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**The impact of the pandemic on  
logistics and supply chain digitalization**

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**ABSTRACT:** The coronavirus pandemic led to supply chain disruptions resulting in adverse economic impacts on global supply chains. Nationwide lockdowns in countries that play key roles in global manufacturing restricted freight movements through air, ocean, and land routes resulting in delivery delays, higher freight rates, and congestion. At the same time, the pandemic has accelerated the growth of the e-commerce sector. Concern around infections has led to a surge in first-time online consumers for categories such as health and pharmaceuticals and fast-moving consumer goods. Companies have had to rethink their approaches to optimizing warehouse locations and inventory to meet customer demand. From a freight perspective, the focus has shifted from a single-mode model towards multi-modal logistics to reduce costs and dependence on any one mode. This chapter will review recent developments, long term impacts and opportunities for growth in the context of this important sector and illustrate some of the key impacts of the pandemic using the example of the emerging economy in India. It concludes by synthesising key takeaways and conclude by reflecting on the future of the sector.

**KEY WORDS:** *Pandemic, logistics, infrastructure, digitalization, automation, autonomous vehicles*

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## Introduction

The year 2020 began with significant uncertainty for logistics and supply chain management. The impacts of large-scale disasters such as earthquakes, tsunamis, and nuclear accidents are usually limited to specific geographical areas and/or industry sectors. However, the COVID-19 outbreak spread to around 170 countries within the first few months of its detection (CDC, 2020). Nationwide lockdowns and mandatory confinements affected every aspect of human life. Major industry sectors were forced to close operations resulting in a negative impact on the gross domestic product (GDP) of both developing and developed nations (Xu et al., 2020). The movement of air, ocean, rail, and road freight became severely restricted. Tighter controls on logistics systems led to shortages in active ingredients, raw materials, and finished goods. Demand significantly outstripped supply in the context of basic household items such as toilet paper as well as products needed in relation to the pandemic such as personal protection equipment, hand sanitizers, and medical ventilators (Hendrickson and Rilett, 2020). Global supply chains that had shown robustness and resilience against large-scale disruptions in recent decades were significantly impacted (Xu et al., 2020).

This chapter provides an overview of the vulnerabilities and opportunities in global and regional logistics systems as highlighted by the pandemic. Many large logistics providers have increasingly built their presence across both developed and developing countries (PwC, 2011). While there are greater challenges associated with operating in emerging markets, the flows of goods both to and within these countries are expected to increase considerably over the next decade due to the growing economic power in these regions. The chapter illustrates the changes in the logistics sector in response to the pandemic by examining the case of one important emerging market economy, India. Although India currently lags behind China in infrastructure development, it is expected to become the most populous country within the next decade (Ritchie, 2019). In conjunction with recent government commitments to investment in infrastructure, this presents opportunities for both large international logistics service providers and local logistics companies. Finally, the chapter discusses the key takeaways from the pandemic and concludes with a reflection on the future of the sector.

## Impact of the pandemic on various modes of freight transport

The freight industry was impacted by a decline in business activities, unused capacity, and the remodelling of business strategies, supply chain networks, and business connections (Herold et al., 2021). All freight modes struggled in the early stages of the pandemic due to these unprecedented circumstances. However, companies gradually reshaped their business models to accommodate challenges associated with the pandemic.

### Warehousing and road freight

Firms often outsource their logistics functions to third-party logistics service providers (LSPs) to achieve greater resilience and flexibility in the flow of goods within and between countries (IFC, 2020). These services may include multi-modal transportation, freight

forwarding, warehousing, and inventory management. The cost of logistics systems can vary from around 25 percent of the GDP in developing countries to around eight percent in Organisation for Economic Co-operation and Development (OECD) countries (Xu et al., 2020). LSPs were significantly impacted due to delays in material production during the pandemic (Herold et al., 2021). Warehouses using a just-in-time approach ran out of inventory whereas others had an excess due to differences in procurement approaches (Wilding, Dohrmann, & Wheatley, 2020). Lower demand led to an increase in inventory of non-essential items in warehouses resulting in increased holding costs and reduced profits (Aćimović et al., 2020).

The manufacturing industry could not provide full truckload (FTL) shipping due to a shortage of raw materials during the pandemic (WSP, 2020). The automotive, construction, steel, and oil and gas sectors experienced both supply and demand shocks and a slow recovery. This led to a collapse in trucking (road freight) spot rates. The economic burden was more severe for small trucking companies which generally do not have robust planning processes for supporting intermittent operations and recovery. The lack of adequate technology adoption and the inability to follow health guidelines created further challenges for these companies. Many trucking companies experienced a decline in their credit ratings during this period.

