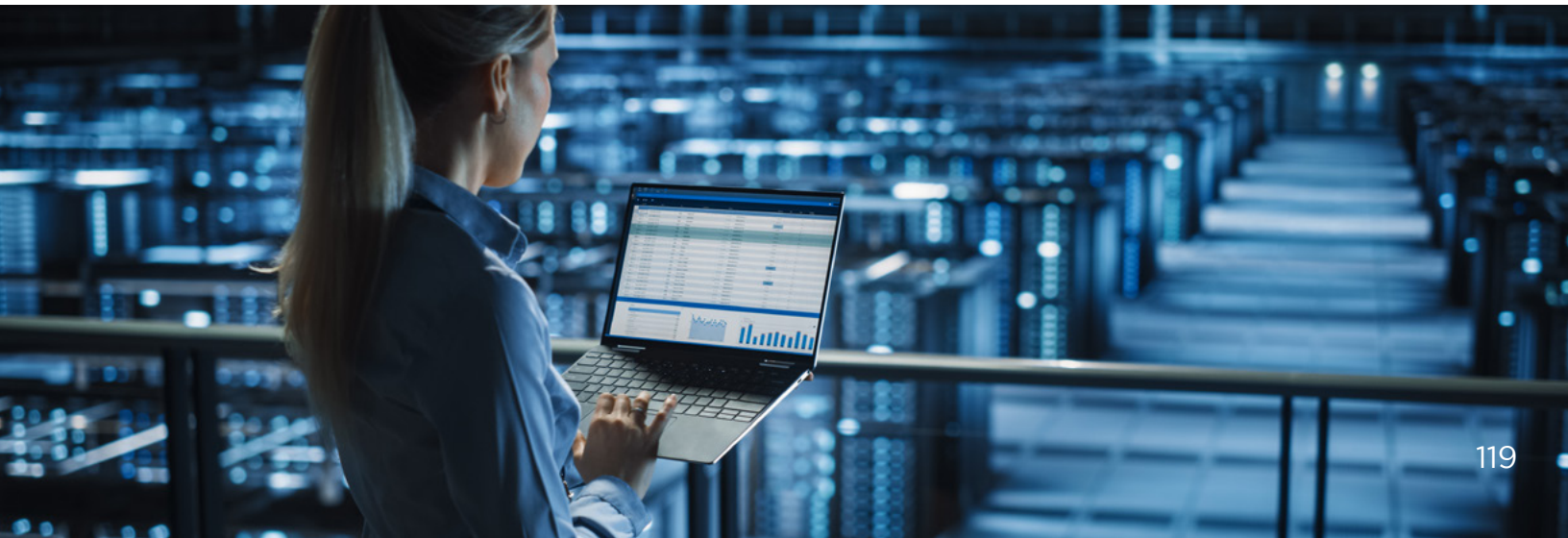
In this sense, the implementation of CRMs has been used to face challenges such as operational efficiency and the improvement of response capacity by impacting critical processes in important sales, post-sales and customer service flow.

The percentage of adoption of this type of tool in the sector is low since less than 15% of the participants claim to have them. This has to do with the orientation of the sector towards a B2B model in which the volume is concentrated in a few clients. In addition to implementation costs, the barriers to adopting this technology have to do with the lack of capacity to adjust legacy processes and systems and resistance to change in the way sales forces and customers operate.

As an example of the implementation of this type of technology, a metallurgical organization in Mexico declares that it uses CRM to manage the follow-up of customer requests, with which it declares that it has managed to improve the resolution rate of its service executives.

E-commerce, marketplaces, and digital payment methods.

Marketing solutions, such as digital sales portals *(e-commerce)*, including digital payment methods, have been widely adopted in the market since they allow the value proposition to be brought to customers and markets in a simpler way. In this sense, manufacturing and retail have very different levels of maturity because their sales are focused on very different audiences. On the one hand, retail is a consumer-oriented industry (B2C) while manufacturing is an industry more focused on intermediate customers (B2B2C).



The main benefits of *e-commerce* platforms, *marketplaces*, and digital payment methods are associated with productivity and efficiency, since they serve to provide a portfolio of services to mass markets, incurring lower commercial costs.

An e-commerce portal is a tool in which organizations display their portfolio of products and services and where customers can place orders, queries and requests in a self-managed manner. These portals typically focus on exclusively marketing the portfolio of the company that implements them. They are an analogy of the point of sale, in its digital format and represent an alternative to physical channels. To implement an e-commerce, not only the deployment of the portfolio is required, but all the business processes must be connected so that the channel sends the customer signals to the different internal areas that must manage the orders from the moment they are received until they are delivered including reverse logistics for the management of returns.

In the case of retail, the level of adoption of e-commerce solutions is high since, for several years, initiatives have been implemented to develop them. Due to this, it is difficult to find an organization in this area that does not have a transactional digital channel already implemented. This level of adoption increased even after the pandemic when many retailers were forced to improve their processes to ensure customer satisfaction.

The case of the manufacturing sector is different since, it is mainly focused on selling, the need for a sophisticated transactional digital channel does not have the same relevance. In this sector, the demand is concentrated in large industrial clients, retailers, and distributors and not in the traditional mass market. This type of client requires more customization with their requirements in terms of interface design and functionalities.

Less than 10% of participants have implemented this type of digital solution. This is due to the greater representation of manufacturing companies in retail trade. In the cases in which it was declared to have some tool, these were more focused on the creation of their portals for suppliers to enter their future demand requirements as part of a collaborative planning and forecasting process (CPFR).

The portal modality serves as a product showcase, without the possibility of generating orders. The low level of integration is explained by the difficulty in establishing a standard portfolio, since each client may require specific properties as they are companies or industrial clients that use the product as part of their production process.

An e-commerce alternative is the marketplace platform, whose main difference is the portfolio of different manufacturers in the same place. Due to this, marketplace platforms acquire greater scale by serving as a link between buyers and sellers, covering a greater variety of products.

In the case of the manufacturing sector, these types of portals are a more appropriate solution; otherwise a client would be forced to access different portals to obtain the replenishment of everything they require. In addition to multi-category marketplace platforms such as Amazon or Mercado Libre, specialized marketplaces have started to proliferate in specific subsectors such as materials for construction and decoration (e.g. Vivadecora in Brazil) or for the sale of used cars (e.g. Kavak), as a few examples.

Another important element in the context of these solutions is digital payment methods that serve to facilitate conversion by offering prospective customers different methods to pay for goods and services. Until recently, digital payment methods were limited only to payment by credit or debit card, or electronic transfers.

For some time now, payment methods have been developed that apply depending on the channel in which they are used. In the case of the physical channel, methods linked to digital wallets available on mobile electronic devices that avoid the need to use a physical card have proliferated.

CASE STUDY

AUTOMATION AND DIGITALIZATION OF ORDER MANAGEMENT

Location: Colombia, Dominican Republic, Haiti, Honduras, Panama, Puerto Rico, others.

Products: Cement, concrete, aggregates, ready mixtures, hydrated limes.

About:

Cement company that has achieved an important leadership in the cement and concrete sector, reaching one of the top 5 places in production in Latin America.
The growing multinational company consolidates its presence in 16 countries and territories with emerging and developed economies. With over 80 years building history.
It has over 6,000 employees in different regions, 10 cement plants, 250 concrete plants, more than 40 mills, ports and terminals, distribution centers, and its own fleet of more than 3,000 assets including mixer trucks, railroad cars and ships.
Its total installed capacity is of approximately 24 million tons of cement and 15 million cubic meters of concrete.

Problem to solve:

In a digital transformation context and after the accelerated search to improve the experience of its customers, the company sought that by 2022, 80% of its interactions were digital, for this reason they have simplified them through a digital platform that in addition to allowing online orders, also lets customers consult them, confirm and schedule deliveries, follow and verify the account statements and quality history.
This strategy seeks to improve customer satisfaction by providing them with a more agile, simple, and accessible experience through the platform. In addition, this allows the company to optimize its internal processes and improve its efficiency, which would translate into greater effectiveness in serving its customers and an improvement in the quality of the services they offer.
In this context, the company should ensure that it has a robust and secure technological infrastructure that guarantees the availability and confidentiality of its customers' information, as well as provide adequate technical support to meet their needs.

Solution implemented:

The company implemented a digital solution designed so that its customers from anywhere and at any time can make, consult and pay their orders in an easy, agile and secure way. The solution has a web version and a mobile app. Moreover, this solution allows them to track in real time the status of their orders and receive notifications about any changes in the schedule of their deliveries.
Importantly, the security of customers' data and transactions is one of the priorities in the implementation of the solution, so state-of-the-art security technologies were used to ensure the protection of user information.
Also, the company uses Artificial Intelligence to manage the production of its products

Results:

Currently, more than 50% of the volume of cement sold in Colombia is generated through the designed platform, which positions them as a leading company in terms of digital solutions in the sector.

- More than 60% and 40% of cement and concrete orders, respectively, are placed through the platform.
- +65,000 orders entered through the web platform and more than 21,000 through the app, equivalent to more than one million tons of product.
- On average, 1,850 customers interact monthly with the platform.
- Savings of US$13 million annually, through the programming and management of its production digitally.

Among them is near-field communication (NFC) or QR, with which proximity or simple scanning ensures the flow of the transaction. The QR can be used in the digital modality in which there are other alternatives such as payment gateways, payment links, and the initiation of payments in the case of bank transfers.

This type of payment tool has a low level of adoption in the manufacturing sector, mainly due to the low level of adoption of digital transactional channels. In the sector, most of the transactions are executed through methods such as transfers.

Transactions in this sector are mostly executed through bank transfers, direct debits, deposits, and sometimes cash. The main adoption barrier regarding these technologies has to do with the culture of the sector that has worked with traditional methods. The opportunity in this area is important since with these solutions some frictions in the billing-to-collection flow can be reduced.

In the case of the study, a cement company was found in Peru that implemented a portal to capture orders for integrating order management. The portal allows the company to improve service levels by increasing the integrity of the information that was previously processed through emails and calls.

Chatbots.

Chatbots are software applications that simulate conversations with humans in written or spoken formats through the use of technologies such as Natural Language Processing (NPL) and Machine Learning (ML). They are solutions used mainly in customer service and sales service areas for the management of queries and requests.

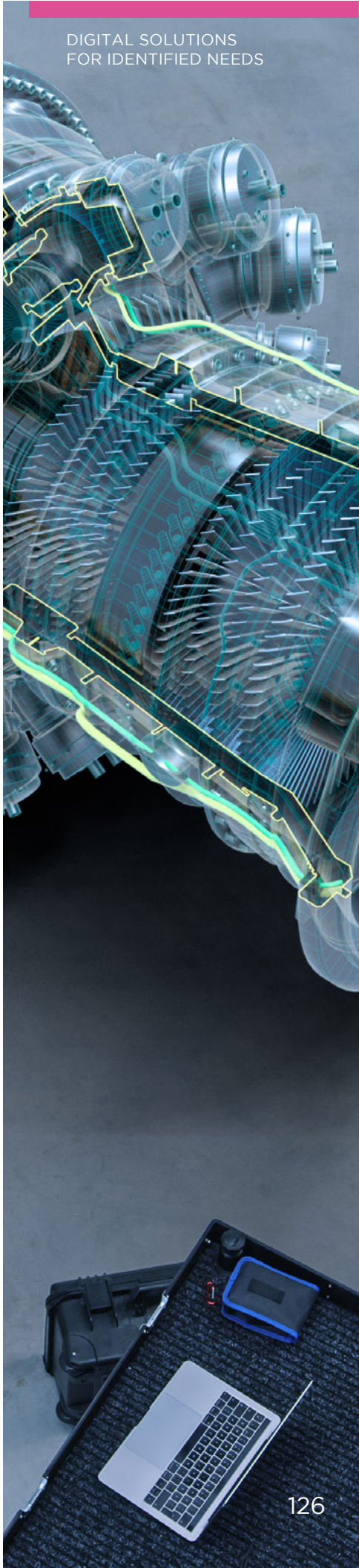
These types of solutions are part of the company's digital channels as they are typically offered as an additional alternative. They are an alternative to digital forms and are typically used for less complex inquiries, requests, and transactions. Through their integration with management systems such as CRM, chatbots can return information required by the client or enter the basic data of a request.

They are also known as conversational assistants in their most developed form which can involve understanding unstructured input and voice interaction. In these cases, in addition to the use of NPL, techniques such as natural language understanding and generation (NLU and NLG) are used.

The main benefits of these solutions are associated with increasing productivity and efficiency of sales forces and back-office functions by reducing the volume of inquiries and requests that must be processed by humans.

Only one of the companies interviewed, belonging to the automotive sector, stated they had this type of solution. In this case, the company uses the chatbot as a contact alternative on its public portal where you can explore the product catalog or resolve simple queries from potential customers.

The low adoption of this tool has to do with barriers such as the low volume of transactions that do not justify the investment in this type of technology and the prioritization of other implementations with a greater contribution of value such as the digitization of customer orders, which continue to be staffed predominantly by sales representatives.



3.1.5 Cross-sectional solutions

In addition to identifying particular solutions for the aforementioned links in the chain, there are also cross-sectional tools that not only perform specific functions according to an area but also influence different areas of the operation, optimize the flow of information, and generate availability and accessibility to data and automate transactional tasks.

Enterprise Resource Planning (ERP) Systems and Advanced Planning Systems (APS).

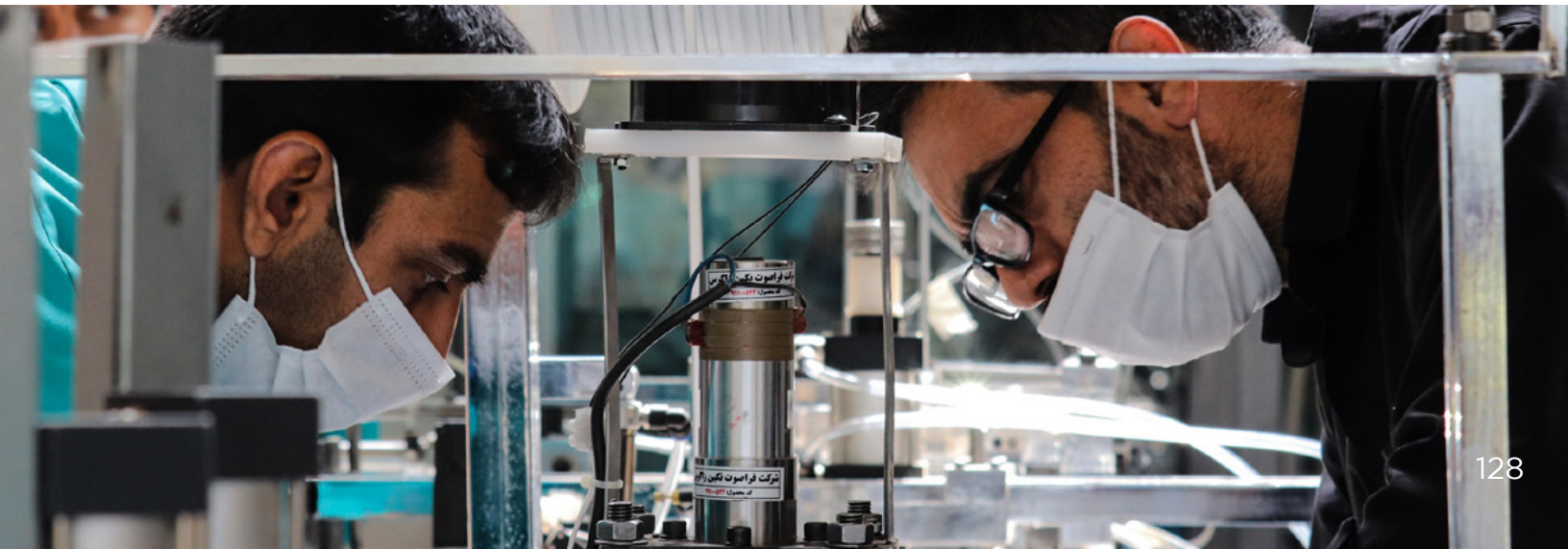
The Enterprise Resource Planning (ERP) systems are systems that organizations use to manage daily activities such as accounting, procurement, project management, risk management, compliance, and supply chain operations. In the first instance, the ERP helps to efficiently manage all processes in an integrated system. ERP systems are complemented by advanced planning systems (APS) focused on supply chain planning.

Both solutions are complementary. While ERP records all the company's operations, APS focuses on ensuring it has the capacities of raw materials, transportation, and resources, to support operations according to projected demand. In that sense, both solutions provide transparency in the entire business process. Specifically, they act as the backbone by overseeing all aspects of different areas and processes such as accounting management, demand and production planning capabilities, replenishment tracking, and supply chain operations and parameters.

The benefits obtained by implementing these solutions are diverse and in general are aligned with the needs of the sector such as increasing operational efficiency, improving traceability and resilience in the supply chain, and ensuring operational continuity. This is achieved through access to consolidated business information and resource planning, which also allows risk reduction and improved market response capacity.

Both tools have a high level of adoption in organizations in the sector since practically all participants have this type of system. The main challenge has to do with the obsolescence of some ERPs and APS, as well as the lack of completion of the implementations, either in geographic or functional dimensions. At least 20% of the companies interviewed state that they are in the process of updating this type of system. Most of the cases are related to the selection of new tools either to update outdated systems or because they have versions that the vendor will not offer support for soon.

