THE LOGISTICS TREND RADAR

5th Edition

Delivering insight today, creating value tomorrow.

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Contents

Figure 1

“As the world finds itself between transformational decades both behind and ahead of us, trend foresight has never been more important. Many transformational trends are here to stay, while new ones constantly arise. At DHL, we are excited to share this fifth edition of our Logistics Trend Radar with you - our customers and partners - to help jointly shape the future of the logistics industry.”

Katja Busch Chief Commercial Officer, DHL

Figure 1: Visitors watch a Covariant robotic arm in action at the grand opening of the DHL Innovation Center in Chicago.

Preface

The past several years in the logistics industry have featured more transformational change than in perhaps the previous century, and the full effects of this are just beginning. The maturation of globalization, the exponential rise of e-commerce, the constant threat of technology disruption, and, most recently, the coronavirus pandemic have fundamentally shifted the entry costs of doing business in the 21st century. As we sit down to reflect on trends in logistics – past, present, and future – one truth becomes abundantly clear: Logistics is entering a transformative decade.

From cloud computing to collaborative robotics, big data analytics, artificial intelligence, and the Internet of Things, logistics professionals have had to make sense of wave after wave of disruptive technology, driving higher levels of digital maturity. The rapid growth of e-commerce still represents only a fraction of global consumer retail spending. Business-to-business e-commerce is expected to follow suit, and dwarfs the consumer market size by a factor of three. The pandemic has contributed to the acceleration of both e-commerce growth and supply chain innovation agendas. Key digital moves to scale and adopt new technology will ultimately determine industry leadership positions in the future.

Looking ahead, increasing digital maturity allows us to focus on social and business trends that will shape the future of the logistics industry. Resilience, sustainability, and future proofing the logistics workforce will take center stage on the strategic agendas of supply chain organizations in the years to come. To stay ahead and actively shape the transformation ahead, logistics professionals need to continuously identify and embrace new trends.

This is why DHL Trend Research regularly publishes our Logistics Trend Radar as a key instrument for the global logistics community. By adhering to a philosophy of staying close to customers, close to technology, and close to operations, we are able to produce a dynamic, living tool that captures the development of societal, business, and technology trends. As a team of passionate innovators at DHL, we are thrilled and humbled to learn that our Logistics Trend Radar is, in fact, the most downloaded DHL document after the international Express air waybill. Both within DHL and across the industry, the Logistics Trend Radar has become an acclaimed benchmark for strategy and innovation, as well as a key tool to shape the direction of specific trends, most recently packaging, 5G, robotics, and artificial intelligence.

We are excited to now invite you to review our fifth edition of this publication, covering the most pressing trends in the near to far future of the logistics industry. We hope that the insights in this report contribute to innovations in your own supply chain, and help you navigate the transformative changes to come.

Please join us on our exciting voyage to deliver insight today and create value for tomorrow!

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Logistics in a Transformative Decade

Looking Back: Innovations that Defined Logistics in the 21st Century

Over the first two decades of this millennium, advancing technology, new business models, and dramatic shifts in customer behavior have reshaped the logistics industry. Ubiquitous access to information and digital services have produced entirely new industries and reshaped established ones.

While technology helps companies to improve the efficiency, flexibility, and speed of their supply chains, social, political, and economic changes have constantly tested those capabilities, with economic shocks and political tensions forcing continual and rapid adaptation.

Tech mega-platforms and the age of e-commerce

The defining business trend of recent years has been the emergence of a new generation of giant technology platforms which can count their users in the billions. US players such as Amazon, Apple, Facebook, Google, and Microsoft, as well as China's Alibaba, Baidu, and Tencent, have become central to the lives of many citizens. Their offerings, based largely on free access, social connectivity, and almost limitless volumes of informative and entertaining content, have dramatically changed the way people use and appreciate technology. For many, the services of these organizations have become an indispensable part of their lives. These attitudes towards technology also carry over from personal life into business, setting the expectations of executives and IT decision makers in business-to-business activity.

Technology is reshaping the way we consume physical goods as well as digital services. Global e-commerce continues to grow at around 20% every year and sales, which passed the USD $3 trillion mark in 2019, are expected to exceed $4 trillion this year. The wide choice, competitive prices, and convenience offered by online commerce are transforming the retail industry at an accelerating rate and making a mark on business-to-business purchasing too. Today, e-commerce is dominated by a handful of very large players such as Alibaba, Amazon, and Mercado Libre. As sales and user numbers grow, these companies continue to expand and diversify their offerings. They are also continually evolving their operating models, in some cases vertically integrating their logistics operations. Non-traditional players are entering the e-commerce space too. Instagram, the image sharing platform owned by Facebook, for example, now allows its billion users to order products by clicking on advertisements displayed within the app.

The technology-driven revolution has plenty more room to run. E-commerce still accounts for only a sixth of total retail sales. There are many sectors that are only beginning to embrace online

Figure 2

commerce. The same experiences that consumers have of e-commerce are carrying over to businesses transactions. In the next decade, business-to-business e-commerce may transform the procurement of industrial equipment, automotive spare parts, and many other goods. The barriers that prevent companies from moving online are rapidly falling. And the emergence of a new generation of third-party vendor (3PV) solutions makes it much easier for even small organizations to add sophisticated e-commerce offerings to their existing business models, for example. The increasing prevalence of and familiarity with application programming interfaces (or APIs) in the logistics industry allows organizations of all sizes to connect core supply chain IT platforms with virtually any other system. For example, an API can connect inventory and order management systems with web shops and external fulfillment and logistics services.

Figure 2: Singles' Day in China epitomizes the size and continued growth of e-commerce, with Alibaba alone reporting in 2019 almost $40 billion in sales in 24 hours, a 26% increase from the previous year.

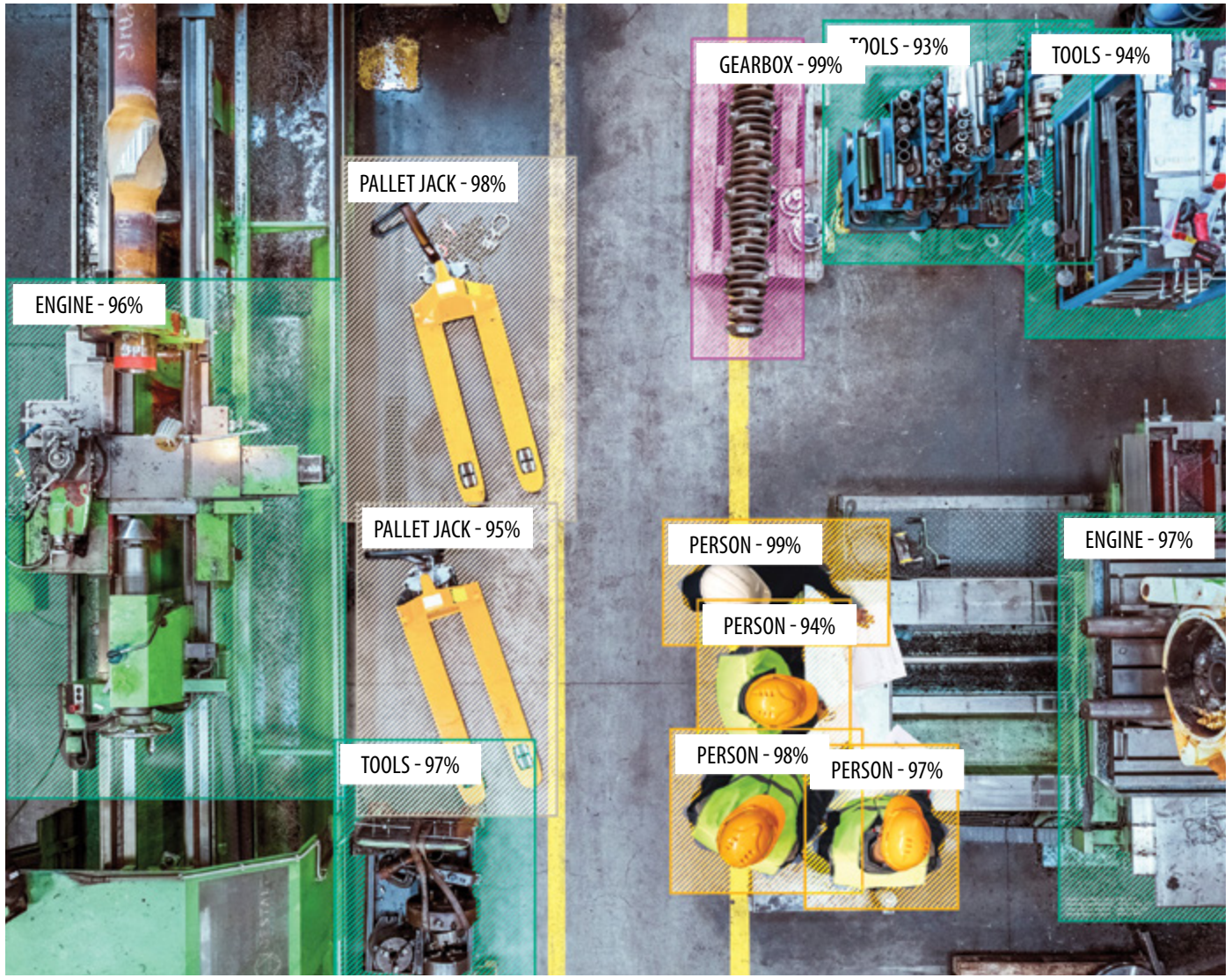


Figure 3

Investors pour capital into disruptive logistics technologies

Away from the interface between companies and their customers, technology is also disrupting the business of logistics. Since 2012, venture capitalists have poured almost $30 billion into the logistics sector. Today around 3,000 startups are working to develop new products, services, and business models in the logistics space. Innovation in logistics covers a broad range of technologies and activities, with four areas attracting particular interest and investment:

1. Big data and advanced analytics

Data is claimed to have taken the place of oil as the world's most valuable commodity, and logistics players operate in a particularly data-rich environment, handling millions of pieces of information about customer orders, shipment movements, and the location and condition of assets. Many supply chain organizations have put data analytics at the top of their strategic priorities, yet many still struggle to systematically and effectively make use of that data. This is driving interest in smart analytics techniques designed to help diagnose operational issues, optimize network planning, and predict future scenarios.

2. Artificial intelligence (AI)

AI lies behind a host of consumer-focused innovations, from targeted advertising to voice-activated virtual assistants. Beyond consumers, machine learning is becoming increasingly common in the business world. For logistics, artificial intelligence is critical to solve the most complex operational challenges like dynamic route optimization and precise capacity and demand prediction, as well as intelligent physical automation. The logistics industry is also embracing the arrival of workflow automation software commonly known as robotic process automation (RPA). Artificial intelligence will continue to play a vital role in the development of RPA, allowing these tools to address more complex, unstructured data formats and processes. According to research by the logistics industry trade association MHI, 79% of supply chain professionals now expect AI to become a core competence in their organization by 2022 and 88% believe it will help to improve risk management and predictability in operations.

Figure 3: Advancements in AI have refined computer vision so that tens of thousands of various objects can be accurately identified and tracked, even on busy facility floors.

Figure 4

3. Robotics and automation

Once the preserve of manufacturing operations, advanced robotics and automation technologies are becoming increasingly commonplace thanks to lower costs, improved capabilities, and the availability of products tailored to the unique needs of the industry. Among the key innovations behind this trend are autonomous driving technologies for both indoor and outdoor mobile assets and new flexible picking and manipulation systems. Robots are becoming easier to integrate too, powered by machine learning and powerful sensors that allow them to adapt rapidly to changing environments and work safely alongside logistics personnel.

4. The Internet of Things (IoT)

IoT has already had a profound impact on the world. Half the Earth's population can already access the internet through smartphones, and the rapid growth of IoT technologies has linked billions of objects. Now, a new generation of communications technologies promises to close the remaining connectivity gaps. 5G data networks offer higher speeds, vastly increased capacity, and greater flexibility for the connection of people and things alike. In addition, a host of other next-generation wireless technologies are emerging to bring everyone and everything online, everywhere. The development of IoT and these next-generation wireless technologies will bring total visibility to supply chains, greatly increasing transparency and service quality for operators and customers.

Beyond these trends, a host of other technologies has arrived on the market showing great potential, but these have yet to reach widespread use in logistics. Blockchain, the underlying protocol behind cryptocurrencies, has potentially game-changing benefits for leaner, faster, and more transparent and secure supply chains. However significant cultural and technical hurdles need to be overcome for broad deployment in logistics. Unmanned aerial vehicles (UAVs) and drone deliveries have captured the imagination of the industry for many years. Today niche players are realizing this vision, although regulatory frameworks may fail to keep pace with technical developments. Self-driving vehicles herald immense leaps forward in the efficiency and safety of logistics transport and so a number of players in the industry are actively exploring this space. For many new technologies, their time is still to come.

Volatility creates challenges and opportunities for logistics

Globalization is another dominant 21st-century theme with supply chains and distribution networks stretching out across the world. Today globalization is entering a new phase as emerging economies consume more of what they produce and countries in mature markets seek to improve the security of critical supply chains and the sustainability of their economies.

By 2025, it is expected the global economy will be dominated by three major centers of gravity: North America, the European Economic Area, and Greater China. Truly worldwide trade intensity has already declined as more commerce takes place within these blocs and less between them. And as global trade growth slows, regional trade is on the rise, giving new dynamism to globalization. In the e-commerce sector, for example, cross-border transactions are increasing at twice the rate of domestic counterparts. A fifth of all e-commerce shipments already require cross-border fulfillment.

While supply chains adapt to these long-term changes in demand, they must also cope with increasingly frequent storms. The UK's departure from the European Union in February 2020 created uncertainty over the future of supply chains between Britain and mainland Europe, for example. Meanwhile, the escalating trade war between the US and China has significantly impacted global supply chains, with new tariffs and counter-tariffs increasing the cost of some categories of goods by 15% or more almost overnight. With geopolitical uncertainty higher than it has been for many years, companies are continually reviewing and adapting their supply chains as they seek to balance cost, speed, and risk.

Figure 4: Over a thousand robots quickly navigate on tracks, fulfilling online grocery orders in an Ocado warehouse.

COVID-19: A Rare Catalyst for Logistics Innovation

Figure 5

Figure 6

The coronavirus pandemic presents unprecedented challenges to governments, healthcare systems, and businesses alike. Supply chains and logistics operations have been on the frontline of the crisis, trying to keep essential supplies moving in the face of significant transport disruptions, movement restrictions, and dramatic volatility in supply and demand.

COVID-19 has also been an opportunity for technology to prove its worth. Across the logistics sector, companies have embraced innovative solutions to help overcome difficulties and maintain operations in the most challenging circumstances.

Wearable technology

With travel bans and enhanced health and safety policies limiting access to manufacturing and logistics sites, companies turned to smart glasses and augmented reality (AR) solutions such as Ubimax xAssist. These systems allow a remote expert to support on-site personnel in troubleshooting, maintaining, and repairing complex equipment.

Maintaining a safe distance from co-workers has become a central element of most organizations' operational safety plans. But enforcing physical distancing can be difficult in a busy warehouse environment. Monitoring solutions such as Kinexon's SafeTag provide workers with an alert if they spend too long in close proximity with someone else. The data from these devices can also aid contact tracing in the event of an on-site virus outbreak.

Figure 5: Companies like Linde have utilized smartglasses and interactive AR technology to retain their high-quality maintenance services for their customers, albeit remotely.

Figure 6: Wearable technology can facilitate adherence to health and safety protocols, such as social distancing in workplaces.

Figure 7

Figure 8

Figure 9

3D printing

As the world faced acute shortages of personal protective equipment (PPE) and critical medical devices, 3D printing technologies provided an important source of additional supply. Companies from multiple sectors used their 3D printers and additive manufacturing machines to make a range of desperately needed items, from face shields to ventilator valves.

Contactless operations

Sharing items such as hand-held scanners presents a risk of virus transmission. Where operations permit, logistics facilities have adopted fixed presentation scanners such as those developed by Cognex for rapid scanning of all items with no need for operators to touch the machine.

As concerns around COVID-19 persist and person-to-person transmission remains prevalent, supply chain organizations and brands are investing more heavily in contactless delivery options such as parcel lockers, autonomous delivery robots, and in-app signature software. These solutions minimize contact between recipients, deliverers, and couriers.

Robotics and automation

Unloading trailers of loose shipments is one of the most physically demanding jobs in the logistics industry. And it typically requires multiple people to work in close proximity within a container. For containers loaded with single-size cartons, robotic trailer unloading solutions such as those from Copal Handling Systems allow the partial automation of this task while keeping workers at a safe distance from each other.

As people sheltered at home and as retail stores closed during the height of the pandemic, there was a dramatic increase in e-commerce volumes. But at the same time fulfillment facilities were facing labor shortages as staff became sick or needed to self-isolate. Assisted picking robots such as those from Locus Robotics helped more automated facilities to meet the sudden spike in demand.

Figure 7: A fleet of LocusBots await deployment to collaborate with DHL operators in the fulfillment process, keeping productivity high despite a limited workforce during the pandemic.

Figure 8: 3D printers have been employed globally to locally manufacture face shields and other essential products en masse. Source: Production Engineering Solution.

Figure 9: Scanners like those by Cognex limit the need for operators to touch hardware and products.

Looking Forward: Building Resilient, Sustainable, and Future-Proof Supply Chains

While COVID-19 commandeered the strategic agenda of virtually every supply chain organization in 2020, it must be recognized that complications from the global pandemic are amplifying several trends. These trends have been shaping the logistics industry for years – the need for resilience, sustainability, and technology maturity in supply chain organizations.

Managing risk with resilience

Efficiency has long been the number one supply chain priority for most companies. Efforts to minimize overall cost have driven the development of low-cost sourcing strategies and just-in-time delivery in many industries. For the most part, these approaches have been extremely successful but recent events, from trade wars to the coronavirus, have brought their weaknesses into the spotlight.

Volatile demand, supply interruptions, and the imposition of new tariffs leave companies scrambling to reconfigure their supply chains. That can be difficult to do when there is little slack in the system or when critical materials are only available from a single supplier or a single region.

Figure 10

For most companies, supply chain risk management is a reactive process. When problems occur, a company builds a temporary taskforce to manage issues on an ad hoc basis. That strategy works, but it can mean precious time is lost as organizations pull together the people, resources, and information required to mount an effective response.

The frequency and severity of recent disruptions encourage many organizations to rethink their approach to supply chain risk. Leading companies are now building proactive risk management systems with a focus on digital tools and well-rehearsed mitigation strategies.

Consultancy PricewaterhouseCoopers (PwC) expects significant growth in the adoption of tools that automate the collection and analysis of supply chain data. Advanced visibility and control platforms will improve a company's ability to understand and react to fast-changing situations but the unpredictable nature of supply chain disruption often means that people, not algorithms, are needed to coordinate an effective response.
As resilience and agility become key dimensions of performance, demand for skilled supply chain personnel is likely to rise, with knock-on effects in recruitment, training, and career development approaches.

The difficult operating environment of 2019/2020 has increased interest in multisourcing strategies, with proponents valuing the increased flexibility and resilience that is brought by sourcing critical parts, materials, and services from a diverse set of suppliers. Rising labor costs and increased automation are opportunely eroding some of the cost advantages of traditional supply chains to the benefit of under-tapped, alternative geographic regions. We expect multisourcing to be on the agenda for the coming years, driven by the enduring macro-force of globalization, but we consider a fundamental reconfiguration of manufacturing and logistics in the near future as unlikely.
In surveys, 84% of businesses currently producing in China have no plans to move their manufacturing operations out of the country, and 74% of companies that source from China say they will continue to do so.

For many organizations, supply chain diversification is likely to be a key part of long-term resilience plans. Sourcing critical goods and services from multiple suppliers in different regions provides companies with more options when problems occur, and the same logic supports the use of multiple production facilities and distribution locations.
In the coming years, we expect more organizations to adopt a China Plus One strategy, with suppliers and manufacturing capacity in the country supported by alternative sources and facilities elsewhere.

Figure 10: Due to COVID-19 travel restrictions, airlines like Lufthansa have swiftly enacted resiliency measures, repurposing seating areas for cargo transport to offset the rapid decline in passengers.

The new sustainability imperative

If the coronavirus pandemic has a silver lining, it is the sudden and dramatic reduction in pollution precipitated by the worldwide economic slowdown. Road traffic fell to levels not seen for decades, with consequent improvements in local air quality. The International Energy Agency estimates that global greenhouse gas emissions will be around 8% lower this year as a result of the virus. That means 2.6 billion fewer tons of carbon caused by human activity will enter the atmosphere.

The impact of the shutdown may not last – air pollution in many major cities returned to pre-crisis levels as lockdown restrictions eased – but sustainability will remain high on the agenda for supply chain professionals. Pressure to do more for the environment is coming from multiple sources. 76% of millennials, for example, consider a company's social and environmental commitments when choosing a job. More than 50% of DHL customers now ask for information on responsible business practices as part of their tender processes. 79% of institutional investors say environmental impact, social impact, and governance structure (ESG) are part of their fiduciary responsibility

Figure 11

to clients. The size of investments with a specific ESG focus has tripled since 2017.

Businesses in multiple sectors are now making environmental commitments a central part of their strategy. Major oil companies including BP and Total have announced plans to move to net zero carbon emissions over the coming years, for example. DHL aims to become a zero-emissions organization by 2050 and has already put more than 11,000 electric delivery vehicles into operation.

The drive for sustainability goes beyond greenhouse gas emissions. The impact of solid waste, especially plastics, is coming under increasing scrutiny around the world. Before the coronavirus pandemic, many regions were already introducing bans on single-use plastic products. The growing mountain of used masks, gloves, and other PPE generated during the crisis is now pushing the issue of plastic waste back up the agenda.

Companies are already responding to demand from consumers and regulators to reduce the impact of waste packaging. Consumer goods giant Procter & Gamble, for example, aims to make 100% of its packaging fully recyclable by 2030. The company already uses post-consumer waste material in the packaging of some products. Secondary packaging is also under scrutiny, especially the rising quantities of material used to protect products in e-commerce supply chains, with companies exploring a variety of options from bio-based and compostable materials to closed-loop returnable packaging systems.

Figure 11: The world cannot hope for a sustainable future without serious, measurable action, including reversing the growing generation of packaging waste.

The future-proof supply chain powered by people and technology

Robotics and automation, big data analytics, machine learning, sensors, IoT, and next-generation wireless will continue to play a critical role in the future of supply chains. This digital transformation was already well underway before the coronavirus crisis, but change has taken on a new urgency as executives look for ways to protect their organizations from future disruptive events. 37 of 80 chief financial officers (CFOs) in one PwC survey say that accelerated automation across their organization will be part of their post-COVID strategy.

As companies digitize their processes, they are finding that increased transparency and flexibility fuels demand for further digitization. Customers quickly come to appreciate the benefits of faster delivery, higher service levels, and clear communication. That ramps up pressure for flawless execution and ever-increasing efficiency. It is also encouraging companies to explore a wider range of technologies. Today's robots, IoT devices, and data analytics systems will soon be joined by autonomous vehicles and blockchain-based data platforms, for example.

The ultimate goal for many organizations is a supply chain that is both automated and agile, capable of sensing, adapting, and learning as supply and demand conditions change.

As digital approaches become increasingly central to supply chains and logistics processes, however, companies are realizing that they need to pay more attention to the human side of their activities. Digital systems need people to build, maintain, and improve them, and supply chain operations require close and continual collaboration between people and machines.

Organizations that fail to recognize the central role of people in the success of their supply chains are already running into problems, from shortages of skilled personnel to the outright rejection of promising new technologies. In the coming years, companies will need to address these issues by taking a human-centered approach to innovation. Leaders are already working hard to foster a digital mindset: establishing positive cultural norms, standardizing processes, and continuously training and reskilling the workforce.

Figure 12: A DHL warehouse operator dons smartglasses while displaying a smart ring wrapped around their fingers.

Figure 12

Putting Vision Into Practice

Developing the 5th Edition of the Logistics Trend Radar

How does the logistics industry understand and see the potential of technological breakthroughs in ever-changing social and business landscapes? Since 2013 at our DHL Innovation Centers, we have developed and continually updated the Logistics Trend Radar to highlight upcoming trends that will be relevant and will impact future logistics. Complementing classic research methodologies, our unique and integrated customer-centric innovation approach helps us to interpret, evaluate, and prepare for what is to come.

Figure 13

Our three Innovation Centers – located in Germany, Singapore, and the US – form a nexus of inspiration, connection, and engagement for our customers, partners, and colleagues. These centers foster the exchange of perspectives and new ideas that drive logistics innovation.

In order to separate the important signals from background noise in today's dynamic world, we have maintained three key values in developing the 5th Edition of The Logistics Trend Radar: staying close to customers, close to new technology, and close to operations.

Close to customers

Since the previous edition of the Logistics Trend Radar (2018), DHL Innovation Centers have welcomed and engaged thousands of customers globally for meetings, workshops, tours, special events, and joint innovation projects. Each of these touchpoints cultivates honest conversation on customer pain points and unmet supply chain needs. Often this validates ideas, develops use cases, and leverages emerging technologies with direct customer buy-in and involvement.

The short feedback loops in these productive discussions empower us with the latest knowledge on the most relevant trends, technologies, and applications for customers. By engaging with supply chain leaders across industries, including automobility, engineering and manufacturing, life sciences and healthcare, e-commerce, fashion, technology, and energy, we strive to keep a balanced picture of the trends impacting supply chains universally and those that are disproportionately impacting specific industries.

Close to new technology

While the logistics industry is rarely first to adopt new technology, supply chains are now undergoing tremendous innovation, propelled primarily by the rise of logistics startups and by technological advances and breakthroughs. For many players in the logistics space, there has never been a better time to leverage novelty, whether through collaboration with partner startups to co-create new solutions or through in-house development of new, sophisticated tools based on operational data, machine learning, and modern IT platforms.

Since the publication of the previous Logistics Trend Radar, we have worked directly with over 100 startups and tracked more than 1,000 to bring new technologies into logistics operations on behalf of our customers. This hands-on approach allows us to learn the jargon and appreciate all the complexities that new machines and tools often entail, from training neural networks for computer vision systems that utilize artificial intelligence (AI) to identifying which obstacles are navigable by autonomous robots on facility floors. In a world where the pace of change is accelerating, and the disruption from innovation is becoming more commonplace, staying at the forefront of emerging technology is now an inherent part of doing business in the logistics industry.

Figure 14

Figure 13: Welcoming visitors since 2015, the DHL Innovation Center in Singapore showcases new technology to inspire customers in the Asia-Pacific region.

Figure 14: Visitors are encouraged to interact with the dozens of pioneering exhibits, from smartglasses to logistics robots, at each of the Innovation Centers, like this one in Troisdorf, Germany.

Figure 15

Figure 16

Figure 15: The DHL Innovation Center in Chicago is the newest addition, bringing customers closer to technology in the Americas region since opening in late 2019.

Figure 16: Teams from the DHL Innovation Centers frequently spend time in internal and customer facilities in their respective regions to understand current operations and to lead and support supply chain projects involving cutting-edge technologies.

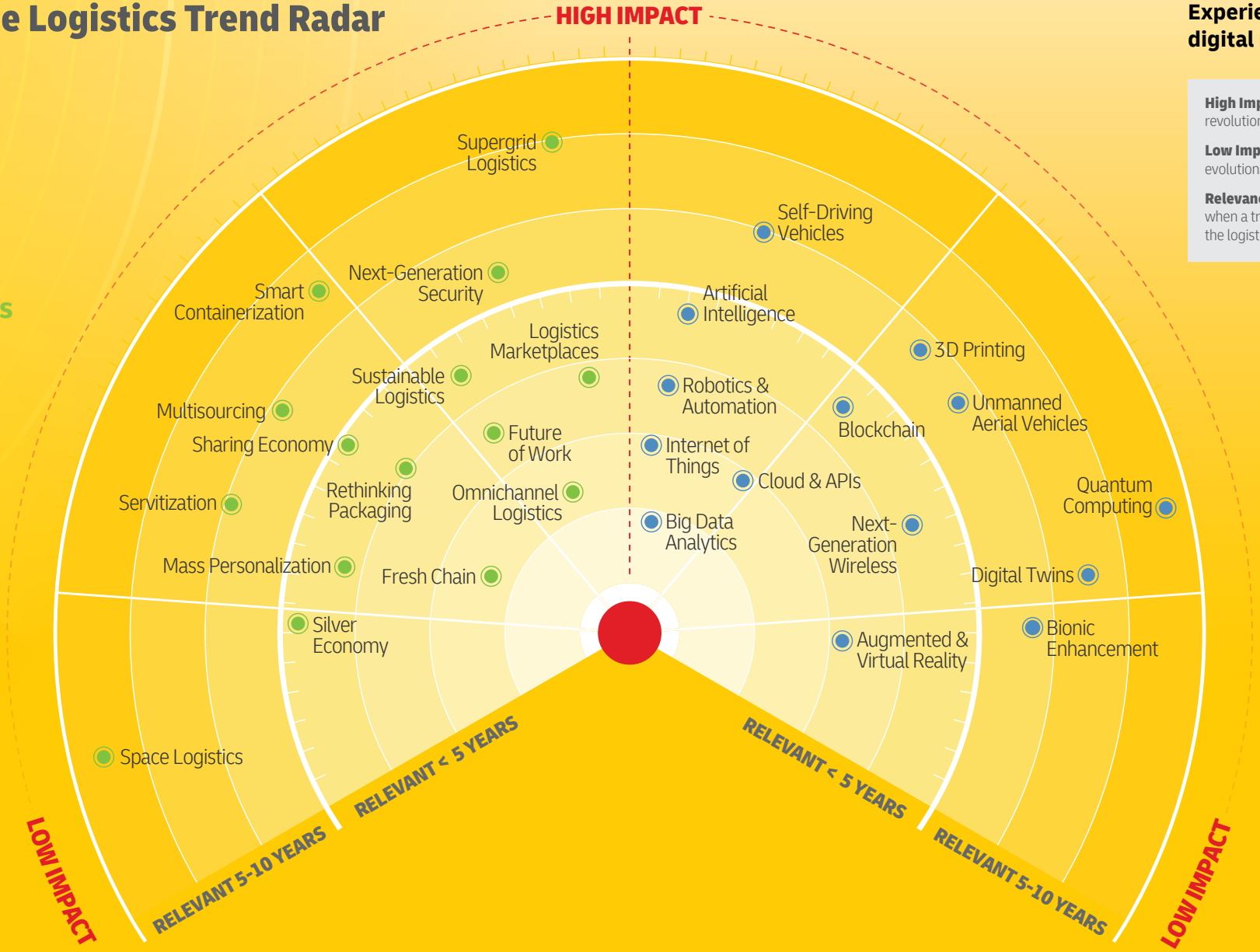
Close to operations

Renewing and sustaining a deep familiarity with air, ocean, road, and rail logistics operations are vital to understanding the relevance of emerging trends and their impact on the industry. Designing sortation equipment in warehouses, planning delivery routes and freight networks, loading and unloading aircraft and delivery vans, picking, scanning, palletizing, and dimensioning shipments – supply chains are an intensely physical business in which the harshness and complex realities of operations alone may determine the success or failure of a new technology solution.

As logistics innovation leaders, we spend significant time in on-site operations. We liaise with both management and workers, walking in their shoes, seeing and listening to their needs, all to better visualize solutions that can be leveraged to improve supply chain processes. By starting small with isolated pilot projects, while thinking big for standardization and scaling, we have been able to successfully deliver innovations, such as computer vision for dimensioning packages and smartglasses for picking orders, directly to customer operations.

Thanks to you – our customers, technology partners, and colleagues – we have been able to validate industry developments and technological advances with practical reality. With supply chains underpinning resilience in a dynamic world, we proudly introduce to you our fifth edition of the DHL Logistics Trend Radar. We hope it delivers insights and inspiration for your innovation endeavors!

At a Glance: The Logistics Trend Radar



Experience the interactive digital radar!

High Impact:
revolutionary applications that are potentially disruptive

Low Impact:
evolutionary changes with incremental improvements

Relevancy:
when a trend will become ubiquitous or commonplace in the logistics industry as a whole

In Depth

Trend Assessment: What Has Changed Since the Last Logistics Trend Radar?

Logistics trends are inherently kinetic, endlessly shifting positions and momentums as larger macro-forces – like demographics, government policies, and customer demand – combine and conflict, shaping the industry landscape. Over the last two years, the DHL Innovation Centers have witnessed and tracked numerous exciting advances, as well as unexpected setbacks, within the trends across the Logistics Trend Radar, and the DHL Trend Research Team has adjusted the position of each trend to reflect the average weight of new developments.

In general, logistics trends have predictably inched closer towards the center of the Logistics Trend Radar as they become more relevant over time, with some additionally experiencing a slight adjustment to their impact value. Other trends have seen larger movements or have been renamed, removed, or welcomed as new to this edition. The biggest and more noteworthy changes are described below.

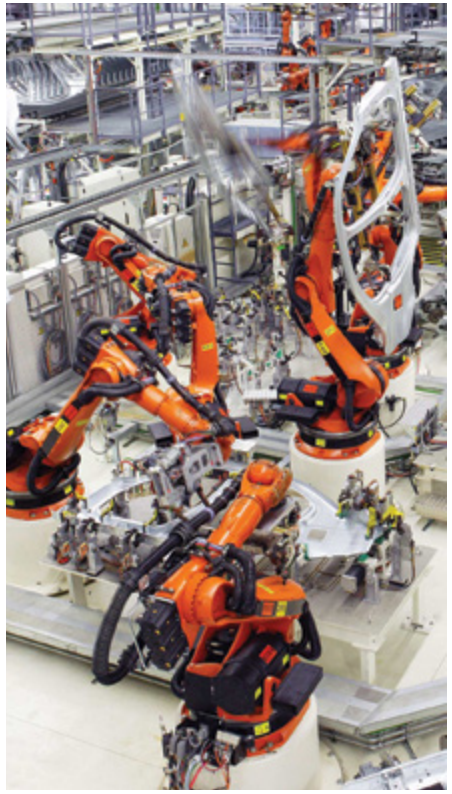


Figure 17

NEW TRENDS

Name	Impact	Relevancy	Explanation
Multisourcing	Medium	> 5 years	As economic and political circumstances change, so too does the logistics industry. While the second half of the 20th century saw much reliance on East Asia as a production center, advances in robotics and computing in the 21st century – combined with contemporary changes in government policies, workforce skills, and consumer demand – have now unlocked production in many global regions previously inaccessible or not considered. Furthermore, increasingly more frequent natural disasters and other force majeure events, from tsunamis to trade wars, have disrupted and even fully incapacitated once lean and reliable supply chains. With the need for resiliency on the rise, globalization is expanding with the geo-diversification of supply chains. The implications for Multisourcing in logistics are recognized and discussed as a new trend in this edition of the Logistics Trend Radar.
Next-Generation Security	Higher	> 5 years	Security and privacy are values already at the heart of the logistics industry, but recent technology (although generally beneficial) has been misused to target, exploit, and disrupt supply chains around the world. To combat these 21st-century threats and further close older gaps, the trend of Next-Generation Security involves a new wave of security products and services. These are smarter and more resilient than the dangers and risks they are required to subdue. No other logistics trend on the previous Logistics Trend Radar properlyy reflected the upcoming generation of best practices in cybersecurity and intelligent physical security. This is why Next-Generation Security is featured as a new trend in this edition.
Rethinking Packaging	Medium	< 5 years	Packaging is one of the few components that is practically universal throughout the logistics industry. Primary, secondary, and tertiary packaging interacts with numerous players along entire supply chains and often dictates how operations are performed at each step. With many industry leaders and participants seeking to automate, reduce waste, and explore reusable and cyclic models for their packaging, as well as adapt supply chain operations in suitable ways, it is appropriate to introduce a new trend focused exclusively on developments around packaging. This edition of the Logistics Trend Radar welcomes the new logistics trend of Rethinking Packaging.
Space Logistics	Lower	> 5 years	Owing to renewed economic and political interest around the world, and greater liberalization and privatization, the 21st century has been deemed the start of a new space race. Governments have announced plans and contract bids for the upcoming decade to explore and settle on the Moon and Mars, and large corporations have begun launching thousands of satellites into orbit for Earth-based digital services. As more humans and machinery operate in outer space, the safe delivery of goods and products through Earth's atmosphere and throughout space will become increasingly crucial. Thus, Space Logistics is a new, although distant, logistics trend in this edition.
Quantum Computing	Medium	> 5 years	Having appeared in a past Logistics Trend Radar, the trend of Quantum Computing and its revolutionary computing paradigm disappeared for a while as the technology remained in the realms of research and academics, and its applicability to the logistics industry was beyond the 10-year scope. However, in the last two years, this trend has rapidly progressed, with large corporations building and offering their quantum computers for commercial services. While many more advances are needed before widespread adoption, Quantum Computing is welcomed back as a logistics trend in this edition.

