HOW NEW TECHNOLOGIES ARE TRANSFORMING TRANSPORTATION IN LATIN AMERICA AND THE CARIBBEAN

Digital economy

Transportation

NTT DATA

IDB | Invest

BACKGROUND

The Latin America and Caribbean (LAC) region is undergoing a digital revolution, and we are convinced that technological innovations have the potential to significantly accelerate and scale the region's development. These technologies are reshaping both traditional sectors and innovative industries. In this context, the main objective of this report is to address the disruptive technologies that are revolutionizing each of the industries in which IDB Invest operates in a structured manner. New emerging business models will be evaluated in the context of economic and social development, the foundation of the IDB Group. The selected models will prioritize inclusion, productivity, and innovation while addressing cross-cutting issues such as environmental sustainability, climate change, and gender equality.

Although new technologies have enormous potential to drive efficiency and open up new avenues of value creation, they also pose significant challenges in terms of governance, security, and equality. The rapid adoption of digital solutions has highlighted the importance of establishing a strong regulatory and investment framework that maximizes benefits while mitigating risks. As a result, the role of different economic agents and their ability to adapt and adopt these innovations becomes a critical aspect of catalyzing sustainable economic and social development.

As we examine the impact and potential of various key technologies in this report, it is important to understand that we are dealing with an interconnected ecosystem that is growing in complexity and scale. Advances in one area, such as Artificial Intelligence or Automation, are fed back and amplified in constructive collaboration with others, such as Big Data or the Internet of Things, resulting in a multiplier effect on value generation. This report aims to highlight how this technological interconnection is reshaping the economic and social context in LAC, providing an analysis that goes beyond the current situation to forecast how new technologies will continue to shape the region over the next decade.

CONTEXT

Transport is a key element for economic and social development and a source of job creation that connects citizens with essential services such as health or education. Simultaneously, it is also one of the largest sources of pollution, accounting for about 22% of the regional carbon dioxide emissions in 2020[1], a higher percentage than other regions such as Europe, Asia, or North America.

This puts the industry in a difficult position. It must combine development and improvement of transportation infrastructure with ensuring that such development is sustainable and aligned with each country´s decarbonization goals.

As a large and diverse region, there are significant differences in the needs and status; however, a common challenge is the lack of infrastructure in rural areas and the congestion of large urban areas. To that extent, vehicle congestion costs cities between 2% and 4% of their GDP[2] due to factors such as lost time, unnecessary fuel consumption, and the increase in business operational costs. Meanwhile, rural areas suffer from poor road network coverage and connectivity, which is lower in LAC than in other comparable regions[3]. This situation implies greater difficulty in accessing markets and services, raises transportation costs, and severely limits rural economic development.

[1] IDB, 2021
[2] Mckinsey, Urban commercial transport and the future of mobility, 2017
[3] Global Roads Inventory Project, 2018

By delving deeper into urban congestion, we discover that, according to the TomTom Traffic Index 2022 – a study that examines data from 390 cities in 56 countries and six continents –, LAC has two cities in the "top 10" cities with the highest traffic congestion in the world: Bogotá and Lima."

INDUSTRY'S IMPORTANCE IN THE REGION AND IDB INVEST'S OUTLOOK

IDB Invest seeks to support transportation projects in Latin America and the Caribbean that have a positive impact on productivity and competitiveness. Projects that reduce congestion and improve the quality and operational efficiency of passenger and cargo transportation while lowering CO_2 emissions and increasing climate resilience are especially important.

In addition to supporting the economic development of cities within countries, an efficient multimodal transportation network with high connectivity is a critical enabler of international trade. According to a World Development Indicators report by the IDB group, there is a positive correlation in the region between a country's GDP per capita and the quality of its infrastructure.[4]

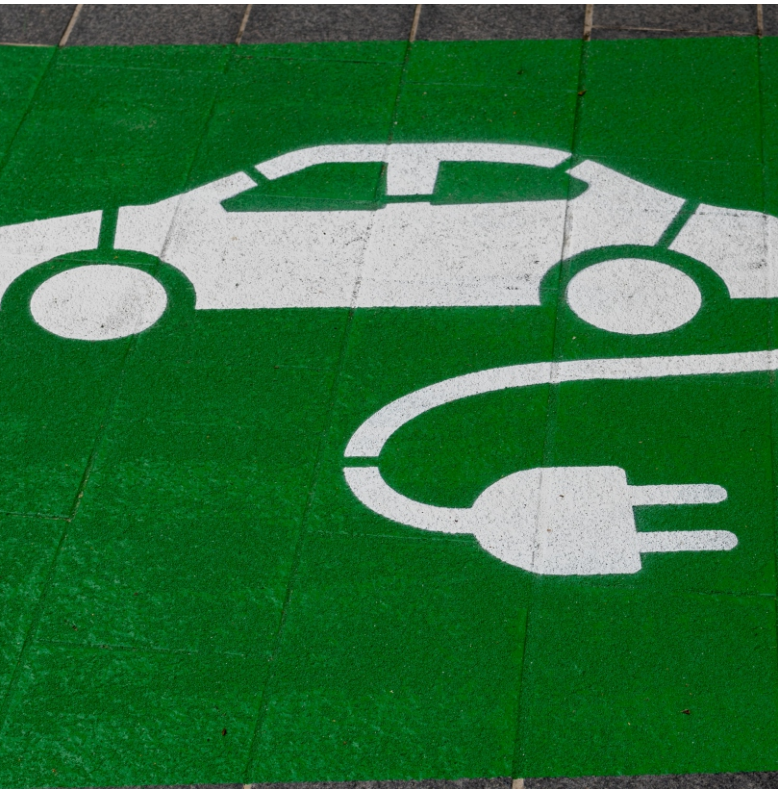
A high-quality transportation infrastructure fosters the growth of other industries, triggering a virtuous cycle that benefits both companies and individuals. According to an IDB group study, a one-unit increase in the quality of a country's transport infrastructure (measured on a scale of 1 to 5) correlates with a 5% increase in exports (measured in USD) in LAC.