The main barriers to carrying out these updates involve the size of the projects since they consume many resources necessary for day-to-day operations. There are other more specific barriers such as data quality and the prior redesign of business processes that must be done to ensure that the implementation truly impacts the organization. Some companies in the sample also commented that the investments are not always justified since the technologies are rigid and cannot adapt sufficiently to their operations.

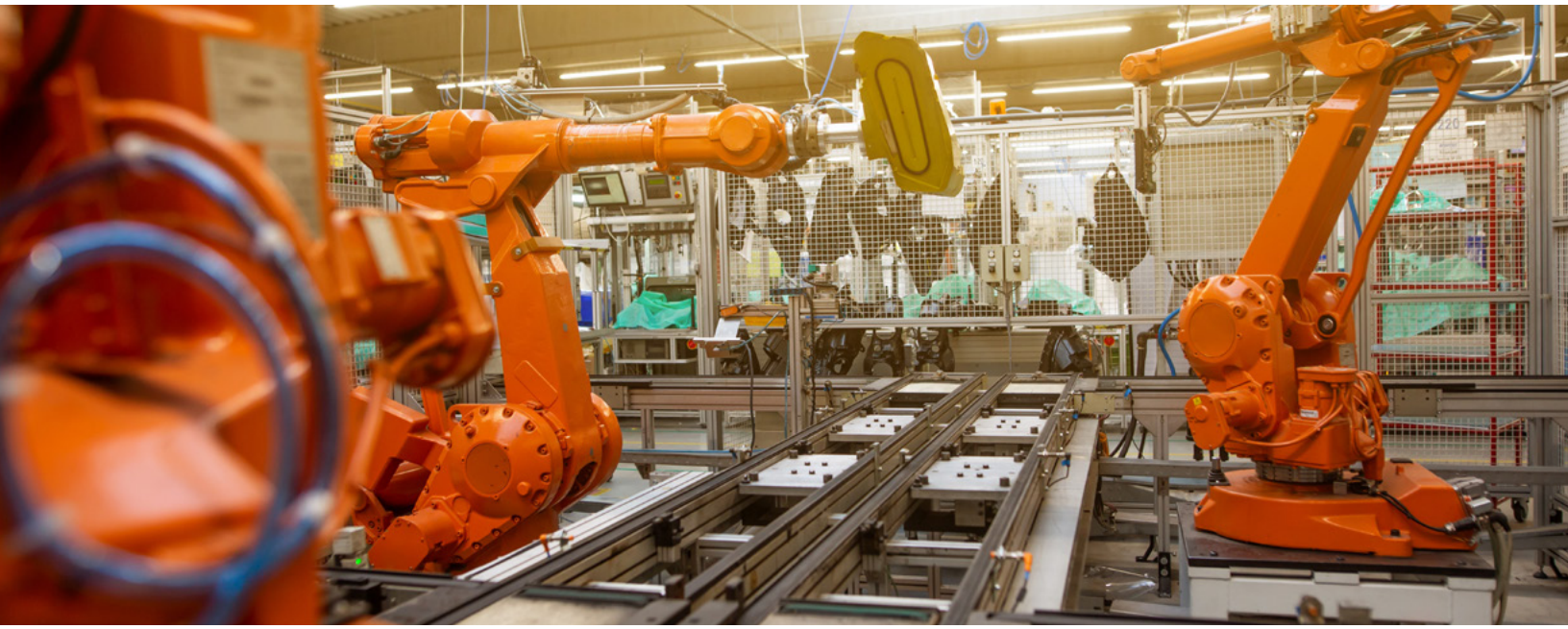


Data-lakes and Data-warehouses.

As discussed throughout this study, a fundamental element of Digital Transformation is the implementation of analytical models that take advantage of data to improve business processes. What is sought with these models is to describe, predict or prescribe actions or events that serve to optimize operations.

The manufacturing sector is an industry that generates large amounts of data through switches that can be found throughout the production process, logistics, or even customer interactions. The data must be stored for analysis, which is why *data-lakes* and *data-warehouses* are used.

A *data-lake* is used to store, process and protect large amounts of data without necessarily requiring a predefined structure. This type of solution provides a scalable platform that allows data to be transferred from any system and enables real-time data processing with analytical modeling programs. Due to the lower storage cost of this solution, it is an excellent alternative to backing up a database in its native (i.e., unmodified) form.



A *data-warehouse* is a data repository that is used (mostly) to store structured and pre-processed data. With this, historical data classified into semantic blocks is collected to generate strategic information. The *data-warehouse* centralizes relevant data for the company, systematizing it and facilitating its analysis. In this sense, a *data-warehouse* is a more rigid solution compared to a *data-lake* since it requires steps prior to implementation. Therefore, efforts to implement a *data-warehouse* are high as it requires investing resources in the initial configuration, including the design and implementation of schemes, data extraction, and transformation processes, and data loading in the warehouse.

Although both solutions are used for data storage, it is important to highlight the differences between the two. *Data-warehouses* are used to store processed, structured data that can be used directly by business users for specific purposes. *Data-lakes,* on the other hand, are used to store data that may or may not be structured and where a specific use is not necessarily characterized. Due to this difference, *data-lakes* tend to be used when there are robust plans to start capturing and storing higher volumes of data in order to discover use cases that may be useful in the future. This is why, in the last decade, more organizations have chosen to develop initiatives to implement *data-lakes.*

The main benefits of this type of solution involve increasing the productivity and efficiency of the organization by enabling centralized information to manage the business. These solutions are a necessary step to enable advanced analytics capabilities, which in turn improve the organization's responsiveness and serve to mitigate risks.

The level of adoption of this type of technology in the companies that were part of the study is high. *Data-warehouses* are used by 83% of companies for some or all their business data and 13% of the participants declared having ongoing initiatives for the implementation of *data-lakes* when they intend to capture more data to incorporate into their analytical models. In the case of *data-lakes,* the main barrier mapped to adoption was the lack of concrete plans for incremental data capture. Another common barrier was the effort to clean the data, which, despite not being necessary to store the data, is required before to using it.

As an example, we highlight three companies, from the distribution (Chile), retail trade (Peru), and manufactured metal products (Mexico) subsectors that have implemented *data-lakes* and have initiatives to continue developing them. It is noteworthy that only one of the cases refers to the manufacturing sector, which may evidence a lower need to capture large amounts of data due to the lower volume of transactions that results from the concentration of its sales in a few clients.

Intelligent automation of non-productive processes.

The Intelligent Process Automation (IPA) refers to the application of automation technologies in the transactional processes of organizations, including robotic process automation (RPA), optical character recognition (OCR), workflows, and platforms process management (BPM) that, sometimes combined with advanced analytics, machine learning, and artificial intelligence, allows the production of automated configurations in different business processes.

RPAs are software robots that automate repetitive back-office tasks such as data entry, structuring and retrieval, button clicks, file uploads and downloads, document reading and processing. In the manufacturing and retail trade sector there are many tasks with these characteristics, especially in customer service processes, purchasing, and support areas such as finance and accounting.

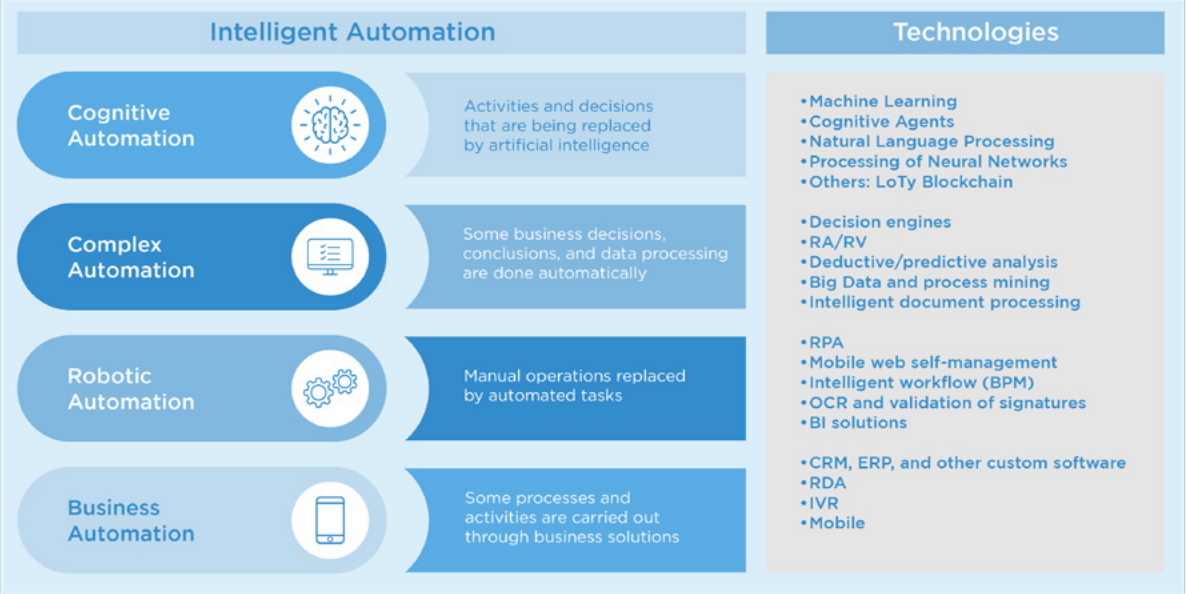
The benefits of implementing this type of automation solution have to do with operational efficiency and productivity since they imply reducing the amount of manual work that is currently performed by people. Depending on the type of process in which they are applied, these technologies also have the potential to improve customer experience, response times, and accuracy of execution.

As previously mentioned, RPAs are commonly integrated with other automation solutions to expand their uses to more situations, such as smart workflows, which are sequences of automated, interconnected, and synchronized processes to achieve a specific result, or the analytical algorithms and decision engines that return some response based on input parameters. The latter case, refers to levels of automation that involve the use of more advanced algorithms.

Process management systems (BPMs) are robust tools used to automate blocks of processes in a more cross-sectional way. These solutions are used to design, execute, supervise, and optimize processes in combination with other tools previously described in this study.

The BPMs contribute to the integration of systems, processes, data structures, and people by having the ability to standardize and centralize a large number of workflows. Some tools used for BPM can model without the need to develop code. To do this, they use a graphical interface that involves functions that represent inputs, outputs, and operations that can be interconnected with other elements such as workflows and RPAs.

Figure 18: Intelligent Automation Framework.



Source: Own elaboration based on NTT Data's intelligent automation framework.

Finally, within the framework of intelligent automation, there are tools such as optical character recognition (OCR), which allow a text image to be read and converted into a format usable by a computer. This technology has the potential to simplify detailed work such as reading an invoice and entering its parameters to be later processed by a person or a robot.

Combined with the use of electronic signatures, these solutions have shown a high capacity to create automated or semi-automated process flows in which efficiencies are generated, either due to the speed to carry out the process or the number of resources focused on it.

The level of implementation of intelligent processes in the manufacturing sector is medium, even though 85% of the participating companies have implemented some of these technologies, most recognize that the automation achieved have not yielded the expected benefits. This is mainly due to factors such as the lack of change management strategies and the retraining of labor forces, the fragmented vision with which automation has been implemented, the inexistence of a government that guarantees the updating of automation when the process evolves or adjusts the data structure and the difficulty to justify the initial investment required.

For example, the case of a metal-producing company in Brazil that has implemented RPAs were identified for the automatic filling of fields in the generation of purchase orders, as well as to automatically authorize recurring orders for smaller amounts. Through these implementations, the total time dedicated to these activities and the number of people focused on it have been reduced, generating savings that result from the greater productivity and efficiency of the process.

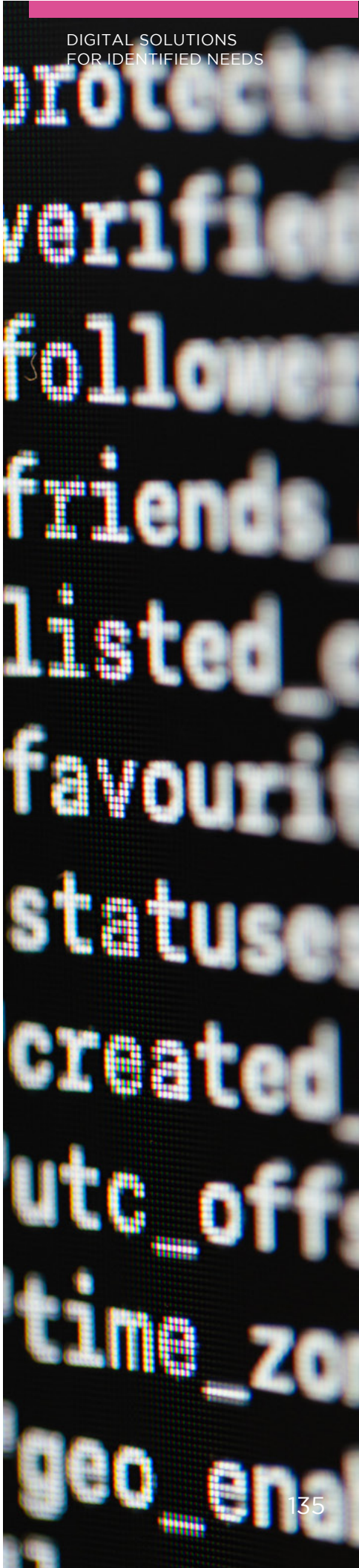
Cybersecurity in applications.

Cybersecurity refers to the set of practices of organizations focused on guaranteeing the security of information through the protection of systems, databases, and networks from digital attacks. The implementation of these practices aims to prevent unauthorized people or organizations from consulting, modifying, or destroying information that endangers the continuity of the business or the integrity of people.

Having cybersecurity standards is particularly important for companies in the manufacturing sector since Digital Transformation implies a substantial increase in the amount of data that is collected and shared through networks.

Implementing cybersecurity practices involves processes and action protocols to guarantee the integrity of the information and ensure that users are capable of identifying, avoiding, and managing attacks. Likewise, at a technological level, it implies implementing computer security tools and processes both for the development of software and for the protection of devices such as computers, mobile phones, networks, and servers.

These types of solutions, are not only necessary, but also offer benefits associated with productivity and ensuring the operational continuity of organizations. By preventing potential attacks, companies can avoid costs associated with system downtime and the loss of sales that can result from it.



Most of the organizations declared having initiatives associated with cybersecurity. However, at least 17% considered opportunities to improve their practices. In particular, the lack of awareness among users regarding practices to reduce the probability of becoming victims of attacks that put the integrity of the organization's information security at risk was highlighted.

WI-FI 6 and 5G.

In this study, we have discussed technologies such as IIOT whose application would not be possible without the existence of solutions that allow the transmission of large volumes of data at high speeds and with low response times. In this context, solutions such as 5G and WI-FI 6 become relevant as they enable the connectivity required for this type of implementation to operate.

The 5G solution refers to the deployment of the fifth generation of mobile networks. This network will allow transmission speeds 20 times faster than the predecessor technology, 4G. Another advantage is the response time that implies data exchanges in practically real-time, which translates into reliability for applications such as remote control of robots, machines, and other productive or logistical elements in which a fraction of a second can be important for ensuring the desired result or avoiding an accident.

The WI-FI 6 is a type of wireless network that is used to digitally connect electronic devices. Like 5G, its main benefits are associated with greater data transmission capacity and better performance in environments with multiple connected devices.

Both solutions enable technologies such as IIOT and complement each other. The state of 5G adoption in Latin America is still intermediate, particularly when considering the geographical breadth of coverage, which in some countries is limited to some sectors of the main cities.

3.2 Solutions for environmental, social and corporate governance management

One of the focuses of the manufacturing industry has to do with environmental, social, and corporate governance. Due to the sectors having high energy consumption and emissions, reducing the environmental footprint is a relevant topic on their agendas. This becomes even more important if one considers that the sector contributes 24% of greenhouse gas emissions[14].

Another important aspect of the sector's agenda in the areas of environmental, social and corporate governance (ESG) is the increase of women who currently represent only 30% of the workforce in manufacturing and 38% in trade in Latin America in 2021 according to ECLAC statistics.

Among the solutions identified in the sector in the area of sustainability, the adjustment of business models towards circular processes focused on recycling and the use of less polluting raw materials, ESG monitoring and management platforms enabled by telemetry and connectivity, and Blockchain as an alternative for the traceability of raw materials and supplies.

14 (Ritchie et al., 2020)

ESG monitoring and management platforms.

ESG monitoring and management platforms are digital solutions that offer the ability to consolidate the management and monitoring of indicators associated with the environmental footprint, social impact, and good corporate governance. Through these platforms, organizations can capture and publish information that allows them to understand and monitor performance in accordance with the goals that have been set and the regulations that must be adhered to in each area.

The benefits of this type of platform, in addition to mitigating corporate risk, are associated with operational efficiency to the extent that they manage to simplify the processes of capturing and auditing this information, or with the operational improvement itself derived from monitoring this type of information indicators mainly due to the lower consumption of resources or the higher yield of raw materials.