Figure 17: The proliferation of robotics in the manufacturing process has shifted the economic landscape such that production centers may feasibly move to other regions around the world.

Figure 18

Figure 19

REMOVED TRENDS

Name	Impact	Relevancy	Explanation
Connected Life	Medium	< 5 years	While it held a central position in the previous Logistics Trend Radar, the Connected Life trend has now departed. The “always-on, always-connected” lifestyle at the core of this trend became superfluous when considering the “everyone, everything, everywhere” concept of connectivity idealized in the trend of Next-Generation Wireless. Additionally, over the last two years, readers have more closely identified logistics applications with the Internet of Things, Big Data Analytics, Artificial Intelligence, and other trends rather than with Connected Life. It has therefore been removed from this latest edition, and readers can find its applications among other associated trends.
Fair & Responsible Logistics	Medium	< 5 years	The removal of this trend was a difficult decision as it reflects the important call to balance maximizing revenue with environmental protection and societal welfare. However, the environmental protection aspect shared much common ground with the renamed and remodeled Sustainable Logistics trend and the new Rethinking Packaging trend. Meanwhile, the imperative of social responsibility while doing business was elevated and acknowledged as a macro-force that applies and shapes all trends in this edition. When engaging with trends from Future of Work to Quantum Computing, readers should be mindful at all times of how they conduct business and the impact that their decisions have on individuals and communities.
Tube Logistics	Lower	> 5 years	In the previous Logistics Trend Radar, Tube Logistics was recognized as a trend resting on the outer edges that could yield new, alternative modes of transport for packages and freight. Like most trends before it, this trend is on a steep part of the hype curve but remains there. The potential viability of the technologies and the impact that Tube Logistics will have on the industry are limited without a life-sized operating proof-of-concept. Tube Logistics is therefore considered to be outside the 10-year scope of this Logistics Trend Radar. However, it is not without precedent that an excluded trend can develop, mature, and find its way back into a future edition.
Low-Cost Sensor Solutions	Medium	< 5 years	The trend of Low-Cost Sensor Solutions found its way into the center of the Logistics Trend Radar – it is within the “here and now” of logistics and has realized ubiquity within the industry as a whole. Low-cost sensors can be found at every stage of the supply chain and across all supply chain players. Simply put, the Low-Cost Sensor Solutions trend is no longer upcoming but is now part of the new normal of today. It has therefore been removed from this edition.

Figure 18: The “always-on, always-connected” theme of Connected Life often found itself in many other logistics trends, and so the trend has been dissolved.

Figure 19: Without a life-sized operating model, Tube Logistics has been removed from this edition of the Logistics Trend Radar but may see a welcomed return in future editions.

Figure 20

RENAMED AND REMODELED TRENDS

Name	Impact	Relevancy	Explanation
Future of Work	Higher	< 5 years	Previously called Digital Work in the last Logistics Trend Radar, the name of this trend was modified to align more with industry terms. In addition, Future of Work highlights how readers may future-proof their workplace and workforce for the upcoming wave of digitalization and automation.
Mass Personalization	Medium	< 5 years	Once called Batch Size One, this trend is now Mass Personalization to expand on the hyper-personalization and customization that is emerging in manufacturing. This new name includes the growing desire for individualized services along the supply chain.
Silver Economy	Lower	< 5 years	Formerly Grey Power Logistics, this trend is renamed Silver Economy to reflect the shifting needs and demands of the aging global population, both as older workers and as elderly consumers.
Sustainable Logistics	Higher	< 5 years	Known previously as Green Energy Logistics, the name of this trend has changed to Sustainable Logistics. This is because green practices within the logistics industry should and currently do extend beyond energy and fuel topics, impacting all aspects of transportation and the supply chain.
Augmented & Virtual Reality	Lower	< 5 years	Augmented Reality has now been paired with the Virtual Reality component of the previously named Virtual Reality & Digital Twins trend. This is because both technologies often rely on similar hardware like headsets, and the two concepts are frequently perceived as related by the industry and by readers.
Digital Twins	Medium	> 5 years	Called Virtual Reality & Digital Twins in the previous edition, Digital Twins now stands as its own technology trend, for the reasons given above.
Cloud & APIs	Higher	< 5 years	Formerly Cloud Logistics, this trend is now renamed Cloud & APIs to acknowledge the importance and various applications of APIs in the logistics industry.

Figure 20: TORE is a revolutionary, wall-less, 180-degree view virtual reality CAVE system designed by Antycip Simulation that can provide immersive experiences for up to 20 people at once.

Figure 21

Figure 22

TRENDS CROSSING INTO 5-YEAR RELEVANCY

Name	Impact	Relevancy	Explanation
Mass Personalization	Medium	< 5 years	With the expansion of scope, the newly named and remodeled Mass Personalization trend deserves prominence closer to the center of the the Logistics Trend Radar. On the manufacturing side, increased demand for uniqueness, paired with recent advances in 3D printing technology and other machinery, enables more and more companies to produce individually curated products cheaper and faster. On the service side, better online platform algorithms and improved artificial intelligence make personalized customer engagement and experiences on a massive scale more of a reality. Solutions abound, and readers should investigate how to achieve individualized services and products.
Silver Economy	Lower	< 5 years	Markets may fluctuate and new technologies may arise, but the global population continues to get older. With more than 1 billion people aged 65 and over by 2030, players in the logistics industry should begin adapting policies and environments to support an older workforce, while also accommodating the needs of elderly customers with new services and products.
Artificial Intelligence	Higher	< 5 years	The trend of Artificial Intelligence has embedded itself in numerous applications throughout the supply chain, heavily influencing and enabling many other trends like Mass Personalization, Self-Driving Vehicles, and even Sustainable Logistics. From computer vision on facility floors to natural language processing in customer service, Artificial Intelligence is here to stay and will proliferate further. Readers are encouraged to explore how they may benefit and make timely investments in the countless AI-based solutions on the market.
Blockchain	Medium	< 5 years	While subject to much hype over the past decade, the trend of Blockchain has endured and simultaneously matured as an important trend for reader consideration. The previous edition of the Logistics Trend Radar identified realistic, meaningful applications for the trend in the logistics industry. Now, this new edition recognizes the traction Blockchain has obtained within impactful applications. Industry participants from manufacturers to last-mile deliverers have begun enrolling in shared blockchains, and, in a few years, as more players adopt, even highly fragmented supply chains will likely be exposed to the trend and its associated benefits.
Next-Generation Wireless	Medium	< 5 years	Although incorporating a diverse array of technologies such as LPWAN and Wi-Fi 6, the trend of Next-Generation Wireless has been significantly bolstered by the imminent arrival of 5G. With a substantially higher data rate and device connection capacity, 5G hardware is slowly being installed in communities globally and incorporated in everyday devices like smartphones. Overall, readers should begin to prepare for next-generation wireless technologies, especially those with sensor-heavy ambitions.

Figure 21: The advantageous person-to-person transfer of knowledge gained from years of experience will be disrupted in companies that do not accommodate the needs of their oldest members.

Figure 22: Global usage of superfast 5G networks is expected to soar as infrastructure is installed and smartphones are made ready for the new technology.

In Depth

Social & Business Trends

Section Contents

In this edition, each trend summary also contains an analysis of sectors that are of highest relevance to the trend based on the feedback of logistics experts.


Auto-Mobility


Engineering & Manufacturing


Technology


Energy


Life Sciences & Healthcare


E-Retail & Fashion

FRESH CHAIN

Orders of groceries, meals, and pharmaceuticals are driving growth in the fulfillment and delivery of temperature-controlled goods through standard networks, creating new challenges for picking, packaging, and transporting shipments with temperature integrity. To enable this fresh chain of single shipments, the industry must develop and implement special processes, innovative cold-chain packaging, and optimized infrastructure.

KEY OPPORTUNITIES

- New business opportunities from increased volume of online grocery and prescribed medicine deliveries driven by COVID-19
- Leveraging innovative packaging solutions to boost cold-chain service quality and resilience
- Using next-generation wireless and IoT technologies for greater visibility, control, and collaboration in cold-chain networks

KEY CHALLENGES

- Maintaining accurate, real-time temperature and condition monitoring compliance for perishables and pharmaceuticals
- Greater hygiene requirements in the cold-chain networks because of COVID-19, e.g. contactless, paperless data logging
- High cost and inefficient return logistics of temperature-controlled packaging solutions

Trend Assessment

Timeframe: < 5 years Impact: Medium Sector Relevance: Below

AUTO E&M TECH ENERGY LS&H E-RETAIL

KEY DEVELOPMENTS & IMPLICATIONS

For the past two years, the global online fresh food industry has experienced dynamic changes, albeit disproportionately across regions. Pre-COVID-19 forecasts had Asia leading online grocery sales, doubling market size through 2023 to reach $295 billion. In the US, sales increased by 15% in 2019, while the average basket size expanded by 6%. Meal kit subscriptions like HelloFresh and Blue Apron – providing weekly recipes to aspiring home chefs with fresh, apportioned ingredients – skyrocketed, with more than 150 active players in the US alone in 2019. Not to be outmaneuvered, grocery store chains globally have responded by offering their own meal kit services to customers. Meanwhile in the medical industry, virtual consultations gained traction, especially for minor illnesses and regular follow-up consultations, leading to more deliveries of prescribed medicine to patients.

COVID-19 and subsequent lockdowns have accelerated the growth and normalization of fresh chain. South Korean online grocery sales jumped by 92.5% in February 2020 when infections were peaking, while the American grocery pick-up and delivery service Instacart experienced a 500% year-on-year) upsurge in order volume and a 35% increase in average basket size. Still, the results are mixed as fresh produce and medicine supply chains struggled to keep pace with unprecedented demand spikes. With increasing demand for home deliveries in the future, the logistics industry must develop and adopt new strategies and operational models to build resilience. Regardless of whether or not the acceleration of fresh chain will continue after the pandemic, increased flexibility and agility will be the way forward.

On-demand delivery of fresh goods is expected to continue surging with more retailers offering omnichannel experiences. However, culture, accessibility to fresh products, and infrastructure will determine the shape and success of such services across countries. In digitally integrated and highly urbanized China, the country's largest hypermarket chain Sun Art rolled out 1-hour delivery services from all its stores in 2018. In car-centric US, the Buy Online, Pickup in Store (BOPIS) model prevails, with 90% of brick-and-mortar retailers anticipated to offer BOPIS by 2021. Meanwhile, grocery e-commerce has grown only modestly in Germany during the pandemic as people continued to visit local shops multiple times a week to get fresh produce. Supply chain professionals will need to tailor strategies and infrastructure, such as bundled refrigerated orders and automated subscriptions, to each location to best optimize operations.

Global cold-chain networks are penetrating more markets as refrigeration and monitoring technology becomes cheaper, allowing perishable and temperature-sensitive shipments to travel further. Africa-based startup Solar Freeze is pioneering mobile cold storage units that resemble shipping containers with solar panels. With postharvest losses in developing countries often as high as 80% due to lack of refrigeration, Solar Freeze seeks to empower smallholder farmers with reliable temperature control through renewable energy, extending produce shelf life by weeks or even months. The startup has also extended its services to include affordable refrigerated delivery – a rarity in many regions – bringing longer-lasting and fresher agricultural produce from farms to markets. Developments in the IoT space have additionally contributed to the growth of cold-chain networks. Recently, German-based Axino Solutions created a product that leverages long-range (LoRa) devices and long-range wide-area network (LoRaWAN) protocols to remotely track and adjust food and pharmaceutical temperatures in real time, accurate to within one degree Celsius. This effectively replaces the labor-intensive task of checking and recording temperatures with a probe thermometer and manually correcting refrigeration temperatures accordingly.

Fresh packaging innovations will enable sensitive biotic products to be transported safely while cutting down on waste. For instance, MaxQ's MaxPlus clinical trials shipper constantly measures the internal thermal energy level for up to 120 hours and provides a data-driven thermal energy management system to predict when intervention is required, allowing pharmaceutical samples to be sent through standard networks and services without the need for climate-controlled trucks and containers. Barcelona startups ColorSensing and Freshcode both offer intelligent packaging labels that change color based on different parameters, such as temperature and the release of volatile gases. It is estimated that almost 90 million tons of food can be saved each year in the EU alone by replacing "use by" or "best by" labels with more accurate and intelligent ones, and this will reduce incidences of food poisoning.

Figure 23

Figure 24: Solar Freeze has pioneered solar-powered refrigeration for smallholder farmers in Africa, where postharvest losses of grown produce can reach up to 80% due to lack of cold storage.

Figure 24

FUTURE OF WORK

Automation, an aging population, the rise of the millennial workforce, and the COVID-19 pandemic are greatly transforming work in the logistics industry. Humans working collaboratively with robots, flexible work systems, continuous learning, and upskilling will help businesses future-proof, stay competitive, and attract and retain the workforce of the future.

KEY OPPORTUNITIES

- Increased employee satisfaction and retention through more creative tasks, career development, and a flexible work environment
- Higher efficiency and cost savings through more flexible and on-demand workforce models
- Technology-aided workforces have higher productivity and better morale as time-consuming, repetitive tasks are automated

KEY CHALLENGES

- Ensuring sufficient wages and job security when deploying on-demand workforce models
- Overcoming employees fears and reservations about new technology and a changing work environment
- Providing the proper training and infrastructure for employees to meet work requirements of the 21st century

Trend Assessment

Timeframe: < 5 years Impact: Higher Sector Relevance: Below

AUTO E&M TECH ENERGY LS&H E-RETAIL

KEY DEVELOPMENTS & IMPLICATIONS

After slow growth in the last two decades, the uptake of industrial robots is expected to increase globally almost seven-fold to 20 million by 2030. This will have a major impact on industries like logistics, and transform today's way of working. A McKinsey report estimates 49% of paid human labor activities, or $16 trillion in paid wages, could already be automated with existing technology. Furthermore, a recent survey found that half of US and two-thirds of Chinese executives anticipate employment decreasing in the next 5 years because of advanced robotics. While worrying, automation does not necessarily mean a complete loss of jobs, merely a shift in the types of jobs, especially those involving critical thinking or creativity. The World Economic Forum expects automation to replace 75 million jobs globally by 2022 yet also generate 133 million new ones.

Figure 25

Other key drivers influencing the future of work are: the aging workforce and the subsequent global industry labor shortage; the rise of millennials and Gen Z who seek jobs with more purpose, less repetitive tasks, and more flexible and enjoyable work environments; and lastly COVID-19, which introduced significant change as many businesses quickly embraced remote working technologies that existed for years. With the post-pandemic era uncertain, it remains to be seen how these changes will persist in future.

Human-machine collaboration will accelerate in two ways – a growing presence of robots in more supply chain steps and an optimized safety buffer between humans and machines. More humans are exposed to and getting familiar with robots as machines expand in breadth and diversify, handling tasks from picking online orders with robotic arms to processing customs documents through workflow automation software. As robots proliferate in supply chains, they are also getting better. They are reaching levels in strength, speed, and precision that can sometimes match or even surpass human capability. Also with improved sensors and machine learning, robots have been able to work closer with humans, minimizing the safety buffer and enabling more collaborative work.

The flexible, on-demand workforce will be a future model for both logistics office and operations roles. With 92% of millennials identifying flexible work schedules as a top priority and with COVID-19 challenging established workplace perceptions, businesses are rethinking many fundamental workplace assumptions to attract and retain talent. As the logistics industry is highly labor intensive and sensitive to fluctuations in the global economy, optimally matching the number of workers to operational demand is one of its biggest challenges. Here, mobile apps and dynamic staff scheduling software that matches temporary workers with high-demand facilities are likely to become commonplace in the near future. Californian startup Phantom Auto engages this trend from a particular angle. Already contracted with last-mile delivery company Postmates and other logistics companies, Phantom Auto uses technology and hardware that allows workers to control remotely semi-autonomous sidewalk rovers, warehouse forklifts, and yard trucks from the comfort of their homes and local centers. Employees are transported digitally around the world on demand to help guide vehicles when problems arise. All these opportunities can increase worker satisfaction and positively impact the company's bottom line. With 60% of employees working flexibly, Dell has been able to cut down on office space, saving $12 million annually since 2014.

Training and upskilling will be crucial for businesses to stay ahead of the curve in the new era of work, with 76% of companies training their current employees in 2020, a jump from 55% in 2018. Many are realizing that they can no longer rely on hiring the skills externally and that it is a lot more cost effective and efficient to train existing employees, develop talent, and promote internally, all the while boosting company morale and attracting future recruits. Recently, Walmart invested $2 billion in wages and training programs to help its workers improve their talents, including valuable soft skills. Concurrently, as its processes become more robotic and automated, Amazon has committed $700 million in training to upskill and retain 100,000 of its employees.

Figure 25: DHL warehouse operators collaborate with LocusBots in the picking process to increase their productivity and limit the total distance they need to travel on foot during a shift.

THE WORLD ECONOMIC FORUM EXPECTS AUTOMATION TO REPLACE 75 MILLION JOBS GLOBALLY BY 2022 YET ALSO GENERATE 133 MILLION NEW ONES.

Figure 26: In the coming future, more employees will be able to work remotely, even drivers through enabling hardware and software by Phantom Auto.

Figure 27: As robots and digital screens become more prevalent along the supply chain, employers must train and upskill their workers to help retain talent.

Figure 26

Figure 27

LOGISTICS MARKETPLACES

Logistics marketplaces aggregate shipper demand and carrier supply across increasingly complex supply chain networks. Providers of these digital brokerage services offer a centralized marketplace to manage not only delivery rates and schedules but also additional services such as shipment visibility and customs document management, providing customers with an enhanced and tailored digital experience.

KEY OPPORTUNITIES

- Increased price transparency through multiple comparisons in the digital marketplace
- Real-time quoting, communication, and flexible execution of transactions
- Flexible sourcing of externally operated services instead of long-term partnerships and dependencies
- Optimized capacity utilization and load balancing by acquisition of additional capacity, reducing empty rides
- Creation of novel service offerings and delivery options in response to evolving customer needs

KEY CHALLENGES

- Physical movement of goods and unforeseen disruptions make it difficult for digital-only players to ensure service quality
- Data security, insurance, liability, and fraud concerns
- Guaranteeing service quality, safety and availability of carriers, especially for premium goods and services
- Integration of advanced technologies into existing structures and systems

Trend Assessment

Timeframe: < 5 years Impact: Higher Sector Relevance: Below

AUTO E&M TECH ENERGY LS&H E-RETAIL

Figure 29: Logistics marketplaces like MyDHLi offer customers streamlined services across many platforms.

KEY DEVELOPMENTS & IMPLICATIONS

The continued surge in e-commerce demand and the need to provide more cost-effective transportation options for shippers have led to a steady but significant growth in logistics marketplaces. Digital solutions that either seamlessly integrate with the existing online architecture of large enterprises or provide smaller firms with access to web-based price quoting capabilities have seen the most growth. Despite an initial spike in logistics for consumer staples at the beginning of the COVID-19 pandemic, total freight demand and volume have since declined – global air cargo demand fell by 27.7% and capacity was down 42% year-on-year in April 2020. Similar trends were observed for ocean, rail, and road freight. However, this has not translated into a drop in demand for logistics marketplaces but rather the inverse, as customers begin relying on these platforms for real-time shipping options in preference to traditional long-term channels.

Freight forwarding marketplaces provide a platform for companies aiming to ship freight using one or more modes of transport with logistics providers. In 2019, the US spent $65 billion, or around 20% of the full truckload amount, on less-than-truckload freight (LTL), highlighting the potential value of freight marketplaces in aggregating customer orders, alongside additional services like parcel tracking. Growth in demand for fast cross-border delivery, as well as for medical equipment, is contributing to a shift towards air freight. Platforms that are situation-dynamic and offer customers the ability to rapidly switch between different modes of transport will be most successful in effectively managing short-term cargo constraints and volatile supply chains.

ON AVERAGE, 25% OF TRUCKS ACROSS MAJOR GLOBAL ECONOMIES TRAVEL EMPTY EACH DAY.

Saloodo!, a DHL digital freight platform, offers shippers and transport providers a transparent medium to optimize cost and time and has recently rapidly expanded from Europe into the Middle East and sub-Saharan Africa.

Warehousing marketplaces offer flexible, on-demand warehouse space and enable seamless quote comparison. Solutions can also be expanded to include robotics and other in-warehouse logistics services. There are currently over 19,000 warehouses in the US with $35 billion in private capital deployed in warehouse construction in 2019, increasing the need for digital platforms to assist in the utilization and management of these warehousing, distribution, and fulfillment centers. In light of the inventory and supply chain volatility caused by the COVID-19 outbreak, shippers are increasingly turning to third-party logistics providers and platforms such as Stowga and FLEXE that offer cloud-based warehouse management systems providing on-demand warehouse capacity (see **Cloud & APIs**).

Last-mile delivery marketplaces offer same-day or same-hour pick-up and other delivery services, supporting a large and growing segment of logistics (12% through 2025) that is typically responsible for a third of the total transportation cost. As price and options for fast delivery are key differentiators for customers, large companies like Walmart are partnering with last-mile platforms to pilot express delivery services. In doing so, it is crucial that all partners have access to real-time information, such as on-demand delivery capacity. There is expected to be increased focus on the management and delivery of bulky items as e-commerce extends into sectors such as furniture and homeware appliances from retailers like Wayfair. Companies in these markets will have to balance cost with shipment quality in marketplace environments as consumers become more accustomed to low-cost and transparent shipments of goods. The shift towards last-mile delivery spurred by COVID-19 will increase local inventory levels and demand for an extensive and connected warehousing and distribution network – challenges that specialist last-mile delivery marketplaces may help logistics players overcome.

Figure 29

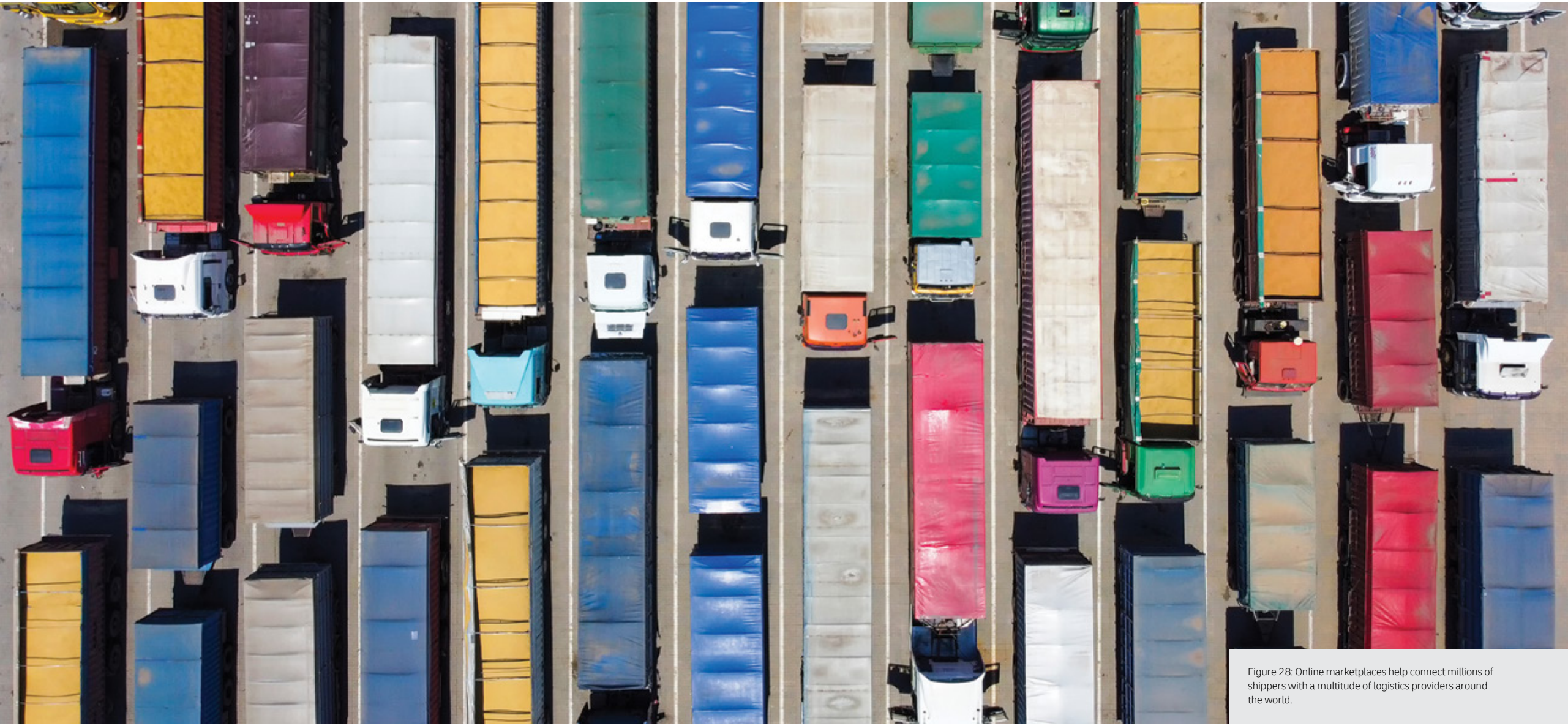


Figure 28: Online marketplaces help connect millions of shippers with a multitude of logistics providers around the world.

Figure 28

MASS PERSONALIZATION

Mass Personalization refers to offering bespoke products or services to meet the demands of individual customers, produced and delivered with mass-production efficiency. For logistics providers this trend will drive greater demand in distribution centers for value-added services within consolidation, fulfillment, postponement and customization activities, as well as more high-touch services in the last mile.

KEY OPPORTUNITIES

- Expand existing production and distribution capabilities to enable new supplemental business models and value-added services
- More demand for logistic services as more products are being delivered directly to consumers
- Improved customer service quality; increased touchpoints between customer and carrier
- With better understanding of unique customer needs, companies can further customize and personalize solutions

KEY CHALLENGES

- Maintain reasonable production and distribution expenditure for customized goods
- Data security and privacy concerns, as personalized products/services may rely heavily on profiling online behavior
- Higher service quality requirements from customers and brands
- Physical security and privacy concerns about in-home and direct-to-consumer delivery and pickup

Trend Assessment

Timeframe: < 5 years Impact: Medium Sector Relevance: Below

AUTO E&M TECH ENERGY LS&H E-RETAIL

KEY DEVELOPMENTS & IMPLICATIONS

As the logistics industry digitalizes, becoming accessible to millions of individual customers, mass personalization and mass customization are important ways to improve service levels and customer satisfaction. Both ideas challenge the "one-size-fits-all" assumption of traditional mass production and convert unique, individual customer needs into opportunities for value creation rather than problems to be minimized. However, there are distinctions between the two. Mass customization is performed by the customer and, in logistics, often takes the form of options to select delivery times, locations, insurances and packaging type. Meanwhile, mass personalization is performed by industry players tailoring products and services to individual customers, based on profiles and past interactions, including customized preferences. Advances in logistics marketplace software and commerce tools empowered customers with more choices to customize shipping options. Complementarily, the big data generated by users, paired with artificial intelligence, transforms these data points into meaningful, personalized products and services, making customers feel unique and preferred, like a "market of one."

While the idea of "market of one" sounds distant, internet users already recognize it as reality. Discovery feeds on Instagram and WeChat, as well as recommendation lists on Amazon, Netfilx, and other platforms, show curated, individualized content based on past app usage and browsing behavior. Despite digital origins, data collected from the internet and sensors fuels personalization in the offline world. More products are being customized, especially in fashion, packaged goods, and life sciences and healthcare. With an ever-increasing expansion of offerings, industry players will begin competing on the collective value of products and services more than on singular metrics like price, shelf space, and time.

Individualized healthcare in the form of personalized medicine, in-home care, and direct-to-patient delivery is growing in the life sciences and healthcare industry. This trend combines genomics, big data analytics, and population health to derive precision healthcare solutions. For example, Amazon-acquired PillPack is a digital pharmacy that packages and delivers rolls of single sachets containing a mixture of patient-specific pills organized by day, time, and dosage. Amazon has additionally patented new features for its connected-home devices that will detect signs of illness through voice changes and subsequently recommend suitable treatments for home delivery. Another promising opportunity to improve care and cut costs is the shift of care delivery into the home, a need that became acute during the COVID-19 pandemic. Many challenges remain but, as more patients choose this option, logistics providers must ensure efficient supply and delivery of medication, medical devices, and other equipment to support safe and effective in-home care.

Personalized fashion, apparel, and consumer goods loom on the horizon, powered primarily by "always-on, always-connected" consumers, the wealth of data they produce, and sophisticated machine learning that tailors individual customer experiences. While the hyper-customization business model did not flourish as anticipated, limited customization has proliferated, and customers' use of filters within options like dress colors and dietary restrictions, as well as their online profiles, connections, searches, and purchases, collectively provide an alternative source of insight into an individual's preferences, amassing gigabytes of information that enable effective recommendations. Advances in machine learning have now connected data across once-siloed lifestyle segments, powering personalized suggestions so effective that some retailers report as much as "a 10% lift in incremental sales and a 5% increase in transaction-size growth." Many sources of data are online subscription services or account-required platforms that inherently drive e-commerce volume. Bespoke consumer products often leverage postponement services and are assembled closer to customers or utilize micro-fulfillment centers to streamline supply chains and shorten delivery times.

Tailored logistics services result from mass personalization directly intersecting with the logistics industry itself, emphasizing customer needs and higher customer satisfaction. Logistics marketplaces, 4PLs, larger logistics organizations, and logistics technology providers have an early edge – more customers mean more data and therefore more insights. Examples include offering greener supply chain alternatives like cargo bikes or solar-powered facilities when a customer expresses interest in recyclable packaging, or recommending security solutions or insurance coverage if a customer habitually sends shipments to high-risk areas. Despite the needs of individual customers, some common qualities are required in supply chains for mass personalization, and players should seek to increase flexibility, visibility, and proximity of all customer services.

Figure 30

Figure 30: PillPack simplifies the user experience by packaging a combination of pills in individual packets by day, time, and dosage.

Figure 31: Limited customization, as opposed to full customization, has proliferated in e-retail and fashion and has been applied even to face masks as they become more commonplace.

Figure 31

MULTISOURCING

Progressively leaner supply chains have sped production and have optimized delivery costs worldwide, but they have revealed their heightened vulnerability in the face of unpredictable man-made and natural forces. Sourcing from multiple suppliers along a supply chain, from raw materials to last-mile delivery, can effectively mitigate risk by adding regional flexibility and build competiveness for logistics players on the global stage.

KEY OPPORTUNITIES

- Reduced supply chain sourcing challenges through diversification of material sourcing
- Enhanced supply chain flexibility by increasing logistics routing and production options
- Lowered transportation and operational costs due to increased competition
- Bolstered positive social impact within local communities

KEY CHALLENGES

- Maintaining traceability in the supply chain
- Managing the growing complexity of suppliers, manufacturing plants, and distribution hubs
- Seamless migration of existing manufacturing processes and shipment channels
- Navigating new trade regulations, tariffs, import/export restrictions, and cultural differences
- Identifying diverse suppliers to collaborate

Trend Assessment

Timeframe: > 5 years Impact: Medium Sector Relevance: Below

The practice of multisourcing is increasingly attractive to logistics players as force majeure events, including unexpected trade tariffs, hurricanes, labor strikes, and pandemics, appear to be on the rise. A survey found that 94% of Fortune 1000 companies saw their supply chain disrupted by COVID-19, while a 2019 scientific paper recently linked "mounting economic impacts" to the growing intensity and frequency of climate-change-related natural disasters. Repeated, unpredictable supply chain disruptions have challenged the notion, cultivated in the 1970s and 80s, of a stable, traditional global supply chain. Marked by a momentous industrial shift in which primarily manufacturing jobs were offshored from established economic powerhouses, such as the US and France, to nations with cheaper labor like China and Mexico, this pattern since the turn of the millennium is slowly transforming to a more complicated web, with goods and services no longer exclusively coming from the usual countries.

There are many factors that enable logistics companies to more feasibly pursue multisourcing. Automation and computing have improved over the years in terms of performance and cost, whereas higher wages in previously cheaper regions have made production more expensive. Additionally, governments globally are playing a more active role in luring foreign companies and investment while promoting domestic entrepreneurialism and healthy competition. Regardless of the enabling factor, the primary motivation for logistics players in seeking multisourcing is to increase the resilience and flexibility of the supply chain.

Supply chain resilience is front of mind for every company manufacturing at scale, impacting sourcing, inventory, management, and logistics processes. More than half of 638 respondents to a 2020 supplier risk management survey have already developed alternative sources of supply for 50% or more of their Tier 1 suppliers. Recently, barring the effects of the pandemic, manufacturers have been forced to reconsider existing operations and to diversify supply chains because of new trade agreements, such as USMCA and Brexit-related trade negotiations. By investing in resilient global networks, assessing existing supply chains, and evaluating redundancy measures, companies can minimize vulnerability to trade regulations and tensions. Given the maturity of current supply chains, however, larger manufacturers are much more likely to supplement rather than replace existing production with additional facilities and supplier relationships. Nike was an early adopter of this strategy and redesigned its logistics network to decrease lead time by diversifying some production from Asia to Latin America. More recently, action camera manufacturer GoPro and smart home technology provider Universal Electronics both announced that, due to tariffs resulting from US-Chinese trade tensions, they will move some production from China to Mexico. As more manufacturers geo-diversify their supply chains, logistics providers are expected to follow and respond to the resulting changing needs of manufacturers. New warehousing and service facilities must be built as production hubs grow across the globe, and new laws and cultural differences must be steadily navigated to ensure smooth-running supply chains. DHL takes part with an additional unique service in the form of Resilience360, a risk management platform for customers that predicts, assesses, and mitigates the risk of supply chain disruptions around the world.