[4] BID, Logística en América Latina y el Caribe: Oportunidades, desafíos y líneas de acción, 2021

INDUSTRY CHALLENGES AND OPPORTUNITIES

From NTT DATA, we identify four major categories that combine the transportation industry´s challenges and opportunities for the next decade:

Social: The recent rise in fossil fuel prices, combined with society´s growing awareness of sustainability as evidenced by important milestones



such as the Paris Agreement or the adoption of the United Nations SDGs, is causing a structural shift within the industry toward a different type of mobility, at both the freight and passenger transportation levels.

The electrification of public and private transportation, as well as the exploration of new types of fuels, such as hydrogen or e-fuels, is a trend stemming from this awareness and commitment. Several cities in LAC are electrifying their public transportation fleets, such as Bogotá, which acquired 401 electric buses with the help of IDB Invest to provide intercity public service in 2022.

In this transition to a new mode of transportation, it is critical to ensure that it is accessible to all citizens and does not exacerbate the inequality problem in LAC, where the cost of public transportation accounts for a significant percentage of the total income of households with fewer resources, which can reach 20%[5]. One of the region´s main challenges is achieving a balance between sustainability and access to high-quality, low-cost infrastructure.

Technological:

Several of the world's largest urban areas can be found in Latin America. Currently, 81% of the region's population lives in urban areas[6], with the figure expected to rise to 89% by 2050[7].

[5] World Bank, 2019
[6] UNDESA
[7] BID, Logística en América Latina y el Caribe: Oportunidades, desafíos y líneas de acción, 2021

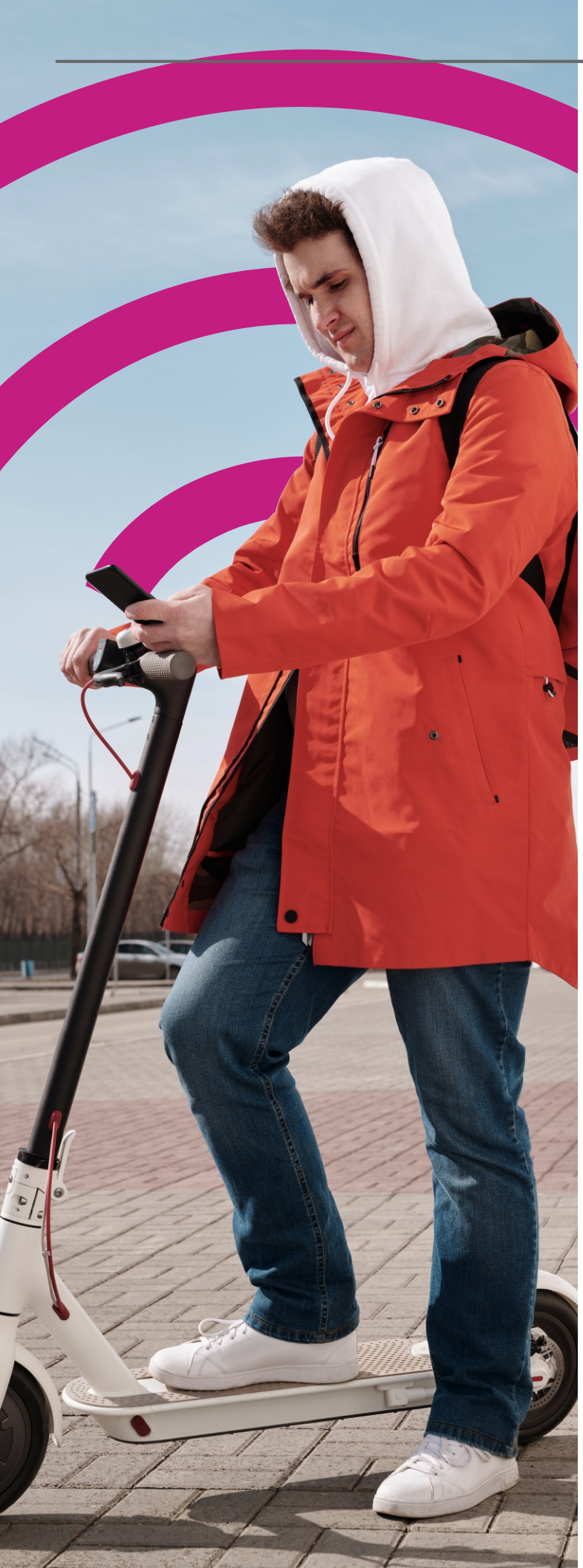
This creates new challenges in terms of traffic, air quality, noise pollution, and travel time, all of which have a negative impact on citizens' standard of living.

