

Logistics Trend Radar

Delivering insight today,
creating value tomorrow.

Version 2018/19



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“The future belongs to those who think ahead. Our Logistics Trend Radar, an industry-acclaimed foresight tool, shows us that innovation will be more important than ever, as digitalization drives the biggest transformation we’ve ever seen in the industry in the coming years. At DHL, we’re excited to work jointly with our customers and partners to shape the journey ahead.”

Katja Busch Chief Commercial Officer, DHL

A handwritten signature in black ink that reads "Katja Busch".

● Preface

Digitalization. Industry 4.0. Software is eating the world. Regardless of the terminology that's being used, by now your organization, like ours, will have felt the challenges of a world embracing the digital revolution. As we sit down to reflect on the past, present, and future trends in logistics, one truth is now abundantly clear: digital is in full swing.

Private life and business life have become increasingly characterized by an appreciation of and dependence on technology, making it a central part of daily interaction, decision making, and competitive advantage. These changes are impacting our industry as well: digital innovation – from connected warehouses to new autonomous last-mile delivery services – is increasing the relevance and presence of logistics in everyday life, making headlines and turning an age-old industry into an exciting place to drive change for the betterment of society.

Looking ahead into the future, we believe digitalization represents the biggest opportunity in logistics since globalization, creating unprecedented opportunities for operational efficiencies, sustainability, new business models,

and richer customer experiences. To stay ahead and actively shape this transformation, logistics professionals need to continuously identify and leverage new trends. This is why we established DHL Trend Research, a program that helps us to apply a customer-centric, open approach to trend foresight and innovation.

DHL Trend Research regularly publishes a key instrument for the global logistics community – the Logistics Trend Radar. This is a dynamic, living tool that captures the development of society, business, and technology trends. It has become an industry-acclaimed benchmark for strategy and innovation and it is further used with industry stakeholders to spark deep dives in specific trends, most recently trends such

as the sharing economy, blockchain, and artificial intelligence.

We are excited to now invite you to review this latest edition covering the most pressing trends on the horizon in the logistics industry. We hope that these insights will inspire and assist you once again in creating, testing, and implementing new innovations that advance the industry on its digital journey.

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



Matthias Heutger

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● Evolution of Logistics

● Smarter, Faster, More Customer Centric & Sustainable

Though logistics has existed for centuries, our industry has rarely made headlines, and our last great innovation is often regarded as the shipping container in the 1950s. As digitalization reaches full swing, logistics has become a hotbed for innovation since the publication of our last Logistics Trend Radar two years ago. An ocean of venture capital funding has created a vast expanse of startups with new cutting-edge business models and logistics-focused technology products and services. Working more closely with technology players, as well as guarding against potential disruption from startups, has become a new reality for established logistics industry players.

So then what does this mean for the future? Put simply, we believe there is huge potential for the logistics industry; there has never been a more exciting time to actively contribute to making global supply chains smarter, faster, more customer centric, and sustainable. In the following pages, we will review some of the key trends taking center stage in logistics innovation in the years to come.

CUSTOMER CENTRICITY: GETTING CLOSER TO THE CUSTOMER THROUGH NEW BUSINESS MODELS AND SOLUTIONS

The adage that the customer is king has never been truer than in today's digital age. Consumers have more buying power than ever before. With ecommerce driving demand for transparency, affordability, convenience, and speed in delivery as well as compelling frictionless returns, it is essential to create new business models and solutions that cater to these needs (see figure 1).

Omni-channel Logistics will continue to be a major trend in retail and beyond in order to deliver a seamless customer

experience. With the B2B online retail market expected to reach double the size of the B2C online market by 2020¹, businesses will need to intensify efforts to tap into new online channels. In logistics, key areas of innovation will include the development of flexible fulfillment networks (e.g., FLEXE), inventory visibility solutions, proximity-based cost models for shipping (e.g., Jet.com) and new last-mile delivery solutions which are increasingly vital but an expensive part of the value chain.

New solutions will also need to be developed in response to customer demand for **Fresh Chain** shipments. The possibility to purchase almost anything online is increasing the volumes of temperature-sensitive shipments such as groceries and pharmaceuticals delivered directly to the customer (see figure 2). Just in the next five years, it is predicted that online grocery sales will increase 10 times faster than in-store sales with 70% of consumers estimated to do some of their household shopping online.² New temperature-sensitive packaging along with network and delivery innovations will be required to facilitate growth in this segment.



Figure 1



Figure 2

Figure 1: Delivering the new omni-channel customer experience: anytime, anywhere; Source: DHL

Figure 2: Managing the growth of fresh chain shipments with innovations in packaging, transport and delivery; Source: AllyouneedFresh

Moving forward, it will be essential to stay as close and as connected to the customer as possible. One trend which will enable such engagement is the trend of **Connected Life** where the growth in smart home technologies such as home speakers, security systems, and door locks presents new opportunities for logistics providers to engage with customers in more convenient, automated, and interactive ways (see figure 3). In the US alone, it is estimated that smart speakers will be present in over 66 million households by 2022, achieving a reach of 172 million consumers.³ Applications such as in-home delivery and automatic replenishment will be key areas to watch.

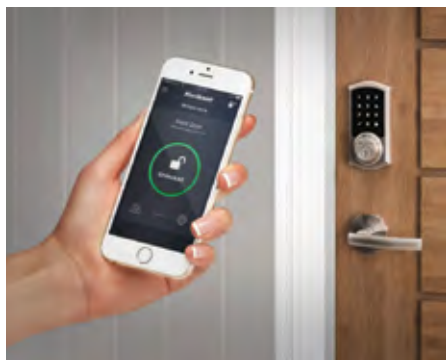


Figure 3

Industrial sectors like manufacturing and automotive will also capitalize on new customer-centric business models. **Servitization** is helping manufacturers shift from selling units of machinery to selling uptime, maintenance, and servicing of the machinery they produce. Thanks to digital technologies and changing customer demands, logistics providers can leverage analytics from machine sensor data, rethinking how to capture digitization value through business model innovation (see figure 4).