Supplier diversity programs are taking prominence among industry players as they provide numerous benefits. Governments, nonprofits, and companies like Dell, Google, IBM, Nike, and Pfizer have all instituted programs globally to promote business with diverse suppliers, which are defined as either small businesses or those that are at least 51% owned and operated by members of an under-represented or under-served group like minorities, women, veterans, and the LGBTQ+ community. Research shows that supplier diversity initiatives are more than simply "feel good" options and can actually save millions of dollars for buyers across industries through increase in competition for contracts and bids. Coca-Cola additionally cites flexibility and agility in its supply chain as benefits of its program, announcing plans to spend over $1 billion on diverse suppliers by the end of 2020. In the logistics industry, supplier diversity programs exist and are likely to be further promoted throughout the supply chain, from fulfillment solutions to digital marketplaces, lowering costs and advancing social responsibility in the communities served.

Figure 32: As the demand for electronic components grows in the US, Bosch is investing hundreds of millions of dollars in new factories in Mexico.

Figure 33: As the center of gravity of production shifts away from traditional regions, resulting impacts to overseas and cross-border logistics will need to be considered, from raw materials to reverse logistics.

Figure 32

Figure 33

NEXT-GENERATION SECURITY

As entire supply chains digitalize and connect, vulnerabilities must be shielded from the increasing likelihood of cyberattacks. In addition to long-established security best practices, supply chains in the future will also need to leverage new, intelligent technology to ensure physical security and to bolster measures against the growing sophistication of counterfeit and contraband activities.

KEY OPPORTUNITIES

- Reduction of counterfeit and contraband goods in legitimate supply chains
- Secure cloud networks and digital interaction for customers, workers, and devices
- Improved physical safety for cargo, operations, and personnel

KEY CHALLENGES

- Legacy IT environments, lack of trained staff, and outdated processes create inherent cybersecurity vulnerabilities
- Turbulent socio-political environments increase the likelihood of vulnerability in physical supply chain operations
- Supply chain employees may not accept new technologies and tools that capture personally identifiable information, especially computer vision

Trend Assessment

Timeframe: > 5 years Impact: Higher Sector Relevance: Below

AUTO E&M TECH ENERGY LS&H E-RETAIL

KEY DEVELOPMENTS & IMPLICATIONS

As one of the largest and most critical drivers of the global economy, the logistics industry has been progressively targeted by cyberattacks, with some sources ranking it as the second most attacked industry in 2019. Furthermore, counterfeit peddlers have increasingly utilized legitimate logistics channels to reach more customers; a recent study found that up to 60% of search engine results for consumer products from automotive parts to children's products are websites that "offer products that are either counterfeit or otherwise infringe intellectual property." As new technologies drive the digital transformation of supply chains, they also inadvertently provide space for new risks and illicit activity, and supply chain participants should be informed and guard against them. Sensors, big data, robotics, artificial intelligence (AI), cloud computing, and more all offer enticing new advantages for logistics organizations, especially for process optimization and resource savings. In addition, these same technologies can be effectively leveraged as security solutions in operations, protecting shipments, privacy, authenticity, and, most importantly, people.

Intelligent physical security refers to the use of smart devices designed to deter nefarious activity in logistics operations either through data capture, physical intervention, or both. Smart locks and seals like those of Roambee or Satlock are finding purpose globally in monitoring shipping container condition, inspection, and any unsanctioned stops. In stationary logistics locations, AI-powered autonomous surveillance systems are on the rise with a future widely anticipated to intersect with drones. These systems automatically learn and detect anomalous events

Figure 34

and decide when to start or stop recording, classifying events in video content, such as a vehicle strike, unknown intruder presence, and other security risks. Similarly, computer vision technology is currently used for biometric screening in ports of entry, quickly verifying a person's identity with their passport photo on file. The same approach is expected to transfer soon to logistics facilities, especially air cargo terminals, to keep employees and operations safe.

Personal data and privacy protection have become pressing issues given the role of the internet and connected devices in modern society. Two years ago, the EU General Data Protection Regulation (GDPR) came into force, elevating an individual's control over their personal data both as consumers and workers, with other countries soon to follow. For supply chain organizations, the protection of customer and employee data has higher importance than the shipments they handle, and logistics providers must adequately safeguard private data. Face-blurring and other anonymizing tactics as part of AI technology implementation may be needed. And the migration from data centers to cloud, spurred by robots and self-driving fleets, has elicited the need for newer security solutions like edge computing and secure access service edge (SASE, pronounced "sassy"). With these solutions a single platform can provide digital protection anywhere regardless of whether or not the user or device is connected to the company network.

Counterfeit and contraband goods are a $461 billion dollar annual problem that, unfortunately, global supply chains inherently facilitate. Opportunely, new solutions are emerging to protect companies from losses from counterfeit goods. On-product authenticity – in the form of package signatures through laser or computer vision technologies – compares the physical characteristics of a package before transport and again at delivery. Fashion brands Montcler and Salvatore Ferragamo have gone further by embedding hidden RFID chips in garments to allow customers to verify product authenticity. Meanwhile, TruTag Technologies has developed an edible microtag composed of microscopic silica particles with up to a trillion unique spectral signatures that could be unnoticeably applied to products from medicines to microchips for less than a penny each. Additionally, blockchain technology promises source-to-consumer transparency, immutably storing product lifecycle information. DHL Supply Chain has taken this approach, developing a blockchain-based serialization tool specifically to combat counterfeit pharmaceuticals. While new tools are emerging to help supply chain professionals fight the growth of counterfeit goods, regular staff training and development is the most essential part of any security and compliance initiative.

Figure 34: RFID hardware embedded into paper tags of products can reduce theft in stores, but they can also provide easy distinction between genuine and counterfeit goods.

OMNICHANNEL LOGISTICS

The next generation of omnichannel retail – including "webrooming," showrooming, and no-line commerce concepts – requires logistics networks to be not just present but also proficient in tailoring to the needs of customers in all channels. Dynamic delivery, fulfillment, and return options necessitate seamless technological integration, data sharing, and collaboration among manufacturers, retailers, and logistics providers.

KEY OPPORTUNITIES

- Optimizing inventory through the supply chain using proper and precise inventory data control measures
- Providing consistent, high-quality customer service across all brand touch points, including human agents, chatbots, email, phone, and in-store
- Adopting real-time big data analytics and AI to constantly evolve with today's ever-changing customer needs and demands
- Migration from or integration of legacy systems and platforms to enable seamless, real-time data flow across the business

KEY CHALLENGES

- High inertia and cost to migrate from or integrate legacy systems
- Siloed mindsets and cultures of legacy multi-channel businesses may prevent supply chains from evolving to meet omnichannel demands
- Challenging customer expectations, including speed, flexibility, reliability, personalization, and care

Trend Assessment

Timeframe: < 5 years Impact: Medium Sector Relevance: Below

AUTO E&M TECH ENERGY LS&H E-RETAIL

KEY DEVELOPMENTS & IMPLICATIONS

Traditionally, omnichannel activities have focused on using multiple discreet, separate channels for a better customer shopping experience through the integration of supply chains. This required players to coordinate points and channels of retail, inventory, distribution, and returns on a single platform. However, omnichannel progress has been limited by many hurdles and issues, such as the use of legacy systems with custom interfaces and siloed cultures, as well as poor inventory visibility and disruptions in customer experience. Only a few major companies like Nike and IKEA succeeded in wholly implementing an omnichannel business model. In response to this, the term "Omnichannel 2.0" has recently surfaced, emphasizing not just the mere existence of a business across all channels, but also cross-channel quality and proficiency, bringing entire enterprises together and personalizing customers' shopping experiences regardless of channel. To profit from the benefits of omnichannel and provide a seamless customer experience, companies must break down channel silos within the organization and make it easier to share data and information both internally and with partners and service providers.

As COVID-19 forces businesses globally to migrate online in a bid for survival, the rate of omnichannel adoption will accelerate in the coming years, with the global omnichannel retail commerce platform market anticipated to hit $11 billion by 2023. Yet, it is not just industry giants making strategic moves during the pandemic. In Singapore and elsewhere, traditionally offline family-owned food hawkers have resorted to an omnichannel model to overcome an unanticipated 30-40% drop in revenue. Respecting local regulations, customers now have greater access than before with options to order take-outs at stores and via online food-delivery platforms like GrabFood and Food Panda. As economies gradually reopen, businesses are expected to maintain and improve existing digital channels, as well as adopt new ones across platforms, instead of reverting to pre-pandemic models.

THE GLOBAL OMNICHANNEL RETAIL COMMERCE PLATFORM MARKET IS ANTICIPATED TO HIT $11 BILLION BY 2023.

Cross-channel, omnichannel platforms shared between manufacturers, retailers, and logistics providers are critical enablers of omnichannel business models and ensure a seamless customer experience. As customers today make purchases in-store, on retailer websites, and through third-party online marketplaces, including social media, retailers must integrate their systems with those of their partners and service providers, replacing legacy systems with cloud-based systems that provide accurate, real-time data (see **Cloud & APIs**).

Thai startup MyCloudFulfillment provides an order-fulfillment warehouse solution that allows easy integration with retailers and logistics partners through application programming interfaces (APIs). When inventory at stores and distribution centers exceeds or drops below set thresholds, replenishment orders are triggered or put on hold in real time. Additionally, online purchase orders can be automatically pushed to retail shops directly for in-store or curbside pickup, as well as to third-party logistics providers (3PLs) for delivery.

"Anytime, anywhere" delivery models continue to be a huge focus for omnichannel businesses, driven by customer expectations and behavior. The continual rise of e-commerce has normalized two-day delivery services, with supply chains now striving for same-day or even same-hour delivery. Retailers aim to expand the number of physical touchpoints, offering customer pick-up and return services for online orders in stores or at no-contact neighborhood smart lockers similar to DHL Packstations. This reduces the distance to customer while securing the brand experience. Furthermore, in the more distant future, omnichannel will be able to accommodate customers with last-mile delivery changes, permitting last-minute modifications to where and when they may receive their order. For example, if a customer was hoping to pick up an online order after work at a store but now must go directly home due to unforeseen events, they would – within a small time window – be able to change the pickup location to, say, a neighborhood smart locker instead. This added flexibility and customer accommodation, however, will require a significantly more robust and agile supply chain for fulfillment.

RETHINKING PACKAGING

With a global market size hovering near $1 trillion, packaging is a vital component of the logistics industry. The continued growth of e-commerce and increasing calls for more sustainability are driving new creative and cost-efficient solutions, with focus on recyclability, reusability, compostability, and biodegradability. Innovation and technology will lead the way to better packaging tomorrow.

KEY OPPORTUNITIES

- High-performing sustainable materials can reduce environmental impact
- Sharing intelligent packaging pools can help industries "close the loop"
- Add capacity while reducing costs and emissions through data-driven optimization
- Increase levels of automation to speed up packaging processes (e.g. box-on-demand, collaborative robots)

KEY CHALLENGES

- Sustainable alternatives to virgin plastic are being explored but remain too expensive
- A unified industry approach is hindered by conflicting country-specific regulatory frameworks on plastic material bans
- Reusable packaging systems require extensive investments in infrastructure to manage a circular flow

Trend Assessment

Timeframe: < 5 years Impact: Medium Sector Relevance: Below

AUTO E&M TECH ENERGY LS&H E-RETAIL

KEY DEVELOPMENTS & IMPLICATIONS

Packaging is fundamental to the logistics industry as it makes products safer and easier to handle and protects them during storage, transport, and delivery. A DHL survey revealed that packaging is moving up corporate agendas across all sectors, with 9 out of 10 customers expecting the relevance of packaging for their business to rise in the near future. Meanwhile, the world is consuming more packaging than ever before; the global packaging market size is anticipated to surpass $1 trillion by 2021, driven by complex global supply chains and the exponential growth of e-commerce. Existing packaging systems have become outdated with e-commerce expansion and the push to improve packaging's environmental footprint. Centuries of innovation and refinement produced today's packaging systems and now research and new technology will transform tomorrow's packaging.

Packaging material has significantly impacted the environment, with packaging representing up to a quarter of the 8.3 billion metric tons of plastic produced since mass production began. Only 14% of that plastic packaging is recycled so there is intense focus on making packaging and the logistics industry more sustainable (see **Sustainable Logistics**). A 2019 survey by DHL Trend Research identified the introduction of sustainable packaging materials as customers' number one near-future packaging priority. Several companies are making progress, actively working to fight plastic packaging of products by focusing on recyclability, reusability, compostability, and biodegradability. In 2018, IKEA started using 100% biodegradable mushroom-based packaging materials from New York-based Ecovative as a replacement for Styrofoam.

In 2020, household and consumer products manufacturer Colgate-Palmolive announced its goal "to achieve 100% recyclable packaging across its entire portfolio by 2025," joining other brands like Coca-Cola, Evian, L'Oréal, Mars, Nestlé, PepsiCo, Unilever, Walmart, and others. As more companies begin using sustainable goods, logistics players must adjust accordingly, implementing sustainable packaging practices when possible and evaluating current operations to ensure new types of packaging can be processed (conveyor belts, scanners, etc.) and products delivered without damage.

Closed-loop logistics models using durable, multi-trip packaging assets provide a longer-term alternative to short-usage plastic. This approach is widely adopted already in logistics flows between manufacturing plants. With e-commerce return rates averaging 30% (and as high as 60% in the fast fashion sector), players are exploring opportunities to bring this approach into the consumer space. Companies like Loop, RePack, Returnity, and The Wally Shop help businesses connect with customers using upcycled, reusable, and returnable packaging for various types of parcel including letters, liquids, and perishable food completely waste-free. Growing more popular are refill stations at stores, such as those provided by Chilean startup Algramo. These allow customers to use their own containers to replenish staple goods, eliminating additional packaging. However, it remains challenging to build an economically viable reusable packaging system in every industry. Key considerations include the required size of the packaging pool, system leakage, achieving cost-efficient infrastructure locations for cleaning, inspecting, and maintaining containers, and the cost, speed, and efficiency of reverse logistics processes. Different companies adopting standardized packaging design may be a solution, allowing them to share the same packaging pool, reduce costs, and simplify inspection, cleaning, and repair.

Intelligence and automation will soon support packaging decisions and handling throughout the entire lifecycle of a packaging system from design, through warehouse pick-and-pack, to final disposal. Trade-offs between product protection requirements, usability, and resource consumption will be optimized in an automated manner. For example, American electronics retailer Best Buy has recently invested in box-making machines that minimize packaging for online orders, reducing shipped air while saving packaging material and void fill. Additionally, the rise of IoT devices enables companies to monitor, understand, and respond to the real-world conditions experienced by a growing number of products in transit and storage, so they can use data to determine more efficient packaging. Automation itself will have its own effects on packaging. A 2020 survey from the Reusable Packaging Association found that 81% of almost 200 manufacturers and poolers expect automation to increase demand for reusable packaging, which can fulfill automation's reliance on standardized containers and pallets. This reflects a growing partnership in the logistics industry between companies that provide automation and companies that produce sustainable packaging.

9 OUT OF 10 DHL CUSTOMERS EXPECT PACKAGING TO MOVE UP THEIR CORPORATE AGENDA.

Figure 35

Figure 35: Ecovative manufactures sustainable packaging derived from fast-growing fungus that can easily be molded to match product dimensions.

Figure 36: Reusable packaging dramatically reduces waste - Repack, for example, utilizes recyclable packaging materials that can last for at least 40 use cycles.

Figure 36

SERVITIZATION

The transformation of traditional product-based business models into outcome-as-a-service models places end users at the heart of strategies and relationships while providing valuable insights into product usage. To fully enable servitization concepts, companies will have to adopt condition-monitoring technologies and service billing models.

KEY OPPORTUNITIES

- Lower upfront investment in equipment as capital expenditure shifts to operational expenditure
- Strengthens the manufacturer's customer relationships through integration and co-location with each company's operations
- Competitive advantage through product and service innovation; data on post-purchase usage can be leveraged for product development; services are harder to replicate than products

KEY CHALLENGES

- Costly and complex vertical integration between manufacturer and customer operations
- Significantly higher service quality demands for manufacturers and logistics providers; breakdown in service can result in potentially significant losses
- Ensuring optimal balance of inventory and supply chain coverage
- Significant change management required to focus on outcomes, not product development alone

Trend Assessment

Timeframe: > 5 years Impact: Medium Sector Relevance: Below

KEY DEVELOPMENTS & IMPLICATIONS

Enabled by digitalization and affordable IoT technologies across industries, servitization will feature significantly in the logistics industry's new normal within a decade. Rather than purchasing expensive equipment such as airplanes and robots, companies can opt to pay for equipment usage, usually per hour of operation or per items successfully picked, and not pay when equipment sits idle or broken. According to an IDC white paper, 82% of over 400 global manufacturers surveyed in 2019 were "actively exploring or moving to servitize their businesses." This momentous shift comes with good reasons. The same paper reveals servitized companies have a 30% service revenue advantage over non-servitized competitors and have "5 times more opportunity to accelerate top-line growth above 5% yearly." In addition, a Synchron Research report finds that 98% of surveyed end users want original equipment manufacturers (OEMs) to offer service agreements for maximized product uptime.

COVID-19 has caused enormous disruption and a recent Business Continuity Institute (BCI) report found that less than a quarter of businesses will revert to pre-pandemic models. Instead a clear majority will digitalize, remodel their supply chains, and/or offer new products and services. With industry players strengthening supplier communication in these tumultuous times, servitization may provide the resilience companies require, all the while putting the needs of end users at the heart of the business.

New customer engagement models appear with servitization – user-centric rather than product-centric models in B2C and B2B relationships. Service providers accept greater risk and responsibility for parts, technicians, and knowledge but gain access to users through more touchpoints, creating new opportunities to enhance user loyalty and add value. Logistics plays a vital role in this new equation as the seamless supply and delivery of parts is critical to maintaining the performance of a servitized asset or fleet. To illustrate, in 2019, Fiat Chrysler Automobiles joined other car manufacturers in providing cars-as-a-service, charging subscribers a monthly fee to access various car models without the responsibility of cleaning and repair. Through apps and online environments, car makers can more frequently engage subscribers with customized messaging and additional offerings and in more positive contexts than frustrating car breakdowns and dealership visits. As another example, GE Healthcare is using data from expensive medical equipment it provides as an affordable service to bolster its own consultation arm with special insights, tailoring whole-hospital services such as planning and budgeting to users' needs. Overall, logistics industry players can expect to improve end-user relationships via servitization, whether they deliver services to the user or they receive services from OEMs.

Co-located and distributed service logistics facilities enable faster response times to conduct predictive maintenance, a hallmark of servitization. As equipment ownership remains with the service provider not with the user, it becomes critical that workshops, service centers, and service technicians are in closer proximity to user operations. Airbus, for example, built a final assembly line in Alabama to increase service responsiveness for North American users, despite already having several capable material and logistics centers and final assembly lines around the globe. With co-located and distributed facilities, spare parts networks, including inventory positioning and pooling opportunities, must be reviewed and redesigned. However, other trends may reduce the significance of this. On-site and on-demand 3D printing can eliminate the need for co-located inventory (see **3D Printing**), while augmented reality (AR) can transport technicians across oceans to provide remote repair and maintenance support (see **Augmented & Virtual Reality**).

Service billing models and tools should be investigated as businesses transition from selling products to providing services. Instead of simply recording products sold, companies moving to servitization must keep track of more complex usage-based bills with accounting tallies across multiple users on predetermined base units (per hour, per kilowatt, per kilometer, per use, per pick, etc.). Additional refunds, one-time purchases, and penalties, in conjunction with usage-based bills, may further complicate the total balance. To help address this issue, software services from Fusebill, for instance, provide flexible and secure subscription commerce engines to help the servitizing business manage and analyze recurring revenue and payments. Furthermore, developments in blockchain-based smart contracts can automate complicated processes in a transparent way, performing steps when pre-agreed conditions are fulfilled (see **Blockchain**).

82% OF GLOBAL MANUFACTURERS ARE ACTIVELY EXPLORING OR MOVING TO SERVITIZE THEIR BUSINESS.

Figure 37

Figure 38

Figure 37: Alstom provides trains-as-a-service for public transportation providers and has innovated unique practices, like scan tunnel systems for maintenance checks, to ensure it meets its service obligations.

Figure 38: GE sensors inform Maersk Drilling of the status of equipment before potential breakdowns, reducing maintenance costs by 20% and improving drilling efficiency.

SHARING ECONOMY

The societal shift from ownership to the sharing of goods, assets, and services through digital platforms has been one of the most groundbreaking trends in recent years. Logistics providers can both facilitate and participate in these networks through workforce allocation, transport utilization, and on-demand warehousing and fulfillment to achieve new levels of efficiency and value creation.

KEY OPPORTUNITIES

- Augmented or potentially new business models based on sharing economy logistics solutions
- Bundling supply chain needs enables logistics providers to deliver better cost and value to customers
- Increase capacity utilization and reduce costs and carbon footprint through asset sharing
- Improve resource planning using a flexible workforce approach

KEY CHALLENGES

- Laws and regulations (e.g. security, insurance, liability, workforce protection) hinder peer-to-peer services
- Horizontal integration of collaborative logistics in existing business models remains difficult among competitors
- Industry fragmentation and the need for physical control of logistics networks slow the growth of sharing economy logistics companies

Trend Assessment

Timeframe: < 5 years Impact: Medium Sector Relevance: Below

AUTO E&M TECH ENERGY LS&H E-RETAIL

KEY DEVELOPMENTS & IMPLICATIONS

The Great Recession of 2009 bolstered the ideological impetus to use technology to build an economy with social, frugal, and sustainable consumption. What began as a way for owners of assets, such as cars and homes, to earn supplemental income by sharing and renting continues today as a viable and increasingly acceptable business model for consumers and corporations. While most early peer-to-peer services for sharing and bartering smaller personal belongings like books and CDs failed to gain traction and sufficient earnings, they helped pave the way for a few dominant digital platforms that generate revenue through online marketplaces, matching supply with demand. As these successful organizations mature, they often develop into more traditional asset-heavy companies yet retain the platform capability to match supply with demand.

OVER $23 BILLION IN VENTURE CAPITAL HAS BEEN INVESTED SINCE 2010, INCLUDING LOGISTICS-FOCUSED VENTURES.

With this honing and refining, the sector has attracted over $23 billion in venture capital funding since 2010, disrupting industries like transportation, hospitality, and to some extent logistics in a progressively maturing market.

Transportation especially has become a kernel, with free-floating shared car fleets likely to reach a $9 billion market size by 2026 and free-floating electric scooters reaching $42 billion by 2030. The success of shared and on-demand passenger transport attracts existing companies to expand focus and adapt their models and tools for freight transport. At the same time, originally pure-play digital freight marketplaces that match shippers and carriers are increasingly investing in warehouses to secure more control of supply chain networks. Moreover, the logistics industry is impacted by the sharing economy directly and implicitly by the trend's intersection with other industries – where peer-to-peer models for sharing personal goods have succeeded, logistics volumes have followed. For example, fashion-sharing marketplace Poshmark doubled its revenue to $2 billion from 2018 to 2019, representing millions more shipments delivered. For the logistics industry, the sharing economy business model has the highest relevance in rethinking three key segments: logistics transportation, fulfillment, and labor models.

Shared logistics transport has proved to be an increasingly prevalent and viable business model over the past several years. Most recently, Uber Freight invested an additional $200 million to bolster its on-demand trucking services, primarily in the form of hiring more drivers and increasing revenue from shippers. The COVID-19 pandemic has driven consolidation and bundling in the on-demand delivery space, with on-demand delivery company Postmates agreeing to an acquisition deal with Uber for $2.65 billion, and Singapore-based Grab investing further into its courier service GrabExpress while demand for passenger rides subsided in the face of lockdown. Established logistics companies must now look at existing fleets and demand to best understand how to integrate similar services in their own operations.

On-demand warehousing and fulfillment has grown significantly, fueled by the global e-commerce boom and primarily smaller merchants looking for flexible warehousing and fulfillment options. On the warehousing front, platforms like FLEXE and STORD have enabled enterprises to add more flexibility to their storage and distribution networks through Airbnb-like renting of pallet positions in warehouses. For fulfillment, companies like Darkstore and Deliverr have developed a network of discreet fulfillment warehouses ranging from urban micro-distribution centers to more traditional centralized warehouses with shared inventory offering third-party fulfilment services.

Shared workforce is becoming an increasingly attractive model for logistics operations to match volatile shipment demand with adequate staffing. As the logistics industry is fueled in large part by third-party labor and contracted employees, and as the growth prospect of online staffing hovers at a 35% CAGR through 2025, supply chain organizations are increasingly looking at on-demand staffing models to ensure smooth operations and to meet service quality targets. DHL Supply Chain has developed its own labor share app in the Americas, allowing warehouse managers to pool shifts between facilities and enable employees from multiple facilities to work flexibly from different locations where they are needed most.

SILVER ECONOMY

As global populations rapidly age, the logistics industry will need to adapt to the rise of the silver economy, offering new services for elderly customers and new opportunities for older workers. Health and safety in regards to seniors will be a primary core theme as new technology assists in augmenting and replacing physical and cognitive tasks.

KEY OPPORTUNITIES

- New business opportunities offering value-added logistics services to elderly customers
- Growth in online shopping platforms for the elderly could result in increased delivery volumes and individualized delivery schedules
- Use of technologies and solutions to support the aging workforce can extend retention and relieve labor shortages

KEY CHALLENGES

- Business models for new logistics value-added last-mile services are not yet validated
- Upskilling of existing personnel to provide adequate services in the last mile
- Coping with future personnel shortages, especially in seasonal peaks and line-haul transportation

Trend Assessment

Timeframe: < 5 years Impact: Lower Sector Relevance: Below

AUTO E&M TECH ENERGY LS&H E-RETAIL

KEY DEVELOPMENTS & IMPLICATIONS

Today, about 1 in 11 people are aged 65 and above. By 2050, this will grow to 1 in 6. Even by 2030, the number of people 65 years old or older will near 1 billion (+37%), with those in Europe and North America together representing a quarter of the total and those in China alone contributing another fourth. As the world's population ages, the needs of older people as workers and consumers must be distinguished from those of younger people and considered as a sizable market in its own right. The realms of work, home, and leisure for older people will heavily incorporate automated processes and technological assistance for both physical and mental tasks. Furthermore, the COVID-19 crisis has highlighted connections and correlations between age and overall health risks. To protect against heightened susceptibility, many governments and businesses have offered reduced-contact services, focusing primarily on last-mile delivery.

Elderly employees are becoming an important topic as more companies start to value their time-acquired experiences and as labor shortages grow increasingly acute. As waves of experienced supply chain leaders and operational staff retire, a brain drain of "tribal knowledge" departs the organization. On the policy side, senior worker support packages, such as flexible hours and part-time employment, can help attract and retain retiring talent. On the technology side, new computer and robotic products and services may encourage older workers to stay on by reducing and assisting with laborious tasks (see **Bionic Enhancements**). Japanese company Cyberdyne is eyeing to scale its certified lumbar robotic exoskeleton beyond nursing homes and rehabilitation centers to prevent injuries in the workplace. Still, with more workers retiring and positions left unfilled, businesses are primarily looking at two alternative, more permanent solutions: readjusting supply chains to incorporate younger populations from Africa and Latin America, for example, and automating processes by replacing humans with computer code and robotics.

1 IN 11 PEOPLE ARE AGED 65 OR ABOVE. BY 2050, THIS WILL GROW TO 1 IN 6.

Elderly consumers with purchasing power that grows each year are shifting the consumer landscape. European Commission reports predict substantial increase in demand for products and services in connected health, smart home solutions, wearable technology, age-friendly education, and silver tourism in the coming decades. Players in these spaces, as well as those in other sectors wanting to attract older consumers, must consider senior needs as part of the customer and product experience. Taobao, the Alibaba-backed online retailer, released in 2018 an "elderly-friendly" version of its app with a less crowded interface, more navigation shortcuts, and faces of the user's children so that they can share online products and easily communicate with family members before purchasing. With more than half of seniors today using websites and applications (only to increase in the future), logistics players will further digitalize and incorporate changes to the user interface and user experience to accommodate older customers lest they lose ground to age-friendly competitors.

Last-mile value-added services have been bolstered by COVID-19 and will diversify from traditional delivery services to support an aging population. With pandemic laws restricting daily activities to protect the most vulnerable, businesses and governments have collaborated to ensure that senior citizens are able to receive essential goods at home without risking exposure, such as California's innovative Restaurants Deliver: Home Meals for Seniors program. With more pharmacies, grocery stores, and other businesses now offering home deliveries during the pandemic (see **Fresh Chain**), last-mile delivery companies have increased their presence, simultaneously adapting services to reduce contact with customers and to better carry the products ordered (see **Self-Driving Vehicles** and **Unmanned Aerial Vehicles**). However, as the pandemic lingers and the population ages further, last-mile services are anticipated to expand beyond food and product delivery. In-home medical check-ups, home cleaning, transportation services, tech support, and auto-replenishment of goods such as medicines are speculated value-added last-mile services to be tested in the mid-term future.

SMART CONTAINERIZATION

Global cargo shipping was revolutionized by the adoption of the standard container, and this brought vast improvements in efficiency and ease of trade. However, the growing need for volume flexibility and increasing time and cost pressures are now necessitating new container formats and processes, especially in the context of shared logistics networks and urban delivery.

KEY OPPORTUNITIES

- Improve handling capability and asset utilization, and generate cost savings through more efficient container formats suited to modern global, cross-border supply chains
- Better in-transit visibility down to shipment-level with enhanced intervention capabilities for supply chain participants (e.g. digital customs process)
- Generate unique fingerprints of each container based on historic and real-time data to analyze circumstances the container experienced during its journey

KEY CHALLENGES

- Developing the new industry standard requires alignment and critical mass of adoption across industries and different actors throughout the supply chain
- Indefinitely long time to value as infrastructure, equipment, and even cities and ports need to be redesigned to accommodate the new standard
- Regulations and certifications prohibit short-term changes to container design, handling procedures, and transportation methods

Trend Assessment

Timeframe: > 5 years Impact: Medium Sector Relevance: Below

AUTO E&M TECH ENERGY LS&H E-RETAIL

KEY DEVELOPMENTS & IMPLICATIONS

Container transport is the lifeblood of global trade. 90% of international cargo is moved via ocean freight transport, and shipping containers represent the foremost type of housing for products as they travel along ocean currents, rail, and road. Meanwhile, unit load devices (ULDs) provide secure clustering of airfreight. In 2019, global shipping container throughput reached approximately 802 million twenty-foot equivalent units (TEUs), a 2.3% jump from the previous year. ULDs have witnessed similar growth with both the normalization of express e-commerce delivery and more commercial airlines realizing the revenue benefits of cargo shipments. While COVID-19 has had an acute impact on international trade, with cancellation of thousands of container ships from Asia to Europe and North America, the reopening of economies and the resumption of global supply chains indicate a future of recovery and sustained growth of use for containers.

That said, however, the standard steel ocean container and the ULD have seen no ground-breaking innovations since invention in the 1950s. Industry regulations, as well as the multitude of participants in global supply chains, have made it difficult for novel ideas to drive new standards. Still, technological advances in sensors, connectivity, and materials paired with the growth and complexity of e-commerce delivery will most likely enable a new wave of containers in the mid- to far future.

Connected containers will provide real-time visibility of global cargo flows, enabling customers, facility operators, and carriers to obtain critical information of the supply chain and the goods held inside. Utilizing sensors and next-generation wireless networks, connected shipping containers and ULDs can act as point measurements of when, where, and possibly why disruptions and delays occur, all the while empowering handlers with opportunities to proactively intervene and minimize impacts along the supply chain. Swiss ULD management company Unilode has developed one of the first aviation-compliant Bluetooth roaming networks, allowing ULD tracking via Bluetooth beacons. The company is currently tracking more than 15,000 ULDs in cooperation with over 60 airlines.

Furthermore, outputs from IoT-connected containers can be integrated with operational data which, when combined with artificial intelligence (AI), can transform ordinary terminals into smart yards and smart ports. Optimized vessel and vehicle traffic and efficiently orchestrated container movements will substantially increase terminal productivity without the need to expand real estate. Moreover, regulatory agencies, insurance companies, customs, and other players that interact at these supply chain crossroads will be able to obtain the necessary information on each consignment before arrival.

Collapsible containers will help reduce transportation runs and inventory costs within the supply chain. While useful in transporting goods and packages in a standardized format, shipping containers and ULDs are voluminous and, when imbalances in shipment patterns cause growing stockpiles of empty containers in one location and a dearth of them in another, additional amounts of space and money must be expended just for simply storing and resupplying empty containers in the supply chain. Collapsibility or foldability – as offered by 4FOLD, Cargoshell, Staxxon, VRR, and others – compacts a container to about one-fourth its original size so inventory and transportation processes become more economically feasible. Although vehicles are still needed to move the containers, the fact that a truck or cargo ship can transport four times as many containers than before will lower the number of transportation runs required and the associated emissions.

New modular and small-format containers will enhance direct goods loading and increase flexibility within the supply chain, especially in urban environments. A rising concept called the Physical Internet takes aim at improving the logistics industry by applying the efficiencies of the digital internet to the real-world distribution of goods. Today, products and packages are continuously loaded in inefficiently sized containers, unloaded, re-consolidated into smaller groupings, and then loaded again in similarly inefficiently sized containers. In the future, paired with wireless sensor technology and collapsibility, combinations of appropriately sized, but standardized, modular “pi-containers” would constitute or even replace shipping containers and ULDs and eliminate the need for re-consolidation. These smaller building-block containers would benefit urban last-mile delivery the most, enabling simple transfer and separation of goods for vans and cargo bikes in places where larger vehicles are unable to travel, all the while maintaining cargo security.

Figure 39: By integrating ULDs into the Bluetooth network, Unilode now readily tracks over 15,000 ULDs across 60 airlines, monitoring temperature, humidity, light, and shock.

Figure 39

SPACE LOGISTICS

With the advent of satellite constellations and habitable bases, space logistics is an emerging niche within the industry. While the core of logistics remains the same, whether in space or on Earth, more stringent constraints and extreme conditions challenge the safe transport, storage, and delivery of materials and products beyond Earth's atmosphere and back.

KEY OPPORTUNITIES

- New, expanding logistics market has recently opened to viable private operations, ripe for exploration and testing of technologies and business models
- In-space, lunar, and planetary warehousing of upmass such as food rations, equipment, and satellites, will enable stable on-demand replacement
- Chance to set standards and trends for the future of space logistics (e.g. packaging and service expectations)

KEY CHALLENGES

- Extreme temperatures, zero gravity, and other special conditions limit which products and materials are allowed and how they are transported
- Launch vehicle dimensions and weight constraints hinder the cost benefits of economies of scale
- Commercial cost-benefit propositions for logistics service providers are untested and the legal framework for logistics operations in space is not yet available

Trend Assessment

Timeframe: > 5 years Impact: Lower Sector Relevance: Below

AUTO E&M TECH ENERGY LS&H E-RETAIL

KEY DEVELOPMENTS & IMPLICATIONS

The last crewed lunar landing was in 1972, and, with technological advancement and successes in the last decade, the vision of living and colonizing space has slowly reawakened. This ushers in a potential niche market for the logistics industry.Private investment in the space sector has reached almost $5 billion, about double the amount in 2017. The number of active satellites in the next ten years is expected to jump 20 times to 50,000, with giants like Amazon's Blue Origin, Facebook, Samsung, and SpaceX leading the charge. In the public sector, the United States officially announced this year that it will pursue commercial projects on the Moon, Mars, and other celestial bodies to rival exploration missions pursued by Russia and China. This comes in light of NASA's already planned lunar mission scheduled for touchdown in 2024, with more substantial plans for "a sustained lunar presence" in the late 2020s.

THE NUMBER OF ACTIVE SATELLITES IN THE NEXT TEN YEARS IS EXPECTED TO JUMP 20 TIMES TO 50,000.