New technologies such as IoT, AI, 5G, or Big Data, together with the massive adoption of the internet and smartphones, can be leveraged within the current urban infrastructure to yield value solutions that remodel public and private transportation, making it more effective and efficient, digitally interconnecting different services, unifying trips on an end-to-end basis and thus creating a superior user experience.

The implementation of big data and the use of data analysis tools can help make better decisions about physical infrastructure and services. Real-time data collection and analysis yields valuable information on traffic patterns, transportation demand, and service efficiency, allowing us to accurately measure the impact of physical infrastructure construction and/or streamlining and how traffic patterns can be managed. Currently, the IDB Group is collaborating with Waze to assess the impact of transportation infrastructure, bike paths, or changes in parking rules on urban congestion.

Regulatory: The advancement of technologies with applications in the transportation industry has not been accompanied by a corresponding regulation.

There is currently no integrated regulatory framework in place that allows for the implementation of sustainable transportation policies and the adoption of clean technologies, such as electric vehicles. Similarly, regulation is often fragmented between different levels of government and jurisdictions, making effective policy coordination and implementation difficult.



Implementing a regulation that encourages the use of new shared mobility, ride-hailing, or delivery platforms is capital for the development of digital transport services in terms of shared mobility. In this regard, regulators should strive to keep up with technological advancements. In Chile, for example, a legal framework for the operation of private transportation platforms was established in 2020, requiring professional licenses and insurance for drivers, vehicle registration, and tax obligations for companies.

It also considered limiting the age of vehicles and requiring drivers to undergo background checks. As a rule, advances in infrastructure and digitalization of the transportation industry should, in general, result from public and private collaboration. This is especially true when it comes to digitalizing different modes of transportation on the same platform, such as a private car transport service combined with a public bicycle rental service. For this collaboration to be successful, transparent regulations that protect the rights of all parties must be implemented.

Security/Cyber-security: Because transportation infrastructure is considered critical, leveraging connectivity and new technologies to implement Intelligent Transport Systems (ITS) becomes a requirement.

ITS improves operational efficiency, safety, planning, and sustainability while providing users with real-time information. Sensors, cameras, navigation, and traffic control can be used on roads, railways, airports, and seaports.

Some ITS applications have specific safety benefits, such as smart traffic lights that help reduce accidents and real-time alerts to emergency services on motorways and highways.

Smart traffic lights can be found in the region, for example, in Buenos Aires. Vehicle flow can also be monitored and regulated in real-time via road surveillance cameras and sensors that collect real-time data on traffic, weather conditions, and accidents. This improves urban mobility while reducing traffic congestion.

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Furthermore, transportation systems are becoming more interconnected and automated, increasing the risk of cyberattacks and disruption of transportation services. In the industry, cybersecurity is critical for protecting privacy and data integrity, as well as ensuring the safety of people and traffic on roads and transportation routes.

In this regard, advanced technologies such as data encryption and artificial intelligence can be used to protect data integrity and prevent cyberattacks while also allowing proactive monitoring of threats, ensuring the safe and efficient operation of transportation systems.

KEY TRENDS

The industry is undergoing a profound change. New technologies and a social push toward a more sustainable future are changing the way we understand mobility, particularly in urban areas.

Transportation Decarbonization

To achieve a neutral carbon footprint in the industry, that is, virtually zero greenhouse gas emissions with some residual emissions that are reabsorbed from the atmosphere, is a global trend that directly impacts various industries.

It should be noted that decarbonization should be a process that affects the entire value chain, from the manufacture of the different components, such as car batteries, to their propulsion, as well as the entire assembly, mounting, and distribution process.

This trend includes two major groups of initiatives:

a) Electrification: The electrification of mass transit, primarily cars, buses, and railways, is a well-established trend in markets such as the United States and Europe, but it is moving at a much slower pace in LAC.

New technologies have the potential to accelerate this trend by lowering component and infrastructure costs and democratizing access to these new modes of electric transportation. As a result, efforts are being made to combine big data, IoT, and AI to extend battery life and optimize product life cycle, from manufacture to integration into circular economy models.