“For me, customer centricity is a digital interface to the customer covering the entire experience – from the first inspiration to purchase to delivery and completion. Only those companies that truly put the customer at the heart of their operations will succeed in the future.”

Dr. Christian Langer – Vice President Digital Strategy
Lufthansa Group

Figure 3: Leveraging the connected lifestyles of customers to enable in-home delivery;
Source: Shutterstock

Figure 4: Customer centricity is the driving force behind the trend of servitization;
Source: Shutterstock



Figure 4

3. <https://www.forrester.com/report/Forrester+Data+Smart+Home+Devices+Forecast+2017+To+2022+US/-/E-RES140374>

4. <https://www.weforum.org/agenda/2017/09/countries-are-announcing-plans-to-phase-out-petrol-and-diesel-cars-is-yours-on-the-list/>

SUSTAINABILITY: BECOMING A ZERO-EMISSIONS INDUSTRY

Governments, industries, and companies all around the world are making sweeping commitments to reduce levels of CO₂ emission and waste. Countries such as France, Germany, India, the Netherlands, Norway and the UK are leading the charge in developing policies that halt the production and sales of petrol and diesel vehicles over the next 10 to 20 years.⁴ Automotive companies are also imposing sustainability as the only option for the future, with companies such as Volvo committing to not developing any new diesel engines in order to focus on greener alternatives (see figure 5). New innovations will also be happening in the area of waste

reduction, with policies such as the European Union ban on disposable plastic packaging by 2030 demanding the adoption of eco-friendly solutions.⁵

In the past two years, the logistics industry has made bold moves to reduce its carbon footprint and take greater responsibility for the adverse environmental effects of core activities like transportation and warehousing. At DHL, we aim to become a zero-emissions logistics company by the year 2050 and have made significant progress in **Green Energy Logistics** through the production and distribution of our own electric delivery vehicle called StreetScooter. With over 5,000 in deployment and plans to produce 20,000 annually, the electrification of logistics fleets will

help to save significant amounts of CO₂ emissions.⁶ Innovations in smart facility management and adoption of renewable energy sources will further accelerate the green transformation in logistics. The sustainability imperative and urbanization are also birthing the creation of new delivery infrastructures that address the intertwined issues of urban congestion and carbon emissions. In future, we will see the standard container evolve into a variety of **Smart Containerization** formats that are intelligent, modularized, and allow for more efficient load utilization. Such new formats are already being tested for urban logistics (e.g., DHL Cubicycle; see figure 6) and can be extended to modularizing the container packaging.

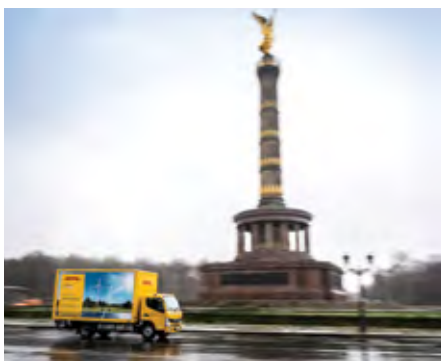


Figure 5

5. https://ec.europa.eu/commission/news/first-ever-europe-wide-strategy-plastics-2018-jan-16_en
6. http://www.dpdhl.com/en/media_relations/press_releases/2018/deutsche_post_dhl_group_agm_2018.html

“The logistics industry provides services that no modern society can do without. We are a part of this world. That’s why we must collectively work to preserve and improve it and ensure our societies and environments prosper. Bold aspirations are necessary, however, to catalyze this process.”

Dr. Frank Appel – Chief Executive Officer
Deutsche Post DHL Group



Figure 6

Figure 5: Green fleets will soon become the standard in logistics; Source: DHL

Figure 6: New container and packaging formats can increase efficiency in transport and reduce carbon emissions; Source: DHL

TECHNOLOGY: CATALYZING INNOVATION WITH A COST-PERFORMANCE TIPPING POINT

The combination of decreasing sensor costs, ubiquitous connectivity, relatively recent prediction capabilities, and ever-increasing computing performance will accelerate the adoption of exciting new technologies in logistics, making supply chains smarter, faster, more agile, and ultimately predictive.

Analytics expertise, data-driven decision making, and the new services that can be achieved with the **Internet of Things (IoT)** represent an immense \$1.9 trillion opportunity in logistics.⁷ Smart warehousing, real-time transport visibility, and predictive delivery are just some of the key areas for IoT innovation in logistics (see figure 7). However, until now only a few IoT applications in logistics have experienced widespread adoption, due to the total cost of deployment, security concerns, and an absence of standards in the fragmented logistics industry.

One key enabler will be **Next-generation Wireless** solutions. In the coming years, the evolution of wireless technologies including but not limited to 5G, WiFi, Bluetooth 5.0, and others will significantly increase access to internet and data connectivity, while simultaneously expanding the scope of wireless capabilities. In technologically mature markets, this will bring richer content consumption, decreased latency, better real-time processing through edge computing, and management of applications in the cloud (see figure 8). In countries that do not have internet access today, connectivity issues will become a remnant of the past; these nations will benefit from a mobile-first internet experience and minimal legacy infrastructure to overhaul.