With these exciting developments in the private and public sector, there are growing questions that need to be answered for space logistics to be successful and sustainable in the future. How will supply lines be planned and managed? With over 128 million pieces smaller than 1 cm (and 1 million pieces larger than 1 cm) currently orbiting Earth, with many travelling at hazardous speeds, how will the accumulation of space debris be curbed and reversed? As launch rates and emissions increase, are there more sustainable ways to transport objects into space? How can products be packaged to survive zero-gravity environments with exposure to high radiation and extreme temperatures? Still, despite the change of location, distances, and gravitational levels, at its core the basic problem to be addressed by space logistics remains the same as on Earth – delivering shipments from point A to point B in a secure, on-time, and cost-effective manner.

Satellite logistics is the newest facet of the logistics industry with tens of thousands of low- and medium-Earth-orbit (LEO and MEO) satellites to be launched in the next few years. Expansive constellations of hundreds to thousands of linked orbiters are planned to provide various services from global internet provision to data collection, and many operators are seeking viability by cutting launch, operational, and decommissioning costs. Italian company D-Orbit targets this demand with solutions that are not unlike those offered by logistics companies on Earth, delivering satellites to their proper destination in orbit and providing close-up damage inspection services. It estimates that it can save satellite operators 40% in costs for constellation deployment and extend satellite life by up to 5 years. D-Orbit also provides safe decommissioning services for end-of-life satellites, to combat growing space debris, and speculates future plans for possible in-space orbital warehouses for satellites.

Supplying cargo will be crucial to expanding human presence in space. There's the challenging task of carefully transporting everything into space (upmass) – provisions, fuel, equipment, materials, and waste – and, in some cases, back down to Earth (downmass). Dimensions, weight, moisture content, pressure, temperature, and the lack of gravity will be heavily scrutinized in everyday and specialized products and in packaging before starting the delivery journey. Furthermore, limited space and weight capacity on rockets and shuttles will hinder cost reductions through economies of scale. Despite these constraints, rewards at this early stage can be great. A study on the logistics of the International Space Station identified enormous opportunities and benefits for governments and the private sector if commercial involvement is permitted. This was confirmed and realized in 2019 when NASA set an unprecedented record, awarding $7 billion in space cargo delivery contracts to various companies in preparation for lunar colonization. As a result, excitement in the private sector has increased, and several companies have since proposed bigger space transport vehicles to hold more passengers and cargo.

Figure 40: With thousands of satellites to be launched into space, D-Orbit's ION Satellite Carrier can safely store, rapidly transport, and accurately deploy microsatellites to their proper destination, reducing costs and extending satellite life.

Figure 40

SUPERGRID LOGISTICS

Going beyond 4PL logistics and logistics marketplaces, the trend of Supergrid Logistics refers to the next dimension of consolidation, orchestration, and optimization of global supply chain networks, integrating swarms of different production enterprises and logistics providers. This opens up new business opportunities for various players, including established 4PLs, specialized companies, and even small local couriers and startups.

KEY OPPORTUNITIES

- Global players can expand their networks, accessing new markets with higher service quality thanks to digital integration
- Increased availability of products in B2C and B2B e-commerce marketplaces, with efficient, fast delivery from anywhere
- Reduction of infrastructure and service development costs; rapid time to value and scalability of services
- Streamline configuration of customized logistics solutions

KEY CHALLENGES

- Collaboration between traditional would-be competitors inhibits integration beyond 4PL services
- Interoperability of services, both digital and physical, from different providers is a major challenge
- Full logistics-as-a-service or similar business models

Trend Assessment

Timeframe: > 5 years Impact: Higher Sector Relevance: Below

AUTO E&M TECH ENERGY LS&H E-RETAIL

KEY DEVELOPMENTS & IMPLICATIONS

Customers today can choose from an abundance of logistics products and services, thanks to traditional companies improving their online presence and offerings in logistics marketplaces, as well as maturing startups that are unbundling the value chain of logistics integrators. The logistics supergrid concept involves the establishment of a single global entity or platform that can smoothly and flexibly integrate all parties across multiple supply chains, enabling the formation of modular services for all customer types, maximizing efficiency and reducing costs.

To illustrate, Alibaba's smart logistics network, Cainiao, is tacitly working towards the supergrid ideal, striving to become the world's most efficient logistics network and aiming to deliver anywhere in China within 24 hours and anywhere in the world within 72 hours. At its core, Cainiao is an intelligent data platform for the Chinese logistics industry that seamlessly connects e-commerce companies with players along supply chains, enabling end-to-end solutions. To date, the company serves over 220 countries and regions, and is able to integrate logistics services from over 200 partners. In doing so, Cainiao has improved global delivery times by 20%, lowered cost-per-package in B2C fulfillment by 9%, and improved China's domestic sort and delivery efficiency by 24-27%.

Market segmentation of actors in a global supergrid includes users and customers, service specialists, configurators, orchestrators of logistics solutions, and logistics platform providers. Logistics platforms form the point of entry for customers to leverage the supergrid, providing a new level of market transparency that gives local companies access to the global market. Players around the world will focus primarily on cross-border integration, premium market segments, and orchestration of regional and service providers that may normally be competitors.

Interoperability is a key factor in the successful development of Supergrid Logistics, given the need for a modular, configurable logistics solution portfolio. Ideally, any combination of internally and externally operated services can be seamlessly selected, orchestrated, and executed on demand. Based on full logistics-as-a-service (LaaS) models, smart business networks can be created that enable fast and cost-efficient execution of individual intermodal, multimodal, and synchromodal solutions.

Next-generation digital forwarders will offer end-to-end logistics services through brokerage platforms or similar concepts to connect shippers and carriers. As core logistics services like fulfillment, transportation, and delivery become commoditized in the supergrid, premium digital services like customs clearance, risk management, security protection, insurances, and compliance checks will provide critical value-add and differentiation for players participating in the logistics supergrid.

Figure 41

Figure 41: Cainiao's logistics network integrates over 200 service providers to develop what could be the world's first logistics supergrid.

SUSTAINABLE LOGISTICS

Ecological imbalances and growing demand from customers and governments for sustainable solutions have cultivated an urgent need for environment-friendly practices in supply chains, from raw material extraction to managing product end of life. Together with optimized processes, zero-emission mobility, and carbon offset solutions for facilities, this momentum will help the logistics industry go green.

KEY OPPORTUNITIES

- Optimization of transportation processes can lower overall emissions and operational costs without expensive capital requirements
- Savings in fuel, power, infrastructure costs, and other economic factors (e.g. maintenance, wear-and-tear costs) when switching to alternative energy sources
- Quiet, zero-emission fleets can enable night-time delivery

KEY CHALLENGES

- Fragmented sustainable infrastructure and limited zero-emission manufacturers
- High capital investment costs for fleets and real estate closer to customers
- Government and regulatory support required to invest in sustainable infrastructure

Trend Assessment

Timeframe: < 5 years Impact: Higher Sector Relevance: Below

AUTO E&M TECH ENERGY LS&H E-RETAIL

KEY DEVELOPMENTS & IMPLICATIONS

A 2020 report by the World Economic Forum predicts that by 2030 the growth of e-commerce alone will result in 36% more delivery vehicles, generating an additional 32% of carbon emissions. Also the equivalent of a full truckload of plastic, from product parts to packaging, currently enters the ocean every minute, quadrupling by 2050 if no action is taken. With these predictions, companies, governments, and customers are all taking steps to eliminate the environmental harm of business as usual. Efficient energy sources, improved material substitutes, optimized buildings and processes, effective environmental policies – all are experiencing a flood of new development. Overall, customer demand for a greener logistics industry spurs investments in technology and supply chain changes, creating an upward cycle so that greener alternatives become the competitive and preferred path forward.

Process optimization has received more focus in the last two years as a cost-effective way to improve sustainability within the logistics industry. Greenplan, a DHL subsidiary, tackles transport emissions by optimizing delivery routes. Using historic traffic data, travel times, delivery windows, and emissions by vehicle type, Greenplan has developed a fully dynamic, customizable route planning tool that empowers its users to drive their own green strategies by reducing the kilometers travelled and the number of routes needed. By further calculating the optimal starting time of delivery routes and incorporating contingency plans, Greenplan estimates, based on its benchmarks with leading industry players, it can reduce a user's carbon footprint and cut up to 20% of their operational costs.

Similarly, optimization can reduce environmental impact in other processes including inventory, back-office paperwork, and packaging. It is estimated that on average a box is 40% too big for its contents (see **Rethinking Packaging**). Eliminating just this excess volume would not only save enormous amounts of packaging material, diesel, and landfill space, but also in the United States alone 24 million truckloads annually, equal to 17 billion kg of emitted carbon dioxide.

Zero-emission logistics fleets are considered one of the most impactful solutions in the fight against climate change, given that the transportation sector is often the biggest or second biggest producer of greenhouse gases. This past year, DHL, Amazon, FedEx, and UPS have all announced plans with automotive suppliers to collectively add hundreds of thousands of electric vehicles to roads in the coming years, citing various benefits from lower operational costs to successfully meeting local emission standards. For companies that cannot fully covert their fleet en masse, UK-based TRAILAR has developed a series of flexible solar panels as an interim step. These can be retrofitted to the top of non-electric vehicle trailers. Depending on vehicle type, from buses to semi-trucks, users realize consistent fuel savings of 3-7%.

Meanwhile, on the aviation front, startup Eviation unveiled in 2019 the world's first all-electric passenger aircraft, an idea that could soon extend to cargo shipments and expand noise-reduced night operations. Also, just as better batteries and fuel cells enabled the viability of zero-emission vehicles, increased demand for zero-emission vehicles has consequently spurred interest in more efficient batteries and fuel cells. As an example, in 2018, Caterpillar began converting its massive mining vehicles from diesel to electric, each saving almost 400 liters of fuel an hour. This trial was deemed so successful that Caterpillar has since started investing millions in next-generation, solid-state battery technology so that more vehicle types in its fleet can enjoy the benefits of zero emission.

Logistics facility design and placement can hugely impact the environment, with buildings using 41% of total energy in the US, 12% more than transportation. With large warehouses, service facilities, and offices dominating the logistics industry, many companies have begun adopting sustainable building materials, better insulation, and IoT devices to optimally manage utilities, lighting, heating, ventilation, air conditioning, and machinery. This improves sustainability while reducing operational costs. In late 2018, European logistics development company Baytree even built a warehouse complete with solar panels and a landscaped edible garden to highlight cost-effective sustainable techniques. Furthermore, building placement is crucial. Consolidating offices and facilities and placing them near import hubs and destinations can reduce total vehicle-kilometers travelled, while putting buildings near public transport lines can increase accessibility for workers and visitors and decrease the need for cars and expensive parking infrastructure.

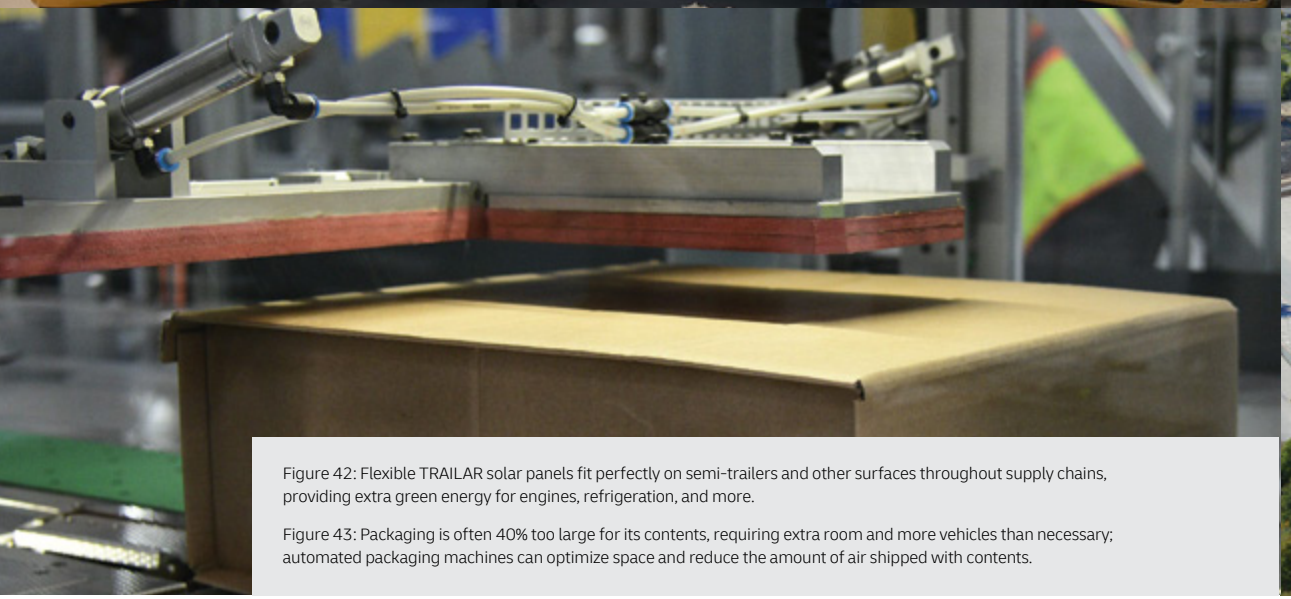


Figure 42: Flexible TRAILAR solar panels fit perfectly on semi-trailers and other surfaces throughout supply chains, providing extra green energy for engines, refrigeration, and more.

Figure 43: Packaging is often 40% too large for its contents, requiring extra room and more vehicles than necessary; automated packaging machines can optimize space and reduce the amount of air shipped with contents.

Figure 42 (Top) Figure 43 (Bottom)

Figure 44: Eviation's upcoming fully electric airplane may one day impact the logistics industry, eliminating aviation emissions and expanding quieter night operations.

Figure 45: Facilities and offices provide enormous, but often overlooked, opportunities to improve sustainability, from massive areas for solar panels to transit-oriented concepts to decrease reliance on private vehicles.

Figure 44 (Top) Figure 45 (Bottom)

In Depth

Technology Trends

Section Contents

In this edition, each trend summary also contains an analysis of sectors that are of highest relevance to the trend based on the feedback of logistics experts.

Auto-Mobility

Engineering & Manufacturing

Technology

Energy

Life Sciences & Healthcare

E-Retail & Fashion

3D PRINTING

Encouraged by opportunities for greater customization, less waste, and more localized manufacturing and delivery, 3D printing will add new diversity to manufacturing strategies, with many combining, not replacing, traditional fabrication with 3D printers. Logistics providers can orchestrate complex hybrid manufacturing networks and utilize networks of 3D printers to offer new logistics services.

KEY OPPORTUNITIES

- Reduce transport costs and time by creating products closer to the point of use
- Logistics providers can become orchestrators of complex and fragmented supply chains for raw materials and end products
- New business models like print farms and on-demand spare parts printing and delivery

KEY CHALLENGES

- Restrictions on materials and the speed of 3D printing could delay full adoption of this technology
- Need to solve the regulatory certification and liability aspects of using 3D printed parts, particularly in the life sciences, healthcare, and aerospace industries
- Authors of digital design templates could be targeted by hackers and incur copyright infringement

Trend Assessment

Timeframe: > 5 years Impact: Medium Sector Relevance: Below

AUTO E&M TECH ENERGY LS&H E-RETAIL

Figure 46: The French military has recently deployed a print farm to streamline its spare parts supply chain.

KEY DEVELOPMENTS & IMPLICATIONS

With the potential to revolutionize how and where many types of item are produced, 3D printing is believed to be one of the most potentially disruptive trends for logistics. 3D printing, or additive manufacturing (AM), has established itself as a rising technology, and its effects on the logistics industry are likely to be realized in the mid-future. In 2019, the global AM market surpassed USD $10 billion and analysts expect it to double in size every 3 years. North America and Europe currently lead the charge, with the United States possessing more than 422,000 3D printers and Germany generating more than $1 billion in related revenues. However, Asia and Australia have ramped up adoption and investment in AM in the past two years, setting up for strong competition in the future. Where 3D printing has been historically a technology for prototyping parts to accelerate product design work, or hobbyists and students experimenting in laboratory environments, additive manufacturing is today gaining traction as a de facto production method for critical machine parts. For logistics providers, there will be more opportunities from 3D printing than one may think, namely growth in the scale and complexity of regional logistics networks as well as business-to-business (B2B) printing services and delivery. While a world of widespread 3D printing is still many years away, there will always be a need to supply polymers and raw materials so logistics providers must adapt their services accordingly.

Regional logistics networks will expand as advances in 3D printing technology allow more product types to be made closer to the consumer. Beyond plastics, 3D printing technology has recently expanded to include various types of wood, metal, ceramic, wax, paper, stone, resin, composite and, in 2018, glass. With only raw materials and digital blueprints traversing oceans and borders, products compatible with 3D printing will see significantly reduced transportation costs, customs duties, and the product security that accompanies long-distance transportation. As a result, there will be more regional production facilities, adding density to local supply chains, including freight hubs and last-mile delivery.

Figure 46

COVID-19 provides a glimpse of how AM could impact logistics in the future. With an unexpected spike in demand for personal protective equipment and ventilation machines, traditional manufacturing was poorly equipped to ramp up supply in a timely manner. Industrial and individual home users of 3D printers collaborated to create digital inventories of blueprint files and produce critical healthcare equipment. In the United Kingdom, the National Health Service open-sourced the design of face shields to allow owners of 3D printers to supply much-needed protective equipment that was suddenly in short supply at the outset of the crisis. Local supply chains had to rapidly adapt their usual logistics patterns, delivering these new pieces of equipment from within communities, instead of from abroad, to regional recipients.

B2B 3D printing services can become the new future for the aftermarket supply chain sector, as AM is expected to massively reduce the need for inventory. A recent MIT paper found that for the automotive industry, 3D printing could “reduce spare parts inventory by 90% and [still] ensure 100% availability.” As shelves are emptied and digital blueprints are instead stored as virtual, space-less inventory ready to be printed, an opportunity presents itself for logistics professionals. With large, open floor plans that are often strategically placed near hubs or customers, warehouses can offer virtual inventory services for storing digital designs, as well as real estate for hundreds to thousands of various 3D printers all working on custom orders of different amounts. Companies like Formlabs, Prusa Research, and Slant 3D are pioneering this space, operating “print farms” that convert passive storage areas into active manufacturing centers to produce high volumes of a desired product per hour, on demand, all the while cutting inventory costs.

ARTIFICIAL INTELLIGENCE

Artificial Intelligence (AI) is finding strong adoption within logistics thanks to the parallel progress of machine learning, computing power, big data analytics, and acceptance by industry leaders. AI stands to improve supply chain efficiency with its prediction and vison recognition capabilities and by driving intelligent workflow automation and delivering new customer experiences.

KEY OPPORTUNITIES

- Competitive advantage through data-driven decision making and the shift towards a predictive AI-powered supply chain
- Reduction in costs through highly efficient and effective processes
- Increased customer satisfaction through the personalization of services using AI

KEY CHALLENGES

- High capital costs and requirements for AI implementation including substantial data sets, computing power, and highly specialized personnel skills in AI
- Ethical concerns regarding the control and explainability of AI
- Resistance from regulatory bodies and workforces affected by automation

Trend Assessment

Timeframe: < 5 years Impact: Higher Sector Relevance: Below

AUTO E&M TECH ENERGY LS&H E-RETAIL

KEY DEVELOPMENTS & IMPLICATIONS

In the past several years, AI has become a top priority for enterprises across industry sectors and even government bodies. 83% of executives in 21 industry sectors believe AI is a strategic priority for their business, and 23% have already implemented AI solutions. On the government side, the notion of maintaining a leadership position on AI has become a critical aspect of political agendas globally, with over 40 national and international entities having developed AI ministries and strategies.

Regarding the logistics industry, McKinsey predicts that almost a third of the $4.2 trillion of value to be created by AI in the next 20 years will result from applying the technology to supply chains alone. Much of this value will come from cost reduction, of which Goldman Sachs estimates a 5% decrease due to AI-powered robotics, automation, process optimization, and data analytics. For a high-volume, margin-constrained industry, a 5% improvement can significantly empower logistics organizations to advance digitalization, efficiency, and resilience in their supply chains. AI is making the greatest progress in logistics with computer vision, workflow automation, and predictive capabilities.

Intelligent computer vision has been on the rise since the major enabling breakthroughs of deep learning in 2012. Advances have allowed logistics scanning, surveillance, and automation systems to effectively "see," analyzing and identifying content in an image or video and operating based on the content. This has changed how shipments are dimensioned, as well as how they are inspected for damage, labeling, and stackability. For robots and self-driving vehicles, leaps in computer vision and deep reinforcement learning have driven progress in autonomous navigation and the picking accuracy of robotic arms (see **Robotics & Automation** and **Self-Driving Vehicles**). Startups like Pilot AI Labs are applying visual AI to surveillance systems, allowing ambient tracking, measuring, and monitoring of shipments and assets throughout facilities, similar to how Amazon Go stores utilize grab-and-go, "just walk out" cashier-less retail shopping for customers.

Cognitive workflow automation has significant potential to streamline the complex back-office work that drives global trade. Global freight forwarding is analogous to a relay race with dozens of handover points and new documents piling on at each leg of the journey. Along the way, logistics professionals and customs agents have to make sense of the information contained in millions of documents in non-uniform formats, from bills of lading to customs declarations. Intelligent optical character recognition (OCR) programs that read both printed and handwritten text with more than 99% accuracy paired with workflow automation software can streamline these activities, freeing logistics professionals from simple and more repetitive tasks and upskilling them to focus on higher-order customer situations (see **Future of Work**).

Predictive logistics remains the most important AI application for industry professionals, given the abundance of supply chain data, as well as better machine-learning algorithms from which to draw predictive insights.

APPLYING AI TO SUPPLY CHAINS WILL RESULT IN $1.4 TRILLION OF VALUE IN THE NEXT 20 YEARS

From capacity planning and forecasting to network optimization, the predictive capabilities of AI are helping logistics operators make precise decisions to proactively streamline operations. For instance, with double-digit e-commerce growth increasing last-mile diversity and complexity, this final segment of delivery is still the most expensive link of supply chains. The challenges of balancing delivery time windows, fuel consumption, travel distance, traffic patterns, load capacity, and ad hoc pickups while simultaneously communicating accurate arrival times and updates to customers make the last mile difficult and costly for operators. Across the industry, however, AI is making strides in dynamic route optimization, managing all these variables in an efficient manner and generating time-window predictions for customers. As AI becomes more intelligent, predictive technology could take logistics players a step further into the territory of anticipatory delivery models. Instead of waiting for customers to order, AI will go beyond same-day or same-hour delivery, supplying goods to customers before they even realize what is needed.

Figure 47

Figure 48

Figure 47: For a smooth, cashier-less customer experience, Amazon Go stores leverage computer vision to track shoppers, tally the items they pick from the shelves, and charge their Prime accounts when they leave the store.

Figure 48: As part of its remote air control tower solution, Searidge Technologies utilizes intelligent video to detect, position, and continuously track all targets on airport surfaces, from construction areas to aircraft.

AUGMENTED & VIRTUAL REALITY

Blending the digital and physical worlds, augmented reality (AR) can augment logistics quality and productivity, empowering workers with the right information at the right time in the right place. Virtual reality (VR) technology enables logistics providers to design, experience, and evaluate environments in a digital world for optimizing material flows and training processes.

KEY OPPORTUNITIES

- Cost savings can be realized through accurately testing virtual concept creations such as warehouse layout planning and product simulations
- Hands-free operation results in higher efficiency and error-free processes
- Repair and maintenance can be standardized and done remotely with a global team of experts
- Faster training in virtual environments thanks to immersive, user-friendly media and language flexibility; potential gamification of work

KEY CHALLENGES

- High development and investment costs required to set up VR solutions that are adaptable and have high technical performance
- Integration into an existing warehouse management system (WMS) requires new standards and interfaces
- Security concerns that hackers may access data containing sensitive information about a company's supply chain processes

Trend Assessment

Timeframe: < 5 years Impact: Lower Sector Relevance: Below

AUTO E&M TECH ENERGY LS&H E-RETAIL

KEY DEVELOPMENTS & IMPLICATIONS

Augmented and virtual reality (AR/VR) technology has experienced generally slow adoption and spread across industries, including the logistics industry. However, societal and workforce policies set in place due to COVID-19 may be the required catalyst for widespread acceptance. In India, AR/VR developers report that demand for their solutions has nearly tripled since social distancing measures were put in place. A similar growth pattern on a global scale is anticipated in an ABI Research white paper, predicting the sale and shipment of an unprecedented 16 million AR/VR headsets in 2021, even taking post-pandemic manufacturing slowdowns into account. As working remotely becomes more commonplace, international business travel more complicated, and in-person meetings less necessary, businesses, including those within the logistics industry, should expect to see AR/VR presence permeate their sectors in the near future.

Smartglasses worker assistance in the realm of AR technology has profound effects on inspection and quality assurance, as well as repair and maintenance. Vision picking, pioneered by Ubimax and DHL Supply Chain, uses smartglasses to enhance the traditional picking procedure. Demonstrating up to a 25% faster pick time and nearly 100% accuracy, smartglasses are being systematically rolled out across DHL and the broader logistics industry today. Furthermore, smart glasses can help improve the quality of repair and maintenance services. Semiconductor company ASML quickly adapted to the COVID-19 landscape by developing an AR smartglass solution that enables its vital customer support

Figure 49

engineering team to troubleshoot remotely in factories around the world without needing to be physically present. This significantly reduces response times and saves the company from potential losses estimated in billions of dollars. And while AR is becoming applicable in more use cases, the technology continues to evolve. In early 2020, Mojo Vision unveiled the first AR contact lens prototype designed to project images directly into the field of view of the user wearing it. This AR medium may easily become the preferred choice of workers in the future compared to heavier and bulkier glasses.

Logistics infrastructure design, enabled primarily by VR, allows users to design and simulate assets without the need for large up-front costs. Boeing, Ford, and Lockheed Martin already extensively utilize Cave Automatic Virtual Environment (CAVE) technology in their product design teams. Projections on a 5-walled display room paired with audio are helping colleagues to globally connect, test, and adapt immersive virtual prototypes with incredible accuracy. CAVE and other VR tools are now finding traction in the logistics industry with the ability to simulate infrastructure layout planning and equipment operation with a handful of logistics planning and consulting firms already incorporating CAVE experiences in service portfolios. These VR concept visualization environments are expected to proliferate as their cost-cutting benefits are realized.

Immersive training using VR provides resource-efficient ways to educate and onboard employees in exciting, stimulating scenarios. In 2018, Walmart began distributing Oculus VR headsets in the United States, making standardized training more accessible to more than 1 million associates. AR/VR startup Virti simulates anxiety-inducing environments to prepare nurses and doctors to cope with a sudden influx in COVID-19 patients. Meanwhile, Boeing is utilizing VR headsets to train NASA astronauts for future Starliner missions to the International Space Station. Practical VR demonstrations in the logistics industry are mostly on health, safety, and quality-related topics such as operating forklifts in busy virtual warehouses. In the case of DHL Express, a VR-based training game helps employees learn how to properly load pallets or containers for optimal density. DHL has also developed virtual reality tours of major air hubs and operational facilities to allow employees to both experience them remotely and increase their understanding of operational processes. In all cases, trainees make decisions and learn in a safe, immersive, and digitally guided environment in preparation for real-world tasks.

Figure 49: Smartlgasses are becoming an increasingly common tool in supply chains, improving productivity with line-of-sight information on picking, inspections, and other processes.

BIG DATA ANALYTICS

Logistics is being transformed through the power of data-driven insights. Thanks to the vast degree of digital transformation and the Internet of Things, unprecedented amounts of data can be captured from various supply chain sources. Capitalizing on its value offers massive potential to increase operational efficiency, improve customer experience, reduce risk, and create new business models.

KEY OPPORTUNITIES

- Transform supply chain organizations so they are led by data-driven insights beyond intrinsic knowledge and historical experience
- Improved visibility during transit, down to shipment level, with enhanced intervention capabilities for supply chain participants (e.g. digital customs processes)
- Use vast amounts of data, as required input for AI, to improve customer experience through predictive operations, proactive customer service, and optimal product and service recommendations

KEY CHALLENGES

- Data privacy, security, and governance
- Data quality – it's NOT the tools, it's the data; the right data provides the right results
- Vast amounts of data are available but not necessarily clean, structured, or accurate; for tangible benefits, data accuracy is essential
- Scarce global talent pool of data and computer scientists

Trend Assessment

Timeframe: < 5 years Impact: Lower Sector Relevance: Below

AUTO E&M TECH ENERGY LS&H E-RETAIL

KEY DEVELOPMENTS & IMPLICATIONS

Since its arrival in the first edition of the DHL Logistics Trend Radar in 2013, Big Data Analytics has developed and today is increasingly becoming part of the de facto operating model for the logistics industry. By 2018, the typical supply chain accessed 50 times more data than in the preceding five years, and now supply chains access even more. Surging demand for personalized and context-based services has driven development of artificial intelligence (AI) and machine learning applications which, in turn, have upped the need for larger datasets in the industry for better results. Additionally, the rapid migration of enterprise data storage from traditional datacenters to the cloud has provided more flexibility in effectively scaling storage and processing power for all collected data. This capacity increase is vital as more than 6 billion people, or 75% of the world's population, are expected to interact with data-input mechanisms by 2025.

The need for visibility and prediction is ever-more pressing. COVID-19 has caused unprecedented uncertainty in supply chains globally, affecting how goods are moved and altering consumer demand and behavior. Big data analytics holds the key to uncovering hidden issues across entire supply chains and surfacing trends that are not so obvious. A recent market analysis predicts an almost 30% post-pandemic CAGR for the global big data analytics market, reaching more than $68 billion by 2025, from $15 billion in 2019. As companies around the world recover from this acute shock, demand is growing for promising features of data analytics, such as mitigating disaster risks, simulating operations, and improving customer service.

Real-time process optimization and simulation are becoming increasingly important tools for supply chain management. The ability to run global supply chains at peak efficiency is more challenging as worldwide complexity grows. Warehouse operators and supply chain managers can make better decisions with granular visibility of processes like order management, and inventory levels and resource utilization become transparent in live dashboards. By uncovering patterns and anomalies in real-time data, operators can do things like allocate the optimal number of staff to certain tasks within a warehouse, group similar orders into the most efficient pick routes, and determine the optimal number of staff and assets between a group of warehouses.

Simulation models take optimization one step further by allowing logistics planners to test the impact of various levers that could be costly to execute on the ground. From exploring the consolidation of distribution centers to testing new delivery routes, simulations help answer service, cost, and risk questions in different scenarios. Building complex supply chain models with hundreds to millions of entities and activities is no trivial task, but companies can leverage analytics to help fill in many variables as input and derive forecast models. Output can then inform future strategies and policies.

Graph analytics is an emerging technical type of data analysis that goes beyond having data in a pure tabular form to map visual structures of nodes and connecting lines. It focuses on the relationship between objects in a dataset. Early applications have been in social

Figure 50

network analysis in, for example, Facebook, LinkedIn, and Twitter. For the logistics industry, graph analytics can help answer difficult questions that other data structures may not, including using shortest path methods to identify longest lead times, the weakest connection in a supply chain, instances of fraud in a customs process, and the relationship and community among industry players and customers. Boston Scientific, a medical device manufacturer, employs massive graphs to identify the relationships between parts, finished goods, and failures. It uses graph algorithms to score and rank parts and goods nodes based on their proximity to failure nodes. This is a powerful method to identify the most prominent sources of failure and analyze the likelihood of downstream problems. Supply chains can similarly increase transparency and identify common points of failure with graph analytics, as well as assess the impact if a certain supplier, facility, or component fails.

Figure 50: Graph analytics links and clusters data points to highlight patterns and relationships that could be used to optimize processes and reduce cost and waste.

BIONIC ENHANCEMENT

Bionic enhancement refers to supporting systems worn close to or within the human body that augment capabilities of the human body and mind. Advanced wearables and exoskeletons can support logistics workforces, especially older workers, in areas such as training, communication, process execution, and optimization. Most importantly, they can minimize health and safety risks in supply chains.

KEY OPPORTUNITIES

- Significant reduction and even elimination of work-related injuries, raising health and safety standards
- Increased efficiency through real-time operational analytics from wearables, enabling proactive correction
- Revolutionary potential for hands-free task execution through gesture and thought-control technologies

KEY CHALLENGES

- Cost/benefit indicators remain challenging and unclear as industrial adoption is only beginning
- Bulkier or unnatural-feeling enhancements may meet with initial resistance during the adoption process
- Ethical challenges with bionic human enhancement can limit and prohibit technological advancement

Trend Assessment

Timeframe: > 5 years Impact: Lower Sector Relevance: Below

KEY DEVELOPMENTS & IMPLICATIONS

Normally reserved for manufacturers and healthcare providers, bionic enhancements are now beginning to enter the logistics industry. This initial appearance points to the rapid acceleration of growth experienced in both the smart wearables market and the exoskeleton market over the past two years. Industry analysts predict that spending on smart wearables will total $52 billion in 2020, a 27% increase from 2019, and anticipate that shipments will more than double between 2019 and 2022. Regarding exoskeletons, the market is expected to hit $5.2 billion by 2025, up 3,900% from a mere $130 million in 2018.

While bionic enhancements as a whole are usually seen as potential aids for more strenuous, physically active occupations within the logistics industry, they can also provide benefit in office-based and managerial roles. Labor shortages and an aging workforce (see **Silver Economy**) have elevated the focus on health and safety in all divisions, and experiments and trials have shown that bionic enhancements, especially exoskeletons, effectively combat work-related fatigue, injury, and musculoskeletal disorders in the workplace. While it seems that the COVID-19 crisis did not have a substantial impact on the demand for bionic enhancements, shutdowns in the manufacturing sector certainly slowed the distribution of products to customers. With industrial centers reopening, the proliferation of this technology trend across all sectors is expected to resume the rapid pace it once demonstrated.

Wearable workforce intelligence is broadly augmenting workers in the logistics industry with many tasks, from safety to awareness and from ergonomics to productivity. Besides smartglasses that are used within DHL operations today (see **Augmented & Virtual Reality**), sensors that monitor posture and movement – like those from startups Kinetic and MotionMiners – are currently helping to reduce injury and optimize body positioning in the workplace. However, within the coming decade smart wearables are anticipated to miniaturize even further and connect even closer to the human body. Logistics sectors will soon be thoroughly exposed to e-textiles, or textiles combined with electronics, with use cases ranging from existing headbands that detect driver fatigue to protective wear that monitors the handling of hazardous materials. Companies are already exploring near-field communication (NFC)-based implants, giving their employees an alternative method of accessing buildings and computers and conducting transactions. Meanwhile, startup Neuralink is developing an implantable brain-computer interface. While commercialization timelines are not so clear, there is viability in augmenting and recording body functions, including sight and limb movement.

Exoskeletons are starting to appear more and more in the logistics workplace. Both "active" exoskeletons (motorized designs) and "passive" exoskeletons (designs with components like springs that store and release energy) are becoming ever lighter and more manageable. Exoskeletons for lifting and reaching are highly relevant for logistics, applicable for sorting, picking, packing, (un) loading, and inducting parcels. Recently, Stuttgart Airport conducted a pilot project with active back-support exoskeletons developed by German Bionic Systems for workers carrying heavy baggage. Other players including Laevo, Ottobock, and SuitX are pursuing passive alternatives in the manufacturing and logistics industries. Moreover, exoskeletons for overhead work are also relevant in supply chains, especially for truck and container loading and unloading. Ford has already deployed 75 passive upper-body EksoVest exoskeletons in 15 plants worldwide for overhead working, while Audi, Boeing, and Toyota are exploring several similar concepts. Finally, Japanese company Nitto and Switzerland-based Noonee are each designing exoskeletons that allow workers to sit down without a chair, providing the user relief in environments that prohibit furniture. Maintenance technicians on crowded logistics facility floors, as well as older employees with limited strength or dexterity (see **Silver Economy**), may find such types of exoskeleton useful. Overall, these advances in exoskeleton technology can help improve productivity while also retaining talent and experience in the workplace.