The widespread use of sensors that collect information with high granularity throughout the battery´s life cycle enables the use of AI models that analyze this data and propose strategies to extend their useful lives, improve the manufacturing process, and forecast when it will be necessary to replace the battery.

Furthermore, digital twins are used to optimize the manufacturing process by simulating the behavior of batteries in various scenarios, assisting manufacturers in identifying improvements that lower their final cost and improve their efficiency.

In terms of infrastructure, technology has the potential to democratize access to electric chargers. Vehicle-to-grid systems, in which the vehicle battery returns electricity to the grid, make this technology more accessible. In turn, the interconnection of the electric charger system with other applications via IoT enables consumers to consult in real time about charger availability, energy prices, and the expected recharging time. Customers in Mexico, Chile, Argentina, Colombia, and Brazil can access this information through LAC applications such as Electromaps.

Electrification presents a significant challenge in terms of higher upfront investment and access to recharging grids. This means that early adopters will most likely be fleets with a high level of utilization and charging points. However, technology can be a viable solution for optimizing fleet usage, as seen with companies such as Cabify or Uber.

b) New Propulsion Systems: As electrification matures, new alternative hydrogen-based systems emerge that will be relevant over the next decade, preserving combustion engines.

The EU was the first region to announce a ban on the sale of vehicles with combustion engines beginning in 2035, with a tentative deadline of 2050 being considered to stop these vehicles from circulating. Over the next decade, more countries are expected to announce similar measures, with LAC following suit.

These bans would not apply to E-fuels because they are less polluting and can be manufactured using renewable resources. However, technological advancements along the entire value chain are required to drastically reduce its cost for widespread adoption.

Despite its environmental benefits, e-fuel adoption in LAC presents challenges. The lack of appropriate infrastructure, the requirement for large investments, and the resilience of traditional energy industries are all barriers to their integration into the region's energy value chain.

Aside from producing e-fuels, hydrogen can also be used to generate electricity and power electric vehicles as an alternative to batteries. In this regard, countries such as Colombia and Brazil have already conducted some pilots with fleets of hydrogen-powered public buses, and there are already pilots underway for the launch of trucks in the region using the same technology.

Digitalization of Mobility

The ability to connect various modes of transportation and services in real-time is transforming mobility in both urban and interurban areas.

Micro-mobility services, such as scooters and e-scooters or bicycles, are being added to the offerings of transportation platforms such as Uber or DiDi, which users can locate on the map, book, and pay from their smartphone.

When we combine this with the availability of public services, such as buses, subways, and car parks, journeys are fully digitalized, resulting in increased efficiency and customer service.

In this context, TaaS (Transportation as a service) models emerge, in which users access on-demand transportation services and pay only for the use of the service. These models include a variety of vehicles, such as cars, bicycles, or electric scooters.

This trend employs new technologies for a variety of purposes:

- **IoT** to send data in real-time and bidirectionally between different interconnected devices. This enables, for example, trip monitoring for increased user safety, which is especially important in the region´s large urban areas.
- **Big Data** to process the large flows of data collected by the interconnected devices, allowing public bus routes to be optimized and recalculated in real-time to maximize the passenger capacity.
- **AI** for managing and optimizing logistics in goods transportation, as well as efficiently managing large fleets of vehicles.

Over the next decade, AI solutions will be able to better leverage data to manage more complex systems that go beyond mobility, such as smart grids, resulting in smarter, more sustainable cities.

Another significant point is the ability to use driving data to generate smart insurance that adjusts rates and coverages based on the driving habits of users.

Concerns about sustainability and improvements in urban infrastructure are boosting shared mobility in large cities, according to this trend. In this sense, digitalization enables new models that enable users to share means of transportation, such as Carpooling and Ridesharing.

The combination of IoT, Big Data, and AI enables the regional development of smart cities focused on developing resilient and efficient infrastructures that improve dwellers´ quality of life. In this context, urban mobility is being transformed by optimizing vehicle flow, implementing intelligent public transportation systems, and integrating autonomous and connected vehicles. Furthermore, smart cities encourage the interconnection of various modes of transportation, promote sustainability through electric vehicles, and use data analysis to improve the planning and administration of the urban mobility system.

There are notable initiatives in LAC that are driving the transition to smart cities to improve the standard of living of their inhabitants, such as Medellín (Colombia) and Santiago (Chile). Medellín has undergone significant change in recent decades. The city has become a role model in LAC by using technology and innovation to improve mobility, safety, and waste management. Furthermore, its aerial tram system, Metrocable, has enabled the city´s most disadvantaged communities, which are located on the city´s slopes, to gain access to new economic and social opportunities in the city center. Santiago, on the other hand, is transforming into a smart city through a series of innovative projects, including the implementation of an electric bus network, which has improved public transportation efficiency and reduced air pollution.

Furthermore, the city has implemented IoT-based projects to improve water and energy management, as well as investments in digital infrastructure to improve access to public services and improve citizen participation.

Autonomous Vehicles

Although it is not currently a trend in the region, great efforts are being made globally to develop this technology, and when it reaches a sufficient level of maturity, it has the potential to transform the transportation industry in LAC.