On the other hand, there has been significant growth in e-retail logistics and last-mile delivery during the pandemic (Shen and Sun, 2021; Verheyen and Kołacz, 2022) (Baker, 2020). The volume of e-commerce in Europe grew by 10 percent in 2021 compared to the previous year (Lone et al., 2021). The sales for the UK-based supermarket retailer, Tesco, grew by 49 percent in the first quarter of 2020 and more than 90 percent in May 2020 (Tesco PLC, 2020). In the US, Walmart and Target's first-quarter sales for 2020 grew by 74 percent and 141 percent respectively (Wilding et al., 2020). The growth in e-commerce has led to a downward shift in acceptable order sizes and a decline in full truckload (FTL) shipping (Kurowski and Huk, 2022).

Uber has rolled out a novel solution through Uber Direct (Aćimović et al., 2020; Uber, 2020). Businesses struggling with high delivery demands were able to use the Uber network of drivers and delivery partners to deliver their products (e.g., food and medical supplies) to densely populated and remote areas. This has helped the drivers and created revenue-generating opportunities for couriers (Aćimović et al., 2020). The pandemic is also expected to accelerate the demand for autonomous vehicles to facilitate contactless delivery of goods (Nerad, 2020).

### Rail freight

Restrictions on the movements of trucks (road freight) during the pandemic led to a re-assessment of warehouse and distribution networks. LSPs were forced to make operational changes to use alternative modes of transport e.g., rail instead of road (Herold et al., 2021). Rail services also grew in demand due to blank sailings (i.e., sailings cancelled by carriers), longer transit time for trucks, and higher air cargo freight rates (IFC, 2020). Rail transport is typically twice as expensive as ocean freight while needing around half the transit time (Tardivo et al., 2020). The trans-Eurasian railway corridor was largely unaffected by the pandemic. Due to elevated shipping prices and a delay in transit time by air and ocean, the

use of rail became the best option for many companies. Even though rail usage for passenger transport was restricted in some countries, cargo trains kept the rail industry in motion with the help of trade agreements between states and national governments. Freight trains were used to transport medical equipment and other healthcare-related supplies between European countries (Jain, 2020). In the UK, the volume of rail freight now exceeds that before the pandemic. However, the volume is still impacted by the global shortage of containers (Clinnick, 2021). In terms of positive long-term impacts, a benefit from the pandemic was that railway companies in many countries moved away from paper-based documentation to reduce the spread of the coronavirus (Tardivo et al., 2020).

### Air freight

Globally around 6.2 trillion USD worth of goods are transported by air every year and represent more than 35 percent of the value of world trade (Dowsett and Lee, 2020). Europe produces just under a quarter of the world's total air cargo business volume. During the pandemic, the air cargo industry faced challenges due to reduced global trade volumes, weakened global economic activity, and consumer confidence. COVID-19 caused a 98 percent drop in global air passenger traffic, which further resulted in a decline in passenger aircraft "belly cargo" capacity. International air freight volumes experienced a decline of 23 percent from June 2019 to June 2020 (Freight Australia, 2021). In Europe, the demand declined by 13.4 percent in November 2020 (WTW, 2021). In Australia, the domestic freight volume on scheduled flights was down by 16 percent from June 2019 to June 2020 (Freight Australia, 2021).

However, cargo airlines were less impacted than passenger airlines globally due to the need for the delivery of emergency aid and essential supplies (ICAO, 2021). The revenue generated from cargo airlines worldwide increased from 101.2 billion USD to 152.3 billion USD even though the total air freight volume had declined. (Statista, 2021). Most of the countries adjusted their traditional means of transportation to facilitate the rapid movement of goods within their country. In Japan, air cargo transportation reached its peak in March 2020 with 121 cargo flights compared to 80 flights at the beginning of the year (IATA, 2020; Statista, 2021; Nakashima, 2022). Cargo carriers with climate-controlled facilities assisted in the worldwide distribution of billions of doses of vaccines. Accelerated e-commerce volumes also boosted freighter aircraft movements.