Figure 51

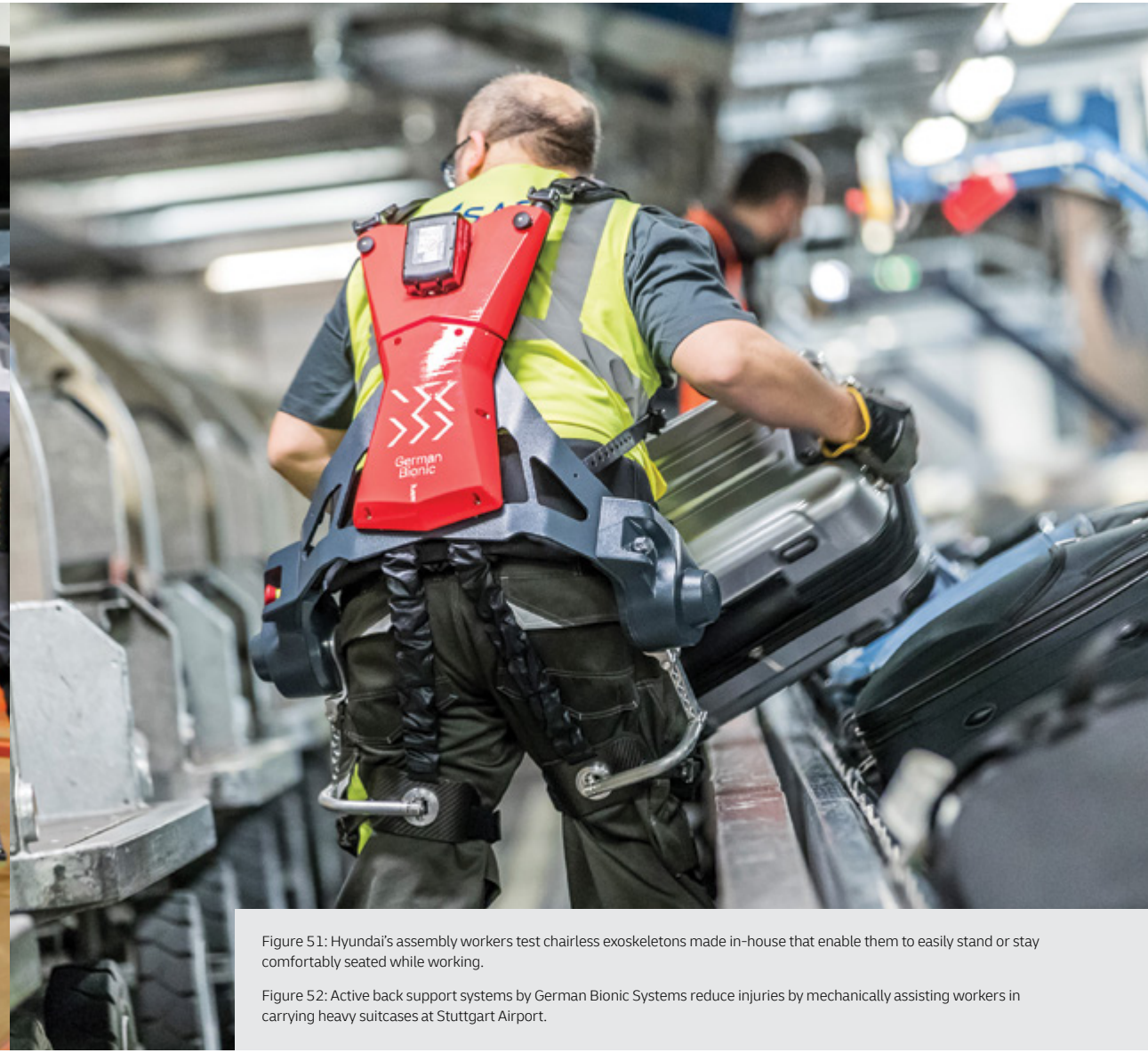


Figure 52

Figure 51: Hyundai's assembly workers test chairless exoskeletons made in-house that enable them to easily stand or stay comfortably seated while working.

Figure 52: Active back support systems by German Bionic Systems reduce injuries by mechanically assisting workers in carrying heavy suitcases at Stuttgart Airport.

BLOCKCHAIN

Removing complexity from global supply chains, blockchain and other distributed ledger technologies (DLTs) can facilitate greater trust and transparency among stakeholders and customers, supporting the automation of administrative and commercial processes. Smart contract concepts and the potential adoption of cryptocurrency as viable payment will also create opportunities for new services and business models in logistics.

KEY OPPORTUNITIES

- Higher levels of transparency between disparate supply chain parties can drive process optimization and better visibility for customers, operators, and authorities
- Process efficiencies and cost savings through the adoption of smart contract principles
- Cryptocurrencies as a potentially accepted form of payment for logistics products and services

KEY CHALLENGES

- Technical limitations such as scalability and power consumption must be overcome to enable sustainable, large-scale deployment
- Industry-wide adoption will be difficult given industry fragmentation and competition
- Governance, standards bodies, and industry consortia will be required to ensure regulations and interoperability between carriers, operators, customers, and customs authorities

Trend Assessment

Timeframe: < 5 years Impact: Medium Sector Relevance: Below

KEY DEVELOPMENTS & IMPLICATIONS

Given the inherent fragmentation and heterogeneity of global supply chains, the multitude of actors involved in global shipping, and the need for trust in and transparency of financial flows, information flows, and material flows, it is no surprise that supply chain leaders have a strong interest in blockchain. In fact, in 2019 a cross-industry survey of 1,300 senior executives by Deloitte revealed that more than half considered blockchain to be in their top 5 strategic priorities for that year and beyond. For supply chain organizations, the promise is enticing – having a single system that is accessible to all parties involved in a supply chain transaction and that carries and stores information immutably by design. Blockchain has established itself firmly in the private sector as the technology underpinning the capabilities of cryptocurrencies like Bitcoin and Ether. Now supply chain leaders are systematically exploring how the decentralized, immutable, and consensus-driven nature of DLTs can be applied to supply chain processes and IT environments. The aims are to enable greater traceability and transparency and the automation of commercial processes, and even become an acceptable form of payment for supply chain products and services.

Traceability and transparency reflect the market's need for a single source of truth in the supply chain, from a raw material's provenance to a product's end of life. According to a deep-dive analysis of the annual Blockchain 50 list in February 2020, product traceability throughout production and the supply chain is the primary use case for blockchain-adopting industry giants across multiple industry sectors including BMW, Cargill, De Beers, Dole, Foxconn, Honeywell, and more. In 2019, using IBM's Food Trust platform, Carrefour and Nestlé extended their use of blockchain for customers to track and check the quality of baby formula "from dairy to shelf" enhancing new parents' trust in the brand. In the mining sector, BHP Billiton has been using blockchain technology for years to record movements of wellbore rock and fluid samples for itself and its partners, helping to increase operational efficiency, safety, and visibility at mining sites.

50% OF 1,300 SENIOR EXECUTIVES CONSIDERED BLOCKCHAIN IN THEIR TOP 5 STRATEGIC PRIORITIES.

The automation of commercial processes through blockchain-based smart contracts has streamlined service and payment transactions while reducing errors in the back office. When pre-determined service level agreement criteria are met (e.g. delivering spare parts in good condition to a Shanghai warehouse by noon), smart contracts allow procedures to self-execute (e.g. full, subtracted, and even split payment) without needing a human to actively participate. Brussels Airport launched its blockchain-based freight management app to streamline the once paper-based process of transferring cargo from forwarders to terminal handlers. Instead of handing over original bills of lading with handwritten signatures, these documents and signatures are now verified digitally, simplifying the process for handling agents. Even more recently, DHL Start-up Lab, in partnership with Dubai Customs, developed and launched TED-X, a blockchain platform solution for cross-border e-commerce, including returns. In less than a year, almost 7,000 shipments were digitally processed in the blockchain system, saving $10,000 in duties and customs for DHL customers and enabling 60% product revenue growth for platform users. The use of blockchain-based smart contracts is currently being expanded and explored for processes beyond payment and cross-border customs documentation, including cargo handling and tracing, escrow agent audits, and contractor reputation scoring.

Cryptocurrency as an alternate form of payment has been the historic breakout use case of blockchain technology. While volatility is still a concern, recent announcements and speculations of giants Amazon, Apple, Facebook, and Google each releasing their own digital currencies in the next couple of years may fuel widespread consumer adoption once implemented. Just like the debit, credit, and PayPal methods of payment that precede them, cryptocurrencies are a viable payment method for logistics products and services, and supplementary acceptance may strengthen logistics providers' competitiveness and further their integration in the digital consumer world.

Figure 53

Figure 54

Figure 53: In partnership with DHL Start-up Lab, Dubai Customs has implemented a blockchain solution for cross-border e-commerce, saving customers thousands of dollars.

Figure 54: IBM's blockchain-powered Food Trust platform enables any user with a smartphone to confirm the history and quality of participating products.

CLOUD & APIs

As cloud-based service applications for the logistics sector continue to disrupt traditional supply chain management, application programming interfaces (APIs) form the basis of on-demand logistics services (or LaaS) and real-time data processing. This allows carriers and third-party logistics providers to integrate and scale software services using centralized cloud-based platforms, replacing existing electronic data interchange (EDI) solutions.

KEY OPPORTUNITIES

- New commercial opportunities enabled by seamless integration within an ecosystem of third-party vendors, web shops, e-commerce platforms and logistics marketplaces
- Expanded service offerings with better pricing transparency for customers
- Scalable automation processes, lowering cost and increasing business agility
- Increased data security by outsourcing cloud security to specialists

KEY CHALLENGES

- Interoperability of existing legacy systems with new platforms
- Mitigation of supply chain risk given economic and trade uncertainty
- Guaranteeing security of platforms with the use of external clouds

Trend Assessment

Timeframe: < 5 years Impact: Higher Sector Relevance: Below

AUTO E&M TECH ENERGY LS&H E-RETAIL

KEY DEVELOPMENTS & IMPLICATIONS

Affecting highly complex operations, COVID-19 exposed vulnerabilities in logistics data and global IT infrastructure, heightening a pre-existing need for more efficient data exchange across the supply chain. The global supply chain management market was nearly $16 billion in 2019, and a post-pandemic CAGR of 11.2% is predicted through 2027. Within this growth, the cloud-based segment is strongest as logistics players begin to realize cloud's reliability, scalability, cost-efficiency, and immediacy benefits. Gartner estimates that, through 2020, 90% of spending on supply chain management systems will be allocated to cloud supply chain solutions.

Application programming interfaces (APIs) are software protocols allowing applications to communicate and exchange information. Over the past decade, APIs have standardized, becoming more like products for specific audiences than mere communication code, and creating the "API economy" from which eBay, Expedia, Google, and others make substantial revenue. For logistics providers, well-designed APIs are critical to providing shipment tracking, full landed cost calculations, rate sourcing, and other logistics services anywhere on the web and via mobile apps.

New commercial opportunities arise as logistics APIs gain traction. By seamlessly integrating, for example, delivery options, fulfillment services, and cargo rates in third-party web shops, e-commerce platforms, and logistics marketplaces, the logistics provider ensures presence in the digital journey of customers looking to buy logistics products and services online. A cohesive customer experience necessitates transparent shipping options, tracking, and last-mile delivery, all of which are increasingly seen as an extension of the brand. Managing a seamless flow of data, financials, and physical goods is critical to the whole experience, and APIs are the glue that ensures the seamless transfer of customer data to the logistics provider for smooth delivery. When the right logistics services are embedded in web properties, this grows volume for supply chain operations and increases basket value for online sellers.

Modular cloud logistics platforms can be integrated via APIs into existing data infrastructure and systems, streamlining and scaling access to on-demand logistics and IT services. This allows logistics providers, carriers, and shippers to connect and determine cost-effective options for ordering, billing, and tracking (see **Logistics Marketplaces**), while decreasing capital expenditure and hardware upkeep. Additionally, cloud platforms with specialized expertise can add functionality for customers and scale using standard interfaces. Customers benefit from the expansion of service offerings, faster delivery, and price transparency. Digital freight network Convoy, for instance, offers software tools and APIs to help shippers increase efficiency and save costs with its in-house, real-time pricing technology. Meanwhile, Transplace, a supply chain management software company, is extending cloud-based platform services access via standard APIs to shippers that already use its existing software systems and want to optimize supply chain operations.

Cloud-powered global supply chains allow companies to minimize capital expenditure and optimize material flows and shipping channels by migrating processes into the cloud. Supply chain management systems involving warehouses, transportation, yards, and labor, as well as their individual components like robots and smartglasses, can all be recorded, coordinated, and orchestrated from one integrated view – a cloud-enabled management dashboard. COVID-19 has accelerated the need for cloud-based automated supply chains to quickly address sudden change. By standardizing APIs and specific workflows, DHL is creating such a cloud network. With Microsoft's Azure IoT cloud service and the Blue Yonder digital fulfillment platform, DHL is building an integrated warehouse robotics management system to enable faster integration of warehouse robots across multiple vendors. The platform allows customers to choose suitable robotics systems based on business need, and provides an efficient process for integrating new automation devices into existing warehouse management systems. Meanwhile, project44, a leading supply chain platform, has partnered with IBM, Oracle, SAP, and other cloud providers to offer standardized API integrations that deliver real-time data access and visibility across the third-party logistics provider, shipper, and carrier network.

DIGITAL TWINS

As unique, virtual representations of potential or actual physical objects and processes, digital twins enable companies to design, visualize, monitor, manage, and maintain their assets more effectively. Led by the engineering, manufacturing, automotive, and energy industries, these simulated replicas help unlock new service-based business models built on valuable insights from operational data.

KEY OPPORTUNITIES

- Remote management, visibility, and condition monitoring of existing logistics assets, facilities, and infrastructure
- Predictive modeling and simulation of future states of logistics assets, facilities, and infrastructure for optimal operation in the future
- New aftermarket logistics service models based on data from digital twins of assets in the field

KEY CHALLENGES

- Precise representation of digital twins and their physical counterparts is hindered by connectivity, limited data sources, and computing resources
- Total costs of developing and implementing digital twins may be prohibitive for many logistics use cases beyond the most complex facilities
- Change management as a digital twin will centralize insight and spur decision making from many disparate stakeholders in organizations to leverage full value

Trend Assessment

Timeframe: > 5 years Impact: Medium Sector Relevance: Below

AUTO E&M TECH ENERGY LS&H E-RETAIL

KEY DEVELOPMENTS & IMPLICATIONS

Fueled by parallel developments in the Internet of Things (IoT), big data, artificial intelligence (AI), cloud computing, and digital reality technologies, the recent arrival of digital twins heralds a tipping point where the physical and virtual worlds can be managed as one. Workers may simply interact with and analyze the digital counterparts of objects and processes just as they would with the physical objects and processes themselves.

For example, Rolls-Royce has looked towards digital twins to drive development of its newest generation of jet engines for safety evaluation tests. The company creates virtual scale replicas of the physical engines to model the performance of the real machines. Although virtual simulations are likely to involve computationally intensive tasks (it takes six weeks to process the 0.2 seconds that determine the failure of a “blade off” test), Rolls-Royce has reported not only material cost savings in the tens of millions of dollars per engine, but also an accelerated development timeline. Furthermore, the data from each successive simulation contributes to the library of insights that inform future Rolls-Royce product designs and maintenance schedules.

Warehouse digital twins are an ideal place for this technology to take hold in logistics. A virtual 3D model of the facility can be paired with inventory and operational data including the size, quantity, location, and demand characteristics of every item. This makes the facility digitally come to life in real time, allowing site managers, customers, and remote management to have full visibility of the operation. During the lockdowns and travel restrictions at the peak of the COVID-19 pandemic, this capability was acutely needed as the number of on-site personnel was limited. In the near future, digital twins can support the design and layout of new facilities, allowing companies to optimize space utilization and simulate the movement of products, personnel, and equipment.

Figure 55

Digital twins of supply chains go one step further beyond a single building, as the flow of goods from source destination depends on the orchestration of multiple elements including ships, trucks, aircraft, order and information systems and, above all, people. This environment of complex interaction can be seen most clearly at major cargo airports and container ports. At these facilities, the challenge of efficient operation is exacerbated by imperfect systems of information exchange, with many participants reliant on offline processes that can be subject to errors and delays. Major port authorities around the world like the Port of Rotterdam and the Port of Singapore are turning to digital twins to design, develop, and implement the next generation of ports and improve their efficiency. While spatial models and operational data have existed for many decades, digital twins present the opportunity to combine the two and perform simulation optimization based on machine learning to predict the future. By initially visualizing how the structures and processes need to be built in a virtual environment, port authorities can then build with confidence the massive infrastructure which must be created the right way the first time.

Aftermarket logistics services can be developed by linking digital twins of manufactured products with logistics services. With a digital twin of any physical object, such as goods or vehicles, the role of the logistics service provider can become extremely important, acting on insights from the virtual realm. For instance, if a vehicle receives damage and requires spare parts, the supply chain is able to react quicker (or even proactively) and more efficiently with notifications from the digital twin, detailing exactly the required parts and where they need to be sent. Highly dynamic variables of addressing unscheduled maintenance can be reduced or eliminated, ensuring a high quality of service within the supply chain and delivering the right products on time.

Figure 55: Digital replicas of real-world products and processes within a supply chain can provide transparency, warnings, and predictions.

INTERNET OF THINGS

The Internet of Things (IoT) has potential to connect virtually anything to anything and accelerate data-driven logistics. Everyday objects can now send, receive, process, and store information, and thus actively participate in self-steering, event-driven logistics processes. IoT promises far-reaching payoffs for logistics providers, generating actionable insights that drive change and new solutions.

KEY OPPORTUNITIES

- Increases the visibility, traceability, reliability, and security of logistics operations
- Real-time connectivity helps to improve service quality, optimize asset utilization, and shorten response times for operations support
- Improved operational efficiency via automatically triggered actions from IoT data
- Creation of more dynamic and customized delivery services for customers

KEY CHALLENGES

- High levels of fragmentation within the logistics industry require significant data harmonization and investment in standards development
- Security risks from fully IoT-enabled supply chains becoming cybercrime targets
- Achieving seamless indoor and outdoor tracking and roaming at a low cost of deployment
- Ruggedized hardware and optimized firmware to maximize the usable life of large logistics IoT deployments

Trend Assessment

Timeframe: < 5 years Impact: Higher Sector Relevance: Below

AUTO E&M TECH ENERGY LS&H E-RETAIL

KEY DEVELOPMENTS & IMPLICATIONS

For the past few years, IoT devices and the data they collect became proven drivers of higher efficiency and better service quality for the logistics industry. Market growth forecasts are bullish enough to expect worldwide spending on IoT technology to reach $1.2 trillion by 2022. Overall, more use cases for sensors are being identified, regulations have become more accommodating and, with more investment and demand driving down costs, sensors and IoT systems have generally become more attractive to logistics operators than ever before.

Moreover, as costs for existing technologies decrease, so does the size of IoT devices. Smartdust, a system of tiny electromagnetic sensors, is becoming reality with American semiconductor company Dust Networks implementing industrial sensors on the one-centimeter scale and with universities recently creating millimeter-sized sensors for biologic implanting. Meanwhile, RVmagnetics has developed a microfilament sensor that measures several physical quantities simultaneously including stress, temperature, magnetic field, humidity, vibration, and more. Sensors this small can be invisibly scattered across a shipped product, machinery surface, and into organic substances without adverse effects to generate gradient heat maps. In the energy sector, smart dust is being explored as coating on wind turbine blades for ambient condition and performance monitoring, capturing weather-related data to inform energy generation levels.

Smart shipments are on the rise as IoT overcomes the complexities of logistics networks. Packaged goods may need to cross several borders via different transportation modes; IoT must accompany them to meet diverse legal and physical requirements while also maintaining digital connection and power. Despite challenges, there have been technological improvements in all use cases (see **Next-Generation Wireless**) including location, temperature, shock, acceleration, light, and damage monitoring, to such an extent that shipment sensors are now part of many companies' supply chains. For example, Decathlon uses wireless RFID tags to identify, locate, and deliver products to stores in over 20 countries. DHL offers customers advanced IoT shipment solutions including theft investigation, satellite geofence-based locking boxes, and anti-jamming systems.

Connected assets are the most common applications for IoT devices as they have higher value, longer lifespans, and less mobility than packages. Initial use cases focused on larger and more expensive assets, such as vehicles in a fleet management system, but the logistics industry is now expanding sensor use to smaller and sometimes more complex assets, such as consigned products. To illustrate, DHL paired up with Alps Electric Europe to develop a bespoke, low-profile sensor to track roller cages throughout and between DHL facilities. Leveraging the Sigfox proprietary low-power wide area network for connectivity, and firmware optimized for minimum power consumption, the sensors can be permanently attached to the roller cages for their entire usable life of up to 15 years. A cloud-based management portal allows operators to mitigate shrinkage of the roller cage pool and recover units that find their way out of the DHL network. Sensors like these not only prevent losses, but also pave the way for virtual life-like replicas and servitized business models (see **Digital Twins** and **Servitization**).

COVID-19 has refocused attention on the most important assets – people. The IoT industry has reacted quickly to the pandemic, offering a wide array of products to enforce safety protocols like physical distancing, contact tracing, face mask usage monitoring, and more. DHL has swiftly responded by building on top of an existing IoT solution. Utilizing wearable sensors from American startup Kinetic that monitor the ergonomic lifting of packaging, the company has reprogrammed them to also alert employees if they fail to allow sufficient physical distance between each other.

IoT for facilities help to improve usage of and protection in existing and future properties. Inexpensive sensors detect and monitor the use of utilities like light and heat and can save facility owners substantial amounts by optimizing usage and increasing sustainability. In 2019, DHL Supply Chain partnered with clean-tech startup BeeBryte, leveraging its smart heating, ventilation, and air-conditioning (HVAC) unit for DHL's Singapore facility. Through automatic, real-time HVAC set-point adjustments based on anticipated weather conditions, building occupancy, and business activity, facility temperatures are maintained within a preferred operating range, and DHL benefits from 40% energy cost savings. Besides utilities, IoT devices can additionally aid in facility security, inventory management, and parking.

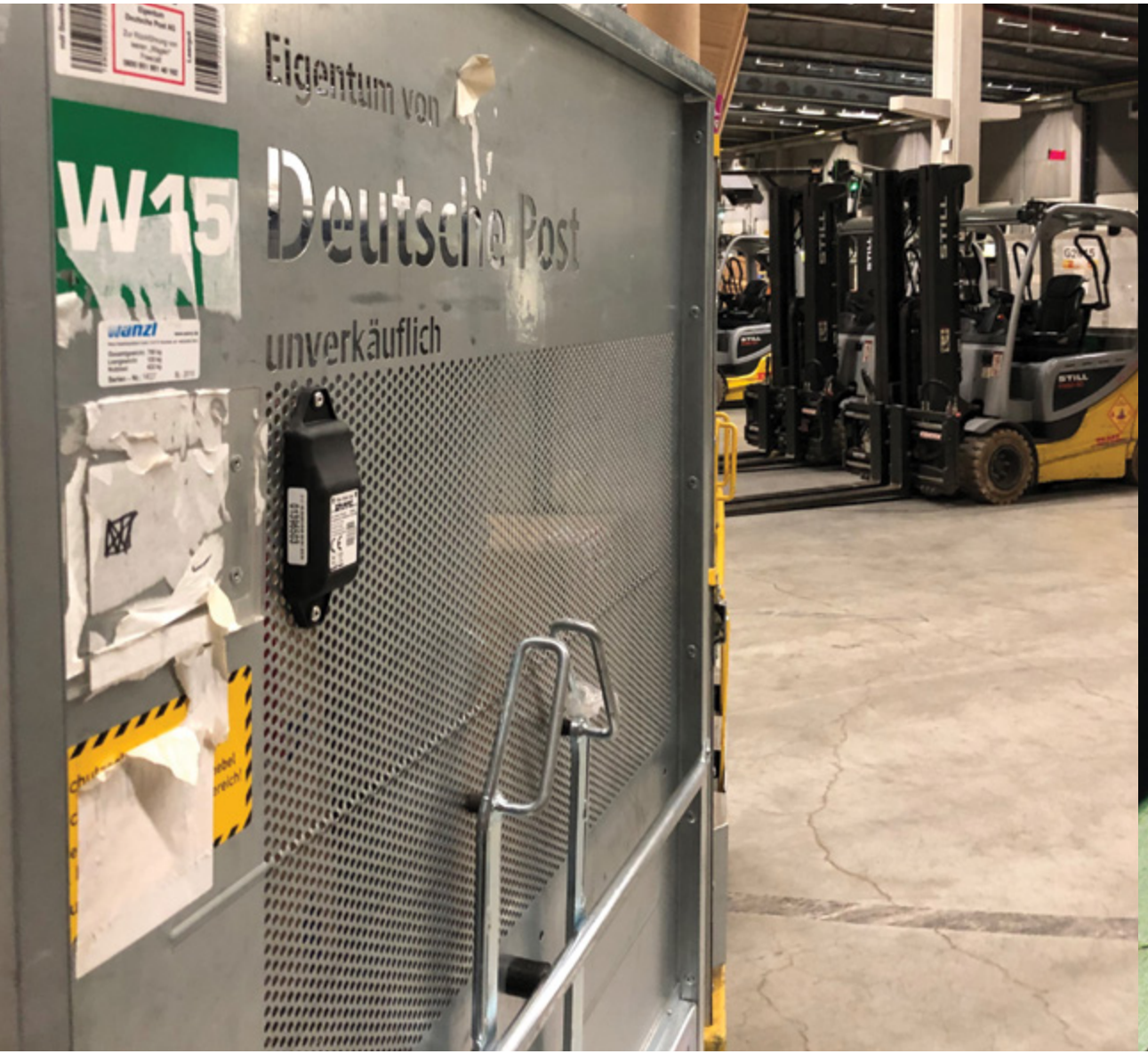


Figure 56

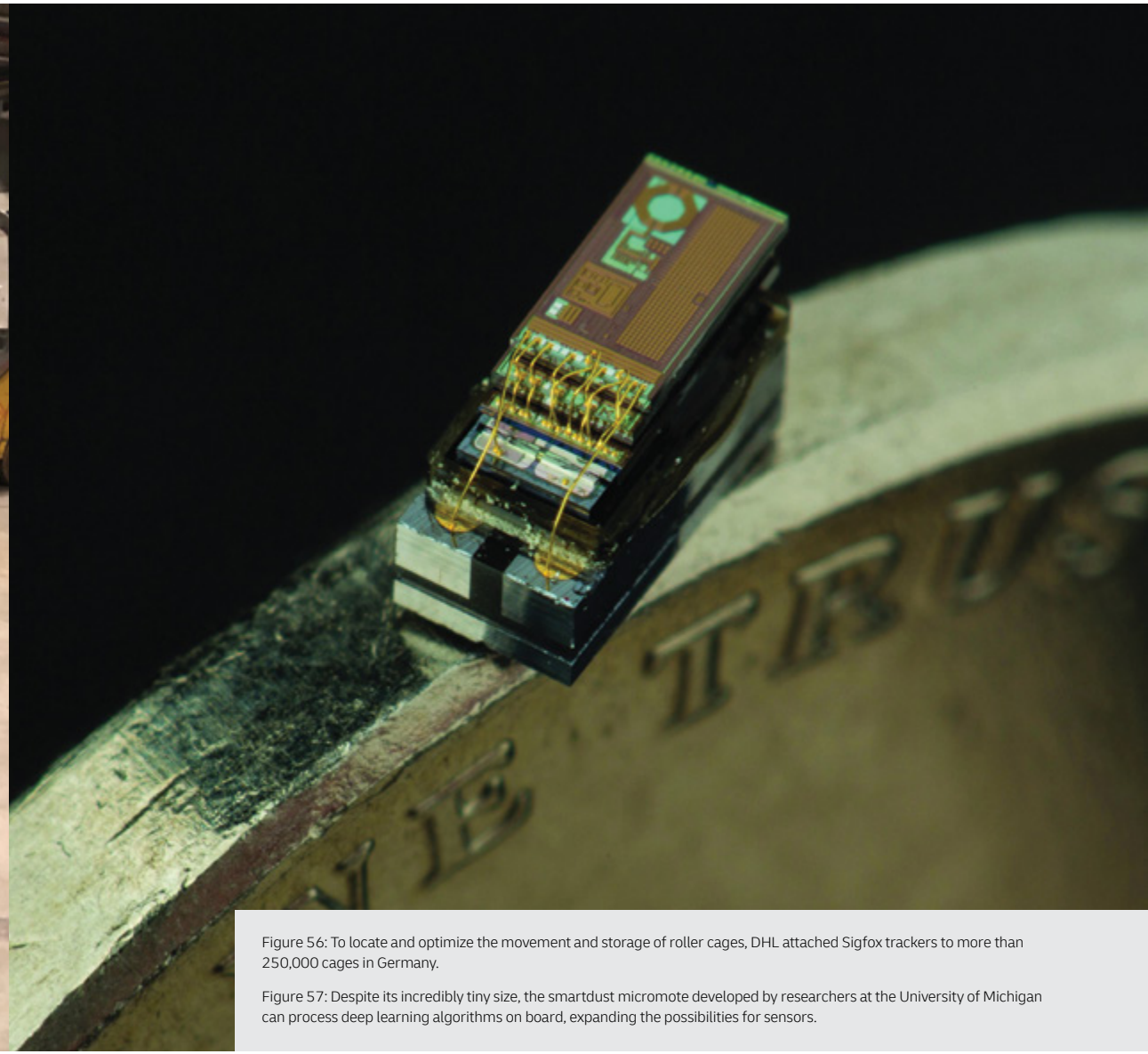


Figure 57

Figure 56: To locate and optimize the movement and storage of roller cages, DHL attached Sigfox trackers to more than 250,000 cages in Germany.

Figure 57: Despite its incredibly tiny size, the smartdust micromote developed by researchers at the University of Michigan can process deep learning algorithms on board, expanding the possibilities for sensors.

NEXT-GENERATION WIRELESS

Beyond 5G, progress across a wide range of wireless communication technologies is now creating new opportunities for industry to improve visibility, enhance operational efficiency, and accelerate automation. Next-generation wireless technologies will enable the next communication revolution, moving beyond today's goal of connecting everyone to a world in which everything, everywhere is connected.

KEY OPPORTUNITIES

- Total visibility of all supply chain operations from end to end, with greater granularity than current track-and-trace systems
- Widespread autonomy of logistics tranport and intralogistics movements thanks to 5G and Wi-Fi 6
- Near-perfect prediction from an enhanced ability to collect, transport, and process supply chain data with low latency and advanced machine learning algorithms

KEY CHALLENGES

- Power and availability may limit viability and geographic reach of the IoT applications that can be built
- As multiple technologies can serve similar use cases, architectural investment decisions may not be immediately clear
- Security of wireless networks and IoT assets will be critical, as each connected device can act as a gateway for cybercriminals to access critical logistics infrastructure

Trend Assessment

Timeframe: < 5 years Impact: Medium Sector Relevance: Below

AUTO E&M TECH ENERGY LS&H E-RETAIL

KEY DEVELOPMENTS & IMPLICATIONS

The Internet of Things (IoT) is already established and developing in logistics, and this new generation of wireless technologies will usher in an era of expanded capabilities that build upon today's successes. The ability to monitor, track, and interact with assets through wireless connections will make supply chains faster, more flexible, more efficient, more predictable, and more resilient. The combined progress of the following five next-generation wireless technologies will fill in today's connectivity white spots on the planet, enabling a future of total visibility, widespread autonomy, and near-perfect prediction to enhance operational efficiency and service quality.

Short-range networks include radio-frequency identification (RFID), near-field communication (NFC), and Bluetooth Low Energy. After failing to replace barcodes in the early 2000s, RFID is again finding traction, this time in contained environments and closed-loop supply chains. Retailers Inditex, Lululemon, and Nike are using RFID to track inventory throughout the supply chain, citing up to 80% faster stocktaking in stores and allowing associates more time for customer interactions. NFC, popularized by contactless payment systems, has found its way into common smartphones and has become the de facto technology for passive temperature monitoring in, for example, DHL's SmartSensor solution for critical life sciences shipments. With the arrival of sensor networks and beacons in logistics operations, Bluetooth Low Energy allows operators to monitor cartons on a single pallet for separation and if damaged during transport.

Local area networks (LANs) include Wi-Fi 6 and ultra-wideband (UWB). Wi-Fi 6 leverages two additional channels in the electromagnetic spectrum – the new 1 and 6 GHz channels on top of the existing 2.4 and 5 GHz channels. In addition to faster speeds and more bandwidth, the protocol can dedicate data traffic to specific applications, giving logistics operations the connectivity headroom needed to operate large fleets of wireless devices, such as scanners and mobile workstations, and even autonomous mobile robots. UWB, originally derived from radar technologies, allows for the precise indoor localization of people, assets, and shipments. One instance of UWB finding traction is the use of UWB tags for physical distancing and contact tracing in warehousing operations in the wake of COVID-19.

Cellular networks will bring about 5G, the fifth generation cellular technology standard with four key attributes. Firstly, enhanced mobile broadband will bring 10-100x higher data rates than standard wireless broadband communication (LTE). Secondly, ultra-low latency communications will support the high-speed, mission-critical communication needed for autonomous vehicles. Thirdly, massive machine-type communication will allow connection of up to 1 million devices to a single 5G cell, giving plenty of headroom for IoT activity. Lastly, network slicing will allow bandwidth to be allocated to dedicated applications. In logistics, this will enable smart roads and autonomous logistics transport, hyper-connected logistics facilities, and the dynamic setup of new or temporary logistics facilities during seasonal peaks.

Low-power wide-area networks (LPWANs), including LTE-M and NB-IoT, utilize narrowband cellular networks to provide a small amount of connectivity over very large areas. In the unlicensed spectrum, LoRaWAN and Sigfox have created their own proprietary networks to achieve a similar goal. These networks are ideal for tracking logistics assets in large, regional areas over a very long period of time, given their wide reach and low power consumption. LPWANs are ideal for tracking mobile and stationary assets; the new Istanbul International Airport leverages LoRaWAN to connect over 1,000 ground support equipment assets to track location, condition, and usage.

Global area networks (GANs) are based on low-Earth orbit satellites (LEOS). These orbit the Earth at several hundred meters and are much smaller and faster than geostationary satellites, circumnavigating the planet in just 100 minutes. With a lowering barrier to entry in the satellite launch market thanks to Amazon's Blue Origin, Facebook, SpaceX, and others, it is expected that between 10,000-50,000 satellites will be launched through 2030 (see Space Logistics). While some aim for a free global internet, for logistics providers this will bring low power connectivity to the remotest outdoor locations on Earth, including oceans, deserts, mountain ranges, and jungles where currently no communications infrastructure exists.

Figure 58: Istanbul Airport leverages LoRaWAN to track the location, condition, and utilization of over 1,000 ground support equipment assets.