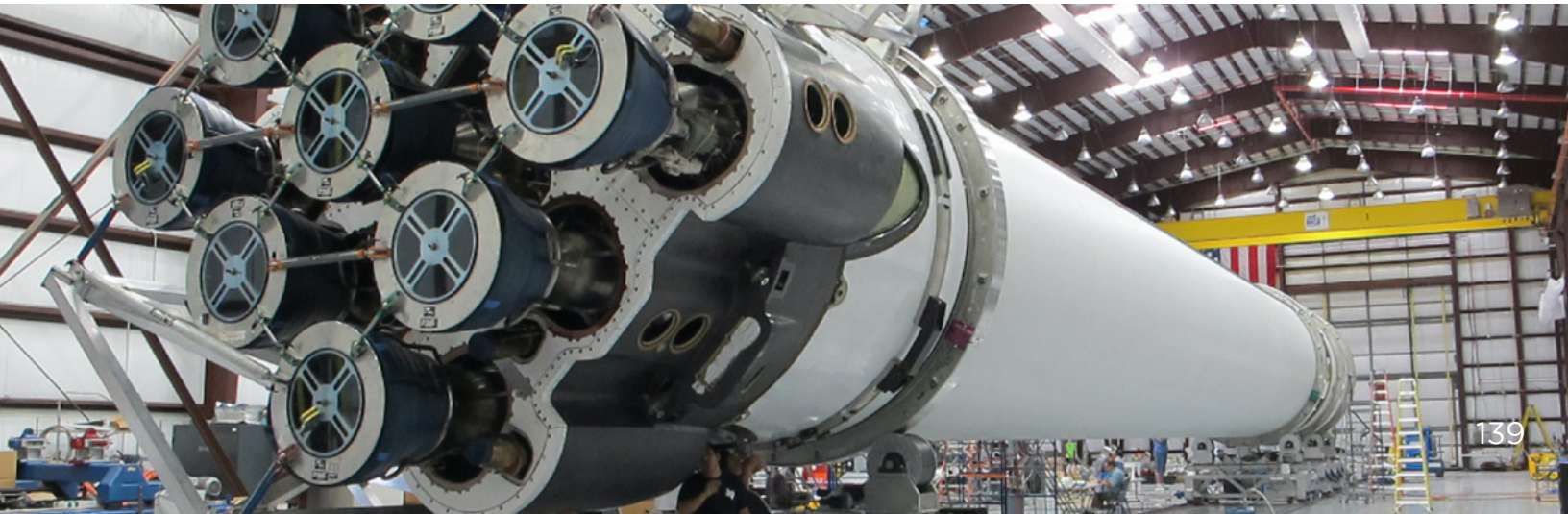
An important element of these tools is the ability to integrate with components that can measure and record in real-time specific indicators associated with the exploitation of resources, consumption, and substitution of raw materials, and emissions at each point of extraction or transformation. These components are typically meters, switches, or software where such information is already available.

In the case of the manufacturing sector, the data and indicators that are managed with this type of platform involve the exploitation of natural resources, the purchase of natural resources, electricity and fuel, workforce diversity, supplier relationships, and financial sustainability.

Sectors such as the cement industry have been pioneers implementing this type of technology in combination with others such installing of equipment to measure factory emissions in real-time, capturing carbon dioxide generated in the production process of cement, replacing fossil fuels with alternative fuels such as biomass and the reuse of rubble to reintegrate into the material production process.

To the extent that these platforms simplify the process of capturing and reviewing indicators, organizations can better manage progress against their goals. The key is that once implemented, most of the time can be dedicated to analysis and decision-making that accelerates the reduction of the carbon footprint and the impact of the business in accordance with the sustainable practices to be adopted.

An element to highlight is that in advanced subsectors such as the automotive industry, this type of tool can also be used to encourage practices to be adopted not only by the organization itself but also by the value chain of its suppliers. Thus, these platforms can be used to qualify suppliers based on their level of maturity in terms of sustainability, aligning the entire supply chain toward greener economies.



Adoption of business models based on processes/circular economies.

Circular economies or processes are concepts that aim to adjust business models more oriented toward sustainability. The concept focuses on increasing the use of resources through the reduction of waste and the recycling of materials and products, to reduce the environmental footprint.

Circular economies are the opposite of linear economies, in which products are made, used, and disposed of without regard to the externalities generated by waste. The circular economy creates semi-closed cycles of production and consumption, in which resources are reused and products are used for as long as possible.

Some of the industrial subsectors in which the circular economy concept is more advanced in its implementation are vehicle manufacturing and the construction materials industry. For example, in the manufacturing of vehicles, manufacturers have begun to design products that can be disassembled more easily in order to recycle their components and reintroduce them into the production chain. In the case of the construction materials industry, companies are adopting the circular economy approach to reduce the use of fossil fuels, as is the case in the cement industry to reintegrate the use of rubble into the value chain and produce a new product but reducing the extraction of natural resources.

In the study, a glass-producing organization in Chile was identified that not only has internalized the concept in its production processes but has created a specific area to ensure that the business model is increasingly oriented towards this concept.

Although the circular economy concept is relatively widespread, in the study, only 13% of the participating organizations stated that they had an advanced system to monitor the elements reincorporated into the value chain, while the rest of the organizations declared that they were in incipient stages for the implementation of this type of model.

This may be associated with the fact that to implement this concept, barriers must be overcome, such as costs associated with the reuse and recycling of materials and the lack of incentives to adopt more sustainable production approaches in which the state of the art tends to be ahead of regulation.

Blockchain traceability and sustainability certification.

Blockchain technology aims to ensure the reliability and traceability of transactions and assets by permanently and securely recording information in distributed ledgers where there is no need for a centralized entity. This technology, which became popular in the last two decades mainly due to the rise of cryptocurrencies, has the potential to be used in other use cases in the manufacturing sector where end-to-end traceability is relevant.

CASE STUDY

SYSTEMATIZATION OF WASTE MANAGEMENT FOR AUTOMOTIVE TRANSMISSION COMPANY

Location: Asia, Europe, United States and Mexico.

Products: Continuously Variable Transmissions and Automatic Transmissions.

About:

Veolia, a company providing resource and waste management solutions, which offers solutions aimed at maximizing the reuse of resources and promote the transition to circular economy models.
Veolia seeks to close the life cycle of products and materials, maximizing their use and minimizing environmental impact. By offering such solutions, their customers can adopt more sustainable practices and gain operational efficiencies.
The client is a Japanese company with presence in Mexico, leader in the automotive sector, dedicated to the manufacture of Continuous Variable Transmissions and Automatic Transmissions.

Problem to solve:

Given the importance of the implementation of systematization and automation in waste management, the company helped its client to face the challenge of the final disposal of its waste.

The challenge:

- Selection of best recovery, recycling, and final disposal options.
- Systematization and automation of waste flow to achieve technically and economically the best management of these.
- Promote recycling and waste minimization through staff awareness and training.

Solution implemented:

Team of more than 15 people, implemented by **Veolia's** team in the client's facilities, for the management of warehouses with RPS (Rear Projecting System) systems. An RPS is used in the industry to improve efficiency of processes and allows the integration of all areas of the company, from engineering to production, to improve the management of information and resources. Responsible of scheduling shipments to their final destination, automatic preparation of documents, logs, reports of operational movements, as well as support to internal audits for certifications compliance. Looking for economic efficiencies and minimize waste generation in the plant.

The solution sought to:

- Optimization in environmental costs.
- Complete control and environmental compliance.
- Search for better alternatives for recycling, treatment, and final disposal.
- Assure the company that its waste is properly managed.

Veolia leverages on its different digital solutions, artificial intelligence, and automation solutions to generate and provide tailor-made solutions for its customers.

Results:

After the implementation of the solution, the client obtained the following benefits:

- Control and automation of the information generated around the handling and shipment of
- dangerous waste.
- Carry out efficient shipment logistics digitally.
- Review of authorizations of transport companies and final destinations.
- Continuous data upload and update for the management of RPS systems.

A blockchain network can be used to track orders, payments, resources, production details, and other applications. Mainly, users have a reliable source of information, which provides confidence to the system by offering verification of the condition of origin to all participants in real-time.

It is precisely this tracking possibility that the main use cases of this technology in the industry are focused on. These cases are associated with applications to verify compliance with degrees of sustainability of inputs and raw materials that enter a process, as well as their suppliers and the origin of their supplies and energy sources.

With this type of application, there is potential to contribute to a more precise measurement of the carbon footprint of an organization and even of a sector. This last point is not without contradiction, since the technology that requires high energy consumption would be used to monitor environmental indicators[15].

15 (Knoll & Viola, 2018)

Within the subsectors determined in the study, the automotive industry stands out, where pilot tests have been implemented that use blockchain to secure the supply chain of components and guarantee that manufacturing and sustainability requirements are met.

That same use case has been piloted in the retail industry to trace the origin of products. In both industries, the objective is similar: to validate conditions of origin. This could be useful not only for certification and trust purposes but also to manage emergency cases such as the detection of batches of defective components that could cause harm to the end user.

Although blockchain has great potential to solve problems associated with traceability, it competes with other traceability solutions mentioned in this study.

The percentage of adoption of this solution in the sector is low and it is only possible to identify participants who experiment with the technology and who represent less than 3% of the sample. This may be related to adoption barriers, among which the effort to establish standards adopted by many organizations stands out, and sharing of the minimum elements worth establishing said traceability.

3.3 Ecosystem of the sector and startups

For the preparation of this study, in addition to the corporate participants, the point of view of some startups and other companies that participate in the different links of the value chain of the manufacturing sector were also included.

On the one hand, the intention is to complement the corporate vision with new organizations whose business model was conceived with digital characteristics; on the other, comparing the information offered by corporations with that of mid-sized companies, as and validating the extent corporations function as a change agent for technological progress in the sector.

As part of the sample, startups, and suppliers focused on monitoring industrial assets and merchandise, last-mile storage and logistics, purchasing and bidding platforms, chatbots with artificial intelligence for customer service, and various manufactured inputs were interviewed. The results of the study were analyzed based on the sample of startups and suppliers interviewed.

Among the main findings, the high degree of specialization of the productive link stands out, where one of the competitive advantages of the sector lies. In line with this, a limited number of startups focused on this link in the chain was identified. The most emblematic cases are associated with companies that offer industrial asset monitoring solutions through switches and IIOT, logistics optimization services in the supply chain and collaborative platforms for purchases and tenders.

As a result of the interviews with startups and companies that interact with organizations in the sector, some findings were characterized:

1. Experience: Most of the expertise in startups comes from profiles that, at some point, were part of the sector. This represents an opportunity since these profiles have both contexts, which should serve as an advantage to understanding needs and satisfying them.

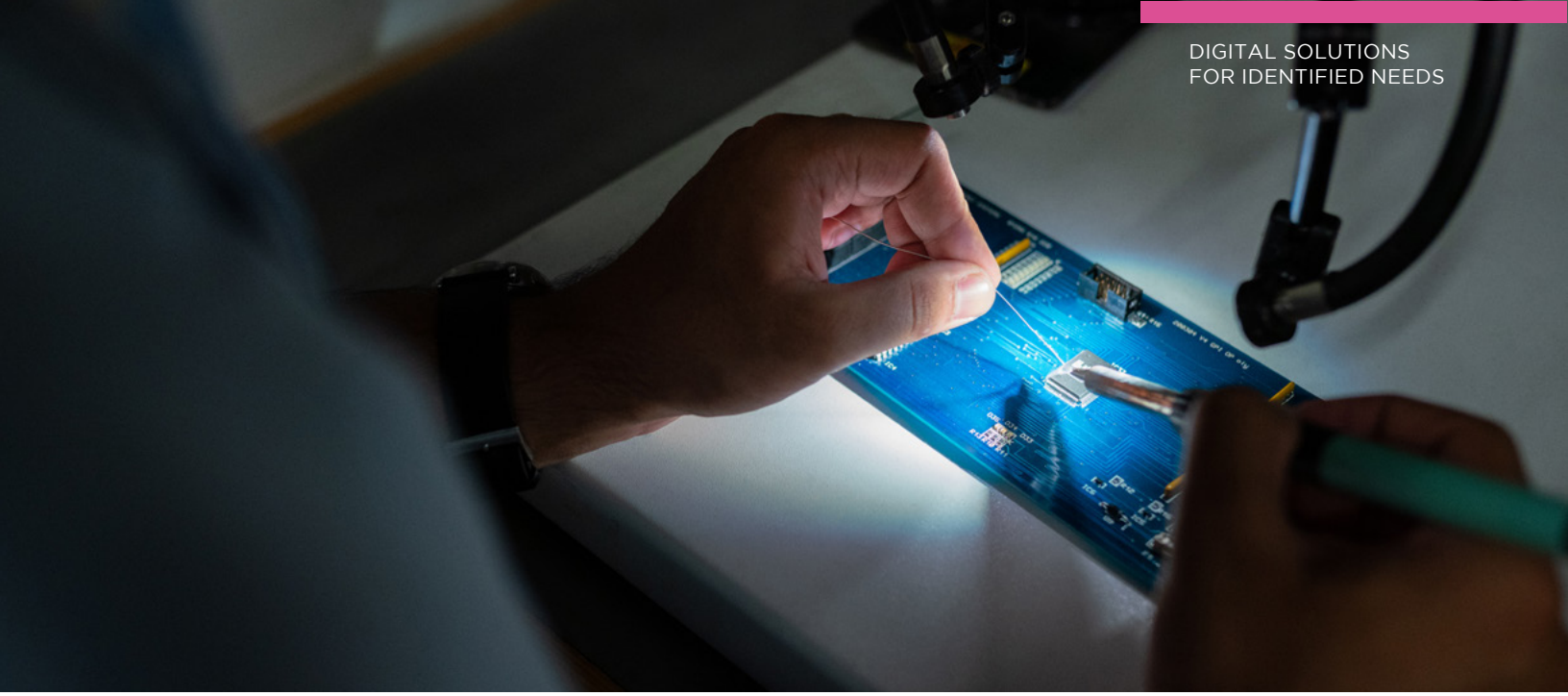
2. Collaboration barriers: Complexity is perceived to collaborate with the more traditional organizations in the sector due to factors such as high bureaucracy in processes, little integration of digital tools, and the scale itself that, on occasions, demands to comply with unilateral conditions to be a supplier or integrate into its chain.

3. Entrepreneurial attitude and risk aversion: In general, startups consider a pending issue exists in terms of entrepreneurial culture so that officials in the manufacturing sector enjoy greater autonomy and appetite to experiment with new solutions and suppliers.

4. Increased customization efforts: All startups interviewed face the challenge of customizing their processes in accordance with the policies and practices of the companies they collaborate with and on many occasions require adjustments despite belonging to the same sector.

Based on the findings, it is concluded that there is enormous potential for startups to achieve greater integration in the manufacturing sector in Latin America and better integrate into its value chain.

This must occur through a process in which large organizations approach the entrepreneurial ecosystem to seek aligned solutions to solve their main challenges. On the other hand, it confirms the incipient state of Digital Transformation in the sector and the opportunity it has to integrate technology into its processes to face the challenges posed at the beginning of this study.



3.4 Roadmap for Digital Transformation in the sector

Understanding Digital Transformation as a means to achieve organizational objectives and not as an end, it is important to incorporate a roadmap to find new ways of operating that allow facing the challenges already described in this study.

Having a roadmap allows laying the foundations so organizations in the region are clear about the steps to go through this process effectively. This general roadmap is a starting point that must be adapted to the specific needs, challenges, goals, and state of maturity of each company in the sector.

Through the study, five phases were identified that contemplate some key actions to achieve the digital and sustainability objectives.

1. Diagnosis of the value chain: It involves understanding the starting point, the specific needs of the organization, the level of digital maturity in relation to the industry, the existing technological capabilities, and the maturity of adjacent industries.