According to NTT DATA, there are three major types of autonomous vehicles: Cars, trucks, and unmanned aerial vehicles. The former is more concerned with passenger transportation, whereas the latter two have significant implications for goods transportation.

Being a technology in the incubation phase and facing hot spot challenges, such as ensuring the safety of both the user of the trip and the other vehicles on the journey, its ultimate success requires the development of various advanced technologies:

AI is critical in AVs, allowing high-speed driving decisions to be made based on the data captured by the vehicle's sensors. This includes responding to unexpected obstacles, improving navigation, and adapting to changing road and traffic conditions.

IoT is another critical component, allowing for the collection of massive amounts of data in real-time about the position of the vehicle in relation to other elements on the route. This enables autonomous cars to have an accurate contextual awareness of their surroundings, improving operational safety and efficiency.

Finally, **5G technology** provides the necessary communication infrastructure for receiving all information from the various sensors in real-time and without interference. This ensures that autonomous vehicles can make timely and accurate decisions based on the most recent available data.

In addition to the above, autonomous vehicles represent an opportunity for technologies such as metaverse and augmented reality, where users will be able to enjoy more interactive onboard entertainment services and visualize the outside of the vehicle by observing additional information such as the weather, speed of journey, map until arrival at the destination, or even their e-mail inbox.

Smart Infrastructures

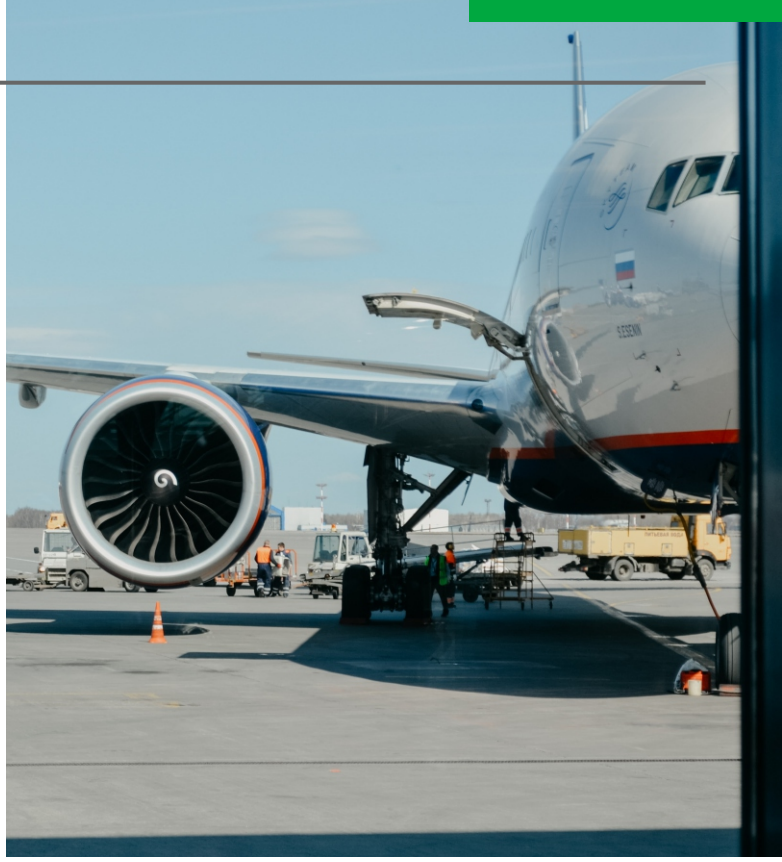
Transportation infrastructure also benefits from the possibilities provided by new technologies, becoming more efficient, safe, and sustainable.

Smart Roads: By incorporating sensors into traffic routes and gradually increasing the number of sensors in vehicles, it is possible to generate a large volume of data on everything that is happening in real-time at every point of the road.

The combination of this data with Big Data models can be used to provide real-time alerts on the state of the road, improve traffic management through smart traffic lights, or instantly alert emergency services in the event of an accident.

IoT adoption will also make roads more sustainable by enabling intelligent lighting systems or even intelligent tunnel systems that optimize traffic and serve as an alternative to avoid flooding.

Long-term improvements are expected to include the incorporation of induction systems into the pavement, allowing electric vehicles to be recharged while driving, as well as the widespread adoption of sensors that enable autonomous driving.



Smart Airports: Airports can use new technologies to reduce manual tasks, optimize passenger and cargo traffic, and improve safety and sustainability.

For example, advanced biometric systems linked with AI allow passengers to arrive at airports later because they can handle the entire transit process, including baggage check-in, security control, and boarding, automatically through self-service. Furthermore, AI can assist air traffic controllers in route control, leading to a safer process with less and less human intervention in the future.

Galeão (Rio de Janeiro) is an example of a smart airport in LAC, where facial recognition technologies have been implemented to improve the safety and efficiency of its operations. Facial recognition cameras are used in the immigration control area to check the identity of passengers and speed up the passport control process, while they are used in the security area to check the identity of employees and ensure the security of facilities.