Figure 59: One SpaceX Falcon 9 rocket can transport 60 of the planned 12,000 satellites the company wishes to deploy to provide global internet coverage.

Figure 58

Figure 59

QUANTUM COMPUTING

Millions of times faster than supercomputers, quantum computers will unlock an unprecedented level of calculating power capable of processing highly complex logistics algorithms in real time and rapidly simulating and iterating product and service models for a better-performing supply chain. Like technological breakthroughs before them, quantum computers will also present new opportunities and risks for cybersecurity.

KEY OPPORTUNITIES

- Complex logistics challenges like the travelling salesperson problem or bin packing problem can be calculated in real time instead of taking decades or centuries to solve with supercomputers
- Unhackable communication between quantum computers will improve the cybersecurity of logistics systems
- Superior materials, equipment, and vehicles designed by quantum computing enable a new generation of ultra-efficient assets for logistics

KEY CHALLENGES

- Several technological breakthroughs are still required for quantum computers to become practical and affordable for everyday use
- Business models for quantum computing are still in development and are not as accessible as supercomputers
- Existing cybersecurity protocols would potentially be indefensible to a quantum-based attack; for example, brute-force hacking could be done exponentially faster

Trend Assessment

Timeframe: > 5 years Impact: Medium Sector Relevance: Below

AUTO E&M TECH ENERGY LS&H E-RETAIL

KEY DEVELOPMENTS & IMPLICATIONS

After years of being limited to academic and scientific circles, quantum computing has finally broken out into the commercial space with advances enabling significant opportunities across applications. While current desktop computers and supercomputers organize, process, and store information called "bits" with binary values (1s or 0s), quantum computers use quantum bits, or "qubits," to perform the same functions. A qubit, however, is both a 1 and a 0 at the same time with a probability between the two values. Unlike a bit, a qubit can also entangle with another qubit, passing on information. To illustrate the significance of this development, given a difficult maze, a supercomputer would calculate paths from the starting point one at a time, albeit quickly, until it finds the exit. In contrast, a quantum computer would calculate all paths simultaneously and report back once the correct path is found.

Impressive breakthroughs in the last two years have justified elevating quantum computing as a trend to monitor this coming decade. In 2019, IBM unveiled its first commercial quantum computer, and, in that same year, Google published a paper claiming quantum supremacy over supercomputers with its own in-house system. In January 2020, China successfully transmitted encrypted data from a satellite to the world's first mobile quantum ground station. In June 2020, Honeywell joined the race, announcing it has built the world's fastest quantum computer with a volume of 64 qubits and offering commercial cloud computational services to businesses. Advances have been inspiring, but, as with all new trends, applications for the logistics industry – such as maximizing efficiency and throughput and minimizing risk and costs on levels never seen before – may not materialize as expected. Nevertheless, malicious use of quantum technology is a real possibility, and logistics industry players are encouraged to evaluate cybersecurity risks due to quantum computing.

Optimizing supply chain processes is considered to be the primary use case of quantum computing for the logistics industry, enabling real-time dynamism that could never be achieved by desktop PCs or supercomputers. In late 2019, in the world's first pilot project for traffic optimization using a quantum computer, Volkswagen partnered with public transport provider Carris in Lisbon, Portugal to individually calculate the fastest route for each of its nine participating buses over 26 stops in near-real time, helping commuters to avoid traffic jams as they arise. Besides dynamic route optimization, quantum computing has also been identified as a key technology in maximizing the simultaneous packing of millions of parcels in thousands of trucks and airplanes worldwide, detecting energy and product waste on a micro level, and boosting resiliency with adaptive, seamless replanning and reallocating due to unexpected shutdowns, late shipments, and cancelled orders.

Cybersecurity is a realm experts believe quantum computing will completely revolutionize. While such technology has the potential to create unhackable communication through its innate properties, a 2019 DigiCert survey found that 71% of IT leaders of critical infrastructure industries saw "the emergence of quantum computers as a large threat to security," with most anticipating quantum computing threats by 2022. This is because traditional encryption codes that would take a supercomputer trillions of years to crack now only require mere seconds or hours with a quantum computer. Researchers today are testing plausible solutions, such as lattice-based algorithms and more advanced cryptography, before quantum computing sees wider use.

Rapid modeling and testing of complex designs and materials on a molecular level will help manufacturers produce better products that can later spur changes and breakthroughs in the logistics industry. For instance, Daimler, in conjunction with IBM, announced in early 2020 the use of quantum computing to develop next-generation automotive lithium-sulfur batteries. These batteries are more powerful, longer-lasting, and cheaper than their lithium-ion counterparts and may help effect the long-discussed electrification of fleets worldwide. Airbus is exploring new computing technology to test and refine numerous iterations of airplane design to maximize speed, efficiency, and sustainability. Faster, cheaper, and greener planes may lower cost barriers for shipment services across regions.

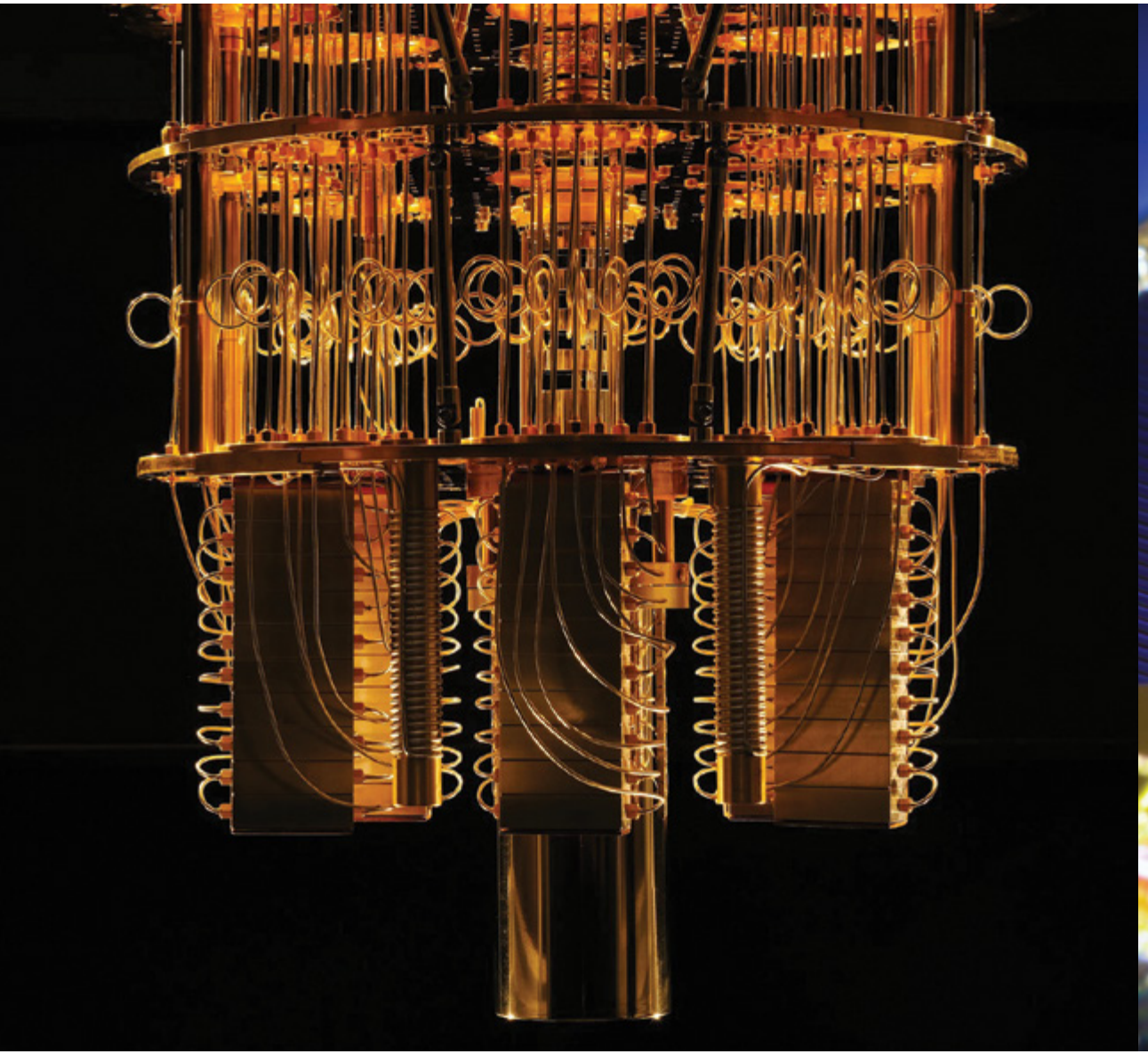


Figure 60

Figure 60: IBM was the first to commercialize a quantum computer, utilizing the more common superconducting inductor loop technology.

Figure 61: Alternatively, Honeywell is pursuing ion-trap technology as the basis of its competing quantum computer to perform difficult calculations in seconds that can take supercomputers thousands of years to complete.

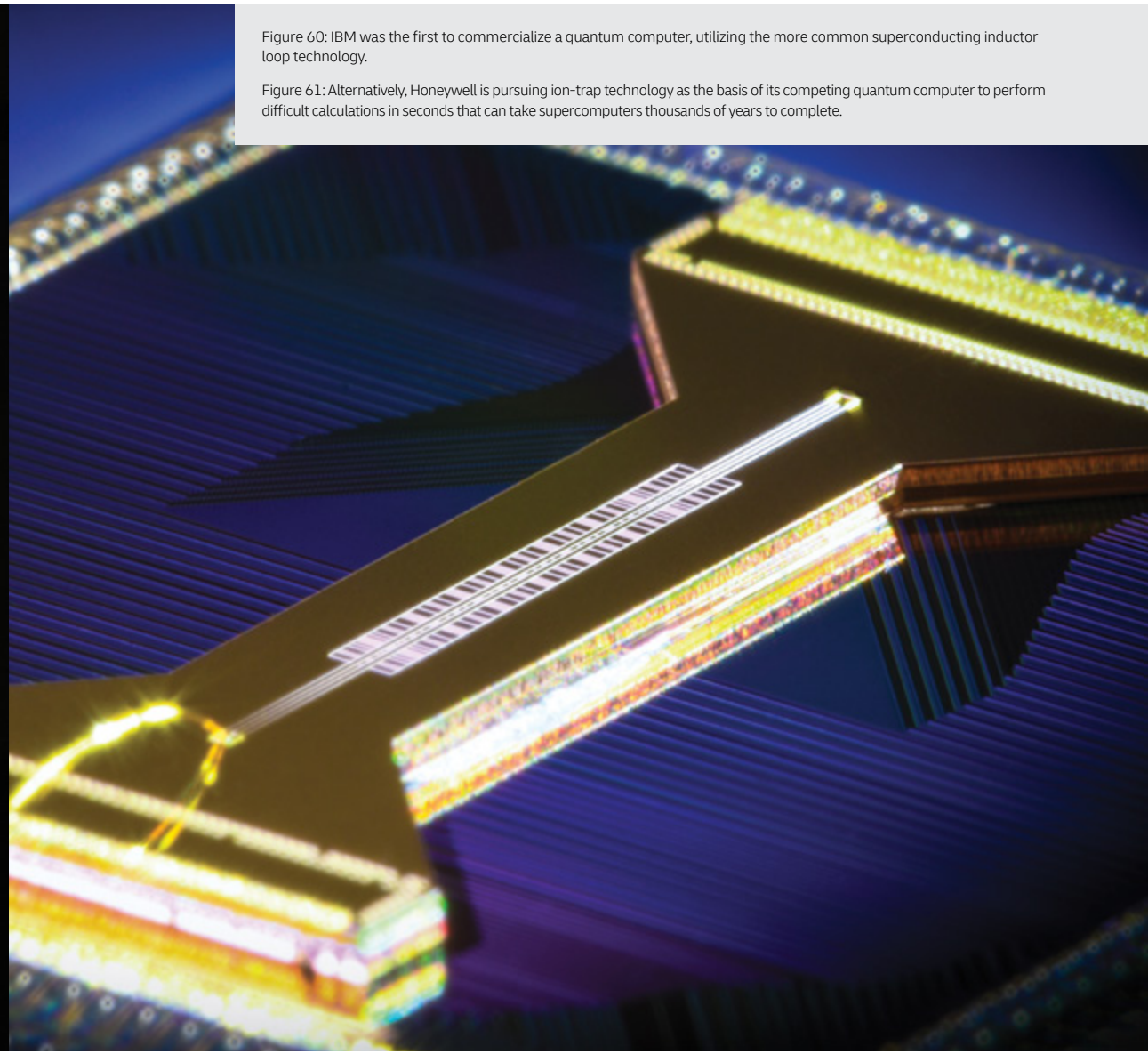


Figure 61

ROBOTICS & AUTOMATION

The first wave of automation using intelligent robotics has arrived in the logistics industry. Driven by rapid technological advancements and greater affordability, robotics solutions are entering the logistics workforce, supporting zero-defect processes and boosting productivity. Mobile or stationary, robots will adopt more roles in the supply chain, assisting workers with warehousing, transportation, and even last-mile delivery activities.

KEY OPPORTUNITIES

- Increase in agility and elasticity of logistics infrastructure to manage market fluctuations cost effectively
- Better asset utilization and overall productivity
- Improved health and safety for supply chain employees
- Automation of repetitive and physically strenuous tasks enables scarce labor to be assigned to more complex tasks

KEY CHALLENGES

- Legal restrictions on the use of robots near human workers
- Safety needs are likely to limit operational speeds for mobile and stationary robots
- Ethical concerns and pushback from labor unions on the appropriate level of automation versus human job security

Trend Assessment

Timeframe: < 5 years Impact: Medium Sector Relevance: Below

AUTO E&M TECH ENERGY LS&H E-RETAIL

KEY DEVELOPMENTS & IMPLICATIONS

Logistics industry players from traditional warehousing to new e-commerce startups are moving towards automated processes to boost throughput, cut costs, and meet growing customer demand. According to the International Federation of Robotics, $3.7 billion worth of logistics systems (111,000 robots) were sold in 2018, a 53% jump from the year before. By 2022, this is expected to grow to $22.5 billion as more processes along the supply chain are matched with robotic solutions.

Logistics robots are diversifying and achieving proficiency that matches and exceeds human capabilities. Upgraded with enhanced hardware and developments in AI, new devices have human-like dexterity, improved vision, and quick, agile movement. With better robots and more use cases, partnerships are being forged throughout the logistics industry – pairing traditional automation providers with a new wave of startups – to achieve next-level value with intelligent automation. Logistics providers, retailers, and manufacturers are following suit, co-innovating products and services for efficiency gains in supply chain operations. The time for logistics professionals to seriously consider robotic opportunities and solutions is now.

Autonomous mobile robots (AMRs) are being adopted on a massive scale by supply chain players. DHL recently announced it will deploy 1,000 Locus AMRs for assisted picking across its facilities, while Canadian e-commerce giant Shopify in 2019 acquired robotic fulfillment company 6 River Systems, hinting at an intent to robotize all current and future facilities. Operating safely alongside human workers in mixed environments, AMRs can substantially improve productivity – up to 50% with point-to-point (P2P) transport with, say, bins or pallets, and up to 150% with assisted order picking, for example with e-commerce orders. AMRs are also widely deployed to clean facility floors or, as in the recent case of Ford utilizing Boston Dynamics' dog-like robots, property mapping and surveilling. Whether AMRs are simply driverless versions of familiar vehicles like forklifts and yard trucks (see **Self-Driving Vehicles**) or completely new types of machinery, they have inherent built-in safety precautions and operation functions to support the reduction of hazards in facilities.

Stationary robots, also commonly known as articulated robotic arms, are approaching human-like performance and throughput; some have even exceeded this. For instance, AI robotics company Covariant set a new bar in early 2020 by managing to pick 10,000 unique items with over a 99% accuracy rate. As performance has improved over the past few years, a wider array of logistics applications has opened up to stationary robots beyond simply palletizing heavier goods and other less complex operations. Random bin picking, co-packaging, sorting orders into put walls, inducting objects onto conveyor belts – all are now supply chain tasks that are within the realm of intelligent and fast articulated robotic arms, sometimes surpassing human counterparts. In late 2018, DHL Supply Chain paired up with Robomotive to create a robot picking cell at its Beringe facility. Not only could the two-gripper stationary robot reach a throughput of 600 picks per hour while depalletizing from up to 4 different pallet positions, it did not need any master database to identify or correctly pick and depalletize the items. In other cases, robotic arms successfully sort 1,000 letters and small packages per hour and show productivity increases of up to 600% for (de)palletizing operations. As these stationary robots proliferate, their costs are lowering and return on investment can now take less than 4 years.

Micro-fulfillment is a focus topic for novel automation and robotics technologies, encapsulating the concept of small-scale warehouse facilities in urban locations, close to the consumer. These new mini inventory and distribution hubs provide valuable opportunities for instant and short-time delivery to a large number of customers. With land more expensive in cities than in rural areas, and with shorter delivery times mandating 24/7 availability and uptime, denser facility design and around-the-clock operations are achieved with fully automated systems and integrated robotics technologies. Walmart has partnered with Alert Innovation for a robot-powered micro-fulfillment center in one of its existing stores, while American grocer Albertsons and Netherlands-based grocer Ahold Delhaize are working with Takeoff Technologies for similar experiments at the back of neighborhood supermarkets. COVID-19 seems to have increased demand for these urban facilities, with all top 100 grocers now looking at micro-fulfillment automation. Takeoff Technologies has more than 100 contracts and 10 centers already under construction.

Figure 62

Figure 62: A Shenzhen Dorabot articulated robotic arm autonomously sorts small shipments by route at a DHL Express facility.

Figure 63: Micro-fulfillment company Fabric heavily leverages autonomous mobile robot (AMR) technology to operate its micro-fulfillment centers in denser, urban areas.

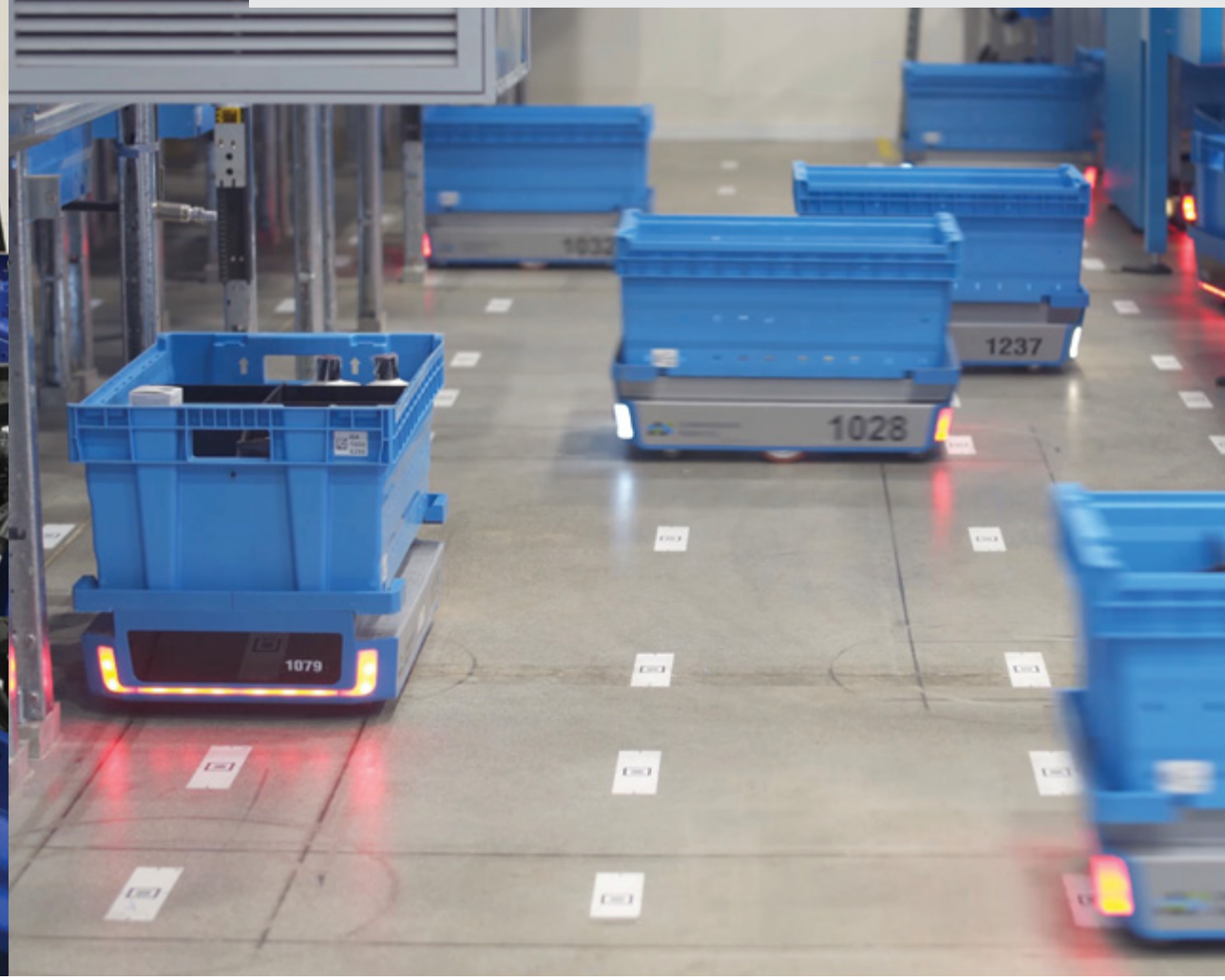


Figure 63

SELF-DRIVING VEHICLES

With technological advancements in artificial intelligence (AI) and ever-increasing investment in the development of sensors and vision technologies, self-driving capabilities will fundamentally transform the way vehicles are assembled, operated, utilized, and serviced. From long-haul trucking to last-mile rovers, self-driving vehicles will upgrade logistics by unlocking new levels of safety, efficiency, and quality.

KEY OPPORTUNITIES

- Faster, more efficient transport thanks to optimized routing, greater lane density, and 24/7 operation
- Better road safety and operational productivity as human error is eliminated
- Reduced greenhouse gas emissions and overall environmental impact due to more efficient fuel consumption

KEY CHALLENGES

- Legal restrictions in various countries/states can slow adoption
- Security and safety concerns about the detrimental consequences of potential hackers and software bugs
- Potential job losses and the need to upskill those people affected by driverless vehicles

Trend Assessment

Timeframe: > 5 years Impact: Higher Sector Relevance: Below

AUTO E&M TECH ENERGY LS&H E-RETAIL

KEY DEVELOPMENTS & IMPLICATIONS

Although the year of widespread adoption remains elusive in the mid-term future, self-driving vehicles today have extended their reach beyond yards and warehouses and, in the last two years, have slowly entered shared and public spaces including highways, sidewalks, and busy ports. Most players in the self-driving vehicle space are focused on cars and trucks. However, some have identified opportunities to explore forklifts and swap bodies while others, emboldened by the COVID-19 crisis, have pursued last-mile delivery rovers. Currently, the technology is not perfect, and almost all solutions require a human to be on standby for legal, safety, and/or operational reasons. Still, the benefits of self-driving vehicles are enough for industry leaders to continue pursuing this trend, and its potential impacts are too great to ignore.

Figure 66

Driverless trucks have made significant headway, proving capable of significantly cutting delivery time and operational costs. In late 2019, a freight truck autonomously delivered butter over 4,500 km (2,800 miles) from California to Pennsylvania in 3 days in inclement weather, including snow (a similar trip would normally take 9 days and a rushed direct order would take 5 days). Even more recently, DHL has been collaborating with Ike, a Californian startup seeking to make the transportation of freight on highways more safe and reliable through automation. While human drivers would still navigate the large semi-tractor-trailer trucks on local roads near facilities, the vehicles can easily switch and efficiently drive autonomously on the long stretches of highways in between. Meanwhile, Einride in Sweden has already been making deliveries on public roads with its level 4 autonomous cabin-less trucks, reducing road freight operations costs by an estimated 60%. In the realm of platooning, there are mixed results. Peloton is progressing with its system, claiming in 2019 an average 7% fuel saving – 4.5% for the lead truck and 10% for the following truck. However, in the same year, Mercedes-Benz announced its retreat from platooning initiatives as these failed to deliver the desired fuel savings during road tests. More technology advances and tests will be needed, as well as the formation and standardization of rules and regulations, before real benefits can be realized in the logistics industry.

Indoor and outdoor facility autonomous vehicles are often split into two different categories: automated guided vehicles (AGVs) that usually follow fixed marked paths, wires, or embedded floor magnets and autonomous mobile robots (AMRs) that utilize advanced sensors and computer technology to navigate floorplans and obstacles. AGVs have existed for decades but, increasingly, supply chain leaders are tending to prefer smarter and more dynamic AMRs. Offering a lower cost and favorable business models, AMRs are being more widely adopted. In indoor spaces, forklifts and tuggers are the primary target of autonomy, with multiple players like Geek+, JBT, Jungheinrich, and Vecna Robotics all providing competitive driverless vehicles that help move pallets and cages. Outdoors, swap bodies have received the most attention with their more standardized form and operations. American startups Phantom Auto and Outrider both recently rose to the challenge, offering autonomous yard solutions to their customers.

Last-mile delivery rovers have been used in a recent surge of trials on city sidewalks in the last two years, for good reason. With last-mile delivery often representing more than 50% of today's total fulfillment costs, a KPMG report estimates that these miniature, single-package rovers can reduce costs to between 2 to 5 cents per kilometer. At this rate, a few cents paid by the customer as a delivery surcharge can make the last-mile delivery of e-commerce items and groceries nearly free. This, paired with the need to reduce contact during the COVID-19 pandemic, has prompted many logistics players – from Chinese giants Alibaba and JD to the US delivery app company Postmates and the Latin American startup Rappi – to start using various rovers in their supply chains. Challenges are still being overcome; most operations are experimental and often subject to strict government regulations, whether just testing semi-autonomous technology or attempting to fully integrate it into the business model.

Figure 66: Ike's semi-autonomous self-driving truck solution can improve truck driver livelihoods while increasing freight productivity.

Figure 64: Crossing a street, Rappi Kiwibots semi-autonomously deliver contactless orders during the COVID-19 pandemic.

Figure 65: Autoguide has focused on making warehouse vehicles self-driving, such as this forklift that is able to manipulate pallets with high accuracy and speed.

Figure 64

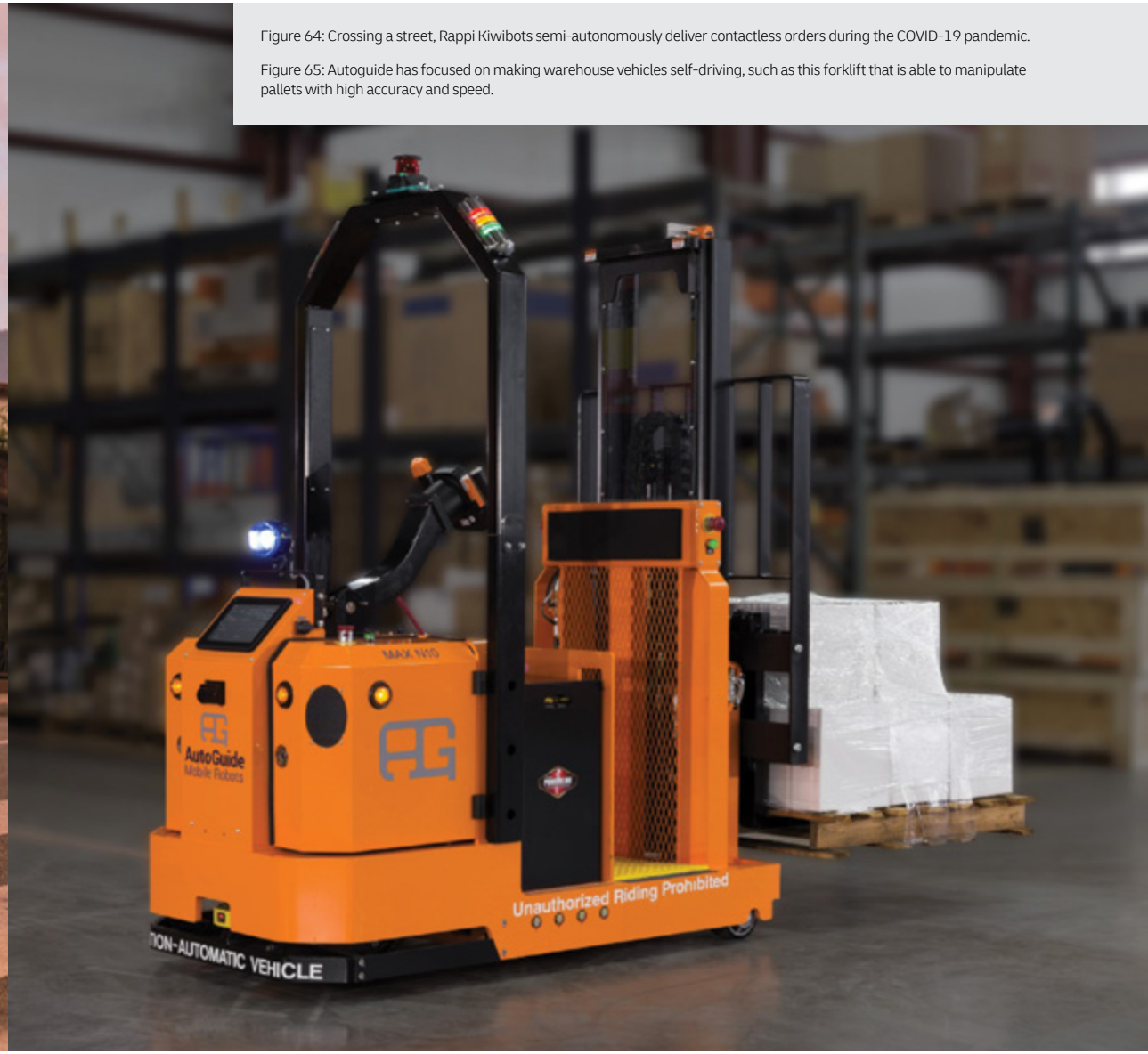


Figure 65

UNMANNED AERIAL VEHICLES

Unmanned aerial vehicles (UAVs) or "drones" can be used to deliver goods in the first and last mile, as well as for intralogistics and surveillance operations. Though popularized in the media in recent years, UAVs will not replace traditional ground-based transportation. However, they will augment delivery with point-to-point and automated operations.

KEY OPPORTUNITIES

- Faster and even automated delivery, especially in remote areas where ground infrastructure is lacking
- More cost-efficient remote inspection of warehouses, outdoor assets, and infrastructure (e.g. rail networks and pipelines)
- Safer, faster surveillance of warehouse campuses and intralogistics operations

KEY CHALLENGES

- Regulatory restrictions might affect the adoption of UAVs in logistics
- Required integration of UAV traffic in crowded airspace networks
- Privacy, noise, and safety concerns especially from the public
- Unauthorized interception and hacking of UAVs

Trend Assessment

Timeframe: > 5 years Impact: Higher Sector Relevance: Below

AUTO E&M TECH ENERGY LS&H E-RETAIL

KEY DEVELOPMENTS & IMPLICATIONS

The last couple of years have seen the concept of UAVs mature within the logistics industry. On the policy side, the EU, the US, and various other countries have each implemented an assemblage of legal frameworks that grant limited but workable space for commercial UAVs in the public realm. This can include beyond-line-of-sight (BLOS) flying permits. In response, many companies have pursued real-world tests to assess the integration of drone technology in operations and supply chains. Overall, property surveillance and inspection continue to be the strongest use cases for UAVs today and in the near future. While development is still in progress for intralogistics and last-mile operations as use cases, both have been greatly accelerated during the COVID-19 crisis, with human contact and worker shortages highlighted as concerns.

Property surveillance and inspection is being transformed by drones. What would normally require a few hours for a crew of workers to safely inspect a wind turbine or patrol a large industrial facility now requires only a few minutes for a trained individual using a UAV. DHL, in partnership with FairFleet, has recently piloted a drone solution to perform aerial mapping and visual inspection tasks for industrial equipment in remote locations using advanced algorithms. This allows DHL to limit the number of hours for staff in risky environments by up to 90% while simultaneously improving understanding of the job site with highly accurate 3D models for engineering tasks and transport planning. Overall, tactical drones have since acquired a more diverse range of capabilities with multiple vendors offering products and services for night operations, gas leak detection, wildlife deterrence, perimeter inspection, and more.

Intralogistics operations is a field that has proved somewhat challenging to UAVs. Difficult navigation in busy facilities, short battery life, and error-prone inventory scanning and counting under variable lighting have all remained as operational barriers to more widespread adoption. Despite these problems, the potential cost-effective benefits are motivating enough companies to overcome these setbacks. Car manufacturer SEAT and Thyssenkrupp Steel both started exploring the use of UAVs in delivering spare parts and laboratory samples, respectively, within their own facilities. Meanwhile, various vendors are improving their drone technology to better service inventory management and stock taking, with Infinium Robotics boasting a UAV design with 4-hour battery life for checking warehouse shelves.

Last-mile delivery service, the most high-profile use case for UAVs, has seen critical development in the past two years. During the COVID-19 crisis, the technology company Wing partnered with local shops in Australia, Finland, and the US, fulfilling over 1,000 online orders within a two-week timeframe. California startup Zipline, an airborne deliverer of blood, pharmaceuticals, and viral tests to rural facilities, expanded its operations into Ghana and has surpassed 60,000 successful deliveries of over 200,000 products to date. Additionally, companies such as DRONAMICS and Elroy Air have sought a long-distance, high-capacity niche, expecting to transport hundreds of kilograms in payload over hundreds of kilometers per UAV. These "trucks in the sky" may prove to be transformative for industries such as mining and manufacturing.

Figure 67

Figure 67: Transporting payloads up to 350 kg (770 lbs) at distances up to 2,500 km (1,550 miles), DRONAMICS soon expects to fly its full-scale Black Swan drone for commercial operations.

Figure 68: FairFleet's global network of drone pilots and software platform enable drone missions as-a-service, including mapping and measuring large cargo items.

Figure 69: Working with the Ghanaian government to establish flight corridors (white), special viral test corridors (red) and no-fly zones (blue), Zipline acts as a successful hub model already serving hundreds of destinations in Africa.