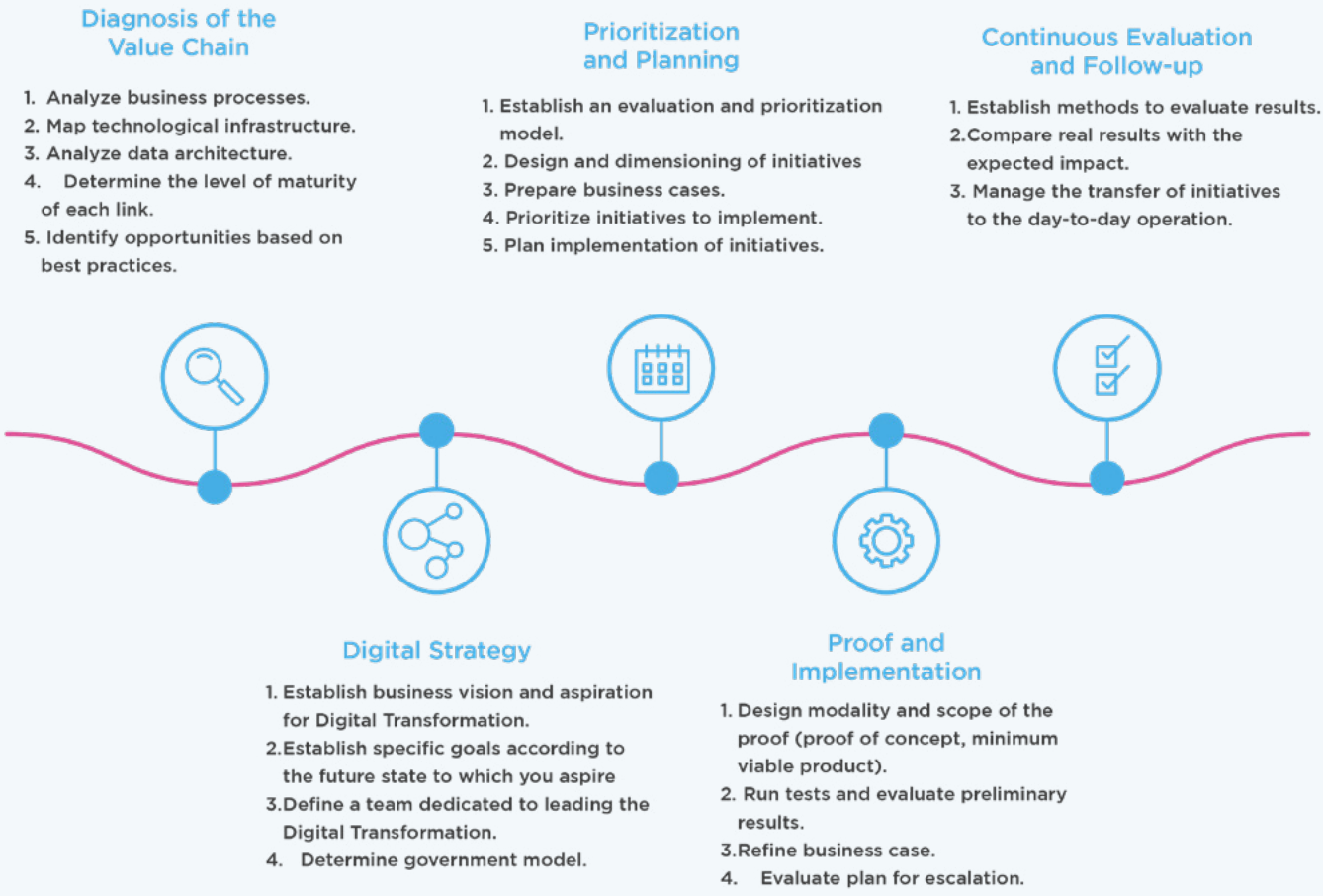
2. Digital strategy: Based on the previous step, the establishment of a Digital Transformation vision and action focuses to achieve specific business objectives and/or a desired level of maturity that also incorporates purpose, governance model, structure, culture, and change management appropriate for the success.

3. Prioritization and planning: Prioritization and design of transformation initiatives that establish implementation milestones and consideration of restrictions that may be associated with the feasibility or level of investment required.

4. Proof and Implementation: Execution of proofs of concept (PoC) or development of minimum viable products for the evaluation of the operation of the improvements before to the scaling of the effective solutions.

5. Continuous evaluation and follow-up: Establishment of mechanisms that allow the performance of key indicators to be measured based on the goals defined for Digital Transformation and specific solutions.

Figure 19: Roadmap for Digital Transformation.



Source: Own elaboration.

Diagnosis of the value chain.

The first step to face Digital Transformation is to analyze the current situation of the company. This study makes it possible to limit the focus of the analysis to the main needs identified, but, as has already been mentioned in this report, a specific diagnosis is required that considers the particularities of each organization and its starting point.

In this line, the diagnosis should focus on understanding the processes, their level of digitization and the value-added of transforming them. It is also important to assess the technologies that support operations, the ecosystem of platforms and systems, the level of automation, and the architecture and data processing tools. Finally, it is necessary to understand the level of digital culture in the organization that covers aspects such as collaboration, the tech literacy (digital knowledge) of the teams, and the use of agile methodologies in organizational and technological development fields.

This diagnostic process is usually complex, not only because it demands resources for observation and analysis, but also because of the difficulty in sharing the conclusions with different areas and directions that may have a divergent or divided perception of the same reality. Another relevant factor is the lack of quality of the information required or the concentration of the company's knowledge in a few profiles that tend to resist sharing said knowledge.

The diagnosis must culminate the identification of business opportunities and needs based on the contrast of technological tools and other capacities observed in the market, incorporating benchmarking analysis to detect the main gaps.

Digital strategy.

For any transformation, a clear strategy is required, supported by a government that allows the actions of the organization to materialize. In this line, organizations must establish the reason that justifies the transformation and the future state they want to achieve, defining a concrete vision with a specific term for its fulfillment.

Once a vision is determined, establish the goals to be achieved, answering questions such as: What are the areas or aspects of the business where we want to transform? Or what specific objectives do we want to achieve in each area? For this, it is recommended to have a team dedicated to Digital Transformation that incorporates executive and management roles with a cross-sectional focus.

In this way, it is possible to connect all the areas of the organization and articulate a strategy that considers synergies between different lines of work.

Likewise, a governance model is required that allows orchestrating decision-making by establishing mechanisms to manage the progress of each line of the portfolio of initiatives and allocate resources efficiently according to the defined budgets.

One of the lessons learned from the study in this phase is that the companies with the highest level of maturity are those that do have a vision and a structured transformation plan that is also known by the organization. In these organizations, which represented 10% of the participants, the plan was also orchestrated by a specific area and had clear mechanisms that served to manage progress.

However, most of the companies in the sector are advancing in their transformation without being clear about the reason and the objectives of the transformation. For this reason, sometimes they tend to implement solutions in silos that do not have an end-to-end vision of the chain and that generate inefficiencies due to rework or duplication. It is essential to establish the aspiration of the organization and have specific objectives so that Digital Transformation solutions have a true impact on the expected goals.

Prioritization and planning

Once the strategy, team structure, and governance to direct and manage the Digital Transformation have been defined, the next step is to establish a model for the evaluation and prioritization of opportunities and initiatives that guarantee the measurement of relevant variables for the strategic objectives. For this, it is necessary to execute a process of design and dimensioning of the initiative, its impact, and its associated costs. At this point, the main challenge is to combine traditional project evaluation methods with the evaluation of innovation projects that have a return component that is more difficult to characterize.

In this phase, it is suggested to have evaluation models that are flexible but that make it possible to effectively compare the value associated with each initiative based on variables such as operational efficiency, the development of new businesses, or the opportunity cost of not transforming a given process.

In addition, other factors must be integrated, such as the feasibility of implementation within a specific period and the resources required, both financial and human. Each organization must be able to determine the weight that the evaluation variables have in the prioritization since this will determine the schedule of the plan.

In organizations where the budget does not represent a restriction, the variable of feasibility and value-added of the initiative become more relevant. However, according to the study, most organizations have some budget restrictions and tend to finance a large part of their plans with the reinvestment of profits or the release of efficiencies that the transformation itself generates.

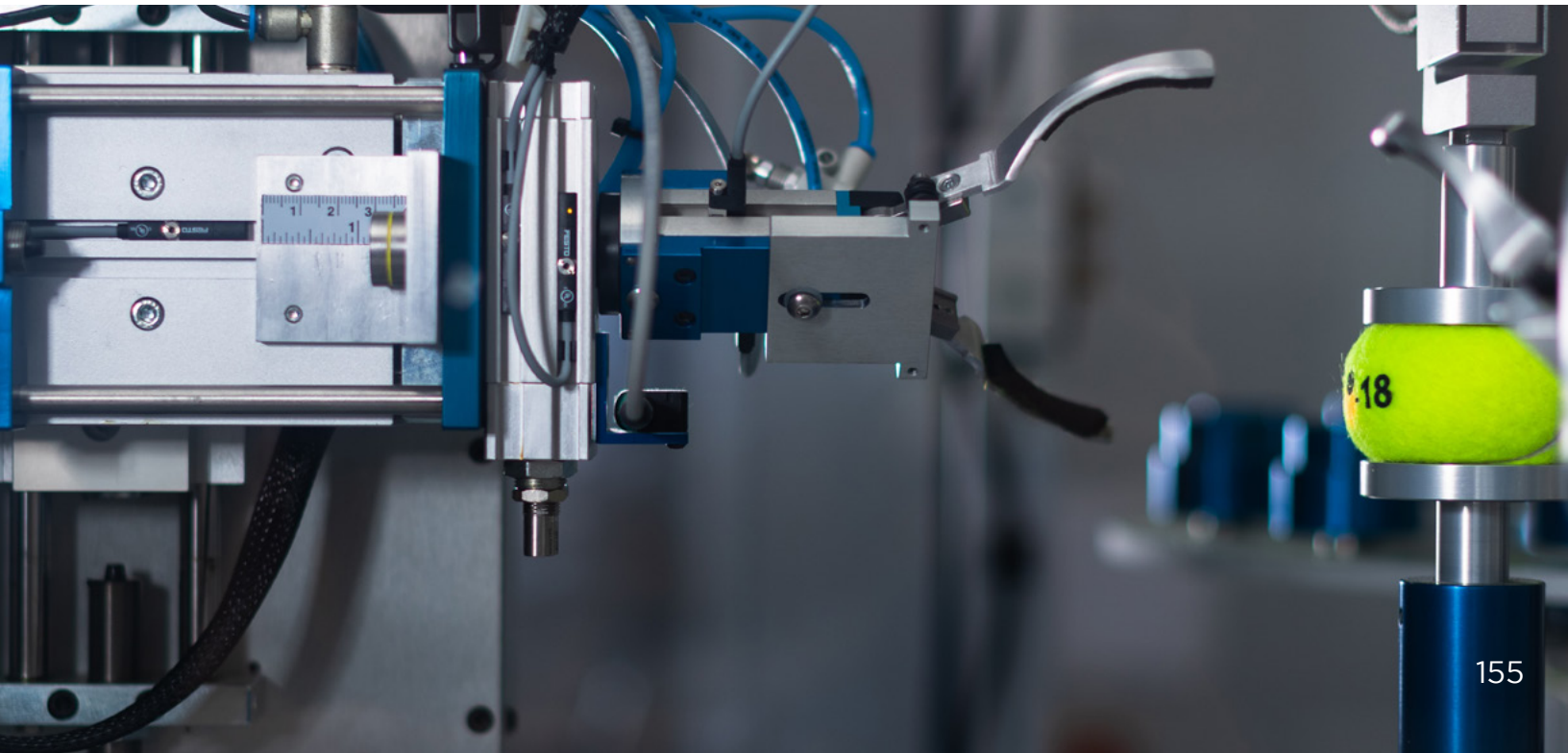
The Digital Transformation plan must be flexible to proactively incorporate high-value initiatives, constantly executing evaluation and prioritization activities to determine short-term focuses or adjust medium-long-term expectations.

Proof and Implementation.

To address the initiatives, it is recommended to have a trial-and-error process that considers proofs of concept for the projects with the greatest uncertainty and minimum viable products (MVPs) in projects where there is less clarity of the effectiveness of the solution. This is intended to optimize resources and test solutions in controlled environments before scaling them to their full potential.

Once the MVPs and PoCs are executed, there will be greater clarity about the impact and complexity of executing the initiative. In cases where it is decided to move to the scaling level, it will be necessary to refine the business cases with the extrapolated results of the tests and develop a detailed plan for the full deployment.

To scale a solution, it is important to fully understand the processes and groups of people that will be impacted, as well as the necessary technology architecture and underlying infrastructure. Once these aspects are analyzed, the next step is to identify the implementation waves that, depending on the process, may be circumscribed to parts of it or to different business units where it is executed.



Continuous Evaluation and Follow-up.

Although the previous steps may be relatively sequential, it is necessary to understand that Digital Transformation is a process and experience of continuous change. Given the above, the team dedicated to its management must have a vision of evaluation and cross-sectional monitoring.

Depending on the strategy and governance model that is defined, methods must be established to evaluate the results of the initiatives, contrasting the real impact with that expected to report the value to the business. In the same way, continuous monitoring must manage the initiatives implemented until they become part of the company's usual operation.

Another relevant aspect is to encourage the development of new ideas derived from the opportunities that are being worked on and incorporate an innovative mentality to face the current and future problems of the organization, where people are required to have the confidence to propose and dare to constantly innovate to stay ahead.

CONCLUSIONS

04

4.1 Study conclusions

Organizations in the manufacturing sector in Latin America have recently faced a period of volatility resulting from high inflation, rising interest rates, and geopolitical and armed conflicts that have disrupted their supply chains.

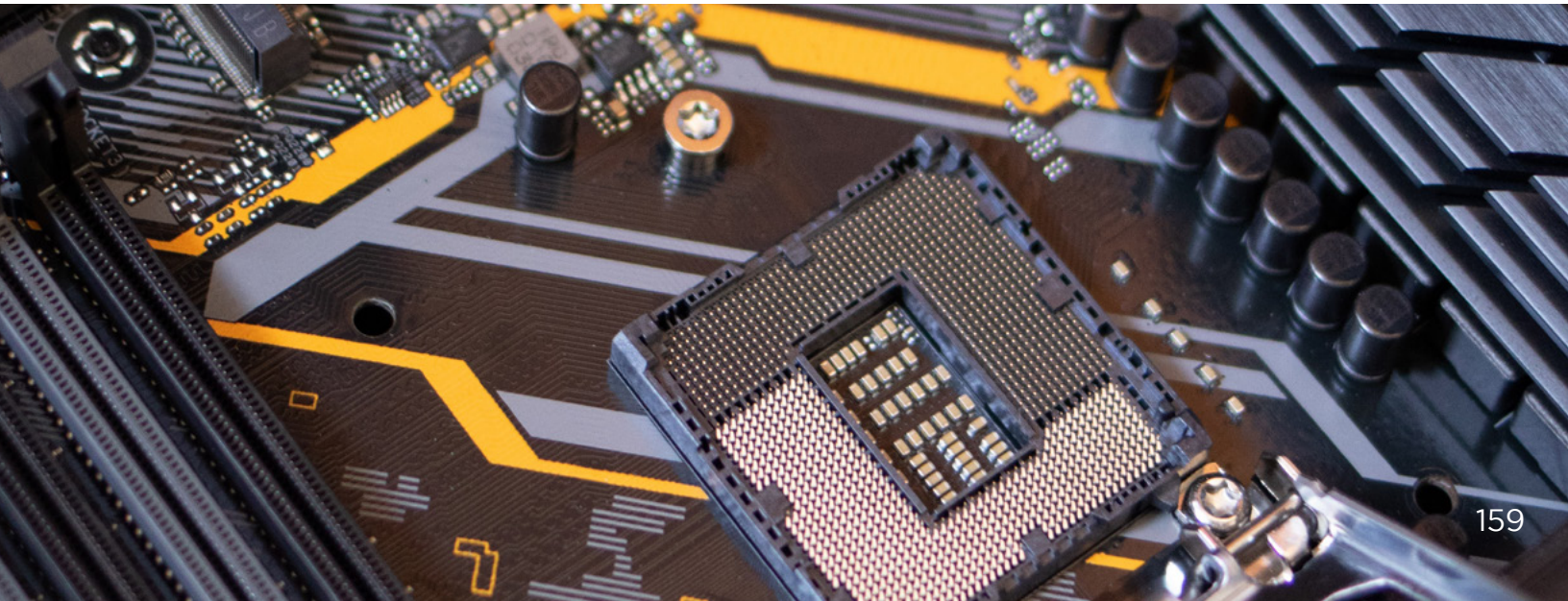
The result of this period has translated into decisions by large corporations to relocate an important part of the productive capacity currently installed in Asian countries. This represents a window of opportunity to attract investment to the region with a long-term vision. To do this, the sector must ensure that it is competitive compared to other geographies, which in turn will imply increasing productivity and efficiency. This study confirms the potential that Digital Transformation has to contribute to this objective.

Through the study, it is concluded that the level of Digital Transformation of the sector in the region is intermediate. However, this level is influenced by concentrated efforts to digitize production processes and the machines that control them, but without a cross-sectional vision that integrates all the links in the chain.

Proof of this is that there is no vision of Digital Transformation installed in the strategic agenda of companies. In most organizations, this vision is found in very specific areas in the form of digital initiatives whose benefits, when analyzed in a fragmented way, are more difficult to characterize and defend. This difficulty negatively impacts the capture and monitoring of value as there are no robust business cases that consider all the variables.

Another point to highlight from our analysis is the lack of funding to venture into larger-scale digital initiatives. In this sense, most organizations finance their initiatives with resources generated by the business operation itself. This financing method impacts the level of ambition of the plans as they are prioritized based on available resources or efficiencies or productivity increases that the initiative itself estimates to capture in the short or medium term.

On the other hand, the study confirms the opportunity that exists to deepen the Digital Transformation of the sector, particularly in areas associated with the incorporation of more data in decision-making, in the generation of systems automation, and the integration of systems and applications with business processes. For this, in addition to incorporating switches to capture and measure data, it is necessary to integrate advanced analytics capabilities that allow processing and exploitation in real-time to generate value. These elements, combined with access to platforms to enter new markets, will enable the sector to better compete in the global context and become a more relevant and productive pole.



Likewise, a growing lack of talent is identified to enable a higher level of adoption of Digital Transformation in the region. In the case of companies in the sector, most claimed they faced a shortage of profiles that have the necessary combination of digital and business skills to enable their agendas. The same occurs in the case of solution providers, which is partly due to a lack of customization of tools to implement by the different manufacturing subsectors.

Relevant opportunities are also identified in the availability of infrastructure since there is a low level of adoption of technologies that enable connectivity. In the case of 5G, this occurs mostly in remote industrial areas, but also in some large population centers. This factor is a major obstacle to implementing digital technologies aligned with manufacturing 4.0 trends and IIOT adoption.

In the field of environmental, social, and corporate governance, there are also important findings. The double effect of Digital Transformation is confirmed, where activities carried out by humans cease to exist while new jobs are generated that require new skills beyond force or manual labor. This allows for greater social inclusion of groups such as women or people with physical disabilities.