The combination of IoT and Big Data also allows for more efficient management of airport temperature and lighting, when combined with the implementation of renewable generation sources such as solar panels, will reduce the carbon footprint and increase energy efficiency.

Similar advancements can be made in railways and ports by incorporating sensors that make passenger and cargo transportation more efficient, automated, and safe.

NEW BUSINESS MODELS

The integral transformation of a critical sector such as transportation is generating a more developed value chain and attracting newer, more technological players, all of which, combined with industry liberalization and regulatory support, are encouraging the emergence of new business models leveraging digitalization.

Intelligent Logistics Systems

The region has a unique logistics matrix, with rail accounting for a 3% share and land transport accounting for more than 85% of domestic freight handling by weight[8]. In terms of international transport, maritime and river transport account for 95% of the total[9], with air transport accounting for the remaining portion, which is focused on goods with high added value.

The current economic situation, which is characterized by the transformation of global supply chains and international conflicts that have a direct impact on strategic markets such as energy, provides a unique opportunity to improve regional logistics performance. Improving logistics efficiency and effectiveness provides significant benefits such as increased competitiveness, cost reduction, and shorter delivery times.

In this scenario, new technologies can assist logistics companies in overcoming the region´s infrastructure gap and the deficiencies in services management, allowing them to be more efficient, save money, and increase shipment security.

[8] IDB, 2020
[9] World Bank, 2019

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Digitalizing the entire supply chain in a single platform, which also integrates financing options and the possibility of consulting with experts in the field is an example of the value proposition of this type of model, which is possible through the efficient combination of various technologies:

IoT: Using sensors in cargo containers, they can track all cargo movements from origin to destination, improving cargo security.

Big Data: Using analytical models, they can calculate more efficient routes, save time and resources, and forecast future demand, allowing operations to be planned more efficiently.

APIs: Because financing is so important in the logistics process, integrating third-party financial services into the platform itself provides value to the end customer while also providing a low-risk source of income for the logistics. Third-party last-mile delivery and long-term storage options are also made available through this channel.

EXAMPLE: SMART LOGISTICS SYSTEMS

nowports

"Faster and more efficient foreign trade"

Maximizes the efficiency of international logistics, offering technology-based solutions to improve shipping process.

OTHER PLAYERS

nuvocargo

cargo

VALUE PROPOSITION

Its mission is to transform supply chains in emerging markets to drive their development, offering a digital freight forwarder to transport large volumes to the Americas, Europe, Africa, Asia, and Oceania

TECHNOLOGY

They incorporate **artificial intelligence, IoT, and Big Data** to improve the import and export chain, giving their customers information regarding efficient routes, market interpretations, access, and processing of online documentation through their website and app

ALLIANCES

It has commercial partners to ensure shipments, as well as connection with customs offices

IMPACT

- Reduces logistics costs
- Increases security and visibility of shipments
- Contributes to the digitalization of the industry

CUSTOMER SEGMENTS

By the nature of their business, the main customers are those looking to export and import their products to and from the Americas, Europe, Africa, Asia, and/or Oceania

RESULTS

+4000

customers

7

countries

KEY CAPABILITIES AND RESOURCES

- Licenses, permits, and certifications such as IATA and WCA Inter Global
- Capital for financing those that import and/or export goods
- Expansion in the Americas

MAIN REVENUE STREAMS

Sales Solution:

- **Logistics:** import and export management
- **Financing:** loans and credits
- **Digital payments:** customers can pay their suppliers from anywhere in the world

Mobility as a Service

Following the COVID-19 pandemic, the region´s digitalization and the use of transportation platforms have increased significantly. In this regard, Mobility as a Service solution appears to integrate various modes of transportation into a single platform, allowing the end user to choose how, when, and with whom they will make each of their journeys.

This enables users to access various modes of transportation in an integrated and personalized manner, easing their mobility in the city and reducing the need to own a vehicle.

Unifying different modes of transportation on a platform presents significant challenges because the systems must be smoothly interconnected to avoid delays and planning issues, and this integration includes both private and public modes of transportation, with the latter experiencing a digitalization delay in LAC.

There are 75 cities in LAC with populations greater than one million, so the potential market for this business model is significant. The keys to success will be to seamlessly integrate mass transportation solutions with micromobility and shared mobility options, both of which are typically electric and focused on the last part of the trip.