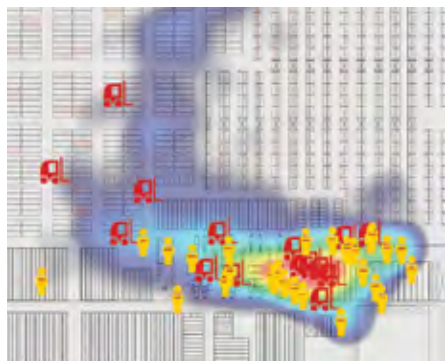


Figure 7



Figure 8

Figure 7: Connected logistics will enable a whole new host of smarter supply chain capabilities;
Source: DHL

Figure 8: New wireless networks can be a catalyst for large-scale IoT deployments in logistics;
Source: Shutterstock



Figure 10

**DHL GLOBAL TRADE
BAROMETER SCORES 64
AT THE BEGINNING OF 2018,**
pointing to a moderate increase in world trade
within three months

DHL Global Trade Barometer – World
2013-present

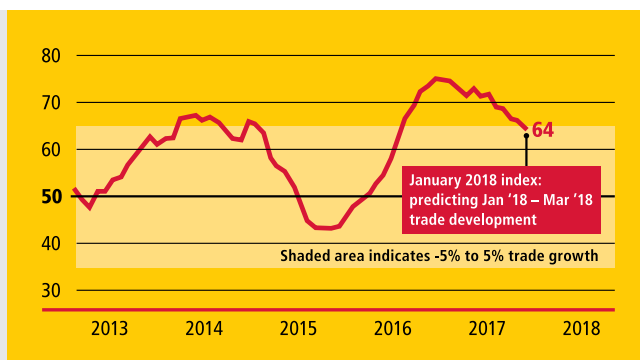


Figure 9

A trend having much greater impact on logistics than expected in the past is **Artificial Intelligence (AI)**; it has come roaring out of research laboratories to become ubiquitous and ambient in our personal lives, so much so that many consumers do not realize they use products and applications that contain AI on a daily basis. As AI adoption leaps from consumer segments to enterprises, key application areas in logistics are back-office automation (e.g., robotic process automation combined with AI), the predictive supply chain (e.g., DHL Global Trade Barometer; see figure 9), and a new AI-powered customer experience.

On the horizon is the use of distributed ledger technologies such as **Blockchain** to remove significant layers of complexity from global supply chains (see figure 10). While blockchain is in its early days and successes are still to be proven, it could potentially add value by facilitating greater trust and transparency between supply chain stakeholders and by supporting the automation of administrative and commercial processes in logistics.

Figure 9: Predicting global trade using the power of AI; Source: DHL

Figure 10: Industry adoption of blockchain could redefine centuries-old processes; Source: DHL

“To stand still is to go backwards – that’s why we need to bring technology into our supply chains, proactively and in a collaborative approach with our partners. New eco-systems need to be developed to foster the next generation of solutions.”

Dave Sheldon – Head of Global Supply Chain Development
Nestlé



“Robots will one day be a common sight in logistics, doing the heavy lifting and traveling the long distances to let people do more meaningful tasks. What will success look like? When robots empower people, and enable those who know nothing about computers or robots to operate them.”

Melonee Wise – Chief Executive Officer
Fetch Robotics

PEOPLE: CREATING THE COLLABORATIVE HUMAN-MACHINE WORKFORCE OF THE FUTURE

Perhaps one of the main elements of digitalization in logistics will be the automation of highly repetitive, labor-intensive, and in some cases physically intensive tasks in operations. While at first glance this may seem to present a picture of a diminishing human role in logistics, automation will drive creation of jobs in entirely new fields in logistics. It is also important to recognize that there is a real need to automate due to increasing labor shortages especially in mature markets and the ecommerce demand for rapid fulfillment and delivery

of orders. Such is the case that China, tackling the challenge of an aging workforce, has in the past five years become the world’s largest market for industrial robots, accounting for over 30% of the global market.⁸

Already today, significant strides are being made in the area of machine-human interaction and collaboration. **Robotics & Automation** will become an integral part of future logistics operations, and in the last two years we have observed the first wave of collaborative robots entering the logistics workforce (see figure 11). More advances in technology and affordability will enable the eventual automation of

key logistics tasks and create new roles in the logistics industry.

This shift in workforce composition is described through the trend of **Digital Work**. This will increase the number of technically skilled jobs in logistics (e.g., programmers and managers of robotics fleets). Innovative new models of work will be needed for recruitment and retention of the increasing segments of millennial and Gen Z talent in logistics. Here tools such as **Virtual Reality** can support operations by enabling workers to use technology for efficient on-boarding, training, and remote collaboration.

Figure 11: Digital work concepts will be crucial in the age of automation; Source: DHL