### Ocean freight

After the detection of COVID-19 in Wuhan province, many countries temporarily halted their trading activities with China. This led to a reduction in total container volume at Chinese ports by 10.1 percent in the first months of 2020 (IFC, 2020). This impacted both key exporters from countries like Brazil, China, India, and Mexico and importers from the European Union. Blank sailings resulted in significant financial losses during this time (IFC, 2020). Ports were closed during quarantine periods to safeguard the health of port workers. Vessels to and from certain countries were restricted or prohibited. Additional rules for quarantine periods of 14 days or other waiting periods prescribed by different countries at the port of entry led to a decline in the movement of perishable goods.

Delays occurred in entry to the port, customs clearance, and loading and unloading of container vessels. These delays in schedules forced ships to abandon empty containers resulting in a shortage of containers where they were needed and an increase in the cost of shipping (Finshots, 2021). This backlog impacted warehousing and freight movement using roads and railways. Delays occurred in ship manufacturing and the availability of parts and led to further reductions in cash flow. Many small shipping companies had to file for bankruptcy due to lack of demand and inadequate cash flow (STA, 2020). Loss of time and money resulted in disputes between shippers and vessel owners. Such disputes also led major vessel operators to visit the “force majeure” clause in their contracts to reduce losses due to extended waiting periods of vessels (STA, 2020).

The next section examines the developments within the Indian logistics sector over the 2020-2021 period with a view to identifying key takeaways that are applicable to both emerging and developed economies.

## Impact of the pandemic on the Indian logistics and freight industry

India went into a nationwide lockdown in March 2020 impacting several industries including transportation, tourism, sports, and entertainment. The government-imposed travel restrictions brought first- and last-mile transportation and intermodal movement of goods nearly to a standstill. The lockdown forced people to stay at home to limit the spread of the coronavirus. Many daily wage earners moved back to their native states and cities due to the lack of adequate work opportunities or reluctance to travel/work during a time of rising infection rates and curfews (GlobalData Healthcare, 2021). Due to this migration, around fifty percent of the long-haul transport companies (organized and unorganized sectors) had no workers available for loading and unloading essential items.

Lack of raw materials for production led to a pause in manufacturing and a consequent downward pressure on the pricing for logistics services. Logistics companies had difficulty in getting timely access to electronic passes for crossing state borders due to differences in state laws (Barman et al., 2021). International border closures, lack of imported goods, weak infrastructure, fragmented supply lines, increased shortage of perishables, and decrease in consumption of high-value food commodities (e.g., broccoli, avocado, and dragon fruit) perception of scarcity around certain items (e.g., personal protective equipment and hand sanitizers), further amplified the challenges (Herold et al., 2021; Hobbs, 2020; Srinivasan et al., 2021). Logistics companies experienced reduced cash flow and difficulty in receiving financial credit from banks and other financial institutions (Barman et al., 2021).

Rail freight decreased by 21% at the peak of the pandemic (Jacob, 2020). Airport congestion increased as a result of staff shortages and a delay in customs clearance (PR Newswire, 2020). Due to a shortage of funds, airlines laid-off employees, or put them on leave without pay (Springthorpe and Batchelor, 2020). Additionally, Intra-Asia trade lanes experienced a major impact due to a reduction in marine vessel capacity and shortages of equipment (Kristiansen, 2020). Due to a large drop in freight volumes, major carriers reported service cancellations and delays, blank sailing between India and the Middle East, Europe, and the Mediterranean region (DHL Global Forwarding, 2020; UNCTAD, 2020).



## Finding opportunities during the pandemic

The provision of cash flow and business recovery support from the government facilitated renewed growth in the transport and logistics industry as well as other sectors. Table 1 summarises the logistics sectors that used the pandemic as an opportunity to build resilient and flexible business solutions. *Atmanirbhar India* (Self-reliant India) is an initiative taken by the government to bring outsourced manufacturing back into India. The country went from a shortage in personal protective equipment (PPE) to the production of 200 thousand PPE kits every day (Gupta, 2020).

**Table 1:** New projects to create opportunity for recovery from the pandemic (Gupta, 2020; Jain and Makhija, 2020; The Insight Partners, 2020; Agarwal, 2021; GlobalData Healthcare, 2021)