Finally, a high level of awareness of the environmental impact of the sector is identified. In this regard, initiatives associated with the adoption of principles of circular economies and energy efficiency are identified. However, despite the existence of a future regulatory element, the level of urgency for organizations to implement this type of initiative is greater when there is a specific economic value to be captured in the form of productivity or efficiency.

Having a Digital Transformation agenda is one of the minimum criteria necessary to guarantee that organizations in the sector can transform and implies identifying processes from which greater value can be extracted through the application of technology. Most of the digital solutions presented in this study have the potential to improve the productivity and efficiency of the sector, as well as contribute to the achievement of environmental objectives.

The latter is becoming increasingly important as it is a sector that contributes a significant fraction of greenhouse gas emissions and consumes vast natural resources and energy to produce goods. For this reason, manufacturing organizations must redouble their efforts to ensure they have digital agendas known by all levels of the organization, sponsored by upper management. This must also be reflected in the allocation of a suitable budget to implement the initiatives and programs that have been defined as critical.

One of the ways to accelerate this transformation is the creation of sectorial mechanisms in which common challenges are faced and main problems are discussed together with specialists from the private sector, the world of startups, regulatory entities, and financing.

In this way, the dissemination of best practices and necessary enablers for the implementation of solutions will be encouraged. These instances can also serve to promote training initiatives to address the shortage of talent in specific fields.

In this context, IDB Invest presents itself as a key player in promoting the development of the manufacturing sector through financing solutions and comprehensive advice.

This study offers a roadmap that organizations can use to compare with their respective Digital Transformation plans. The roadmap is a powerful starting point for organizations that do not have an agenda. With this study, we also hope to encourage sectoral communication and strengthen relations between organizations in the sector and IDB Invest.

The goal is to help the manufacturing industry in Latin America evolve and reach a level of competitiveness commensurate with the relevance of the region.

4.2 Recommendations for Digital Transformation

Digital Transformation is experienced in a particular way in each organization depending on its specific needs. However, some relevant aspects for the success of this process that are cross-sectional for the subsectors of the region are identified.

This line, the following stand out:

- Setting a cross-sectional vision and plan for Digital Transformation for all areas in the organization.
- Having inspiring leaders who promote a culture of Digital Transformation.
- Promoting talent and delivering digital skills to profiles that know the business.
- Making traditional project evaluation models more flexible by incorporating multivariate analysis to value digital initiatives.
- Generating instances to test new ideas from trial-and-error implementations.
- Collaborating with the market ecosystem and understanding what startups and disruptive players in the industry are doing.
- Incorporating industry benchmarks and using cases in Digital Transformation decision-making.

Setting a cross-sectional vision and plan for Digital Transformation for all areas of the organization.

To manage Digital Transformation, it is necessary to have a clear and defined vision, establishing a plan that considers all areas of the organization. This vision must respond in a concrete way to the question “What do we want to achieve in the short, medium, and long term in terms of Digital Transformation?” Once this question is answered, it is recommended to address the stages proposed in the roadmap described above and have a plan of Digital Transformation initiatives.

The tools used to establish this type of vision are strategic planning models such as SWOT (Strengths, Weaknesses, Opportunities, and Threats), PESTLE (Political, Economic, Social, Technological, Legal and Environmental), or the industry analysis itself.

Once the cross-sectional vision and plan are set, the execution of the strategy is carried out hand in hand with the following recommendation.

Having inspiring leaders who promote a culture of Digital Transformation.

To fully carry out the cross-sectional vision and plan for Digital Transformation, leadership must be committed to the digital culture that inspires and transmits to all employees the importance of adopting this new mentality to walk the path of transformation. Without a leadership that promotes the digital culture, the organization will experience greater resistance to the paradigm shift and difficulties generated by not having a designated role to manage this transition.

It is recommended to establish a specific role to promote and implement the Digital Transformation strategy as a digital director *(Chief Digital Officer - CDO),* who combines the commercial aspect with the digital experience to strategically guide the business. A digital director must perform the following responsibilities:

- Leads the company toward the digital future.
- Detect digital technology opportunities and their application in the business.
- Educate senior management on the digital aspect, permeating thought towards other collaborators, and promoting talent.
- Promote change in the organization relying on digital solutions, testing and evaluating new technologies.

Promoting talent and delivering digital skills to profiles that know the business.

Considering the appropriate commitment from senior management, leaders must establish a continuous training process for the development of digital capabilities throughout the organization so that employees receive the required support and enhance talent in Digital Transformation, aligning them with the vision and mitigating obstacles that arise in the way of implementation.

The sector must address talent development by complementing specialized business knowledge with digital skills to face the challenges of Digital Transformation.

Making traditional project evaluation models more flexible by incorporating multivariate analysis to value digital initiatives.

Since the sector is oriented towards using traditional project evaluation models, many initiatives are discarded or postponed because they compete with productive scalability investments. This is why new approaches must be integrated to value digital initiatives that incorporate variables of qualitative benefits, opportunity cost, or the enabling of new solutions with financial impact.

There are different methodologies for evaluating projects. The most traditional is the benefit-cost analysis (ABC) method and the investment analysis method (AIF) that focus on estimating the expected returns of an innovation project based on an analysis of benefits and costs. There are other methods such as the Value Analysis of Innovation (VAI) in which more complex variables are incorporated to quantify the value-added such as the impact on the market, operational efficiency, quality, and customer satisfaction.

Additionally, spaces must be created that encourage the generation of new ideas and solutions to address business problems. Through these spaces, employees will not only be more involved in the entire transformation process, but they will also be more interested in participating and experimenting with projects and ideas that add value to the organization.

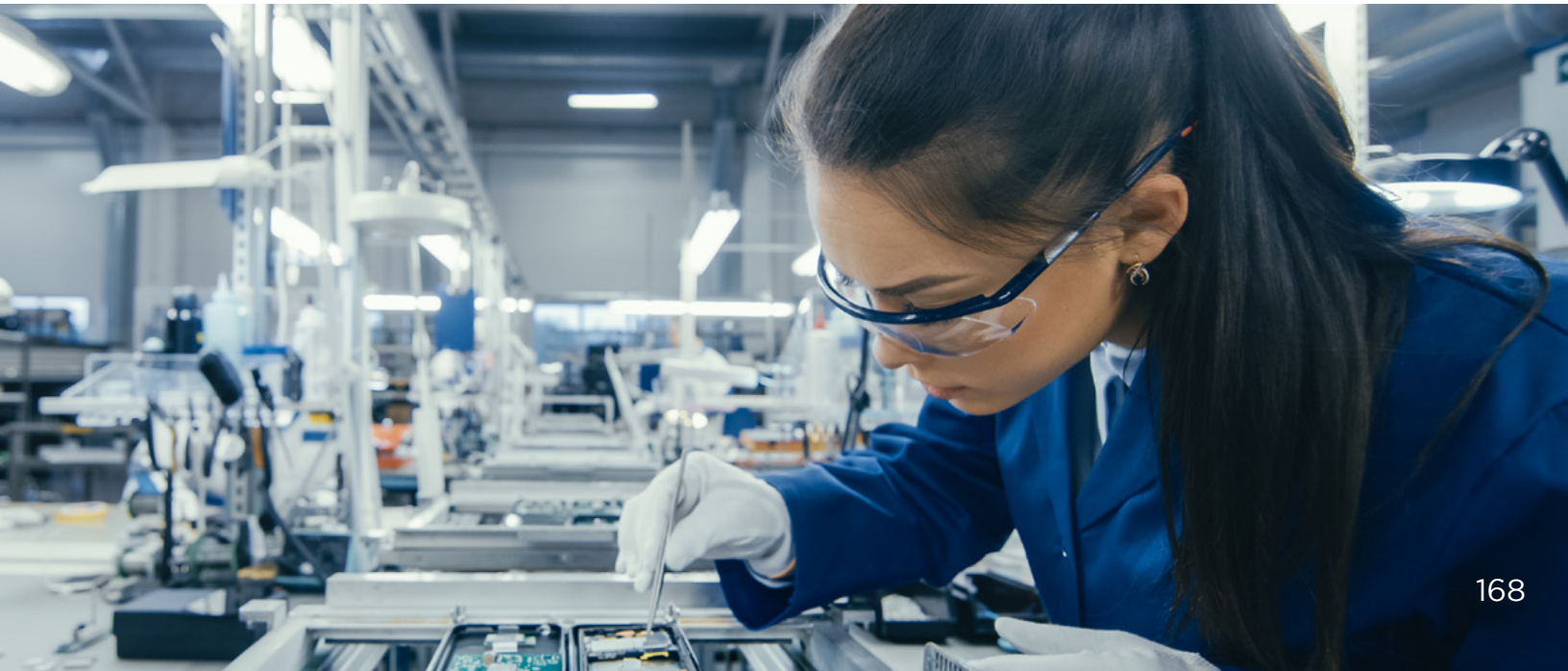
Ways to generate spaces for innovation are the following:

- Encourage forums where collaborators can contribute ideas and new digital projects.
- Promote educational games to invite employees to generate innovation, using gamification techniques.
- Round tables or focus groups by area to identify problems in the processes and propose disruptive solutions to these problems.

Generating instances to test new ideas from trial-and-error implementations

The Digital Transformation is a constantly evolving process where technology applied to the manufacturing and retail sectors advances rapidly. For this reason, experimenting by testing new ideas in controlled scenarios such as proofs of concept or minimum viable products should be a central part of organizations.

Being in constant iteration helps make visible changes that add value to organizations, minimizing risks and costs by testing and validating efficient hypotheses. This allows selecting and refining the initiatives with the greatest potential to generate real business impact.



Collaborating with the market ecosystem and understanding what startups and disruptive players in the industry are doing.

Being aware of the trends and disruptions that the competition implements is crucial to staying competitive in the market. In this way, the implementation of innovative solutions is enabled, and alliance opportunities are created with other organizations in the sector and/or other sectors to generate a collaborative ecosystem between organizations.

Large corporations generally have a slower digital implementation speed than startups, because their bureaucratic processes are longer and the risk of change and implementation is also usually higher. Forming supplier alliances where both parties can benefit allows the agility of the startup company and the established capabilities of large organizations to combine and achieve optimal system results.

In this sense, something that has been of value to organizations is the active participation in industry associations, entrepreneurship, and business incubators in which solutions are continually presented, use cases, barriers are discussed, and examples of players who have achieved specific transformations. Companies in the manufacturing sector claim to be informed of what is happening and encourage new ideas to transform.

Incorporating industry benchmarks and using cases in Digital Transformation decision-making.

An effective way to stay ahead of solutions and tools used in the market is incorporing benchmarks and use cases. This allows comparing organization's current capabilities and solutions with those available in the market, both from the same industry or from technological innovations or other adjacent industries. The goal is to improve decision-making regarding which solution is best for different processes or use cases in the organization. In addition, this gives companies the competitive advantage of being constantly updated on the state of Digital Transformation.

The tools used to perform benchmarks are diverse. When verifying performance, more detailed methods such as process/product benchmarking and financial ratios are used. Some tools can support the identification of transformation use cases and the mapping of the applicable technology. Some, like the Business Process Model and Notation (BPMN) and Lean Process are oriented towards efficiency. Others, such as Service Design, Design Thinking, and Human-Centered Design (HCD) are aimed at reducing friction between users and staff and incorporate incremental iteration as a foundation for solving more complex problems.

ATTACHMENTS

05

5.1 Limitations in data collection and analysis

For a correct interpretation of the study results, it is important to consider the limitations that may exist around the collection of data and information in an analysis of this nature.

The analysis presented is the result of the investigation based on the information obtained in the DMA and the interviews carried out with a sample of companies from the manufacturing sector and the retail trade sector in the region. A risk of bias exists in the results based on the characteristics and level of maturity of the different companies, as well as the different visions of the profiles interviewed.

Potential limitations in the study results are detailed below:

- **Participating companies:** Companies from Latin America and the Caribbean region that are part of different manufacturing subsectors (included within the scope) and the retail trade sector participated. The only requirement for companies to participate was a turnover of more than $50 million USD. Additionally, a sample of suppliers and startups from these sectors was available to obtain a complete vision of the current situation of Digital Transformation throughout the value chain. All these companies, which have participated voluntarily and free of charge, have been selected for their relevance in their respective markets and their accessibility to the study team.

- **Representativeness of the countries and subsectors:** To represent the current situation in these sectors in the region, we aimed to have the maximum possible similarity in participating companies between the countries and subsectors within the scope. However, the willingness of companies to participate in the study has varied depending on country or subsector, generating variations in the representativeness of the final sample. For this reason, the conclusions of a country or a subsector have a risk of bias due to the level of maturity and vision of the participating companies within the perimeter.

- **Company self-assessment:** The results of the study have been obtained through the self-assessment carried out by senior management profiles on the current state of their different companies. In no case has an in-depth diagnosis of the organizations been carried out by the study team. For the self-assessments, the participation of at least two profiles with a different role within the company (strategic, operational, technological, or financial) has been sought, however, the information provided by the interviewees may not reveal a holistic vision of the organization or could be a biased view.

5.2 Additional description of the variables analyzed in the DMA evaluation

To obtain an assessment of the digital maturity level of the organizations included in the study, a Digital Maturity Assessment framework was designed that focuses on the nine fundamental domains that entities must evolve in their transformation process.

One of the main challenges that entities face in their transformation processes is the joint evolution of each of these domains. For this reason, both the questionnaires and the interviews carried out an exhaustive analysis.

The domains evaluated are listed below:

1. Strategy and business model
2. Sustainability and renewable energies
3. Processes and operations
4. Governance
5. Systems and technology
6. New businesses and digital products
7. Organization
8. Big Data & Analytics
9. Innovation

These nine domains are divided into subdomains, to obtain a more detailed assessment. This subdivision enables three important analyses related to (1) the identification of the critical points of improvement at the digital level, (2) a diagnosis focused on the level of progress of the digitization of the processes of the value chain, and (3) the level adoption of new technologies. This assessment provides an objective picture of the digital maturity of companies, by giving an interrelated view of the domains that allow company leaders to make better decisions when driving Digital Transformation.

1. Strategy and Business Model.

The purpose of this first category is to identify if there is a strategy based on transformational trends that incorporates digital challenges at the level of organizational definitions, strategic objectives, and financial investment/budget. To provide detail about the domain, the following subdomains were considered:

- **Strategy and Digital Transformation:** The level at which the strategy is supported by digital and transformational technologies and incorporates digital challenges at the level of organizational definitions.

- **Business Model Industry:** The level at which the value proposition is aligned to the Digital Transformation and integrates technology as an attribute of the strategy.

In this sense, an organization with maturity in this category prioritizes digital objectives and goals, allocates a significant budget portion for Digital Transformation, senior management promotes the use of digital assets in the organizational culture, and digital assets generate unique services that the customer values. Likewise, they implement agile and methodological approaches to distribute the digital strategy throughout the entire company, in addition to seeking a differential experience for the client that incorporates digital solutions in products and services acquired.

2. Sustainability and Renewable Energies.

This second domain aims to identify the classification and evaluation of the integration of sustainability in the internal operations and image of the organizations. Companies seek to align sustainability and the use of renewable energies with the Digital Transformation strategy, relying on tools and models that facilitate this incorporation. The subdomains used to evaluate this category are the following:

- **Sustainable practices:** Level of knowledge of the concept of sustainability and degree of orientation of the organization towards sustainability objectives based on circular economy and measurement of emissions through digital tools..

- **Renewable energies:** Level of use of clean energy and application of digital tools to optimize energy consumption.

It has been identified that an organization that successfully incorporates sustainability seeks to reduce its resources through a circular economy model, by having software and a team dedicated to efficiently reducing and measuring environmental impact metrics. Also, the use of renewable energy in its operation is necessary to advance more ambitious goals such as action plans to become a carbon-neutral company.

The most advanced organizations in this domain have a digital ecosystem capable of accurately measuring the impact generated internally and in their value chain, thus executing positive compensation strategies for the impact generated. Likewise, sustainable maturity goes hand in hand with the organization's strategy and business model. However, to achieve a carbon-neutral operation, organizations are fostering collaboration between companies that share the same vision to increase their green practices and seek to eliminate their use of non-renewable energy.

3. Processes and Operation.

This domain is relevant for the digital maturity of the sector, where it is intended to identify the processes, key activities, and optimization plans leveraged on tools, technologies, and/or digital assets. It is the category with the largest number of subdomains. This segmentation served to deepen and expand the detail in the specific analyzes of digital processes and operations. The subdomains are the following:

- **Planning:** Level of digital leverage and automation of the organization's planning processes.
- **Replenishment:** Level of optimization of replenishment processes from the application of automation, traceability, and monitoring technologies.
- **Production:** Level of automation and incorporation of technologies for the production processes themselves and the digitization of quality management activities.
- **Marketing and distribution:** Optimization level and incorporation of digital capabilities for sales order management and distribution logistics monitoring.
- **Support processes:** Level of efficiency and automation of support processes associated with performance management and transactional back-office that execute accounting, billing, payment, and financial reporting tasks.

This subclassification identifies common guidelines that many organizations in the industry pursue, such as (1) the integration of production processes in digital control platforms, (2) quality management through Six Sigma tools, and (3) the use of ERP systems that integrate back-office tasks of the main links in the value chain (administration, replenishment, production, storage, logistics, etc.).