In terms of the technology associated with this type of solution, IoT is critical to the real-time communication of the various modes of transportation, allowing data to be collected that these platforms can use to:

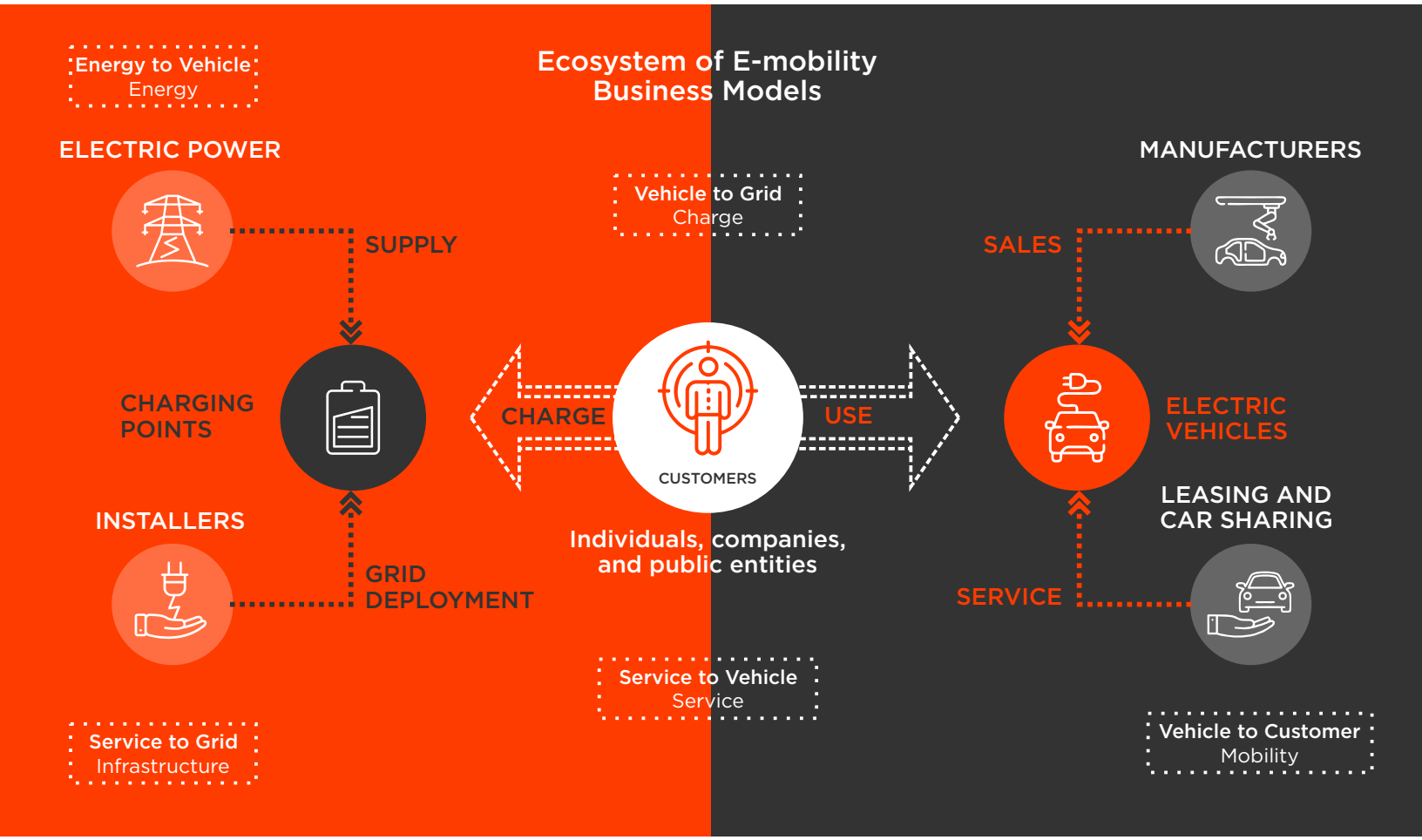
- Predict transport demand and propose alternative schedules and routes
- Identify patterns of behavior
- Control the environmental impact of mobility
- Identify which areas have the highest traffic flow and which routes have the highest congestion

Models Associated with Electric Mobility

As previously stated, e-mobility is one of the most important innovation niches globally, and this trend is expected to continue over the next decade. Around the e-mobility ecosystem, a diverse set of agents and new business models are emerging, as briefly described below.

a) Vehicle to customer

It refers to the development of business models that bring electric mobility closer to all types of publics, going beyond traditional private ownership, such as subscriptions to electric cars with all services included (insurance, maintenance, etc.) that allow customers to own an electric vehicle without making an initial outlay.



b) Energy to vehicle

It addresses the issues of recharging point´s supply of green energy of renewable origin. Stations, for example, provide battery swapping services for urban electric scooters, charging the scooter´s batteries with solar energy from solar panels installed at the station.

c) Service to grid

It is the deployment of various recharging models that aims to optimize the selection and location of recharging points, for example, by providing a network of recharging points via public infrastructure such as streetlights and poles.

d) Vehicle to grid

It aims to maximize the use of recharging assets, as well as the distributed resources that are EVs, and provide grid flexibility, where the trend is to go for intelligent recharging of electric vehicles with dynamic actions to meet the needs of the grid, allowing users to reduce the cost of recharging or even be financially rewarded for the energy they return to the grid.