Figure 11

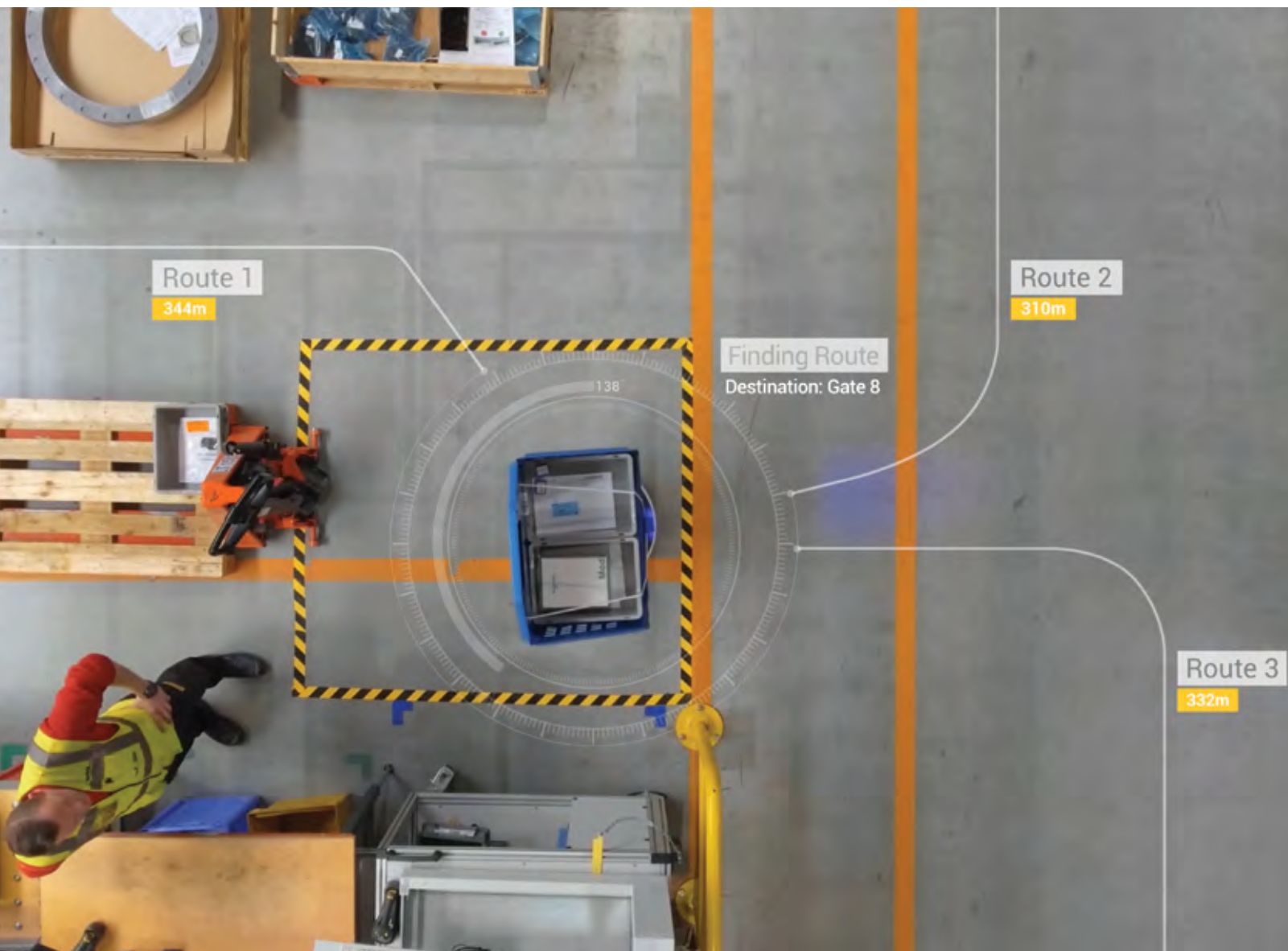


Figure 12: Collaborative robots will strengthen the logistics workforce of the future; Source: Fetch Robotics

Figure 12



● Insights & Inspiration

So how does one gaze into the future of the logistics industry? We leverage what we call our four key sources of inspiration. Surprisingly, for this edition of the Logistics Trend Radar these sources have not changed; they remain megatrends, microtrends and startups, industry experts and research partners, and our customers. Together, these sources continue to provide us with the most comprehensive, strategically important input on social, business, and technology trends that will impact the logistics industry (see figure 13). One thing that has changed since our previous edition is the role and behavior of these sources in relation to one another. As a logistics provider, we continue to see ourselves as an essential contributor participating in and helping to cultivate a harmonious, innovation industry ecosystem.

● How Did We Arrive at the New Logistics Trend Radar?



Figure 13

In the development of this new edition, we reviewed global megatrends that will impact the industry in its entirety such as digitalization, urbanization, aging population, and sustainability. These are important to monitor as they accelerate and in some cases mandate change in logistics (e.g., global agreements on trade or environmental policy). To identify the next generation of logistics

innovations, we exchanged with startups and industry partners that relentlessly develop the new business models and digital solutions that can drive significant transformation when scaled. And to understand the future requirements and challenges for logistics services, we listened, talked, and engaged with our customers as they will ultimately define the route ahead.

Figure 13: Key sources of trend identification;
Source: DHL

From all of these perspectives and insights, we pieced together a vision for the future of logistics. However, as much as we aim for an accurate prediction, we know from experience the impact of some trends will not materialize. Innovation does not follow a linear path; startups can fail or grow up and become acquired. Partners can be customers too. Technologies come and go. Innovation is a somewhat frenetic, unpredictable practice that relies on culture and capabilities as much as it does on breakthrough technologies and business acumen.

Since the last edition of the Logistics Trend Radar, several trends have merged or disappeared. For example, one trend that never truly arrived was de-stressing the supply chain through tactical slow-downs to operate more sustainably and at higher quality levels, as technology made smarter and faster supply chains a reality. Several others have matured and have become the 'new normal' – for example, on-demand delivery – no longer qualifying as true trends. What is key and what we hope you will embrace from reading this study is the importance of exploring trends early on. As the saying goes, the best way to predict the future is to create it.