By way of illustration, and as identified throughout the study, other relevant aspects that allowed us to identify this classification by subdomains are (1) the use of autonomous robots in production lines, (2) the implementation of IoT switches to quality control, (3) the expansion of replenishment platforms in the cloud with real-time data or (4) the amplification of systems to generate the capacity to connect with supplier platforms, speeding up the company's replenishment.

4. Governance.

With the incorporation of this domain, the aim is to identify the management and support processes within a defined, known, and clear governance with the details of roles, responsibilities, activities, and relationships. Additionally, evaluate if the decision-making process about the company is supported by digital attributes such as reports and data. The segmentation of this category is as follows:

- **Governance:** Level of transformation management processes, response to changes, value generation process through clarity in decisions supported by data, and the existence of a structure for the deployment and transformation of digital processes.

- **Development, industrialization, and deployment:** The level at which the company generates use cases and safeguards the knowledge so that it can be used by everyone.

In this category, it was determined that digital maturity is achieved thanks to the government strategy and Digital Transformation objectives are defined jointly with the Digital Officer profile. Similarly, advanced companies in this domain have integrated predictive digital tools with a key metrics dashboard that is visible in real-time, promoting digital adoption by using digital platforms.

5. Systems and technology.

The technological and systems capacity seeks to assess the level of implementation and integration of technological assets, digital architecture, and cybersecurity protocols. Digital technology applied to the manufacturing sector has a wide range of applications and uses throughout the value chain.
The options on the market range from basic solutions such as MES and ERP systems to more complex solutions such as Digital Twins or inventory management with RFID. To learn more about the type and level of solutions used by organizations in the sector, it was divided into the following subsectors:

- **Transactional systems architecture:** The degree to which the organization has integrated systems in its operation that support the digitization of processes.
- **Digital platforms:** Level of digital platforms in the organization and ability to enable online processes and accessibility of different devices.
- **Security and cybersecurity:** An organization's level of management of threats and cybersecurity controls.
- **Use of Technologies:** Application of disruptive technologies in the organization and specific focus of the implementations carried out by the company.

Organizations that have achieved greater maturity in this area have all or most of their platforms in the cloud, with different levels of authorization and are friendly with multiple devices, in addition, all systems are integrated which facilitates its automation and digitization. In terms of cybersecurity, pioneering companies have a network that extends to all devices that aims to integrate all operations and value chain systems.

6. New Businesses and Digital Products.

Through this domain, the level of incorporation of digital components in the organization's products and/or services is evaluated, the way they offer attractive shopping experiences and services for customers, what level of digitization they integrate into their channels and the maturity of new digital payment modalities. The following items were considered:

- **New products and services:** Level of incorporation of digital components in the company's products and/or services and the degree of customization of these.
- **Channels:** Level of use of the digital channel in the commercialization of products/services and the use of potential channels for the commercialization of products/services (Networks, social networks, Apps, digital B2B, etc.).
- **Payment methods:** Level of payment methods available in the company's digital channels and the degree of personalization of these.

According to these subdomains, a company is considered mature in this area when it has integrated omnichannel logic into its value chain, new digital marketing models, implements digital components in most of its products and services, and incorporates multiple payment methods such as payment apps and digital wallets.

7. Organization.

In this domain, technological adoption and the digital culture of the organization are evaluated. The ability to promote digitization from the management layer, the incorporation of training actions in digital skills, the use of systems in the management of human resources, and the level of attraction and retention of specialized profiles are considered to assess whether companies can support an agile and digital operation. All the above is evaluated through the following subdomains:

- **Personnel & Culture:** Level of internalization and digital culture shared by the members of the organization, promotion of digitization from management, and implementation of training actions in digital skills.
- **Mindset:** Use of agile and systems-based methodologies for project management..
- **Structure, talent, and capacity:** Use of profiles associated with Digital Transformation and their level of maturity.

A company with high digital maturity in this domain has management that is aware of the importance of Digital Transformation, therefore, it prioritizes and operates under agile work systems, actively promotes training actions linked to digital skills, and its roles lead reinvention of the organization focused on creating value for the market and society.

8. Big Data & Analytics.

This domain evaluates the information capture capacities, data storage efficiency, and processing capacity to generate value perspectives in decision-making from the application of analytical models. Following the same line as the previous domains, this one is evaluated with the following:

- **Big Data:** Level of information capture, storage efficiency, and management of master data to standardize information sources for its extraction and analytical processing.

- **Analytics:** Data processing capacity, application of analytical models to identify behavior patterns and generate predictions for business decision-making.

It was determined that the companies with the greatest digital maturity in this domain apply predictive analytics models in conjunction with machine learning to report based on forecasts. In addition, they have *data-warehouses* or *data-lakes* that centralize enriched information through AI. They are also using IoT-enabled switches in the value chain and incorporating a dedicated master data onboarding team.

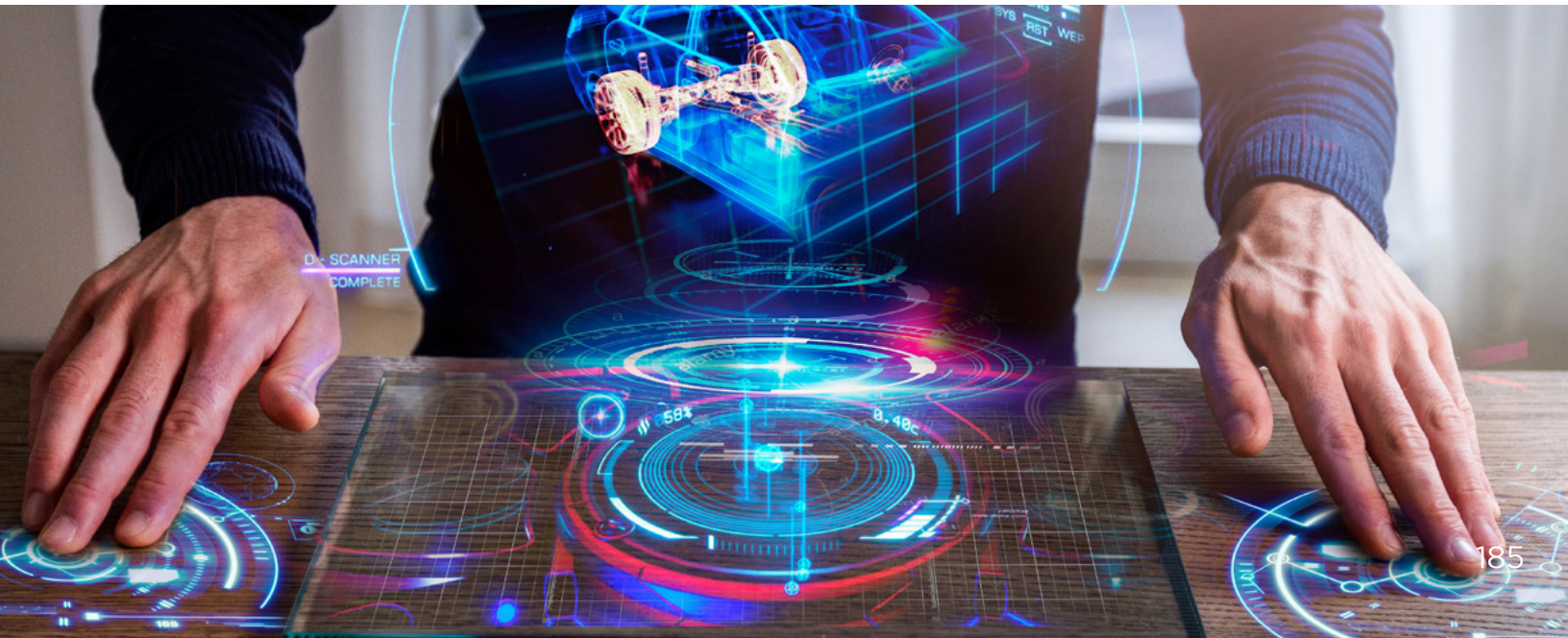
9. Innovation.

Finally, this domain evaluates the capacity of organizations to carry out and manage innovation in line with their strategic and digital objectives. It is specifically measured considering the following subdomains:

- **Innovation management:** Level of formality and cross-sectional design of innovation processes supported by methodologies, instances, and practices to promote and manage innovation.

- **Digital tools in innovation:** Digital capabilities are applied to support the processes and instances of innovation that are used in the organization.

The most up-to-date organizations in this domain stand out because they have an innovation program with roles dedicated to management, manage innovation stages on a cloud platform, evaluate business results, and allocate an annual budget to the program with processes, standardized methodologies, and techniques.



5.3 Detailed explanation of the country prioritization process

To obtain representative results of the current situation of the Digital Transformation of the Manufacturing and Retail Trade sectors in Latin America and the Caribbean, a prioritization analysis was carried out to select the countries and subsectors with the greatest relevance for the economy of the region. Official data from the reference sources of the World Bank and the United Nations Industrial Development Organization (UNIDO) were considered, with contributions from the IDB's Manufacturing and Retail Trade unit.

PRIORITIZATION OF COUNTRIES

Factors were considered that evaluate the relevance, the potential of the sectors in each of the countries analyzed and their contribution to the value-added of the industry in the region. These factors include the economic impact of the sector in the country and the region, the size of the labor force, the level of the industrial competitiveness of the country, the level of investment of the country in its infrastructure, and technological and innovation capabilities.

The evaluation of each of these factors is detailed as follows:

Economic impact: Contribution of the manufacturing sector to the economic development of the country. Consider the following variables:

- **Manufacturing Value-added (VAM):** Value of gross production by producers minus the value of intermediate goods and services that are consumed in production before accounting for the consumption of fixed capital in production.

$$VAM_{Manufacture} = Value_{Gross\ Production} - \sum Value_{Intermediate\ goods}$$

- **VAM contribution to total GDP:** Percentage of Manufacturing Value-added with respect to the total value of the country's Gross Domestic Product (GDP).

$$Contribution\ of\ VAM_{Manufacture} = \frac{VAM_{Manufacture}}{GDP_{Country}}$$

- **Industrial Production Index (IPI):** Monthly evolution of manufacturing productive activity in the country. It reflects the joint evolution of quantity and quality, eliminating the influence of prices. Data source: The Global Economy, 2022.

Each variable was evaluated at a low, medium, or high level and a score from 1 to 3 (respectively) based on ranges defined in the following table:

	VAM Manufacturing (billions of dollars)	VAM Contribution Manufacturing (%)	IPI	Score
High	Over 50	Over 15%	Over 3	3 points
Medium	Between 20 and 50	Between 9% and 15%	Between 1 and 3	2 points
Low	Under 20	Under 9%	Under 3	1 points

Labor force: The total number of employees in the manufacturing sector in the country.

	Employees (millions)	Score
High	Over 2	3 points
Medium	Between 0,5 and 2	2 points
Low	Under 2	1 point

Competitiveness level: Competitive Industrial Performance Index (CIP) data provided by UNIDO. This index measures the ability of countries to produce and export manufactures competitively.

	CIP	Score
High	Over 0.05	3 points
Medium	Between 0.02 and 0.05	2 points
Low	Under 0.02	1 point

Infrastructure: Total value of the country's capital investment in infrastructure as a percentage of total GDP.

$$Investment\ in\ Infrastructure = \frac{Capital\ Investment_{Infrastructure\ Country}}{GDP_{Country}}$$

	Investment in Infrastructure (% of GDP)	Score
High	Over 20%	3 points
Medium	Between 15 and 20%	2 points
Low	Under 15%	1 point

Technology and Innovation: Technological and innovation capacities in the country. Depending on the following variables:

- **Innovation:** Global Innovation Index provided by the World Intellectual Property Organization (WIPO). It encompasses the country's investment in Science and Innovation, technological progress, technology adoption, and socioeconomic impact.

- **VAM of medium and high technology:** Value-added of medium and high technology in manufacturing as a percentage of total VAM.

$$VAM_{Medium\ and\ High\ Technology,Manufacture} = \frac{VAM_{Medium\ and\ high\ technology,Country}}{VAM_{Manufacture,\ \ Country}}$$

- **Expenditure on Research and Development (R&D):** Capital investment in Research and Development actions in the country as a percentage of total GDP.

$$Expenditure\ in\ I + D = \frac{Capital\ Investment_{I+d,Country}}{GDP_{Country}}$$

Each variable was evaluated at a Low, Medium, or High level and a score from 1 to 3 (respectively) based on the ranges defined in the following table:

	IMI	VAM Contribution Medium and high technology (% VAM total)	Expenditure on R&D (% of GDP)	Puntuación
High	Over 30	Over 30	Over 0.3%	3 points
Medium	Between 25 and 30	Between 20% and 30%	Between 0.2% and 0.3%	2 points
Low	Under 25	Under 20%	Under 0.2%	1 point

Once all the factors were evaluated for each of the countries, they were prioritized according to the following weighting model:

	Economic impact	Labor Force	Competitiveness	Infrastructure	Technology and Innovation
Weight	40%	20%	12.50%	12.50%	15%

Finally, the countries that obtained an average rating higher than 1.5 points were selected within the scope of the study. These countries are: Mexico, Brazil, Chile, Argentina, Colombia, Peru, and Ecuador.

Table 2: Prioritization of countries.

	ECONOMIC IMPACT			LABOR FORCE	COMPETITIVENESS	INFRASTRUCTURE	TECHNOLOGY AND INNOVATION				
	VAM (trillions $)	VAM (% of GDP)	IPI	Manufacturing employees (Millions)	CIP	Capital Investment (% of GDP)	IMI	VAM medium and high technology (%total VAM)	Expenditure on Innovation (% of GDP)	Score	Pos.
Mexico	185.56	17.28	2.95	3.93	0.15	19.31	34.5	46	0.31	2.8	1
Brazil	141.15	9.77	-0.5	6.59	0.07	15.4	34.2	34	1.16	2.7	2
Chile	25.12	9.93	-3.05	0.45	0.06	19.82	35.1	20	0.36	2.2	3
Argentina	59.83	15.37	4.69		0.04	14.02	29.8	25	0.49	2.2	4
Colombia	29.9	11.02	9.1	0.65	0.03	19.01	31.7	24	0.23	2.1	5
Perú	24.65	12.2	0.97	0.63	0.03	17.82	31.2	15	0.13	1.9	6
Ecuador	15.38	15.57	-	0.3	0.02	23.12	25.4	15		1.6	7
Paraguay	6.59	18.48	-	-	0.02	20.16	26.4	22	0.15	1.4	8
Panamá	3.12	5.78	10.41	0.05	0.01	24.06	28	6	0.15	1.4	9
Uruguay	5.52	10.3	3.9	-	0.02	17	32.2	18	0.42	1.4	10
El Salvador	3.67	14.89	2.27		0.02	17.91	25	19	0.16	1.3	11

NOTE: Some of the smaller countries in the Latin American and Caribbean region were excluded from the prioritization analysis due to the volume of their industry and the lack of data from official public sources.

PRIORITIZATION OF SUBSECTORS

For the prioritization analysis of the different subsectors of the manufacturing industry, their manufacturing value-added data and their relevance in the region was considered according to their contribution to the total VAM of these countries.

Their prioritization model is detailed below:

- **Manufacturing value-added (by subsector):** Value of gross production of producers in the subsector minus the value of intermediate goods and services consumed in production before accounting for the consumption of fixed capital in production.

$$VAM_{Subsector} = Value_{Gross\ Production,Subsector} - \sum Value_{Intermediate\ Goods,Subsector}$$

- **Contribution of the VAM of the subsector to the VAM of the prioritized countries:** Percentage of manufacturing value-added in the subsector with respect to the total value of the VAM of all the subsectors in the prioritized countries.

$$Contribution\ of\ VAM_{Subsector} = \frac{VAM_{Subsector}}{GDP_{Country}}$$

Once the data was analyzed, a combination of manufacturing subsectors was selected that represents 83.7% of the total VAM of the region:

Table 3: Prioritization of subsectors.

	MEXICO	BRAZIL	ARGENTINA	COLOMBIA	PERU	TOTAL	VAM (%)
Chemicals and chemical products	$11.0	$24.4	$7.8	$4.3	$1.6	$49.2	18.8%
Moto vehicles, trailers and semi-trailers	$37.3	$11.5	$2.6	$0.5	$0.2	$52.2	18.4%
Basic metals	$7.6	$9.8	$3.4	$0.9	$1.6	$23.3	8.4%
Machinery and equipment not classified elsewhere	$3.8	$11.4	$2.8	$0.4	$0.6	$19.1	7.2%
Fabricated metal products	$5.0	$6.5	$2.5	$0.6	$1.3	$15.8	6.5%
Rubber and plastic products	$5.3	$6.3	$2.8	$1.2	$0.9	$16.4	6.4%
Other non-metallic mineral products	$5.3	$5.0	$2.7	$1.6	$1.7	$16.4	6.2%
Paper and paper products	$3.1	$6.6	$1.9	$1.1	$0.8	$13.5	5.6%
Electrical machinery and appliances	$4.4	$4.6	$0.8	$0.5	$0.3	$10.6	3.9%
Textile	$1.3	$2.8	$1.0	$0.5	$0.6	$6.3	2.3%
Retail commerce	$1,180	$3,490	$567	$323	$253	$5,813	-

Source: Own elaboration from UNIDO (United Nations Industrial Development Organization) database extracted on June 16, 2022.