e) Service to vehicle

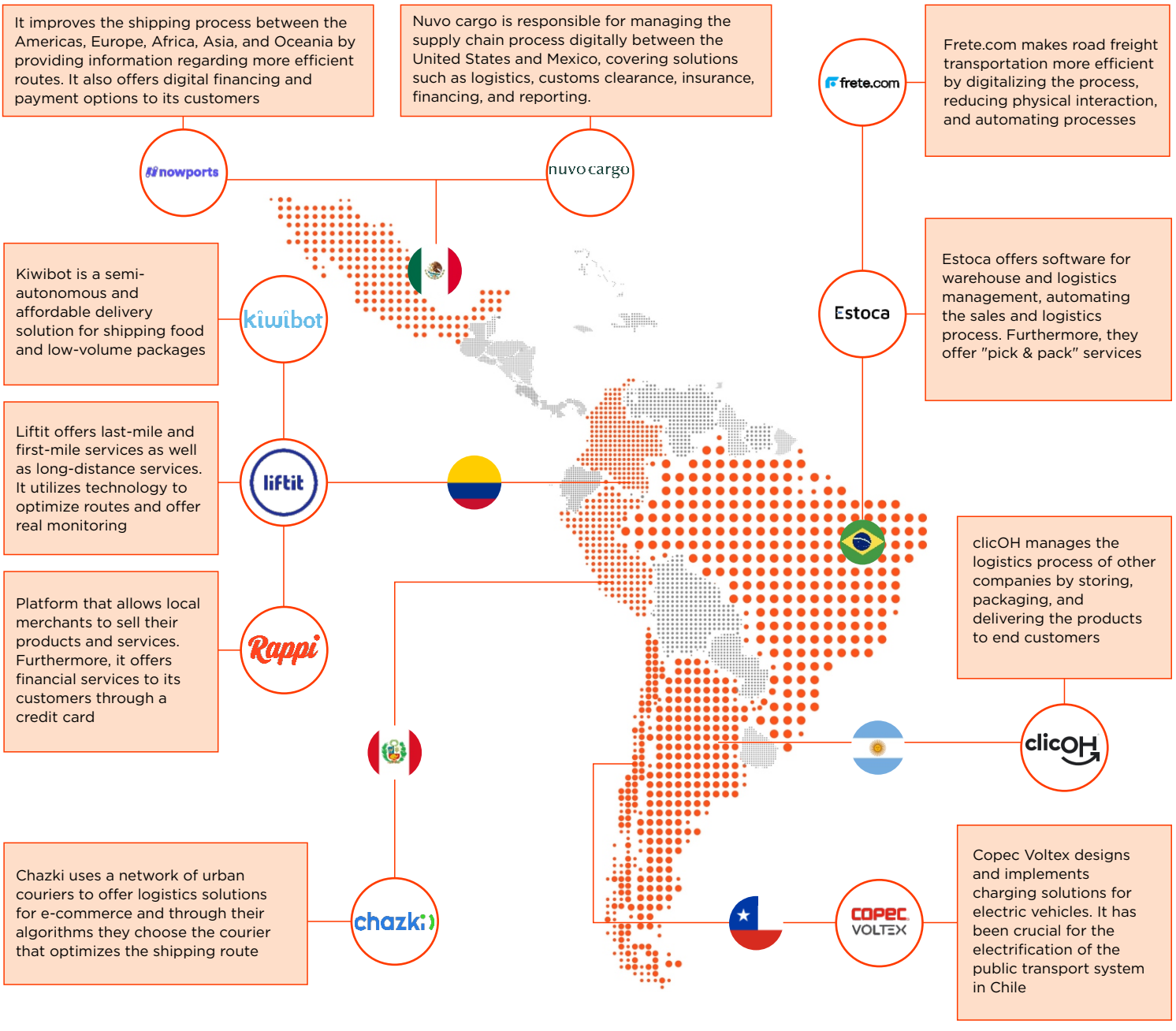
It is the enhancement of the customer experience while recharging, the promotion of digital channels and processes in conjunction with valuable products and services, and the use of mobile applications to make the customer participate in the ecosystem, for example, allowing the customer to interact with the smart charging system from their smartphone to smart, see for example their charging session.

Looking ahead, for all of these business models to thrive in the future, innovation in V2G technologies, AI platforms, and smart charging algorithms will be critical.

MAP OF PLAYERS

The emergence of new digital players is reshaping the LAC transportation sector. Companies like Uber and Cabify have universalized access to private transportation through technologically advanced solutions, and platforms like Rappi have reinvented the concept of delivery by facilitating the transportation of a wide range of products.

Furthermore, the emergence of new digital platforms such as Liftit and Frete.com is optimizing logistics and the supply chain, resulting in increased freight transport efficiency. The incorporation of disruptive technologies such as AI, IoT, and Big Data is paving the way for the development of autonomous vehicles and smart mobility solutions, paving the way for a sector revolution. Meanwhile, efforts are being made to improve the integration of various modes of transportation in order to provide more holistic and efficient mobility solutions.



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