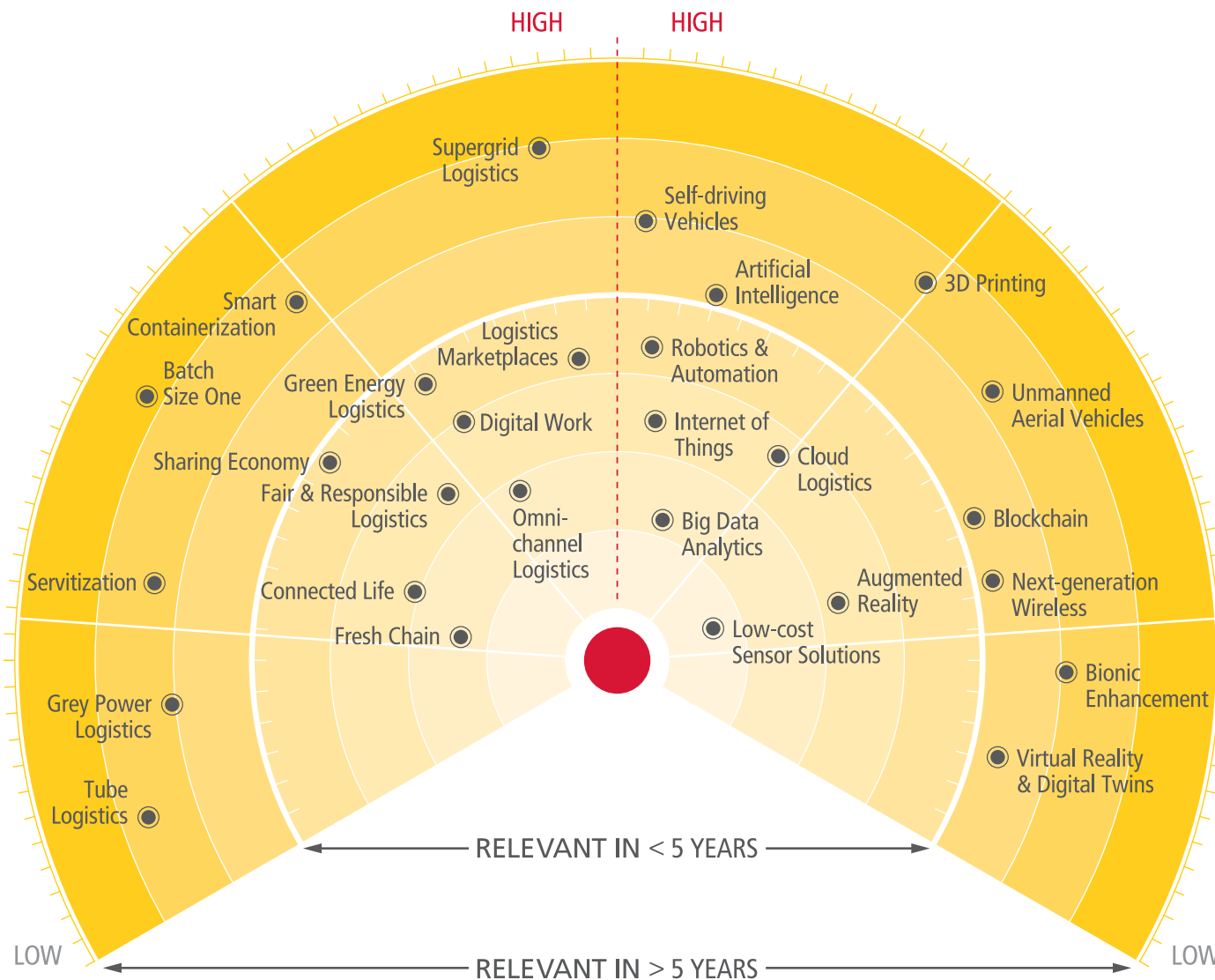
And with that remark, we would now like to introduce you to the new Logistics Trend Radar and hope this serves once again as a valuable source of insight and inspiration!

At a Glance: the Logistics Trend Radar

↑ HIGH: Creates new (potentially disruptive) ways of doing business
↓ LOW: Provides incremental improvement opportunities

Social & Business Trends

Technology Trends



2018/19

Overview: Trends Summary

Batch Size One	Medium	>5 years	Increasing consumer demand for personalization could lead to the mass production of highly customized goods, resulting in decentralized 'batch size one' production. Manufacturers can leverage new technologies and business models to bring the production process as close to the consumer as possible and reduce lead times. Supply chains will need to accommodate changes in time and place of production and integrate new postponement services.
Connected Life	Medium	<5 years	Through the continued adoption of mobile and wearable devices and, more recently, smart home devices, the 'always-on, always-connected' lifestyle of consumers offers numerous opportunities for logistics optimization. Secured, real-time access to the consumer's ecosystem of connected devices can enable a variety of innovative pick-up and delivery services, as well as improved customer service support and valuable insight generation for logistics providers.
Digital Work	High	<5 years	Our aging population, the rise of the millennial workforce, and automation of repetitive and physically intensive labor will in future greatly transform the logistics industry. Robots designed to work collaboratively with humans – both physical devices and software (virtual bots) – are on the increase. To remain competitive, companies must develop fresh ways of recruiting, upskilling, and training the existing and future workforce.
Fair & Responsible Logistics	Medium	<5 years	The intersection between the need to remain competitive while at the same time increasing sustainability has triggered growth in 'fair and responsible logistics'. Logistics providers can meet both demands by providing new

Social & Business Trends

Fresh Chain	Medium	<5 years	Online shopping of everything from groceries to pharmaceuticals is driving growth in the fulfillment and delivery of temperature-controlled goods through standard networks. This in turn creates new challenges to pick, package and deliver single shipments with temperature integrity. To enable this new fresh chain of single shipments, companies will need to develop and implement special processes, innovative cold chain packaging, fast networks, and optimized infrastructure.
Green Energy Logistics	High	<5 years	With continued growth in global trade and ecommerce fueling parcel delivery volumes, there is a growing need for environmentally and neighborhood friendly solutions to last-mile delivery in cities and logistics operations. This development coupled with an increasing shift towards renewable or 'green' energy sources (solar, wind, etc.) is propelling the development of electric mobility and facility solutions for logistics, helping the industry go green.
Grey Power Logistics	Low	>5 years	As global populations continue to age at a rapid rate, grey power logistics – the logistics for an aging society – will be required to meet the challenges of this demographic shift, particularly the provision of new services such as home delivery of medicines. This will involve integrating logistics with medical and preventative care networks to provide new services for the elderly.

Overview: Trends Summary

Logistics Marketplaces	High	<5 years	The growing need for transparent, flexible, and easily adjustable logistics services has fostered the creation of digital brokerage platforms that match a variety of logistics demands with supply. These centralized marketplaces can provide visibility on the information, rates, and services of different logistics providers, and enable solutions to be digitally tailored to meet the needs of each customer.
Omni-channel Logistics	High	<5 years	The next generation of retail (including 'webrooming', showrooming, and no-line commerce concepts) requires logistics networks tailored to the needs of each single channel. This new face of retail will require logistics providers to maintain an integrated view of all customer channels and inventory, along with dynamic delivery and fulfillment options and seamless customer service interactions.
Servitization	Medium	>5 years	Servitization is the process of transforming traditional manufacturing strategies to focus on delivering product-enabled service models. By moving from a product-based to a services-based business model, servitization creates strategic and closer links to the customer while also providing valuable insights into product usage which may not be visible today. To enable servitization concepts, logistics will be critical in ensuring product uptime and efficiency.
Sharing Economy	Medium	<5 years	The societal shift from ownership to asset sharing has been one of the most groundbreaking trends in recent years. Everything from underutilized parking spaces to heavy industrial equipment can now be shared via digital platforms. Logistics providers can help facilitate these networks and can also participate in sharing platforms to fully utilize logistics networks and assets, achieving new levels of efficiency and value creation.