NOTE: Some of the smallest countries in the Latin American and Caribbean region were discarded from the prioritization analysis due to the volume of their industry and the lack of data from official public sources.

5.4 Description of the activities of the manufacturing value chain

The value chain is defined as the full range of activities necessary to create a product or service. For companies that produce goods, this chain includes the steps that take a product from its conception to delivery to the final customer.

Each of these stages - design and development, replenishment, production, warehousing and logistics, and sales - are commonly known as links in the value chain. Depending on the manufactured product, the sequence of the value chain may vary, however, all manufacturing value chains begin with design and/or development and end with the final distribution.

The value chains in the manufacturing sector are made up of five links, with an additional link in some subsectors: Design and Development, Replenishment, Production, Warehousing and Logistics, Sales and Customer Service, and the additional Generation of Circular Economy. Each link is made up of different activities depending on the type of product and the processes that it entails.

Design and development.

As previously mentioned, this is the initial link in the value chain in the manufacturing sector. It begins with the outline of the product idea, where you define what you want to do. The research and development stage continues where the requirements and attributes of the product are identified, the market analysis is carried out and the materials and technologies are investigated to make manufacturing viable. Next the design stage, where the idea is landed concretely through the generation of plans and selection of materials, to end with physical tests, prototyping, and initial quality control.

Replenishment.

The next link in the value chain varies depending on the nature of the product and the organization. In general, it involves the purchasing department, which must comply with supplier management; execution of the purchase and in conjunction with the area in charge of quality control of raw materials and supplies, evaluate the supplier and the purchased input; then, generate a constant replenishment plan and coordinate inputs and outputs with the raw material warehouse. This link plays a critical role in manufacturing processes since the lack of raw materials can trigger a complete stoppage of production.

It should be noted that this is not done in the entire sector, for example, in the manufacture of cement, most organizations extract raw materials for their production.

Production.

The production link is the center of the manufacturing chain, it refers to the selection and use of materials, equipment, and processes necessary for manufacturing. This link can include the manufacture of materials, components, the finished product, and/or the manufacture of services that satisfy the needs of the market.

Likewise, this link is responsible for guaranteeing high quality and compliance with the standards established by the organization, both in manufacturing processes and in finished products.

Storage and logistics.

The fourth link in the value chain involves all activities related to the receipt, storage, distribution, and delivery of materials, finished products, and inventory management. These activities are aimed at improving the flow of materials and products in the company, minimizing time and movements, and ensuring that products are produced and delivered on time and in the correct manner. The warehousing and logistics link also helps ensure that storage and transportation costs are kept low for the company.

Sales and customer service.

The sales and customer service process are responsible for managing dealings with end customers. On the sales side, it runs the entire flow from lead generation and lead management, to closing and awaiting delivery, following up on product delivery, and trying to drive repurchases. In the customer service part, it refers to the after-sales service, such as guarantees, repairs, returns, and refunds. This link has a direct impact on the generation and prediction of the demand for the organizations' products.

Generation of Circular Economy.

Lastly, the process of generating a circular economy, with a strategic and sustainable approach, seeks to manufacture products by maximizing the use of resources, reducing waste, and increasing the reuse of materials. This type of production model has gained greater weight in the region, thanks to the change in regulations in some countries over the last decade, which has prompted organizations to adopt the circular economy, in addition, customers increasingly value companies that have implemented this model. These two points imply that many of the entities focus on the digitization and automation of processes, to improve the efficiency and effectiveness of their operations and maximize the value generated by the circular economy.

Description of priority value chains

The study prioritized the value chains of some of the sector's products, considering their importance and weight in the industry and the region.

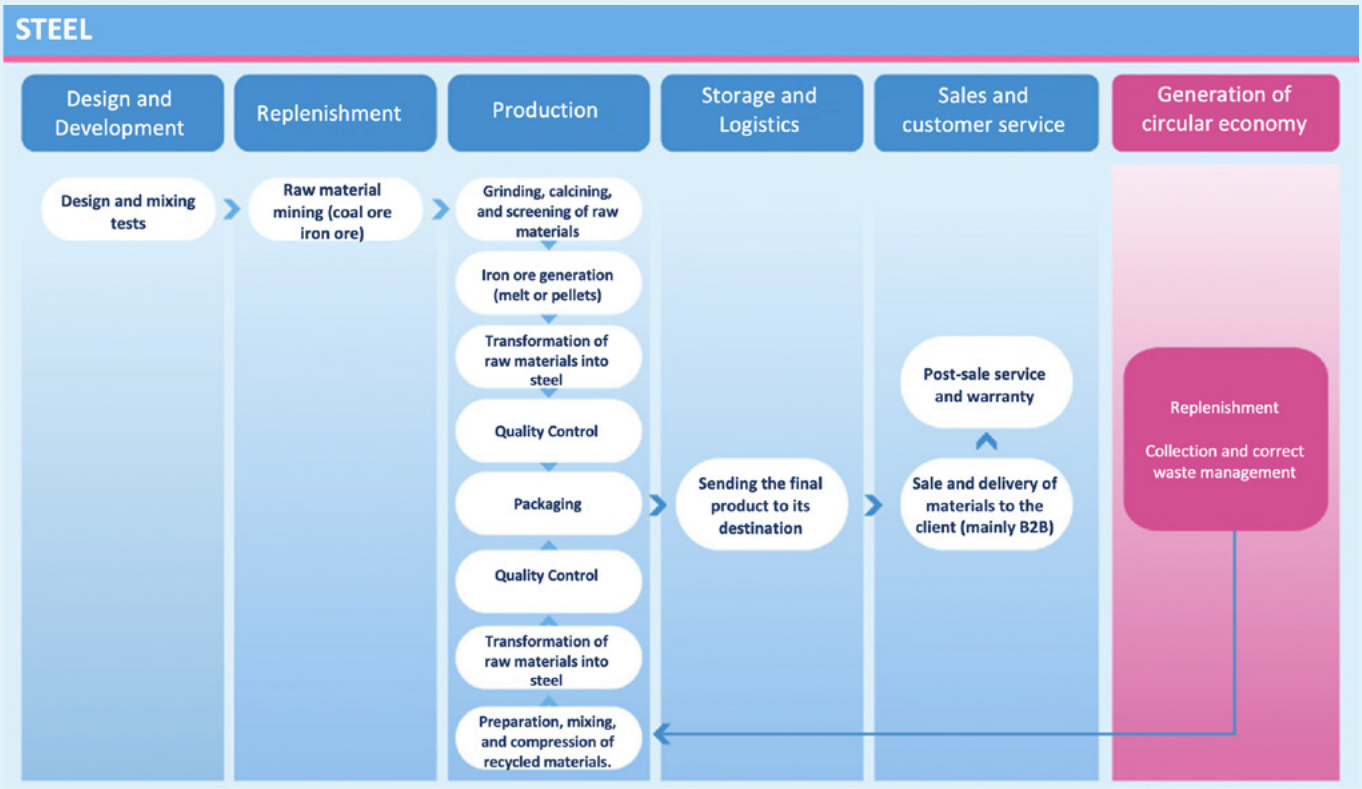
Steels.

This value chain begins in a similar way to the previous one, once the formulation of the mix is established, the extraction of minerals such as iron, limestone, and coke begins. These elements are mixed and subjected to high temperatures to produce steel. In some cases, the mixture becomes somewhat of a molten hammer or steel granules, which are later poured into molds to shape semi-finished products such as beams, plates, and tubes through casting. Some organizations with these semi-finished products pass them through several stages of lamination to obtain detailed structural and decorative products.

The final process involves heat treatments, such as hardening, to increase the strength of the steel, and surface finishes to improve its appearance. Finally, with the order generated, the product is sent to the final destination, the sale is closed and delivered to the customer.

The generation of a circular economy in this value chain occurs with the disposal and collection of waste itself. By separating the usable from the non-usable, usable waste is used through a new process to generate new steel parts, which minimizes the need to extract minerals from the ground to manufacture these products and promotes the correct disposal of waste by part of the companies.

Figure 20: Business Model of the Steel

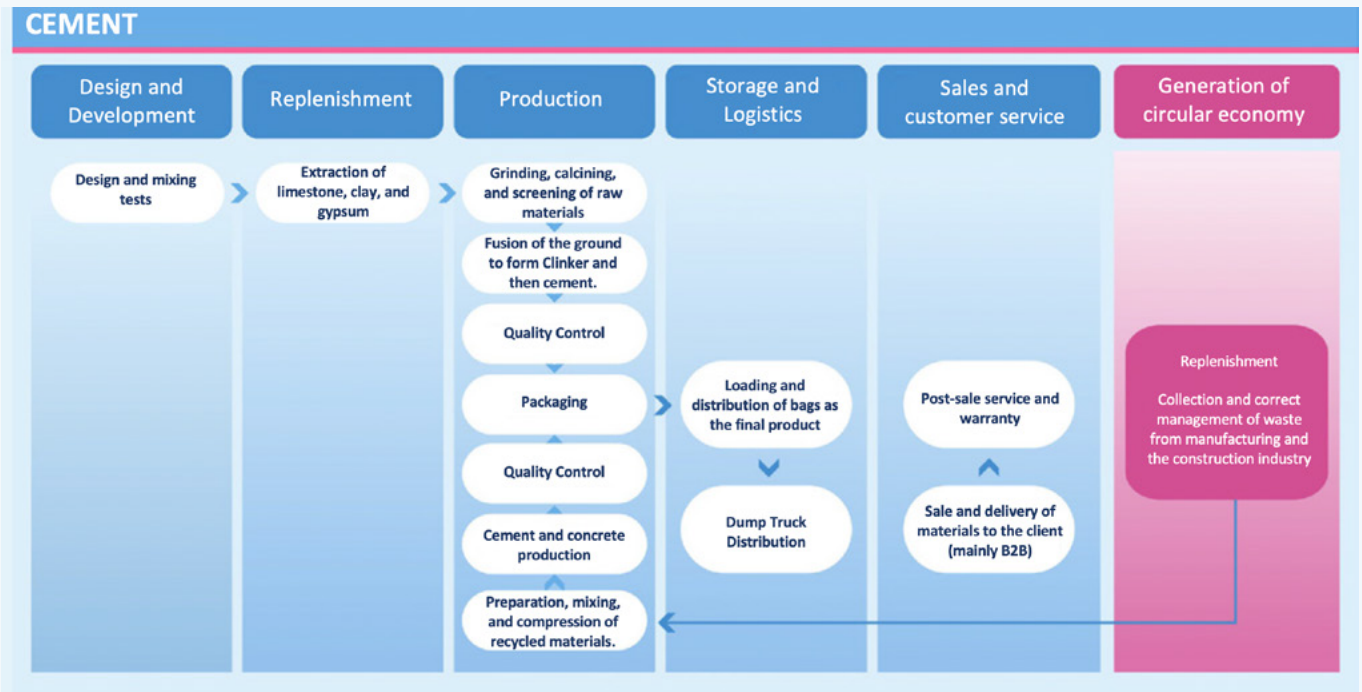


Cement.

The cement industry in LAC is highly relevant since it is produced regionally and supplies the local market with very little dependence on imports. Cement production requires a complex and robust supply chain. This chain begins with the extraction of raw materials such as limestone, clay, gypsum, and other minerals. These resources are then transported to a cement manufacturing plant where they undergo a combination of thermal, mechanical, and chemical processes. The materials are then mixed to create Clinker, which is ground to produce the fine powder known as cement. The final product is then transported to destination locations for use in construction.

The generation of a circular economy in the cement business model begins with the disposal and collection of waste itself. Usable waste from the manufacturing process will be separated and those from the construction industry will be collected for processing and generating cement and concrete. Similar to the steel business model, this minimizes the need to extract minerals from the ground to make more products and promotes proper waste disposal by companies.

Figure 21: Business Model of cement.



Paper and paper products.

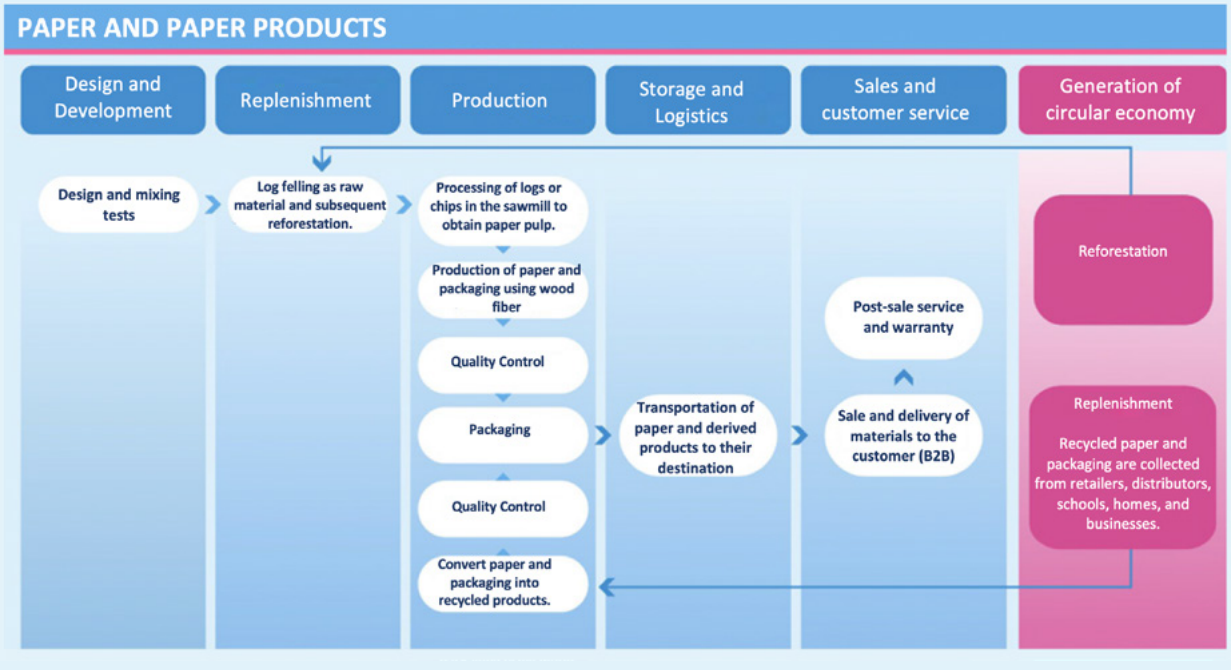
The paper business model and the production of paper products begins with the felling of logs to use as raw material to form wood pulp or paper pulp. It is worth noting the place that reforestation has in this value chain.

Companies apply this practice to limit the exploitation of natural resources. Paper cellulose pulp is obtained from the processing of logs that are subjected to a grinding process to separate individual fibers.

The paste is then mixed with water to form a paper mass, which is passed through a press to extract excess water. Once this is done, the resulting waterless pulp is used to produce various types of paper, such as printing, packaging, and toilet paper. Once the product has been completed, and the order has been placed, it is shipped to the final destination for sale and delivery to the customer.

The generation of circular economy in this business model occurs with the refo-restation by the organizations, for its subsequent replenishment, and with the collection of paper and packaging of its derivatives, which have been recycled, to be reused in the process of new products.

Figure 22: Business model for paper and paper products.



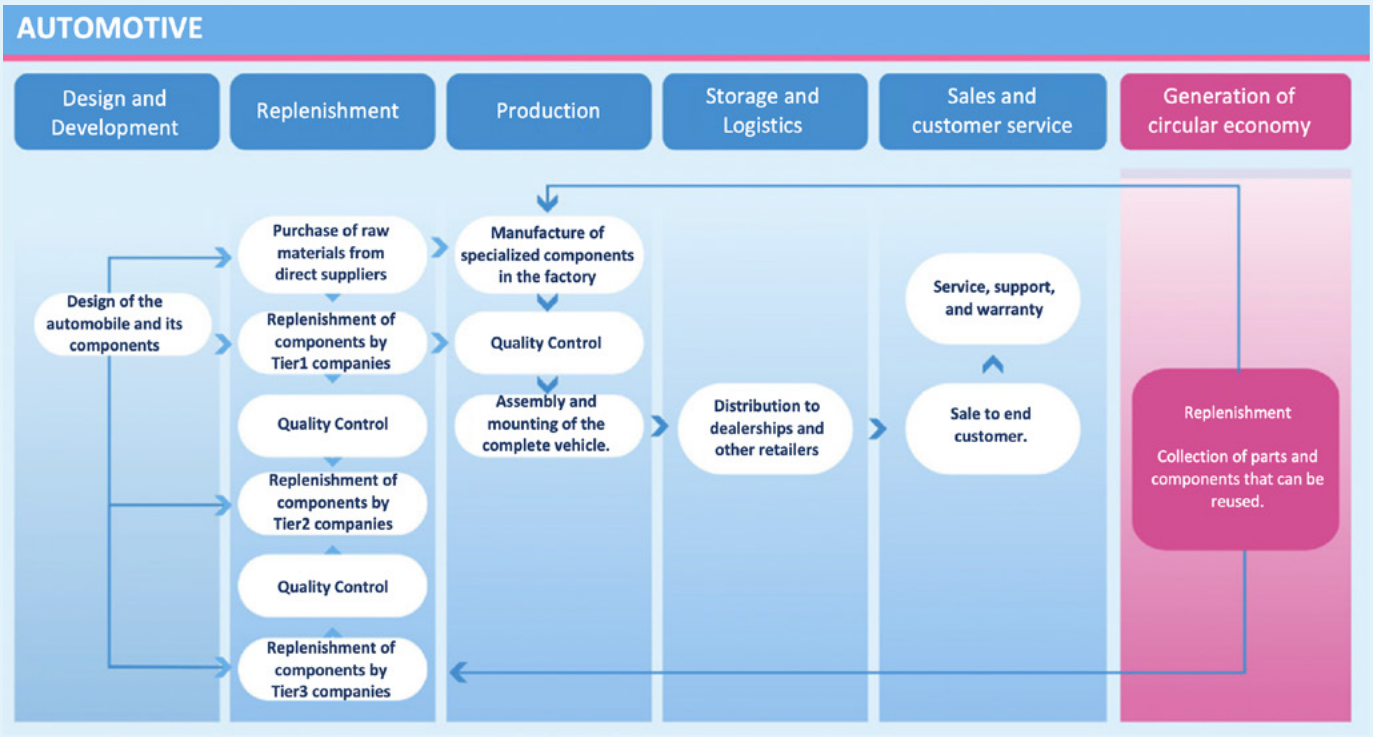
Automotive

The automotive business model is made up of a complex supply chain, involving various participants who manufacture some components in geographies other than the LAC region. The first step of the model is the design. This can be done in-house or through external contractors. Once the vehicle has been designed, companies turn to the supply chain to source specific components, through Tier 1 companies. The assembly and assembly of some complete vehicles are carried out in conjunction with the replenishment of top-level companies and some manufacturers that produce individual elements of the car. Once the vehicles are ready for sale, they must be distributed to dealerships and other retailers.