Logistics sector	Opportunities
Warehousing and road freight	<ul style="list-style-type: none"> <li>• <i>Atmanirbhar India</i> – Supporting the manufacturing of goods locally rather than outsourcing them globally</li> <li>• Contactless payment systems by using apps such as Google Pay, Amazon Pay, and Paytm</li> <li>• Provision of daily essential items through online apps or platforms e.g., Amazon selling grocery items with same-day delivery</li> <li>• Warehousing automation, which helps to reduce dependence on human laborers</li> <li>• Alternative options to the use of digital payment apps such as users making payments through text messages using unstructured supplementary service data (USSD) via the National Payments Corporation of India (NPCI) or biometric fingerprint using the BHIM application or through their Aadhar Cards via the Aadhaar Enabled Payment System (AEPS)</li> </ul>
Rail freight	<ul style="list-style-type: none"> <li>• Dedicated services <i>such as Kisan Rail</i> (farm products) and <i>Doodh Duronto</i> (milk products) to provide a better reach for farmers</li> <li>• Sleeping coaches converted into makeshift hospital beds for treatment and isolation for providing medical support to rural areas</li> <li>• <i>Oxygen Express</i> – transporting oxygen tanks from manufacturing plants to distant cities/states during the second wave of the pandemic</li> </ul>
Air freight	<ul style="list-style-type: none"> <li>• Usage of passenger planes as cargo planes for the transport of medical supplies and vaccinations globally</li> </ul>
Ocean freight	<ul style="list-style-type: none"> <li>• Increased use of digital platforms that allow users to instantly search, compare, and book container space online and simplify the overall booking process</li> </ul>

The growth of public awareness and acceptance of the need for social distancing paved the way for e-commerce companies to sell essential items online and provide contactless deliveries in both cities and rural areas (The Insight Partners, 2020). The companies expanded their warehousing locations to avoid delivery delays and ensure the continuity of their business operations. Amazon delivered handwash, disinfectants, sanitizers, healthcare devices, household cleaners, baby products, and grocery essentials across the country. App-based payments/cashless transactions (e.g., Google Pay, Paytm, Amazon Pay, BHIM) assisted in facilitating zero-touch or contactless deliveries. Several retailers moved to an online platform or used social media platforms (Facebook, Instagram, and WhatsApp) to expand their reach. Customers can now choose from a wider range of products leading to competitive pricing and boosting e-commerce sales. According to a report published by Unicommerce, the Indian e-commerce industry recorded an overall order-volume growth of 17 percent during the pandemic (Jain and Makhija, 2020; The Insight Partners, 2020). The e-commerce logistics market has been estimated to grow at a compound annual growth rate of 18.8 percent from 2020 to 2027 with a revenue growth from USD 2.93 billion to USD 11.48 billion by 2027 (The Insight Partners, 2020). At the beginning of the pandemic, the warehousing segment struggled with cash flow disruptions and the unavailability of workers (Kapoor, 2021). However, due to the accelerated adoption of e-commerce and higher inventory levels, the demand for warehousing space is likely to grow despite the pandemic. With India's growth as a pharmaceutical hub, the demand for large cold chain warehouses and omnichannel solutions is likely to increase as well. The need for cost optimization and the growing e-commerce market has also resulted in the growth of quality warehousing space in smaller towns and cities.

The rail sector played an important role in COVID-19 crisis management. Indian Railways (IR) launched new initiatives to recover quickly from the effects of the pandemic (Agarwal, 2021). To assist with the shortage of workers, hospital beds, and medical equipment in India's healthcare systems, IR allowed significant use of its asset base and skilled workforce to support the healthcare industry. Railway buildings were used as quarantine centres. Nearly 5,600 train coaches with more than 70,000 beds were deployed to support isolation requirements due to the extremely high number of COVID-19 cases in rural areas. IR and their resource partners assisted in manufacturing PPE kits, HAZMAT suits and coveralls, sanitizers, sample collection booths, oxygen concentrators, sanitizer dispensing machines, hospital beds, and furniture, and even ventilators (WSP, 2020). The temporary suspension of passenger services created an opportunity to capture new traffic and customers by running special parcel trains. These parcel trains and container cargoes helped courier services and the e-commerce industry in transporting goods that otherwise would have been sent as air freight. Dedicated freight trains, such as *Kisan Rail* (farm products) and *Doodh Duronto* (milk products) enabled farmers to transport goods such as spices, vegetables, dairy products, and fruits in record time to demand centres during the pandemic (Agarwal, 2021). The *Oxygen Express* trains assisted in safely transporting liquid medical oxygen from oxygen plants located in suburban areas to hospitals across the country during the second wave of COVID-19.