Figure 68

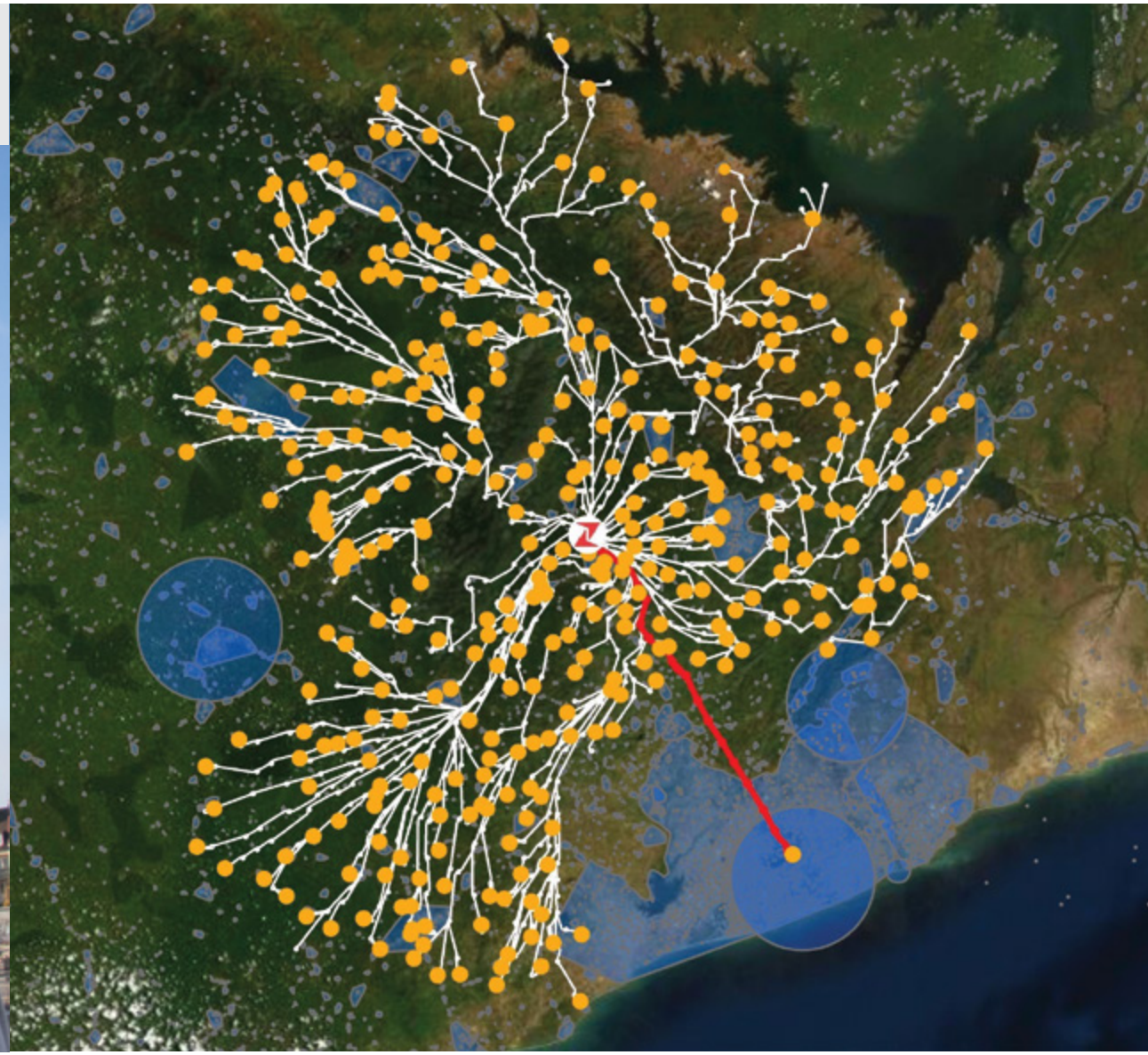


Figure 69

Sources

eMarketer (2020): Global Ecommerce 2020. https://www.emarketer.com/content/global-ecommerce-2020

TechCrunch (2019): Here's Mary Meeker's 2019 Internet Trends report. https://techcrunch.com/2019/06/11/internet-trends-report-2019/

Crunchbase (2019): SoftBank Vision Fund Leads Billion-Dollar Bet On Freight Firm Flexport. https://news.crunchbase.com/news/softbank-vision-fund-leads-billion-dollar-bet-on-freight-firm-flexport/

AngelList (2019): Company Website. https://angel.co/logistics

MHI (2020): The 2020 MHI Annual Industry Report - Embracing the Digital Mindset: https://www.mhi.org/publications/report#download7

Mckinsey & Company (2019): Globalization in transition: The future of trade and value chains. https://www.mckinsey.com/featured-insights/innovation-and-growth/globalization-in-transition-the-future-of-trade-and-value-chains

Accenture (2019): Cross Border the Disruptive Frontier. https://www.accenture.com/_acnmedia/pdf-102/accenture-cross-border-the-disruptive-frontier.pdf

McKinsey & Company (2020): Supply chain risk management is back. https://www.mckinsey.com/business-functions/operations/our-insights/supply-chain-risk-management-is-back

MED-TECH (2020): 3D printing firm producing 40,000 face shields per week for NHS. https://www.med-technews.com/news/3d-printing-firm-producing-40-000-face-shields-per-week-for-/

Driving (2020): Ferrari is 3D-printing parts to convert snorkels into respirators. https://driving.ca/ferrari/auto-news/news/ferrari-is-3d-printing-parts-to-convert-snorkels-into-respirators

YouTube (2019): Presentation Barcode Scanning with Cognex DataMan 374. https://www.youtube.com/watch?v=jL5yBezR5F0

Copal (2020): Company Website. https://www.copalhandlingsystems.com/en/

Locus Robotics (2020): Company Website. https://locusrobotics.com/

Supply Chain Dive (2020): PwC: Automation is key to supply chain agility post pandemic. https://www.supplychaindive.com/news/coronavirus-pwc-automation-agility/577729/

Metro (2020): Air pollution has returned to pre-coronavirus lockdown levels. https://metro.co.uk/2020/06/26/air-pollution-has-returned-pre-corovirus-lockdown-levels-12908235/

The British Petroleum (2020): Company Website. https://www.bp.com/en/global/corporate/who-we-are/reimagining-energy.html

Total (2020): Total adopts a new Climate Ambition to Get to Net Zero by 2050. https://www.total.com/media/news/total-adopts-new-climate-ambition-get-net-zero-2050

EuroNews (2020): Will plastic pollution get worse after the COVID-19 pandemic? https://www.euronews.com/2020/05/12/will-plastic-pollution-get-worse-after-the-covid-19-pandemic

P&G Company (2019): P&G Announces New Global Commitment to Reduce Plastic. https://us.pg.com/blogs/Plastic50by2030/

Sources: Social & Business Trends

FRESH CHAIN

Oliver Wyman (2020): China's E-Grocery Booms as Consumer Diet Shifts During Epidemic. https://www.oliverwyman.com/media-center/2020/mar/survey-amid-covid-19-outbreak-reveals-drastic-shift-in-chinese-consumers-diet.html

The Grocer (2020): Coronavirus: DTC Meal Kit Businesses Report Record Demand. https://www.thegrocer.co.uk/online/coronavirus-dtc-meal-kit-businesses-report-record-demand/603244.article

AAM (2020): Pharmaceutical Shipping Costs Spike in Response to Global Covid-19 Pandemic. https://accessiblemeds.org/resources/press-releases/pharmaceutical-shipping-costs-spike-response-global-covid-19-pandemic

Pulse (2020): Online Retail Sales Rise Fastest in Feb in Korea Amid COVID-19 Spread. https://pulsenews.co.kr/view php?year=2020&no=329278

VentureBeat (2020): How Instacart Remade its Systems to Handle a 500% Jump in Order Volume. https://venturebeat.com/2020/05/21/how-instacart-remade-its-systems-to-handle-a-500-jump-in-order-volume/

McKinsey & Company (2019): Auchan China's Chairman on the Future of Grocery. https://www.mckinsey.com/industries/retail/our-insights/auchan-chinas-chairman-on-the-future-of-grocery

Digital Commerce 360 (2020): Bopis is the Next Wave of Ecommerce. Are You Ready? https://www.digitalcommerce360.com/2020/02/18/bopis-is-the-next-wave-of-ecommerce-are-you-ready-for-that/

eMarketer (2020): What Does Online Grocery Shopping Look Like in Western Europe During Covid-19? https://www.emarketer.com/content/what-does-online-grocery-shopping-look-like-in-western-europe-during-covid-19

Solar Freeze (2020): Company Website. http://solarfreeze.co.ke/

EEWeb (2019): Creating a Smarter Planet With Long Range & Low Power LoRa Devices and the LoRaWAN Protocol. https://www.eeweb.com/profile/semtech/articles/creating-a-smarter-planet-with-long-range-low-power-lora-devices-and-the-lorawan-protocol

MAXQ (2020): Company Website. https://www.packmaxq.com/pharmaceutical-clinical-trials

EIT Food (2019): Out of Date: An Intelligent Food Freshness Label That Can Help Tackle Food Waste. https://www.eitfood.eu/blog/post/out-of-date-an-intelligent-food-freshness-label-that-can-help-tackle-food-waste

Fresh Code (2020): Company Website. http://freshcodelabel.com/

EuroCommerce (2020): Rising to the Food Waste Challenge. https://www.eurocommerce.eu/media/134575/Food%20Waste%20Brochure%20-%20final.pdf

FUTURE OF WORK

Visual Capitalist (2018): Chart: Why Industrial Robot Sales Are Sky High. https://www.visualcapitalist.com/industrial-robot-sales-sky-high/

Oxford Economics (2019): How Robots Change the World. https://www.oxfordeconomics.com/recent-releases/how-robots-change-the-world

McKinsey & Company (2017): A Future That Works: Automation, Employment and Productivity. https://www.mckinsey.com/~/media/mckinsey/featured%20insights/Digital%20Disruption/Harnessing%20automation%20for%20a%20future%20that%20works/MGI-A-future-that-works-Executive-summary.ashx

Boston Consulting Group (2019): Advanced Robotics in the Factory of the Future. https://www.bcg.com/de-de/publications/2019/advanced-robotics-factory-future

World Economic Forum (2018): The Future of Jobs Report 2018. https://www.weforum.org/reports/the-future-of-jobs-report-2018

Forbes (2018): 5 Ways Millennials Are Shaking up the Workforce From the Bottom Up. https://www.forbes.com/sites/heidilynnekurter/2018/11/15/5-ways-millennials-are-shaking-up-the-workforce-from-the-bottom-up/#76ccc0002415

Forbes (2020): Phantom of the Operator: Self-Driving Tech's Slowing Timetable Creates Opening for This Monitoring and Guidance Startup. https://www.forbes.com/sites/alanohnsman/2020/01/17/phantom-of-the-operator-self-driving-techs-slowing-timetable-creates-opening-for-this-monitoring-and-guidance-startup/#53be011d12ef

Samantha McLaren (2019): How These 4 Companies Are Embracing Flexible Work — and Why You Should Too. https://business.linkedin.com/talent-solutions/blog/work-flexibility/2019/how-4-companies-are-embracing-flexible-work

Fortune (2019): 'Upskilling' Your Workforce? Start by Measuring the Skills They Have Now. https://fortune.com/2019/06/22/upskilling-training-workforce-measure-skills/

McKinsey & Company (2020): Getting Practical About the Future of Work. https://www.mckinsey.com/business-functions/organization/our-insights/getting-practical-about-the-future-of-work#

LOGISTICS MARKETPLACE

IATA (2020): Air Cargo Capacity Crunch: Demand Plummets but Capacity Disappears Even Faster. https://www.iata.org/en/pressroom/pr/2020-06-02-01/

Frieght Waves (2020): Shipper Rate Report. https://www.freightwaves.com/wp-content/uploads/2020/05/Shipper-Rate-Report-May.pdf

Freight Waves (2020): A New Digital Network for Freight Forwarders Booms During Covid-19. https://www.freightwaves.com/news/a-new-digital-network-for-freight-forwarders-booms-during-covid-19

Supply Chain Dive (2020): Warehouse Capacity Contracts as Imports Arrive Amid Low Demand, Closed Storefronts. https://www.supplychaindive.com/news/coronavirus-logistics-managers-index-warehouse-capacity/577763/

Freight Waves (2020): Flexe Integration With Google Merchant Center Supports Free, Fast Delivery. https://www.freightwaves.com/news/flexe-integration-with-google-merchant-supports-free-fast-delivery

Stowga (2020): Company Website. https://www.stowga.com/

TechCrunch (2018): Walmart partners with delivery logistics platform Bringg on last-mile grocery delivery. https://techcrunch.com/2018/09/06/walmart-partners-with-delivery-logistics-platform-bringg-on-last-mile-grocery-delivery/

Supply Chain Dive (2020): Wayfair Is All in on Logistics. https://www.supplychaindive.com/news/wayfair-logistics-investment/573199/

MASS PERSONALIZATION

Frank Piller (2020): University Website. http://frankpiller.com/mass-customization/

VWO (2020): How Does Amazon & Netflix Personalization Work? https://vwo.com/blog/deliver-personalized-recommendations-the-amazon-netflix-way/

TechCrunch (2018): Amazon buys PillPack, an online pharmacy, for just under $1B. https://techcrunch.com/2018/06/28/amazon-buys-pillpack-an-online-pharmacy-that-was-rumored-to-be-talking-to-walmart/

PillPack (2020): Company Website. https://www.pillpack.com/how-it-works

McKinsey & Company (2019): The Future of Personalization—and How to Get Ready For it. https://www.mckinsey.com/business-functions/marketing-and-sales/our-insights/the-future-of-personalization-and-how-to-get-ready-for-it

MULTISOURCING

Fortune (2020): 94% of the Fortune 1000 are seeing coronavirus supply chain disruptions: Report. https://fortune.com/2020/02/21/fortune-1000-coronavirus-china-supply-chain-impact/

Coronese Et al. (2020): Evidence for sharp increase in the economic damages of extreme natural disasters. https://www.pnas.org/content/116/43/21450

Forbes (2020): If Multi-Sourcing Is A Best Practice, Why Are So Few Companies Doing It? https://www.forbes.com/sites/stevebanker/2020/05/01/if-multi-sourcing-is-a-best-practice-why-are-so-few-companies-doing-it/#6b651ce16121

Supply Chain Digest (2017): Nike Hopes to Shave Some Lead Times to 10 Days from Nearshoring Production, as it Transforms Supply Chain and Go-to-Market Strategy. http://www.scdigest.com/ontarget/17-11-01-1.php?cid=13235

Digital Trends (2019): From GoPro to Lenovo, Trump Tariffs Would Have Raised Prices on Tech From Mexico. https://www.digitaltrends.com/features/donald-trump-mexico-tariffs-tech-lenovo-gopro/

MIT Sloan Management Review (2020): Maximizing the Benefits of B2B Supplier Diversification. https://sloanreview.mit.edu/article/maximizing-the-benefits-of-b2b-supplier-diversification/

Ayres & Cramton (1996): Deficit Reduction Through Diversity: How Affirmative Action at the FCC Increased Auction Competition. http://cramton.umd.edu/papers1995-1999/96slr-deficit-reduction-through-diversity.pdf

Brannman & Froeb (2006): Mergers, Cartels, Set-Asides, and Bidding Preferences in Asymmetric Oral Auctions. https://www.mitpressjournals.org/doi/abs/10.1162/003465300558795

Mummalaneni (2019): Affirmative Action as a Cost Cutting Tool in Procurement Markets. http://faculty.washington.edu/simha/Affirmative_Action_as_a_Cost_Cutting_Tool.pdf

The Coca-Cola Company (2012): The Coca-Cola Company Announces Terrez Thompson as Vice President of Global Supplier Diversity. https://www.coca-colacompany.com/press-releases/the-coca-cola-company-announces-terrez-thompson-as-vice-president-of-global-supplier-diversity

NEXT-GENERATION SECURITY

Hornet Security (2020): Cybercrime Threatens the Future of the Logistics Industry. https://www.hornetsecurity.com/data/downloads/reports/document-cybersecurity-special-logistics-en.pdf

Supply Chain Brief (2018): 7 Supply Chain Security Concerns to Address in 2019. https://www.supplychainbrief.com/security/?open-article-id=9387037

Roambee (2020): Company Website. https://www.roambee.com/beelock/

SATLOCK (2020): Company Website. https://www.satlock.com/wp/en/rastreo-gps-usat-i/

Cision PR Newswire (2020): At a CAGR of 34.7%, Safety and Security Drones Market to Rise Globally During 2019-2027 - Coherent Market Insights. https://www.prnewswire.com/news-releases/at-a-cagr-of-34-7-safety-and-security-drones-market-to-rise-globally-during-2019-2027--coherent-market-insights-301031530.html#:~:text=The%20global%20safety%20and%20security,the%20forecasted%20period%202019%2D27.

International Airport Review (2020): Incorporating Biometrics in Aviation: The Journey to Touchless U.S. Air Travel. https://www.internationalairportreview.com/article/118268/biometric-technology-aviation-history-benefits/

ZDNet (2019): What is GDPR? Everything You Need to Know About the New General Data Protection Regulations. https://www.zdnet.com/article/gdpr-an-executive-guide-to-what-you-need-to-know/

Supply Chain Brain (2019): Blockchain and Edge Computing: Supercharging the Supply Chain. https://www.supplychainbrain.com/blogs/1-think-tank/post/29701-blockchain-edge-computing-supercharging-the-supply-chain

Digital Commerce 360 (2018): Meet the New Tech on the Front Line of Fight Against Fakes. https://www.digitalcommerce360.com/2018/03/01/meet-new-tech-front-line-fight-fakes/

TechCrunch (2019): Trutag Raises 7-5 Million Series-C for Tiny Edible Barcodes That can be Placed on Pills Food and Vaping Systems. https://techcrunch.com/2019/10/17/trutag-raises-7-5-million-series-c-for-tiny-edible-barcodes-that-can-be-placed-on-pills-food-and-vaping-systems/

Packaging Europe (2019): Insights in Blockchain Technology. https://packagingeurope.com/insights-in-blockchain-technology/

OMNICHANNEL LOGISTICS

Supply Chain Asia (2019): Omnichannel 2.0 to Further Redefine the Shopping Experience. http://supplychainasia.org/omnichannel-2-0-redefine-shopping-experience/

SupplyChain247 (2019): Difference Between Ominchannel & Omnichannel 2.0. https://www.supplychain247.com/article/the_difference_between_omnichannel_and_omichannel2

Veridian (2018): What Exactly is Omnichannel 2.0 and How is It Different? https://veridian.info/omnichannel-2-0/

Market Research Future (2020): Determine the Extent of Covid-19 Pandemic Disruption in Your Market. https://www.marketresearchfuture.com/reports/omnichannel-retail-commerce-platform-market-6956

Michelin Guide (2020): Singapore Hawkers go Digital. https://guide.michelin.com/sg/en/article/features/singapore-hawkers-go-digital

GrabFood (2020): Company Website. https://www.grab.com/my/food/

FoodPanda (2020): Company Website. https://www.foodpanda.com/

Forbes (2019): Tech Debt – The Final Hurdle To True Omnichannel Retail. https://www.forbes.com/sites/nitinmangtani/2019/09/05/tech-debt--the-final-hurdle-to-true-omnichannel-retail/#36cc0c7964aa

MyCloudFulfillment (2020): Company Website. https://mycloudfulfillment.com/en/

RETHINKING PACKAGING

Intrado (2020): $1 Billion Global Packaging Industry to 2021 - Growing Demand for FMCG and Pharmaceutical Packaging Presents Opportunities. https://www.globenewswire.com/news-release/2020/05/12/2031745/0/en/1-Billion-Global-Packaging-Industry-to-2021-Growing-Demand-for-FMCG-and-Pharmaceutical-Packaging-Presents-Opportunities.html

DW (2019): 180 Countries — Except us — Agree to Plastic Waste Agreement. https://www.dw.com/en/180-countries-except-us-agree-to-plastic-waste-agreement/a-48686333

Ellen Macarthur Foundation (2020): Company Website. https://www.ellenmacarthurfoundation.org/publications

Medium (2018): IKEA Starts Using Biodegradable Mushroom-Based Packaging for its Products. https://medium.com/wedonthavetime/ikea-starts-using-biodegradable-mushroom-based-packaging-for-its-products-42d079f98bb1

Cosmetics Design Europe (2020): Colgate Launches Vegan Toothpaste in 100% Recyclable Plastic Tubes. https://www.cosmeticsdesign-europe.com/Article/2020/01/15/Colgate-Palmolive-launches-vegan-toothpaste-Smile-for-Good-in-100-recyclable-plastic-tubes

Nestle (2020): What Is Nestlé Doing to Tackle Plastic Packaging Waste? https://www.nestle.com/ask-nestle/environment/answers/tackling-packaging-waste-plastic-bottles

Ellen Macarthur Foundation (2020): Companies Take Major Step Towards a New Plastics Economy. https://www.newplasticseconomy.org/news/11-companies-commit-to-100-reusable-recyclable-or-compostable-packaging-by-2025

Invesp (2020): E-Commerce Product Return Rate – Statistics and Trends [Infographic]. https://www.invespcro.com/blog/ecommerce-product-return-rate-statistics/

Loop Store (2020): Company Website. https://loopstore.com/

The Wally Shop (2020): Company Website. https://thewallyshop.co/

Returnity (2020): Company Website. https://returnity.co/

RePack (2020): Company Website. https://www.originalrepack.com/

Fast Company (2019): This Startup is Ditching Plastic Waste by Bringing the Refills to You. https://www.fastcompany.com/90416401/this-startup-is-ditching-plastic-waste-by-bringing-the-refills-to-you

StarTribune (2019): How Best Buy Tries to Deal With a Glut of Cardboard Boxes. https://www.startribune.com/how-best-buy-tries-to-deal-with-a-glut-of-cardboard-boxes/511629982/#:~:text=A%20packing%20slip%20gets%20inserted,easier%20for%20customers%20to%20open.

Supply Chain Dive (2020): More Automation Means More Reusable Packaging: Survey. https://www.supplychaindive.com/news/automation-reusable-packaging-survey/579890/

SERVITIZATION

IFS (2019): IDC Business Value Study for Manufacturing. https://www.ifs.com/corp/sitecore/media-library/assets/2019/09/19/idc-ifs-man-business-case-brief

Syncron (2020): Maximized Product Uptime: The Emerging Industry Standard. https://www.syncron.com/resources/maximized-product-uptime-web-lp/

BCI (2020): Under a Quarter of Businesses Will Return to 'Old Model'. https://www.thebci.org/news/under-a-quarter-of-businesses-will-return-to-old-model.html

Avis Budget Group (2020): Avis Budget Group and Fiat Chrysler Automobiles Sign New Connected Car Agreement, Giving a More Streamlined, Self-Serve and On-Demand Rental Experience in Europe. http://ir.avisbudgetgroup.com/news-releases/news-release-details/avis-budget-group-and-fiat-chrysler-automobiles-sign-new

LEAD Innovation Management (2020): Can Servitization Heal the Sick Hospitals? https://www.lead-innovation.com/english-blog/servitization-hospitals

Eleanor Musson (2016): Servitization & the Future of Logistics. https://www.linkedin.com/pulse/servitization-future-logistics-eleanor-musson/

Fusebill (2020): Company Website. https://www.fusebill.com/

SHARING ECONOMY

Working Capital Review (2020): The Next Generation Sharing Economy. https://workingcapitalreview.com/2020/04/next-generation-sharing-economy/

Global Market Insights (2020): Car Sharing Market Size By Model (P2P, Station-Based, Free-Floating), By Business Model (Round Trip, One Way), By Application (Business, Private), Industry Analysis Report, Regional Outlook, Application Potential, Price Trend, Competitive Market Share & Forecast, 2020 – 2026. https://www.gminsights.com/industry-analysis/carsharing-market

The Balance Small Business (2019): The Sharing Economy and How it is Changing Industries. https://www.thebalancesmb.com/the-sharing-economy-and-how-it-changes-industries-4172234

Fast Company (2019): Exclusive: Poshmark Doubles Sellers Revenues From $1b to $2b in Just One Year. https://www.fastcompany.com/90409133/poshmark-doubles-its-revenues-from-1b-to-2b-in-a-year

The Verge (2019): Uber will Spend $200 Million to Expand its Uber Freight Trucking Venture. https://www.theverge.com/2019/9/9/20856812/uber-freight-200-million-expansion-chicago-headquarters

TechCrunch (2020): Uber-Reportedly-Agrees-To-Acquire-Postmates-For-2-65-Billion. https://techcrunch.com/2020/07/05/uber-reportedly-agrees-to-acquire-postmates-for-2-65-billion/

GrabExpress (2020): Company Website. https://www.grab.com/ph/express/

Stord (2020): Company Website. https://www.stord.com/

Flexe (2020): Company Website. https://www.flexe.com/

Darkstore (2020): Company Website. https://www.darkstore.com/#/

Deliver (2020): Company Website. https://deliverr.com/about-us/

PracticalEcommerce (2020): 5 On-Demand Warehousing, Fulfillment Providers. https://www.practicalecommerce.com/5-on-demand-warehousing-fulfillment-providers

McKinsey & Company (2016): Independent Work: Choice, Necessity, and the Gig Economy. https://www.mckinsey.com/featured-insights/employment-and-growth/independent-work-choice-necessity-and-the-gig-economy

SILVER ECONOMY

United Nations (2019): Ageing. https://www.un.org/en/sections/issues-depth/ageing/

United Nations (2019): Data Query. https://population.un.org/wpp/DataQuery/

UBS (2020): China's Silver Economy. https://www.ubs.com/global/en/asset-management/insights/china/new-world-order/2020/silver-economy.html

Los Angeles Times (2019): Desperate for Workers, Aging Japan Turns to Robots for Healthcare. https://www.latimes.com/world-nation/story/2019-07-25/desperate-for-workers-aging-japan-turns-to-robots-for-healthcare

European Commission (2018): The Silver Economy. https://www.mayoractual.com/media/mayoractuals/files/2018/09/11/Silver-Economy.pdf

Pew Research Center (2017): Technology Use Among Seniors. https://www.pewresearch.org/internet/2017/05/17/technology-use-among-seniors/

Fast Company (2020): California Will Enlist Restaurants to Make and Deliver Meals for Food-Insecure Seniors. https://www.fastcompany.com/90497723/california-starts-meal-delivery-plan-for-food-insecure-seniors

SMART CONTAINERIZATION

Port of Rotterdam (2020): How a Steel Box Changed the World Economy. https://www.portofrotterdam.com/en/doing-business/logistics/cargo/containers/how-a-steel-box-changed-the-world-economy

Statista (2020): Container Throughput Worldwide From 2012 to 2019 With a Forecast for 2020 and 2021 (In Million TEUs). https://www.statista.com/statistics/913398/container-throughput-worldwide/

Unilode (2020): Digitisation of the ULD Fleet Is Progressing Fast with all Containers and Pallets Expected to be Digital by End 2021. https://www.unilode.com/digital-transformation/digital-uld-fleet/#

Cargoshell (2020): Company Website. http://www.cargoshell.com/

4FOLD (2020): Company Website. https://4foldcontainers.com/

Staxxon (2020): Company Website. https://staxxon.com/

VRR (2020): Company Website. https://vrr.aero/the-products/efficient/

Christoph Schendera (2020): Modular Air Freight Container Modular System (Modular ULD Containers). https://patents.google.com/patent/DE202017002454U1/en

SPACE LOGISTICS

Seraphim Capital (2020): Seraphim Space Index April 2019 to March 2020- 12 Month Venture Funding Approaches $5bn Mark. https://seraphimcapital.co.uk/insight/news/seraphim-space-index-april-2019-march-2020-12-month-venture-funding-approaches-5bn

McKinsey & Company (2020): Large Leo Satellite Constellations: Will It Be Different This Time? https://www.mckinsey.com/industries/aerospace-and-defense/our-insights/large-leo-satellite-constellations-will-it-be-different-this-time

White House (2020): Executive Order on Encouraging International Support for the Recovery and Use of Space Resources. https://www.whitehouse.gov/presidential-actions/executive-order-encouraging-international-support-recovery-use-space-resources/

Forbes (2020): Trump Wants to Mine the Moon. This Is How NASA Will Do That Using 'Roomba'-Sized Rovers. https://www.forbes.com/sites/jamiecartereurope/2020/04/09/trump-wants-to-mine-the-moon-this-is-how-nasa-will-do-it-using-roomba-sized-rovers/#7f23c52b40d6

Wikipedia (2019): Space Debris. https://en.wikipedia.org/wiki/Space_debris#:~:text=There%20are%20estimated%20to%20be,across%20or%20larger)%20is%2034%2C000.

D-Orbit (2020): Information Paper. Baker and Eichstadt (2005): Commercial Cargo Transport Service for ISS. https://www.sciencedirect.com/science/article/abs/pii/S0094576505001542?via%3Dihub

BreakBulk (2019): Supply Chain Extending to Moon, Mars, Beyond. https://breakbulk.com/Articles/logistics-in-space

SUPERGRID LOGISTICS

AJOT (2020): Cainiao Smart Logistics Network Shaves off Delivery Times with New Investments in Global Logistics Infrastructure. https://ajot.com/news/cainiao-smart-logistics-network-shaves-off-delivery-times-with-new-investments-in-global-logistics-infrastructure

Alibaba Group (2019): Cainiao Network – Smart Logisitics Network. https://www.alibabagroup.com/en/ir/presentations/Investor_Day_2019_CainiaoNetwork.pdf

Statista (2019): Fourth-Party Logistics (4PL) Market Size From 2018 to 2027. https://www.statista.com/statistics/992952/fourth-party-logistics-market-size-worldwide/

Supply Chain Dive (2018): The 4PL Era Begins. https://www.supplychaindive.com/news/3pl-4pl-evolution-logistics-supply-chain-management/532779/

Business Wire (2019): Europe Fourth Party Logistics Market to 2027. https://www.businesswire.com/news/home/20190917006001/en/Europe-Fourth-Party-Logistics-Market-2027-

GlobeNewswire (2020): The Asia Pacific Fourth Party Logistics Market Accounted for US$ 18.75 Bn in 2018 and is Expected to Grow at a CAGR of 6.3% Over the Forecast Period 2019-2027, to Account for US$ 32.28 Bn in 2027. https://www.globenewswire.com/news-release/2020/01/23/1974005/0/en/The-Asia-Pacific-fourth-party-logistics-market-accounted-for-US-18-75-Bn-in-2018-and-is-expected-to-grow-at-a-CAGR-of-6-3-over-the-forecast-period-2019-2027-to-account-for-US-32-28.html

SUSTAINABLE LOGISTICS

World Economic Forum (2020): The Future of the Last-Mile Ecosystem. https://www.weforum.org/reports/the-future-of-the-last-mile-ecosystem

PEW (2020): To Solve the Ocean Plastics Problem, the World Needs a Plan. https://www.pewtrusts.org/en/research-and-analysis/articles/2020/02/25/to-solve-the-ocean-plastics-problem-the-world-needs-a-plan

Logistics Management (2019): Sustainable Packaging Is Ready to Make Its Mark. https://www.logisticsmgmt.com/article/sustainable_packaging_is_ready_to_make_its_mark

U.S. Environmental Protection Agency (EPA): Fast Facts on Transportation Greenhouse Gas Emissions. https://www.epa.gov/greenvehicles/fast-facts-transportation-greenhouse-gas-emissions

The ECOBAHN (2020): Electric Vehicles: Is Electric Last-Mile Delivery the Key to Sustainable Ecommerce? https://theecobahn.com/logistics/electric-vehicles-are-electric-delivery-vehicles-really-more-sustainable/

Trailar (2020): Company Website. https://www.trailar.co.uk/blog

Eviation (2020): Company Website. https://www.eviation.co/

Clean Technica (2018): Swedish Copper Mine Converting Monster Trucks to Run on Electricity. https://cleantechnica.com/2018/03/12/swedish-copper-mine-converting-monster-trucks-run-electricity/

Caterpillar (2020): Fisker Inc. Announces Strategic Investment From Caterpillar Ventures. https://www.caterpillar.com/en/company/innovation/caterpillar-ventures/news/fisker.html

USGBC (2019): Benefits of Green Building. https://www.usgbc.org/press/benefits-of-green-building

Baytree (2020): Company Website. https://www.baytree.com/

Sources: Technology Trends

3D PRINTING

SmartTech Analysis (2020): 2020 Additive Manufacturing Market Outlook and Summary of Opportunities. https://www.smartechanalysis.com/reports/2020-additive-manufacturing-market-outlookket-outlook-and-summary-of-opportunities/

3D HUBS (2020): 3D Printing Trends 2020 Report. https://www.3dhubs.com/get/trends/

AMFG/Autonomous Manufacturing (2020): 40+ 3D Printing Industry Stats You Should Know. https://amfg.ai/2020/01/14/40-3d-printing-industry-stats-you-should-know-2020/

Markets and Markets (2019): 3D Printing Market by Offering (Printer, Material, Software, Service), Process (Binder Jetting, Direct Energy Deposition, Material Extrusion, Material Jetting, Powder Bed Fusion), Application, Vertical, Technology, and Geography - Global Forecast to 2024. https://www.marketsandmarkets.com/Market-Reports/3d-printing-market-1276.html

ALL3DP (2019): The 3D Printing Materials Guide. https://all3dp.com/1/3d-printing-materials-guide-3d-printer-material/

Forbes (2020): COVID-19 and 3D Printing. https://www.forbes.com/sites/stevebanker/2020/04/13/covid-19-and-3d-printing/#213ad0d43f7a

3D Printing Media Network (2020): University of Nottingham Designs Certified 3D Printed Face Shields for NHS. https://www.3dprintingmedia.network/university-nottingham-certified-3d-printed-face-shields-nhs/

MIT (2020): Impacts of 3D Printing on Global Supply Chains by 2020. https://ctl.mit.edu/sites/ctl.mit.edu/files/library/public/2014ExecSummary-BhasinBodla.pdf

Formlabs (2020): Company Website. https://formlabs.com/de/

Prusa Research (2020): Company Website. https://www.prusa3d.de/

Slant 3D (2020): Company Website. https://www.slant3d.com/

ARTIFICIAL INTELLIGENCE

Forbes (2017): How Artificial Intelligence is Revolutionizing Business in 2017. https://www.forbes.com/sites/louiscolumbus/2017/09/10/how-artificial-intelligence-is-revolutionizing-business-in-2017/#36c3433e5463

Future of Life Institute (2020): National and International AI Strategies. https://futureoflife.org/national-international-ai-strategies/

The Economist (2018): How AI is Spreading Throughout the Supply Chain. https://www.economist.com/special-report/2018/03/28/how-ai-is-spreading-throughout-the-supply-chain?FEATURE_ARTICLES_V1=0

PilotAI (2020): Company Website. http://pilot.ai/index.html

Pocket-lint (2020): What is Amazon Go, where is it, and how does it work? https://www.pocket-lint.com/phones/news/amazon/139650-what-is-amazon-go-where-is-it-and-how-does-it-work

TDWI (2018): Using OCR: How Accurate is Your Data? https://tdwi.org/articles/2018/03/05/diq-all-how-accurate-is-your-data.aspx

AUGMENTED & VIRTUAL REALITY

ZDNet (2020): AR and VR Should Be Booming. So Why Aren't We Interested? https://www.zdnet.com/article/ar-and-vr-now-have-a-chance-to-show-what-they-can-do-but-they-still-cant-break-through/

The Economic Times (2020): AR, VR and New-Age Tech Companies Report Increase in Demand as Covid-19 Grounds Workforce. https://economictimes.indiatimes.com/tech/software/ar-vr-and-new-age-tech-companies-report-increase-in-demand-as-covid-19-grounds-workforce/articleshow/74871031.cms

ABI Research (2020): COVID-19 Pandemic Impact: Manufacturing Slowdowns and Increased Demand Will Balance to See 16 Million Total AR and VR HMD Shipments in 2021. https://www.abiresearch.com/press/covid-19-pandemic-impact-manufacturing-slowdowns-and-increased-demand-will-balance-see-16-million-total-ar-and-vr-hmd-shipments-2021/

ASML (2020): Augmented Reality to the Rescue During the Coronavirus Pandemic. https://www.asml.com/en/news/stories/2020/augmented-reality-to-the-rescue-coronavirus

Design Boom (2020): AR Contact Lenses Place Micro-Displays Inside Your Eyes. https://www.designboom.com/technology/mojo-vision-smart-contact-lenses-ar-01-17-2020/