Social & Business Trends

Smart Containerization	Medium	>5 years	Adoption of the standard container revolutionized global cargo shipping, bringing vast improvements in efficiency and ease of trade. However, growing need for volume flexibility and increasing time and cost pressures will necessitate new container formats and processes, especially in the context of shared logistics networks and urban delivery. New packaging formats are also essential to handle the rise in single shipment volumes from ecommerce.
Supergrid Logistics	High	>5 years	Going beyond 4PL logistics, supergrid logistics will raise a new generation of logistics companies with primary focus on the orchestration of global supply chain networks that integrate swarms of different production enterprises and logistics providers. This opens up new business opportunities for different logistics branches – 4PL providers, companies with special expertise in complex or specific services, and even small local couriers and startups.
Tube Logistics	Low	>5 years	Propelled by technological progress in driving systems as well as growing congestion in megacities, there is renewed interest in the use of existing and new tube infrastructures for cargo transportation. Innovations such as the Hyperloop could one day provide rapid cargo transit within and between cities for express shipments or even passenger traffic.

Overview: Trends Summary

3D Printing	High	>5 years	Encouraged by opportunities for greater customization, less waste, and more localized manufacturing and delivery, 3D printing will impact logistics by adding new diversity to manufacturing strategies. Some companies may stop traditional fabrication, but most will combine 3D printing with mass production techniques. Logistics providers can orchestrate complex hybrid manufacturing networks and utilize networks of 3D printers to offer new logistics services.
Artificial Intelligence	High	>5 years	Artificial intelligence (AI) is rapidly transforming the way logistics providers operate as a result of the ongoing trend towards automation and continued improvements in computing. AI will augment human expertise through systems that help generate novel insights from big data and eliminate difficult tasks. In logistics AI will enable back-office automation, predictive operations, intelligent logistics assets, and new customer experience models.
Augmented Reality	Medium	<5 years	Blurring the lines between the digital and physical worlds, augmented reality (AR) will provide new perspectives in logistics planning, process execution, and transportation. By adding virtual layers of contextual information onto a heads-up display or other digital device, AR empowers workers by providing the right information at the right time and in the right place.
Big Data Analytics	High	<5 years	Logistics is being transformed through the power of data-driven insights. Thanks to the vast degree of digitalization, unprecedented amounts of data can be captured from various sources along the supply chain. Capitalizing on the value of big data offers massive potential to optimize capacity utilization, improve customer experience, reduce risk, and create new business models in logistics.

Technology Trends

Bionic Enhancement	Low	>5 years	Bionic enhancement technologies such as advanced wearables and exoskeletons have the potential to expand the boundaries of current physical barriers. Smart clothing, bionic arms, and even futuristic brain-computer interfaces can support the logistics workforce, especially older workers, in areas such as training, communication, process execution, and optimization. Most importantly, they can also minimize health and safety risks in the supply chain.
Blockchain	Medium	>5 years	Evolving beyond its association with bitcoin, blockchain and other distributed ledger technologies can remove significant layers of complexity from global supply chains. It can facilitate greater trust and transparency between supply chain stakeholders, supporting the automation of administrative and commercial processes. Smart contract concepts will also create opportunities for new services and business models in logistics.
Cloud Logistics	High	<5 years	Ideal for complex, volatile environments, cloud computing enables a variety of new 'logistics-as-a-service' (LaaS)-based business models. Logistics providers can activate and deactivate customizable, modular cloud services on demand using a pay-per-use approach. This allows highly scalable service and management capabilities without requiring the traditional development, setup, and maintenance costs of own IT infrastructure.

Overview: Trends Summary

Internet of Things	High	<5 years	The Internet of Things (IoT) has the potential to connect virtually anything to the internet 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 that can use the data from connected objects to generate actionable insights that drive change and new solutions.
Low-cost Sensor Solutions	Medium	<5 years	Sensor technologies that were originally developed for consumer electronics such as wearables, smartphones, and even gaming consoles enable exciting new applications within the logistics industry. These low-cost sensor solutions can digitally enhance cumbersome manual logistics activities. Dimensioning, quality control, and visualization are some examples of applications bringing new levels of intelligence, safety, and efficiency to logistics operations.
Next-generation Wireless	Medium	>5 years	Breakthroughs in existing wireless network technologies and the rise of entirely new networks are accelerating IoT applications in both the consumer and enterprise environments. In logistics, these intelligent networks can enable cost-effective seamless indoor and outdoor connectivity and localization of shipments and assets. The vision of a connected supply chain with complete transparency and traceability becomes more and more tangible.

Technology Trends

Robotics & Automation	High	<5 years	The first wave of automation using collaborative 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. Robots in particular will adopt collaborative roles in the supply chain, assisting workers with warehousing, transportation, and even last-mile delivery activities.
Self-driving Vehicles	High	>5 years	With technological advancements in AI as well as increasingly heavy investments in the development of sensors and vision technologies, self-driving vehicles will soon fundamentally transform the way vehicles are assembled, operated, utilized, and serviced. From trucks to last-mile robots, self-driving vehicles will transform logistics by unlocking new levels of safety, efficiency, and quality.
Unmanned Aerial Vehicles	Medium	>5 years	Unmanned aerial vehicles (UAVs) or 'drones' can be used to deliver goods in the first and last mile as well for intralogistics and surveillance operations. UAVs will not replace traditional ground-based transportation. However, they will provide value in operating safely in remote, potentially dangerous-to-access locations.
Virtual Reality & Digital Twins	Low	>5 years	Virtual reality (VR) technology, commercially popularized through video games, has since evolved for use in manufacturing, distribution, and supply chains. By enabling users to design, simulate, and evaluate environments in 3D, logistics providers can make better-informed decisions for optimizing material flows and monitoring processes. Digital twins of logistics operations can further unlock supply chain optimization.