Before the pandemic, the Indian air cargo market faced fierce competition from other modes of freight transport. During the pandemic, the domestic cargo business saved cash-strapped airlines as they transported medical equipment and essential items for the e-

commerce industry. While India has been the largest manufacturer of pharmaceuticals in the world for a long time, the country emerged during the pandemic as a global vaccine manufacturer and distributor (GlobalData Healthcare, 2021). With the rise in demand from e-commerce and the pharmaceutical sectors, freight carried per domestic flight in India increased by an average of 0.6 tons in the post-pandemic era, as compared to the months prior (Burroughs et al., 2021). Due to the decline in passenger demand, many airlines shifted their business strategies to focus on air cargo. Air India Express (AIE) fleet used the cargo-in-cabin concept to carry agricultural products, mainly fruits, and vegetables, to West Asian countries, Singapore, and Kuala Lumpur (Radhakrishnan, 2021).

### Support from the Indian government

To help businesses recover from pandemic-related losses, the Indian government prepared strategies in collaboration with the Reserve Bank of India (RBI), Insurance Regulatory and Development Authority (IRDAI), Securities & Exchange Board of India (SEBI), and the sectoral ministries (SIRU, 2020). A recently announced national logistics policy has resulted in the creation of a portal for the e-commerce market (<https://gem-registrations.org/>). This portal will create opportunities for micro, small and medium enterprises (MSMEs) and accelerate their recovery. A special economic stimulus of 268 billion USD was announced in May 2020 as part of the *Atmanirbhar Bharat* initiative (Juneja, 2021). Government reform policies such as the launch of the Goods and Services Tax (GST) regime, the grant of infrastructure status to the logistics segment, and relaxed international trade norms, including 100 percent foreign direct investment (FDI) in logistics, is likely to support the growth of the warehousing and logistics sector in India (Kapoor, 2021).

During the first lockdown period, the National Highway Authority of India (NHAI) suspended toll collection on national highways to avoid delays in the transportation of essential goods and minimize physical contact at toll booths. This reduced the financial burden on the logistics sector (Express Drives Desk, 2020). Under the *Bharatmala Pariyojana Project*, the Indian government has sanctioned over 80 billion USD for the construction of roads. Further monetary allocations have been made to augment existing road infrastructure. The government is also funding 574 seaport projects at the cost of 82 billion USD along with a variety of other initiatives aimed at building India into a leading blue ocean economy. To boost the operational model of major ports, public-private partnership engagement models have been proposed with a budget of 0.30 billion USD (ITLN, 2021). A budget of over 16 billion USD has been allocated to the railways in the 2021-2022 financial year to develop the eastern and western Dedicated Freight Corridors (DFC) as part of the National Rail Plan for India.

### Key takeaways for the logistics and supply chain sector worldwide

Both governments and businesses can prepare for the future based on experiences during the peak of the pandemic and the subsequent recovery period. Businesses will need to transition into new approaches to operations and put in place substantial business

continuity plans (Wilding et al., 2020). The key takeaways for the logistics and supply chain sector are discussed below.

**Investing in infrastructure:** Vaccinations, booster doses, close contact minimisation, and deep cleaning of facilities will very likely remain as on and off requirements in a connected world. The logistics and transportation industry needs to implement new ways of working to mitigate the impacts of future outbreaks. Innovative ways to combat future pandemics in the logistics industry can involve providing remote site support, introducing virus detection scanning, automated warehousing, using disinfection robots to sanitize the warehouses, contactless product scanning, and semi-automated trailer unloading robots (Wilding et al., 2020). Adoption of contactless delivery strategies, cashless transactions, and replacement of physical ticketing with QR code scanning should continue to reduce the touchpoints in the supply chain. The ability of companies to invest in innovating their operational infrastructure needs to be enabled by infrastructure investments by governments. This includes investment in high-speed internet services, and road, rail, and port infrastructure (Broadman, 2020; Biswas, 2021). The development of infrastructure along with relevant policies and legislations would also facilitate greater private sector investment in innovative technologies. Currently, there are several startups in India that are focusing on robotic solutions for logistics and supply chain management (Tracxn, 2021, 2022). Startup companies such as Arkrobot, GreyOrange, iFuture Robotics, Peer Robotics and Unbox Robotics have developed automation solutions for increasing efficiency and reducing errors in order fulfillment processes (i.e., picking, packing, and sorting) in warehouses and distribution centres. Other startups are developing autonomous cargo vehicles (e.g., Ati Motors), self-driving technologies that are applicable to both passenger and cargo vehicles (e.g., Swaayatt Robots) and autonomous delivery robots (e.g., Accelo Innovation).