Singularity Hub (2020): Mojo Vision's Augmented Reality Contact Lenses Kick off a Race to AR on Your Eye. https://singularityhub.com/2020/01/17/mojo-visions-augmented-reality-contact-lenses-kick-off-a-race-to-ar-in-your-eye/

EPG (2020): Into Virtual Reality with the EPG Holodeck. https://www.epg.com/gb/logistics-consulting/virtual-reality-warehouse-planning/epg-holodeck/

Automation and Digitisat India (2020): Immersive Workflows: The Use of AR & VR in Manufacturing. https://www.industr.com/en/immersive-workflows-the-use-of-ar-vr-in-manufacturing-2466310

Walmart (2018): How VR Is Transforming the Way We Train Associates. https://corporate.walmart.com/newsroom/innovation/20180920/how-vr-is-transforming-the-way-we-train-associates

Space (2020): Virtual Reality Will Be a Big Part of Boeing's Starliner Astronaut Training. https://www.space.com/boeing-starliner-capsule-virtual-reality-astronaut-training.html

BIG DATA ANALYTICS

Raconteur (2020): Why You Need a Cognitive Supply Chain. https://www.raconteur.net/manufacturing/cognitive-supply-chain

Seagate (2020): Company Website. https://www.seagate.com/de/de/our-story/data-age-2025/

Frost and Sullivan (2020): Big Data Analytics Among Top Three Deployment Priorities for Enterprises, Says Frost & Sullivan. https://ww2.frost.com/news/press-releases/big-data-analytics-among-top-three-deployment-priorities-for-enterprises-says-frost-sullivan/

IBM (2020): What is Supply Chain Optimization? https://www.ibm.com/supply-chain/optimization

Gartner (2020): Gartner Top 10 Trends in Data and Analytics for 2020. https://www.gartner.com/smarterwithgartner/gartner-top-10-trends-in-data-and-analytics-for-2020/

Neo4j (2020): Graph Data Science Streamlines Complex Medical Supply Chain Analysis. https://neo4j.com/case-studies/boston-scientific/

BIONIC ENHANCEMENT

Gartner (2019): Gartner Says Global End-User Spending on Wearable Devices to Total $52 Billion in 2020. https://www.gartner.com/en/newsroom/press-releases/2019-10-30-gartner-says-global-end-user-spending-on-wearable-dev

Gartner (2019): Gartner Says Worldwide Wearable Device Sales to Grow 26 Percent in 2019. https://www.gartner.com/en/newsroom/press-releases/2018-11-29-gartner-says-worldwide-wearable-device-sales-to-grow-

Exoskeleton Event (2020): Exoskeletons and Wearable Robots: Current Practice and Future Perspectives in Automotive, Aviation, Construction, Healthcare, Logistics, Manufacturing. http://exoskeleton-event.wearablerobots.eu/wp-content/uploads/2019/12Exoskeletons-and-Wearable-Robots-Event-Web.pdf

The Wall Street Journal (2020): Wearable Devices Take Ergonomics to a New High-Tech Place. https://www.wsj.com/articles/wearable-devices-take-ergonomics-to-a-new-high-tech-place-11583267614

Supply Chain Movement (2020): Supply Chain Start-Up in the Spotlight. https://www.supplychainmovement.com/supply-chain-start-up-in-the-spotlight-motionminers/

IDTechX (2019): E-Textiles 2019-2029: Technologies, Markets and Players. https://www.idtechex.com/en/research-report/e-textiles-2019-2029-technologies-markets-and-players/671

Startup.ch (2017): Nanoleq AG. https://www.startup.ch/index.cfm?page=129367&profil_id=14798

Nanoleq (2020): The Future of E-Textiles. https://nanoleq.com/technology/

Business Insider (2020): Elon Musk Says There's a Chance His AI-Brain-Chip Company Will Be Putting Implants in Humans Within a Year. https://www.businessinsider.com/elon-musk-neuralink-brain-chip-put-in-human-within-year-2020-5?r=DE&IR=T

Stuttgarter Zeitung (2020): Exoskelette Am Flughafen Stuttgart Halb Mensch – Halb Maschine. https://www.stuttgarter-zeitung.de/inhalt.exoskelette-am-flughafen-stuttgart-halb-mensch-halb-maschine.78b5c665-e2c6-4ba1-a247-d655b65a9cc1.html

Trans.Info (2020): This Is How Exoskeletons Were Born and Are Used in Logistics. https://trans.info/en/this-is-how-exoskeletons-were-born-and-are-used-in-logistics-163321

The Robot Report (2018): Ford Adding Eksovest Exoskeletons to 15 Automotive Plants. https://www.therobotreport.com/ford-eksovest-exoskeletons-automotive/

Automotive Logistics (2019): Exoskeletons to Support Lineside Employees at Audi. https://www.automotivelogistics.media/people-and-skills/exoskeletons-to-support-lineside-employees-at-audi/39770.article

WhichCar (2019): Move Over Iron Man. Audi Workers Get Ultra-Cool Exoskeletons to Build Cars. https://www.whichcar.com.au/news/audi-workers-will-now-build-cars-using-exoskeletons

Audi Media Center (2019): Being Tested: Audi Production Tests Exoskeletons for Overhead Tasks. https://www.audi-mediacenter.com/en/press-releases/being-tested-audi-production-tests-exoskeletons-for-overhead-tasks-12421

The Wall Street Journal (2019): Industrial Exoskeletons Give Workers a Lift. https://www.wsj.com/articles/industrial-exoskeletons-give-workers-a-lift-11547730001

Nikkei Asian Review (2017): Japanese Manufacturer Develops 'Wearable Chair' for Surgeons. https://asia.nikkei.com/Business/Japanese-manufacturer-develops-wearable-chair-for-surgeons

Startup Ticker (2017): Noonee Launches Chairless Chair at Hannover Expo. https://www.startupticker.ch/en/news/april-2017/noonee-launches-chairless-chair-at-hannover-expo

BLOCKCHAIN

Deloitte (2019): Deloitte's 2019 Global Blockchain Survey. https://www2.deloitte.com/content/dam/Deloitte/se/Documents/risk/DI_2019-global-blockchain-survey.pdf

Block Data (2020): Forbes Blockchain 50 – Products Data Deep Dive. https://blog.blockdata.tech/2020/04/forbes-blockchain-50-products-data-deep-dive/

Coindesk (2019): Nestle, Carrefour Extend Blockchain Tracking Effort to Baby Milk. https://www.coindesk.com/nestle-carrefour-extend-blockchain-tracking-effort-to-baby-milk

SupplyChain247 (2016): World's Largest Mining Company to Use Blockchain for Supply Chain Management. http://www.supplychain247.com/article/worlds_largest_mining_company_to_use_blockchain_for_supply_chain

BRUCLOUD (2018): Brussels Airport Launches Blockchain Application on Their Winning Brucloud Data Sharing Platform. https://brucloud.com/news/read/8/brussels-airport-launches-blockchain-application-on-their-winning-brucloud-data-sharing-platform

CCN (2018): Alibaba Subsidiary Reports Successful Use of Blockchain Technology for Logistics Data. https://www.ccn.com/alibaba-subsidiary-reports-successful-use-blockchain-technology-logistics-data/

Money (2020): Ethereum-Bitcoin-Blockchain-Predictions. https://money.com/ethereum-bitcoin-blockchain-predictions/

CLOUD & APIs

Allied Market Research (2020): Supply Chain Management Market Expected to Reach $37.41 Billion by 2027. https://www.alliedmarketresearch.com/press-release/supply-chain-management-software-market.html

Logistics Management (2020): Cloud Takes the Starring Role. https://www.logisticsmgmt.com/article/cloud_takes_the_starring_role

TeraTech (2020): Everything CF Summit 2018: Unlocking the Power of APIs w/ Adobe API Manager. https://teratech.com/everything-cf-summit-2018-unlocking-the-power-of-apis-w-adobe-api-manager/

Convoy (2020): Company Website. https://convoy.com/

Transplace (2020): Company Website. https://www.transplace.com/

Project44 (2020): Company Website. https://www.project44.com/

DIGITAL TWINS

CIO (2018): Rolls-Royce Cdo Neil Crockett Drives Data Into Engine Design. https://www.cio.com/article/3525828/rolls-royce-cdo-neil-crockett-drives-data-into-engine-design.html

The Straits Times (2020): Digital Twin to Test Upcoming Tuas Mega Port's Design. https://www.straitstimes.com/singapore/transport/digital-twin-to-test-upcoming-tuas-mega-ports-design

IBM (2019): How the Port of Rotterdam Is Using IBM Digital Twin Technology to Transform Itself From the Biggest to the Smartest. https://www.ibm.com/blogs/internet-of-things/iot-digital-twin-rotterdam/

INTERNET OF THINGS

McKinsey & Company (2019): Growing Opportunities in the Internet of Things. https://www.mckinsey.com/industries/private-equity-and-principal-investors/our-insights/growing-opportunities-in-the-internet-of-things#

The New Economy (2019): Microscopic 'Smart Dust' Sensors Are Set to Revolutionise a Range of Sectors. https://www.theneweconomy.com/technology/microscopic-smart-dust-sensors-are-set-to-revolutionise-a-range-of-sectors

RVmagnetics (2020): Company Website. https://www.rvmagnetics.com/

Zetes (2020): Integration of Supply Chain System. https://www.zetes.com/en/technologies-consumables/supply-chain-systems-integration

NEXT-GENERATION WIRELESS

Inditex (2020): Company Website. https://www.inditex.com/how-we-do-business/our-model/customers

Supply Chain Dive (2019): Lululemon Leverages RFID, Supplier Relationships to Manage Inventory Amid Coronavirus Demand Drop. https://www.supplychaindive.com/news/coronavirus-lululemon-rfid-supplier-inventory/575109/

Supply Chain Dive (2019): When it comes to speed, Nike says RFID is key. https://www.supplychaindive.com/news/Nike-RFID-speed-inventory/557875/

McKinsey & Company (2020): Large Leo Satellite Constellations: Will It Be Different This Time? https://www.mckinsey.com/industries/aerospace-and-defense/our-insights/large-leo-satellite-constellations-will-it-be-different-this-time

QUANTUM COMPUTING

IBM (2020): What Is Quantum Computing? https://www.ibm.com/quantum-computing/learn/what-is-quantum-computing/

Frank Arute et al. (2019): Quantum Supremacy Using a Programmable Superconducting Processor. https://www.nature.com/articles/s41586-019-1666-5

XINHUA NET (2020): China's Quantum Satellite Links with World's First Mobile Ground Station. http://www.xinhuanet.com/english/2020-01/02/c_138674381.htm

IEEE Spectrum (2020): Honeywell Claims It Has Most Powerful Quantum Computer. https://spectrum.ieee.org/tech-talk/computing/hardware/honeywell-claims-it-has-most-powerful-quantum-computer

Volkswagen (2019): Volkswagen Optimizes Traffic Flow With Quantum Computers. https://www.volkswagen-newsroom.com/en/press-releases/volkswagen-optimizes-traffic-flow-with-quantum-computers-5507

CISION PR Newswire (2019): New Research: It Sees the Emergence of Quantum Computing as a Looming Threat to Keeping Valuable Information Confidential. https://www.prnewswire.com/news-releases/new-research-it-sees-the-emergence-of-quantum-computing-as-a-looming-threat-to-keeping-valuable-information-confidential-300940171.html

NEXXY Technologies (2020): The Use of Quantum Computing in Cyber Security. https://nexxytech.com/2020/01/14/the-use-of-quantum-computing-in-cyber-security/

Tech Republic (2020): Daimler and IBM on How to Build a Better Battery with Quantum Computing. https://www.techrepublic.com/article/daimler-and-ibm-on-how-to-build-a-better-battery-with-quantum-computing/

Airbus (2019): A Quantum Leap in Computing Power. https://www.airbus.com/newsroom/stories/is-quantum-computing-is-the-next-game-changing-technology-in-aerospace.html

ROBOTICS & AUTOMATION

International Federation of Robotics (2020): Service Robots: Global Sales Value Reaches 12.9 Billion USD. https://ifr.org/ifr-press-releases/news/service-robots-global-sales-value-reaches-12.9-billion-usd

Business Wire (2020): KNAPP and Covariant Introduce the Pick-it-Easy Robot, Powered by Artificial Intelligence (AI) to North American Market. businesswire.com/news/home/20200309005803/en/KNAPP-Covariant-Introduce-Pick-it-Easy-Robot-Powered-Artificial

Tech Crunch (2019): Shopify Buys Warehouse Automation Tech Developer 6 River Systems for $450 Million. https://techcrunch.com/2019/09/09/shopify-buys-warehouse-automation-tech-developer-6-river-systems-for-450-million/

Engineering.com (2020): Covariant AI-Enabled Robotic ARM has Warehouse Fulfillment Applications. https://www.engineering.com/AdvancedManufacturing/ArticleID/19930/Covariant-AI-Enabled-Robotic-Arm-Has-Warehouse-Fulfillment-Applications.aspx

The Spoon (2020): Kroger to Build Three Robot-Powered Fulfillment Centers in the Pac. Northwest, Great Lakes and West Regions. https://thespoon.tech/kroger-to-build-three-robot-powered-fulfillment-centers-in-the-pac-northwest-great-lakes-and-west-regions/

Globest (2020): Robotic Grocery Microfulfillment Facilities are on the Rise Due to Covid-19. https://www.globest.com/2020/05/20/robotic-grocery-microfulfillment-facilities-are-on-the-rise-due-to-covid-19/?slreturn=20200718084649#

SELF-DRIVING VEHICLES

Popular Mechanics (2019): A Self-Driving Freight Truck Just Drove Across the Country to Deliver Butter. https://www.popularmechanics.com/technology/infrastructure/a30196644/self-driving-truck-cross-country/

Omar Allam (2019): Twitter Website. https://twitter.com/Oa11am/status/1204574084610379777

Ike (2020): Company Website. https://www.ike.com/

Reuters (2019): Driverless Electric Truck Starts Deliveries on Swedish Public Road. https://www.reuters.com/article/us-einride-autonomous-sweden/driverless-electric-truck-starts-deliveries-on-swedish-public-road-idUSKCN1SL0NC

Forbes (2019): The Truck Platooning Market Experiences Growing Pains. https://www.forbes.com/sites/stevebanker/2019/07/09/the-truck-platooning-market-experiences-growing-pains/#5cdf741057ca

Commercial Fleet (2019): Mercedes Switches Focus Away From Platooning Trials. https://www.commercialfleet.org/news/truck-news/2019/02/04/mercedes-switches-focus-away-from-platooning-trials

AGV Network (2020): Company Website. https://www.agvnetwork.com/automated-guided-vehicles-manufacturers#germany

Bain & Company (2019): Now Hiring: Investing in Retailers' Most Important Asset. https://www.bain.com/insights/now-hiring-investing-in-retailers-most-important-asset/

KPMG (2018): Autonomy Delivers: an Oncoming Revolution in the Movement of Goods. https://advisory.kpmg.us/content/dam/advisory/en/pdfs/2018/autonomy-delivers-final-secured-web.pdf

Nikkei Asian Review (2020): Coronavirus Lockdown Sparks Expansion of Drones and Robot Deliveries. https://asia.nikkei.com/Opinion/Coronavirus-lockdown-sparks-expansion-of-drones-and-robot-deliveries

Postmates (2020): Introducing Serve! https://support.postmates.com/buyer/articles/360030116731-article-Introducing-Serve-

Business Insider (2020): Softbank-Backed Delivery Startup Rappi is Testing out Robots for Contactless Delivery — Take a Look. https://www.businessinsider.com/delivery-startup-using-robots-in-colombia-to-avoid-coronavirus-2020-4?r=DE&IR=T

UNMANNED AERIAL VEHICLES

ETH Zürich (2019): Applications of Drones in Warehouse Operations. https://ethz.ch/content/dam/ethz/special-interest/mtec/pom-dam/documents/Drones%20in%20warehouse%20opeations_POM%20whitepaper%202019_Final.pdf

Infinium Robotics (2020): Company Website. https://www.infiniumrobotics.com/

The Verge (2020): Alphabet's Nascent Drone Delivery Service Is Booming. https://www.theverge.com/2020/4/9/21214709/alphabet-wing-drone-delivery-coronavirus-covid-19-demand-increase-toilet-paper-baby-food

Zipline (2020): Company Website. https://flyzipline.com/

TechCrunch (2020): Zipline begins us Medical Delivery with Drone Program Honed in Africa. https://techcrunch-com.cdn.ampproject.org/c/s/techcrunch.com/2020/05/26/zipline-begins-us-medical-delivery-with-uav-program-honed-in-africa/amp/

Elroy Air (2020): Company Website. https://www.elroyair.com/

Dronamics (2020): Company Website. https://www.dronamics.com/

Pictorial Sources

Figure 1: DHL Visitors watch a Covariant robotic arm in action at the grand opening of the DHL Innovation Center in Chicago.

Figure 2: Forbes Singles' Day in China epitomizes the size and continued growth of e-commerce, with Alibaba alone reporting in 2019 almost $40 billion in sales in 24 hours, a 26% increase from the previous year.
https://specials-images.forbesimg.com/imageserve/5dcac119e0af7b0006b11fb0/960x0.jpg?fit=scale

Figure 3: Gestalt Robotics Advancements in AI have refined computer vision so that tens of thousands of various objects can be accurately identified and tracked, even on busy facility floors.
https://www.gestalt-robotics.com/ki-bildverarbeitung

Figure 4: Forbes Over a thousand robots quickly navigate on tracks, fulfilling online grocery orders in an Ocado warehouse.
https://content.fortune.com/wp-content/uploads/2020/04/Erith-2020-76_titl-shift-blur.jpg?resize=1440,960

Figure 5: Linde Companies like Linde have utilized smartglasses and interactive AR technology to retain their high-quality maintenance services for their customers, albeit remotely.
https://www.realwear.com/wp-content/uploads/Home-Feature-Image-Linde.jpg

Figure 6: LinkedIn Wearable technology can facilitate adherence to health and safety protocols, such as social distancing in workplaces.
https://media-exp1.licdn.com/dms/image/C4E12AQEGnQHhGLuuUA/article-inline_image-shrink_1500_2232/0?e=1602115200&v=beta&t=UOmIvUXo9zTxUvOKkS-FYexeSmve8mxU2ZZDgUWYtno

Figure 7: DHL A fleet of LocusBots™ await deployment to collaborate with DHL operators in the fulfillment process, keeping productivity high despite a limited workforce during the pandemic.

Figure 8: Production Engineering Solution 3D printers have been employed globally to locally manufacture face shields and other essential products en masse.
https://www.pesmedia.com/wp-content/uploads/2020/04/20200402_3D-Visor_012_V2-1024x1276.jpg

Figure 9: Sensotec Scanners like those by Cognex limit the need for operators to touch hardware and products.
http://sensotek.ru/images/Cognex/IS7K_G2_pills_1749x2100_300_RGB.jpg

Figure 10: Air Cargo News Due to COVID-19 travel restrictions, airlines like Lufthansa have swiftly enacted resiliency measures, repurposing seating areas for cargo transport to offset the rapid decline in passengers.
https://www.aircargonews.net/airlines/airlines-fill-passenger-seats-with-cargo-to-meet-demand/

Figure 11: Despabilate The world cannot hope for a sustainable future without serious, measurable action, including reversing the growing generation of packaging waste.
https://despabilate.com/wp-content/uploads/2020/06/DESTRUIR-EL-AGUA-ES-ATENTAR-CONTRA-LA-VIDA-EN-EL-PLANETA-www.tvnoticias.com-2.jpg

Figure 12: DHL A DHL warehouse operator dons smartglasses while displaying a smart ring wrapped around fingers.

Figure 13: DHL Welcoming visitors since 2015, the DHL Innovation Center in Singapore showcase new technology to inspire customers in the Asia-Pacific region.

Figure 14: DHL Visitors are encouraged to interact with the dozens of pioneering exhibits, from smartglasses to logistics robots, at each of the Innovation Centers, like this one in Troisdorf, Germany.

Figure 15: DHL The DHL Innovation Center in Chicago is the newest addition, bringing customers closer to technology in the Americas region since opening in late 2019.

Figure 16: DHL Teams from the DHL Innovation Centers frequently spend time in internal and customer facilities in their respective regions to understand current operations and to lead and support supply chain projects involving cutting-edge technologies.

Figure 17: Kuka The proliferation of robotics in the manufacturing process has shifted the economic landscape such that production centers may feasibly move to other regions around the world.
https://www.kuka.com/-/media/kuka-corporate/images/products/systems/anlagenbau-automotive_r.g?rev=88d98954c1844f7ab72655f0192ef6b1&hash=E00E567A07730277CB13181B6E1DB189

Figure 18: Wikipedia The "always-on, always-connected" theme of Connected Life often found itself in many other logistics trends, and so the trend has been dissolved.
https://en.wikipedia.org/wiki/Smartwatch#/media/File:Smartwatch-828786.jpg

Figure 19: Immobilien Business Without a life-sized operating model, Tube Logistics has been removed from this edition of the Logistics Trend Radar but may see a welcomed return in future editions.
https://www.immobilienbusiness.ch/wp-content/uploads/2020/01/3D_Simulation_5_Gesamtsystem.jpg

Figure 20: Installation TORE is a revolutionary, wall-less, 180-degree view virtual reality CAVE system designed by Antycip Simulation that can provide immersive experiences for up to 20 people at once.
https://www.installation-international.com/wp-content/uploads/2019/01/to-use-3.jpg

Figure 21: Nikkei Asian Review The advantageous person-to-person transfer of knowledge gained from years of experience will be disrupted in companies that do not accommodate the needs of their oldest members.
https://www.ft.com/__origami/service/image/v2/images/raw/https%3A%2F%2Fs3-ap-northeast-1.amazonaws.com%2Fpsh-ex-ftnikkei-3937bb4%2Fimages%2F7%2F7%2F2%2F2%2F20962277-1-eng-GB%2FR20190527%20young%20old%20workers_2048x1152.jpg?source=nar-cms

Figure 22: Fortune Global usage of superfast 5G networks is expected to soar as infrastructure is installed and smartphones are made ready for the new technology.
https://content.fortune.com/wp-content/uploads/2020/01/GettyImages-1184880128.jpg?resize=1440,960

Figure 23: Nikkei Asian Review Food delivery services, whether from grocery stores or restaurants, have been bolstered by lockdowns spurred by the COVID-19 pandemic.
https://www.ft.com/__origami/service/image/v2/images/raw/https%3A%2F%2Fs3-ap-northeast-1.amazonaws.com%2Fpsh-ex-ftnikkei-3937bb4%2Fimages%2F2%2F3%2F8%2F8%2F25798832-1-eng-GB%2FThai%20ecommerce_Data.jpg?source=nar-cms

Figure 24: Kenya Climate Innovation Center Solar Freeze has pioneered solar-powered refrigeration for smallholder farmers in Africa, where postharvest losses of grown produce can reach up to 80% due to lack of cold storage.
https://www.kenyacic.org/sites/default/files/images/news/IMG_0390.jpg

Figure 25: DHL DHL warehouse operators collaborate with LocusBots in the picking process to increase their productivity and limit the total distance they need to travel on foot during a shift.

Figure 26: Reuters In the coming future, more employees will be able to work remotely, even drivers through enabling hardware & software by Phantom Auto.
https://s4.reutersmedia.net/resources/r/?m=02&d=20190923&t=2&i=1432975291&r=LYNXMPEF8M14U

Figure 27: DHL As robots and digital screens become more prevalent along the supply chain, employers must train and upskill their workers to help retain talent.
https://3er1viui9wo30pkxh1v2nh4w-wpengine.netdna-ssl.com/wp-content/uploads/prod/sites/40/2020/06/DHL-Warehouse-Robotics-Plattform-1.jpg

Figure 28: Shutterstock Online marketplaces help connect millions of shippers with a multitude of logistics providers around the world.
https://www.shutterstock.com/de/image-photo/many-trucks-parking-queue-unloading-top-1774410647

Figure 29: DHL Logistics marketplaces like MyDHLi offer customers streamlined services across many platforms.

Figure 30: Berndt+Partner PillPack simplifies the user experience by packaging a combination of pills in individual packets by day, time, and dosage.
https://bp-group.de/wp-content/uploads/2019/05/pillpack_dispenser_kitchen-1.jpg

Figure 31: Westword Limited customization, as opposed to full customization, has proliferated in e-retail and fashion and has been applied even to face masks as they become more commonplace.
https://images1.westword.com/imager/u/original/11679680/img_4012.jpg

Figure 32: Enterprise IoT Insights As the demand for electronic components grows in the US, Bosch is investing hundreds of millions of dollars in new factories in Mexico.
https://i1.wp.com/enterpriseiotinsights.com/wp-content/uploads/2018/04/bz181_bbm_mx-3639.jpg?fit=2048%2C1367&ssl=1

Figure 33: Port of Hamburg As the center of gravity of production shifts away from traditional regions, resulting impacts to overseas and cross-border logistics will need to be considered, from raw materials to reverse logistics.
https://www.hafen-hamburg.de/images/0/fotos/news/ONE%20Columba%20KH-291218-07.jpg

Figure 34: Reddit RFID hardware embedded into paper tags of products can reduce theft in stores, but they can also provide distinction between genuine and counterfeit goods.
https://i.redd.it/diyev6lg3tv31.jpg

Figure 35: Ecovative (2019) Ecovative manufactures sustainable packaging derived from fast-growing fungus that can easily be molded to match product dimensions.
https://miro.medium.com/max/11232/1*WHkPvX65lHGBpx_zUgKFpA.jpeg

Figure 36: Nordiske Medier Reusable packaging dramatically reduces waste - Repack, for example, utilizes recylable packaging materials that can last for at least 40 use cycles.
https://f.nordiskemedier.dk/2fbtuxeys2pbtbjb.jpg

Figure 37: Alstom (2018) Alstom provides trains-as-a-service for public transportation providers and has innovated unique practices, like scan tunnel systems for maintenance checks, to ensure it meets its service obligations.
https://www.alstom.com/sites/alstom.com/files/2018/07/12/IMG_6665_13_03_17R.jpg

Figure 38: GE (2020) GE sensors inform Maersk Drilling of the status of equipment before potential breakdowns, reducing maintenance costs by 20% and improving drilling efficiency.
https://www.ge.com/news/sites/default/files/Maersk%20Drilling_Integrator.jpg

Figure 39: Unilode (2020) By integrating ULDs into the Bluetooth network, Unilode now readily tracks over 15,000 ULDs across 60 airlines, monitoring temperature, humidity, light, and shock.
Uniload Information Source.

Figure 40: D-Orbit (2020) With thousands of satellites to be lastartuunched into space, D-Orbit's ION Satellite Carrier can safely store, rapidly transport, and accurately deploy microsatellites to their proper destination, reducing costs and extending satellite life.
D-Orbit Information Source.

Figure 41: Cargo Airport & Airline Services Cainaio's logistics network integrates over 200 service providers to develop what could be the world's first logistics supergrid.
https://www.caasint.com/wp-content/uploads/2020/07/Cainiao-teams-up-with-Volga-Dnepr-Group-HGK-MAD-1024x768.jpg

Figure 42: DHL Flexible TRAILAR solar panels fit perfectly on semi-trailers and other surfaces throughout supply chains, providing extra green energy for engines, refrigeration, and more.

Figure 43: Star Tribune Packaging is often 40% too large for its contents, requiring extra room and more vehicles than necessary; automated packaging machines like this one can optimize space and reduce the amount of air shipped with contents.
https://stmedia.stimg.co/ows_156113418688922.jpg?fit=crop&crop=faces

Figure 44: Electrek Eviation's upcoming fully electric airplane may one day impact the logistics industry, eliminating aviation emissions and expanding quieter night operations.
https://electrek.co/wp-content/uploads/sites/3/2019/06/eviationaliceparisairshow.jpg?quality=82&strip=all

Figure 45: Drapers Facilities and offices provide enormous, but often overlooked, opportunities to improve sustainability, from massive areas for solar panels to transit orientation to decrease worker and visitor reliance on private vehicles.
https://s3-eu-west-1.amazonaws.com/emap-nibiru-prod/wp-content/uploads/sites/2/2015/03/09213900/Hanover-Aerial-shot-1.jpg

Figure 46: 3D Print The French military has recently deployed a print farm to streamline its spare parts supply chain.
https://3dprint.com/wp-content/uploads/2020/07/frencharmy3dprinter_ultimaker_spare.png

Figure 47: Geek Wire

For a smooth, cashier-less customer experience, Amazon Go stores leverage computer vision to track shoppers, tally the items they pick from the shelves, and charge their Prime accounts when they leave the store.
https://cdn.geekwire.com/wp-content/uploads/2020/02/amzngo3-630x420.jpeg

Figure 48: Airport InFocus As part of its remote air control tower solution, Searidge Technologies utilizes intelligent video to detect, position, and continuously track all targets on airport surfaces, from construction areas to aircraft.
https://airportinfocus.com/wp-content/uploads/2018/07/NATS.jpg

Figure 49: Hamburg News Smartlgasses are becoming an increasingly common tool in supply chains, improving productivity with line-of-sight information on picking, inspections and other processes.
https://www.hamburg-news.hamburg/sites/default/files/2020-05/xPick-with-xBand.jpg

Figure 50: Medium Graph analytics links and clusters data points to highlight patterns and relationships that could be used to optimize processes and reduce cost and waste.
https://miro.medium.com/max/3200/1%2aVRGNDjrrXYCVW0pdHvFtTg.png

Figure 51: Hyundai Hyundai's assembly workers test chairless exoskeletons made in-house that enable them to easily stand or stay comfortably seated while working.
https://www.hyundai.news/eu/brand/hyundai-motor-group-ventures-further-into-new-robotics-industry/

Figure 52: German Bionic Active back support systems by German Bionic Systems reduce injuries by mechanically assisting workers in carrying heavy suitcases at the Stuttgart Airport.
https://www.germanbionic.com/wp-content/uploads/2020/02/STR_Gepa%CC%88ckverteiler_Exoskelett-3-scaled.jpg

Figure 53: Histerius In partnership with DHL Start-up Lab, Dubai Customs has implemented a blockchain solution for cross-border e-commerce, saving customers thousands of dollars.
https://www.histerius.com/hs0619/dubai_customs.jpg

Figure 54: Information Age IBM's blockchain-powered Food Trust platform enables any user with a smartphone to confirm the history and quality of participating products.
https://s27389.pcdn.co/wp-content/uploads/2017/08/IBMBlockchain_02_crop.jpg

Figure 55: Siemens Digital replicas of real-world products and processes within a supply chain can provide transparency, warnings, and predictions.
https://assets.new.siemens.com/siemens/assets/api/uuid:03bd0089-d391-4261-b9b8-d88feab61f1e/width:3840/quality:high/version:1571828472/411-190404-kv-intralogistics-1920x1080px.jpg

Figure 56: DHL To locate and optimize the movement and storage of roller cages, DHL attached Sigfox trackers to more than 250,000 cages in Germany in 2019.

Figure 57: Medium Despite its incredibly tiny size, the smartdust micromote developed by researchers at the University of Michigan can process deep learning algorithms on board, expanding the possibilities for sensors.
https://miro.medium.com/max/10956/1%2a4Ysg_5mTDtIzONojkpLYPQ.jpeg

Figure 58: CNN Turk Istanbul Airport leverages LoRaWAN to track the location, condition, and utilization of over 1000 ground support equipment assets.
https://i2.cnnturk.com/i/cnnturk/75/1280x720/5d4990c8c8c37322e005b41c.jpg

Figure 59: TechCrunch One SpaceX Falcon 9 rocket can transport 60 of the planned 12,000 satellites the company wishes to deploy to provide global internet coverage.
https://techcrunch.com/wp-content/uploads/2019/11/starlink1_vertical_03_twitter.jpg

Figure 60: Medium IBM was the first to commercialize a quantum computer, utilizing the more common superconducting inductor loop technology.
https://miro.medium.com/max/4096/1%2aCBVN0kxVuMAyEdkscIzfZg.jpeg

Figure 61: Honeywell Alternatively, Honeywell is pursuing ion-trap technology as the basis of its competing quantum computer to perform difficult calculations in seconds that can take supercomputers thousands of years to complete.
Honeywell Information Source.

Figure 62: DHL A Shenzhen Dorabot articulated robotic arm autonomously sorts small shipments by route at a DHL Express facility.

Figure 63: Fabric Robot (2019) Micro-fulfillment company.Fabric heavily leverages autonomous mobile robot (AMR) technology to operate their mirco-fulfillment centers in denser, urban areas.
https://files.geektime.co.il/wp-content/uploads/2019/10/Fabric-funding-3-1571835438.jpg

Figure 64: Rappi Robots (2020) Crossing a street, Rappi Kiwibots semi-autonomously deliver contactless orders during the COVID-19 pandemic.
https://www.eltiempo.com/files/article_main/uploads/2020/04/27/5ea74274c4f86.jpeg

Figure 65: DHL Autoguide has focused on making warehouse vehicles self-driving, such as this forklift that is able to manipulate pallets with high accuracy and speed.

Figure 66: Ike (2020) Ike's semi-autonomous self-driving truck solution can improve truck driver livelihoods while increasing freight productivity.
Ike Information Source

Figure 67: Dronamics Transporting payloads up to 350 kg (770 lbs) at distances up to 2,500 km (1,550 mi), DRONAMICS soon expects to fly its full-scale Black Swan drone for commercial operations.
Dronamics Information Source.

Figure 68: FairFleet FairFleet's global network of drone pilots and software platform enable drone missions as-a-service, including mapping and measuring large cargo.
FairFleet Information Source.

Figure 69: Zipline Working with the Ghanaian government to establish flight corridors (white), special viral test corridors (red) and no-fly zones (blue), Zipline acts as a successful hub model already serving hundreds of destinations in Africa.
Zipline Information Source.

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SPECIAL THANKS TO
our over 13,000 customers, partners, and employees
who visit our DHL Innovation Centers every year, providing us with invaluable feedback to develop our Logistics Trend Radar.

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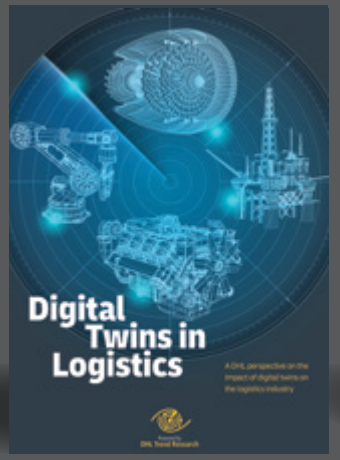

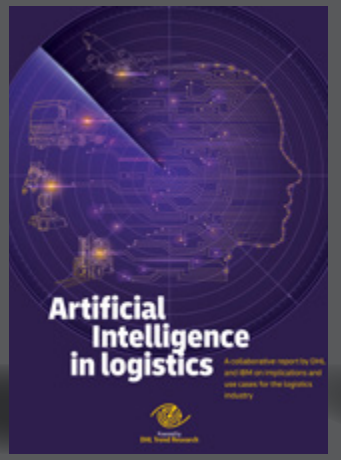

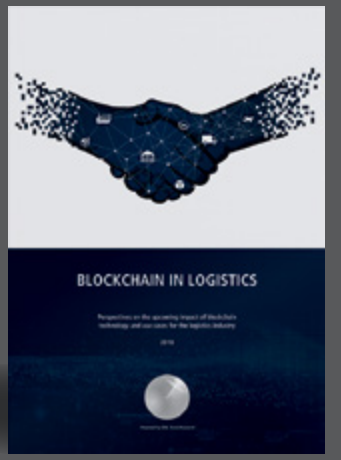

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