They are responsible for promoting, negotiating prices, and delivering the vehicles to end buyers. This value chain ends with service and support, including vehicle maintenance and repair, as well as offering warranties and other forms of protection for buyers. This can be provided directly through dealerships or specialized service centers.

The generation of circular economy in this subsector is achieved through the recovery of materials such as plastic, metal, and glass to be reused in the manufacture of new vehicles and/or through the recovery and use of used components, such as engines, parts of bodywork, tires, etc.

Figure 23: Business Model Automotive.



5.5 Specificities of countries and subsectors

In the Latin American and Caribbean regions, the level of digital maturity of manufacturing and retail companies varies greatly depending on the country, subsector, or type of company. During the interview process and analysis of the results of the DMA, some particularities of some countries and subsectors were identified that are not general for the entire region. These particularities are mentioned below:

COUNTRIES

Mexico.

- The manufacturing subsectors that are within the scope of the study and that have greater relevance in the manufacturing GDP are: motor vehicles, chemicals, machinery, and metals. Of these industries, the most digitally advanced are automotive and chemicals.

- Due to Mexico's geographical position, its free trade agreements, the high competitiveness of its industry, the availability of qualified labor, the size of its local market, and the availability of digital talent (it is the first country in the region in STEM profiles) there is a high presence of international company plants in some sectors. The presence of this type of company, which imports best practices from more digitally advanced regions, such as the United States or Europe, raises the level of competition and demand in the market, forcing local companies to evolve digitally to maintain competitiveness.

- One of the most relevant barriers to digital adoption in Mexico is the low cost of labor, which in many cases makes it difficult to justify the financial investment in some automation initiatives.

Brazil.

- Within the scope of the study, the most competitive industries in Brazil are the pulp and paper industry and the steel industry. In terms of technological progress, the most prominent are: plastics, machinery, and chemicals.

- One of the main challenges that have been identified for the implementation of new technologies in the Brazilian manufacturing sector is the lack of knowledge of leaders on the benefits and implications of Digital Transformation.

- In Brazil, as in some subsectors in Mexico, most of the companies are family-owned and have not generated a digital culture at the corporate level, which is slowing down the adoption of digital initiatives

- Despite the high relevance of the Brazilian industry in the LAC region, digital initiatives have hardly been implemented beyond the automation and sensorization of some plants. Some of the barriers identified are low availability of qualified personnel, the absence of a solid telecommunications infrastructure, and the lack of collaboration between different agents in the value chain.

Chile.

- After the food, beverage, and tobacco industries, which are outside the scope of this study, the manufacturing industries in Chile that make the greatest contribution to GDP are metal products, machinery, and chemicals, which in turn are the digitally more competitive industries within the intermediate level identified in the country.

- The high level of sustainability in Chile stands out as the first country thanks to government initiatives within the 2030 agenda and its regulatory framework. In this sense, all manufacturing subsectors are developing circular economy initiatives.

Colombia.

- The main area of opportunity is innovation. Compared to other countries in the region, the country lags in public policies that promote R&D among manufacturing organizations and SMEs, so Production systems have little value-added.

- Resistance to change is identified by employees within the organizations. The lack of digital culture and the belief that automation and digitization projects will eliminate jobs are a barrier to the deployment of this type of initiative, affecting the competitiveness and productivity of the industry in the country.

Argentina.

- The main manufacturing industries in Argentina are the automotive, chemical, and metallurgical industries, which are the industries betting the most on innovation.

- An important gap identified is the Digital Transformation plans of the organizations and the reality of their plants. Although Argentine companies see Digital Transformation as a key pillar for their industrial development and claim to have short-term transformation plans, the deployment of initiatives that involve cutting-edge technologies is also in a very early phase.

Peru.

- The most relevant manufacturing industries are the textile and clothing industry, the wood and paper industry, and the metal-mechanic industry of which, the metals industry is the most digitally advanced. In general, Peru has been identified as a follower country where digital initiatives are normally implemented once they have proven successful in other countries.

- The commitment of Peruvian companies to initiatives that include Internet of Things (IoT) solutions stands out as a complement to the initiatives that are being deployed for automation and cloud solutions.

SUBSECTORS

Motor vehicles:

- The auto sector is one of the most digitally advanced in the region. Automotive companies are integrating cutting-edge technologies both in Production lines and in the cars themselves, providing them with digital services to promote maintenance activities and improve the user experience.

- On the contrary, in the railway carriage sector, the level of adoption of new technologies is practically nil. At the operational level, a high level of craftsmanship is identified in the production processes and the presence of basic management systems. Several industry leaders mention they are unaware of the applications and benefits that a Digital Transformation of their operation can offer, due to the characteristics of their market and the low cost of labor, they do not view it necessary to invest in these types of solutions to improve their operational efficiency. Where they do see an important challenge in improving traceability throughout the production process, from the origin of their raw materials to the delivery of the finished product, since in the event of a railway accident it is necessary to review the end-to-end process to identify root causes and corresponding responsibilities.

Metals and metal products:

- In the industry for the manufacture of metallic materials for infrastructures, the low level of implementation of automation and digitization that currently exists in the plants stands out. Due to the characteristics of the products, which do not require high precision in cutting and welding activities, production lines do not require sophisticated technologies to improve product quality. On the other hand, the organizations mention that the high investments in automation are rarely justified, since having cheap labor, the payback is very long and the initiative ends up deprioritizing

Chemicals and chemical products:

- The chemical industry, due to the characteristics of its products and production flows, is intensive in capital, research, and development activities. Industry organizations are constantly researching and experimenting to improve the properties of their intermediate goods (which are also used in other industries) and their finished products, as well as streamlining procedures involving precision of variables such as temperature, pressure, or humidity, among others. These factors are making Digital Transformation a fundamental pillar among industry organizations to speed up processes and achieve greater operational efficiency through sensorization and advanced analytics capabilities.

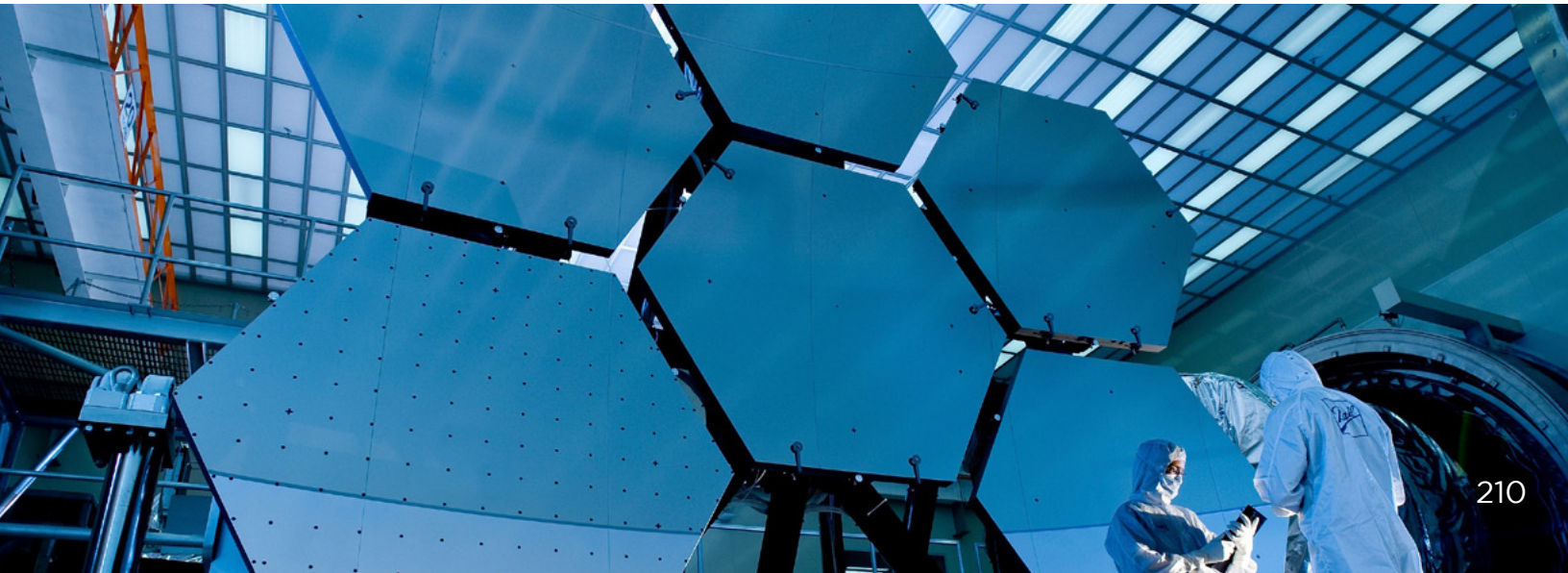
Non-metallic mineral products:

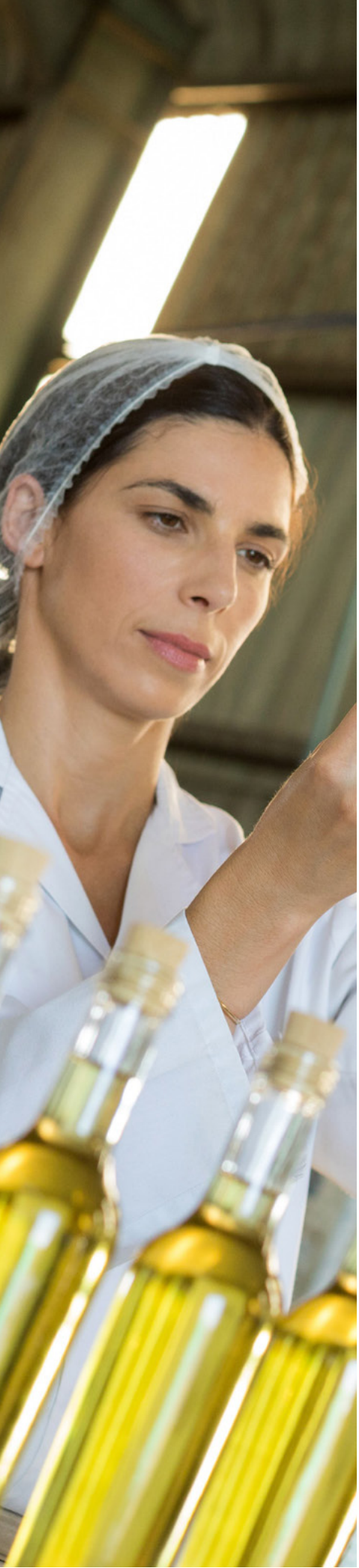
- Among the cement companies, it should be noted that many are vertically integrated and manage the value chain of cement, concrete, and aggregates, serving traditional massive channels through construction retail and industrial channels through their network of concrete plants. In terms of digitization, the control of the production process through switches and controllers in both the cement and aggregates plants stands out, as well as the use of routing software to optimize concrete delivery routes..

- In terms of ESG, cement companies are pioneers in circular economies and the use of alternative fuels

Retail commerce:

- Retail commerce is characterized by its closeness to the final consumer, so the focus of its digital maturity is more oriented to customer interactions, enabling technologies at points of sale and digital commerce (e-commerce) models focused on generating sales and efficient contact with customers.





- A clear trend is the implementation of analytical capabilities for the segmentation of digital customers and machine learning models to define dynamic pricing strategies.

- Additionally, it should be noted that the sector is in a state of greater digital maturity in terms of new service models and capabilities to generate income through various sales channels, which combine physical and digital capabilities through the implementation of online purchasing strategies and store pickup, or even innovate in models based on sales through marketplaces or last-mile delivery platforms.

5.6 Complete map of solution providers in Latin America and the Caribbean.

#	Company	Web page	Solution	Origin	Operation
1	Pulsar	www.pulsarml.com	Plant Monitoring	United States	LAC
2	Stratasys	www.stratasys.com	3D Printing	Mexico	LAC
3	I-Optia	www.i-optia.com	AI for industrial operations	Colombia	LAC
4	Tsol	www.tsolco.com	Logistic software	Mexico	LAC
5	Mojix	www.mojix.com	Digital solutions for the entire supply chain	United States	LAC
6	Seebo	www.seebo.com	AI for predictive analytics	United States	LAC
7	BALLUFF	www.balluff.com	Solutions for smart manufacturing	Germany	LAC
8	Micro-Epsilon	www.micro-epsilon.com	Switches and measurement systems	United States	LAC
9	Less Industries	www.lessindustries.com	Smart Monitoring	Argentina	LAC
10	Sensorbox	www.sensorbox.com.br	Telemetry	Brazil	Brazil
11	Nc Tech	www.nctech.com.mx	Solutions for smart manufacturing	Mexico	Mexico

12	Tractian	www.tractian.com	Smart monitoring and asset management	Brazil	Mexico and Brazil
13	Prysmex	www.prysmex.com	Digital platform for security control	Mexico	Mexico
14	Obralink	www.obralink.com	Automation of the progress control of works	Chile	Chile
15	Arvolution	www.arvolution.com	Digitization of inspection and security tasks	Mexico	LAC
16	Universal - Robots	www.universal-robots.com	Robots for operations automation	Denmark	LAC
17	Samsara	www.samsara.com	Cloud solutions for industrial operations	United States	LAC
18	SAP	www.sap.com	Manufacturing Operations Management Software	Germany	LAC
19	Vuxiz	www.vuzix.com	Smart glasses with augmented reality	United States	LAC
20	Nowports	www.nowports.com	Software for international logistics	Mexico	LAC

21	Datup	www.datup.ai	SaaS platform for demand planning	Colombia	LAC
22	Mesbook	www.mesbook.com	Factory Management System in Real-time	Spain	LAC
23	Kawasaki Robótics USA	www.kawasakirobotics.com	Collaborative robots for manufacturinga	United States	LAC
24	Siemens	new.siemens.com	Industrial automation systemsl	Germany	LAC
25	GoEpik	www.goepik.com	Digitization of machine and equipment inventories	Brazil	Brazil
26	Manufactura Cohesiva	www.cohesivemanufacturing.com	3D graphics design technology	Colombia	Colombia
27	Smart Factory SAC	www.smartfactorysac.com.pe	Industrial automation solutions	Peru	Peru
28	Cisco	www.cisco.com	Connectivity systems for advanced manufacturing	United States	LAC
29	TAI Smart Factory	www.taismartfactory.com	Production management and control systems	Spain	LAC

30	Aveva	www.aveva.com	Industrial software for digital twins	United Kingdom	LAC
31	Microsoft	www.microsoft.com	Comprehensive manufacturing cloud solutions	United States	LAC
32	ABB	new.abb.com	Digital solutions for manufacturing	United States	LAC
33	BlueYonder	www.blueyonder.com	Supply Chain Planning and Management Solutions	United States	LAC
34	Iconics	www.iconics.com	Advanced Automation Software	United States	LAC
35	Oracle	www.oracle.com	Manufacturing software powered by IIOT and AI	United States	LAC
36	Augury	www.augury.com	Software for the prevention of machine failures	United States	LAC
37	Trideo	www.trideo3d.com	3D printers and manufacturing	Argentina	Argentina

38	Trimarker	www.trimaker.com	3D printing solutions	Argentina	Argentina
39	Dataprophet	www.dataprophet.com	Platform based on AI and ML to improve the efficiency of production processes	United States	United States
40	Desh Tecnologia	www.deshtec.com.br	Communication solutions for industrial IoT	Brazil	Brazil
41	Trackage	www.trackage.com.br	Monitoring solutions for logistics activities	Brazil	Brazil
42	Flex	www.flex.com	Automation and digitization solutions for production and logistics processes	Brazil	Brazil
43	Map Tag	www.maptag.mx	Optimization of delivery routes for last-mile logistics	Mexico	Mexico
44	Valiot	www.valiot.io	AI software for efficiency in production processes	Mexico	LAC

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