**Adopting alternate sources of supply and freight transport modes:** Dependence on a single supplier or a single mode of transportation carries the risk of supply chain disruption during pandemics or other force majeure events. Firms need to map their supply chains with a focus on value-adding manufacturing and distribution locations (Wilding et al., 2020). Warehouse and distribution networks can be optimized based on resilience objectives, sales channels, customer proximity, supplier locations, and demand patterns. A shift of focus from the stock value to the number of days till stockout under a specific level of customer demand will help to avoid the risk of running out of just-in-time inventory when it is needed the most. Effective relationship management with skilled resources within the firm and across the supply chain, appropriate information systems, and process transformations will assist in just-in-time resourcing during major disruptions. In the Indian context, for example, government support for bringing manufacturing back to India resulted in the production of millions of PPE kits during the pandemic. Indian Railways and their partners assisted in the manufacturing of these kits. The railways were also used to transport parcels which would have been otherwise sent via airfreight to support the accelerated growth in e-commerce as well as oxygen tanks to support the healthcare system.

**Increasing material handling automation:** Shifting the focus to customer satisfaction may help to sustain long-term relationships and accelerate the speed of economic recovery. Repositioning supply chain networks and adopting new digital technologies will assist in unlocking the true potential of the logistics industry and accelerate the speed of economic

recovery (Novak et al., 2021; Shen and Sun, 2021). With the increasing adoption of material handling automation, fewer employees in logistics firms would need to work onsite. Firms should look at ways to motivate and support their employees through flexible and remote work arrangements. The warehouse automation market in India, for example, is expected to grow over 26% over the 2021-2026 period (Miyazu, 2022). The introduction of the GST and real estate investments are expected to facilitate the growth of large warehousing parks with modern facilities and material handling automation technologies. Amazon is already investing in setting automated warehouses across India. This part of the company's commitment to invest 5 billion USD in India. This progress towards automation is global in nature and expected to change the nature of work within the logistics sector.

**Developing and implementing digitalization strategies:** Digitalization in business needs to be given priority and considered as the new normal (Hegde, 2020). The main drivers for the digitalization of logistics networks are the customers (i.e., the senders and receivers of goods/packages) who have a growing expectation of instantaneous information regarding their shipments (Broadman, 2020). A renewed interest in emerging technologies such as the Internet of Things (IoT), blockchains and 3D printing will help companies survive and thrive during other large-scale crises (PR Newswire, 2020). In India, over 55% of logistics companies already use real-time data for monitoring shipments (CXOtoday, 2021). Interest in IoT adoption is also growing with 11% of the logistics companies currently using the technology. Large international logistics service providers such as DHL are well-placed to accelerate IoT adoption in their logistics operations across both developed and developing countries.

## Conclusion

The pandemic highlighted many vulnerabilities in logistics and supply chain systems around the world while simultaneously accelerating investment and digital innovation. Investment in infrastructure is going to be critical for the future of the sector in all countries. Both developed and developing countries deal with complex internal political dynamics that limit investment in infrastructure. In the Indian context, this has stymied investment in Indian ports resulting in around 30% of the country's overseas cargo being transshipped from other locations, notably, Sri Lanka where China is the majority shareholder of the main port (Broadman, 2021). This has an economic impact on India's domestic development and serves as a cautionary note for other countries. Over the course of the next decade, countries have significant scope and incentive to invest not only the development of ports but domestic infrastructure to support the adoption of autonomous vehicles for last mile logistics, and the development of underground distribution networks, and re-usable transport infrastructure (Acioli et al., 2021; Milani, Mohr, & Sandri, 2021). Many countries have the potential to build on the onshore manufacturing capabilities developed during the pandemic (e.g. PPE kits and vaccines) and create opportunities for their domestic logistics sectors.

Almost half the world's population continues to have no access to the internet (United Nations, 2021). This not only represents systemic inequality but a missed opportunity for retailers and logistics firms as well. The rapid rise in online retail activity during the

pandemic has highlighted the fact that infrastructure development policies will also need to include a focus on digital infrastructure to create opportunities for logistics firms, especially in emerging economies where the digital divide is significant (Shenglin et al., 2020). Digitalization will help in both the transformation of traditional logistics businesses (e.g., DP World) and the growth of younger digital logistics firms (e.g., Flexport) that provide proprietary data platforms for various modes of freight transport (Broadman, 2020). This trend is expected to continue alongside the increase in adoption of material handling automation thereby changing the nature of work within the sector. This will transform employment opportunities and create greater diversity within the global logistics workforce.

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