○ In Depth

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.

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Automotive & Mobility



Engineering & Manufacturing



Technology



Energy



Life Sciences & Healthcare



Retail & Consumer

○ Social & Business Trends

Batch Size One

Increasing consumer demand for personalization could lead to the mass production of highly customized goods, resulting in decentralized 'batch size one' production. Manufacturers can leverage new technologies and business models to bring the production process as close to the consumer as possible and reduce lead times. Supply chains will need to accommodate changes in time and place of production and integrate new postponement services.



KEY DEVELOPMENTS & IMPLICATIONS

In contrast to the common practice of off-shoring manufacturing to countries such as China, the 'batch size one' trend anticipates that companies will establish micro-production sites closer to demand such as near or within megacities. Answering the need for product hyper-customization and ever-faster delivery times, these highly automated micro-production sites will utilize cutting-edge robotics, automation and 3D printing technologies to rapidly produce personalized goods (e.g., Adidas Speed Factory). Manufacturers will be able to react immediately to location-dependent trends, and deliver goods with shorter timeframes with first-movers already testing this. Logistics providers must design flexible and digitalized processes, revise warehouse operations, and utilize new agile delivery concepts to maximize operational effectiveness.

New warehouse hyper-customization services will answer the future need for speed. Warehouses will connect production with logistics, offering extended postponement services on behalf of customers. With 3D printing

and other mobile automation technologies, logistics providers can take over final assembly and/or product customization. They can also use their global networks to customize stock and deliver closer to the point of demand.

Inventory management and replenishment for micro-production sites will need to be carefully forecasted and managed in order to keep just the right amount of stock in close proximity to each site. This may increase the need for flexible, multi-user warehouse environments in order to improve geographical coverage of stock and remain responsive to sudden fluctuations in demand.

Agile 'batch size one' delivery concepts are needed to manage the increasing number of single orders and shorter delivery routes as production becomes more decentralized and moves closer to the customer. This may result in more frequent deliveries from more loading points. The use of on-demand logistics services and last-mile robotics solutions designed for the transport of small payloads could facilitate 'batch size one' shipments.

KEY OPPORTUNITIES

- Offers extended warehouse fulfillment service opportunities (e.g., onsite 3D printing)
- Achieves individualized product and service offerings for the end customer
- Builds customer loyalty through closer, more direct end-customer relationships

KEY CHALLENGES

- Financial feasibility of 'batch size one' production is yet to be validated
- Difficult to plan and implement logistics processes in fast-changing environments
- Complexity in managing supply chain responsiveness and flexibility in last-mile delivery

Redesigning the Textile and Apparel Supply Chain – SEWBOT by SoftWear Automation

- SEWBOT is a breakthrough robotics innovation that can automate the highly complex and manual activity of apparel production
- The solution is capable of producing a t-shirt within 26 seconds; its planned use is localized manufacturing for some of the world's largest fashion retailers
- Further developments in this technology may enable a leap from localized mass production to 'batch size one' production of apparel

Source: SoftWear Automation



Trend Assessment

Timeframe: > 5 years

Impact: Medium

Sector Relevance: Below



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Connected Life

Through the continued adoption of mobile and wearable devices and, more recently, smart home devices, the 'always-on, always-connected' lifestyle of consumers offers numerous opportunities for logistics optimization. Secured, real-time access to the consumer's ecosystem of connected devices can enable a variety of innovative pick-up and delivery services, as well as improved customer service support and valuable insight generation for logistics providers.



KEY DEVELOPMENTS & IMPLICATIONS

Growing adoption of mobile and smart home devices reflects ever-connected consumer lifestyles both at home and at work. For logistics providers, integrating with these connected lifestyles can enable a whole host of optimized and new logistics services including improved pick-up and delivery and automated replenishment services. This can decrease operational costs and increase customer satisfaction through 'first-time' delivery and enable better planning and optimization through customer insights. Looking ahead, effective data privacy and security will be critical to successful adoption as well as the integration and management of various smart devices within logistics processes.

Smart home delivery and pickup utilizes smart, interconnected home and personal devices to remove the traditional inconveniences of missed deliveries and costly re-delivery attempts. This has enabled the relatively recent realization of new IoT-based delivery concepts, such as secured in-home pick-up and delivery services using smart locks as well as parcel delivery into the trunk of smart cars while the car owner or user is at home or at work.

Automatic replenishment services are emerging to meet the growing demand for convenience logistics. By 2020, it is estimated that over 50% of everyday essential household consumable products will be automatically replenished from the connected home.¹ Connected devices such as a smart fridge can trigger an automated grocery order on detection of low stock. Smart appliances can monitor usage and predict when a reorder should be placed (e.g., Kwik). This concept can also be applied to businesses that require rapid stock replenishment.

Digital logistics service agents embedded as conversational interfaces in smart home devices (e.g., Amazon Alexa) can assist customers with real-time updates on the status of package deliveries, enable rescheduling, and notify of any delays. Interacting through voice allows users to seamlessly access logistics data. This can result in reduced customer support costs, increased user attention, and wider adoption of IoT (particularly among the elderly or disabled).

KEY OPPORTUNITIES

- Increased transparency, traceability, and reliability of logistics operations
- Cost savings for retailers, customers, and couriers through successful deliveries
- Reduced environmental footprint with fewer re-delivery attempts
- Improved service quality for the customer

KEY CHALLENGES

- Privacy and data security concerns about the devices and who is harnessing the data
- Slow adoption due to integration complexities of multiple IoT platforms, numerous protocols, and large numbers of APIs
- Establishing trust and highly secure processes to enable in-home delivery

Enabling New Convenience in Unattended Delivery – Amazon Key

- New delivery service called 'Amazon Key' uses approved smart lock providers and Amazon's Cloud Cam to enable in-home delivery of parcels
- Courier scans the parcel and requests access via the cloud. The cloud grants permission to the courier who can unlock the door. The Cloud Cam records the delivery
- Customer receives a notification and short video clip of the successful delivery

Source: Amazon



Trend Assessment

Timeframe: < 5 years

Impact: Medium

Sector Relevance: Below



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1. <https://blogs.gartner.com/robert-hetu/gartner-predicts-2020-50-everyday-essential-products-will-autoreplenished/>

Digital Work

Our aging population, the rise of the millennial workforce, and automation of repetitive and physically intensive labor will in future greatly transform the logistics industry. Robots designed to work collaboratively with humans – both physical devices and software (virtual bots) – are on the increase. To remain competitive, companies must develop fresh ways of recruiting, upskilling, and training the existing and future workforce.



KEY DEVELOPMENTS & IMPLICATIONS

An estimated 49% of activities that people are paid to do today can potentially be automated by adapting current, demonstrated technology.² While digitalization will certainly automate many logistics processes, it will also relieve increasing labor shortages, particularly in mature markets, and help boost the performance and retention of existing workers. This shift will increase the number of technically skilled jobs in logistics (e.g., programmers and managers of robotics fleets). Innovative new models of work will be needed for recruitment and retention of the increasing segments of millennial and Gen Z talent in logistics.

Human-machine collaboration will greatly influence the future of digital work. In operations robots designed to assist workers with manual handling activities will prove critical to supporting an aging workforce. Software robotics will be essential, particularly in the back office to handle significant amounts of manual and repetitive data entry (spreadsheet data entry, customs document processing, etc.). Here, technologies such as robotic process automation (RPA) in combination

with AI can automate many tasks. This enables both time and cost savings, and allows workers to do more meaningful and skilled activities such as process innovation.

Flexible, on-demand workforce models in logistics will become commonplace as sharing economy principles gain adoption in the enterprise. These models appeal particularly to the younger generations with 39% of millennials in the US willing to work in a sharing economy model.³ Key concepts include crowd-sourced delivery (e.g., Postmates) and on-demand staffing to cover operational peaks with unprecedented speed (e.g., Jobdoh).

Training and upskilling will be constantly required to prepare existing logistics workers for changing tasks. Employees will need training on areas of technology, ensuring they understand and are capable of using physical and software robotics in logistics. Such investments will help retain the existing workforce while also extending retention of older employees. Training concepts and development plans need to be adapted to suit individual needs and capabilities.

KEY OPPORTUNITIES

- Increase in employee satisfaction through the assignment of more challenging tasks
- Technology-aided workforce can improve productivity by automating time-consuming, repetitive tasks
- Greater network and organizational flexibility using on-demand workforce concepts
- Efficiency boost in operational procedures which also leads to more precision in repetitive tasks

KEY CHALLENGES

- Achieve harmonious balance between human workers and physical/virtual robotics
- Ensure sufficient wages and job security when deploying or utilizing on-demand logistics concepts
- Enable relevant training and upskilling for existing logistics workers particularly for technical tasks

Outsourcing Data Science through Online Competitions – Kaggle

- Companies that struggle or are unwilling to hire in-house data science talent can utilize Kaggle, a platform that hosts data science competitions
- These competitions help companies to solve data-based business problems and to recruit data science talent
- The platform provides access to more than a million data scientists

Source: Kaggle



Trend Assessment

Timeframe: < 5 years

Impact: High

Sector Relevance: Below



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2. <https://www.mckinsey.com/~/media/McKinsey/Global%20Themes/Digital%20Disruption/Harnessing%20Automation%20for%20a%20future%20that%20works/MGI-A-future-that-works-Executive-summary.ashx>

3. <https://www.bloomberg.com/news/articles/2015-06-15/these-charts-show-how-the-sharing-economy-is-different>

Fair & Responsible Logistics

The intersection between the need to remain competitive while at the same time increasing sustainability has triggered growth in 'fair and responsible logistics'. Logistics providers can meet both demands by providing new services that generate revenue while also improving the welfare of society and protecting the environment. Key application areas focus on circular logistics concepts and facilitating fair access, production, and trade.



KEY DEVELOPMENTS & IMPLICATIONS

Consumers are increasingly basing their buying decisions on whether a product was sourced, manufactured, and transported in a fair and responsible manner. Recent legislation, such as the European Union's ban on the use of plastic packaging by 2030⁴, and commitments by major cities to become carbon neutral⁵ are further challenging companies to move from traditional corporate social responsibility (CSR) practices to place sustainability at the core of their business. Looking ahead, innovation in circular logistics infrastructure and the adoption of digital identifiers as well as IoT, blockchain, and other traceability technologies will further accelerate fair and responsible behavior along supply chains.

Circular logistics focuses on the development of new logistics services and infrastructure solutions that enable a circular economy. First ideas integrate recycling into the logistics infrastructure. For example, delivery trucks can pick up recycling goods on their return routes and drop these off at warehouses; they require dedicated areas for inspection, repair and recycling. Sustainable

packaging concepts are also key to enabling efficient, safe transport and storage of used goods (e.g., damaged lithium batteries).

Fair access to logistics services may foster the 'go local' movement and potentially improve living conditions and economies in developing as well as developed regions. Logistics providers can support local businesses by bringing their fair and regionally produced goods to the global marketplace. This could include specialized transportation solutions such as first-mile collection in hard-to-access areas and new types of flexible micro-fulfillment services for local businesses.

Responsible end-to-end logistics chains incorporate fair production and trade practices at each stage of the supply chain. Logistics providers can drive transparency and traceability by providing services such as identifying responsibility risks, and can certify processes to confirm they are conducted in a responsible manner (e.g., labor conditions, environmental impact).

KEY OPPORTUNITIES

- New services create sustainable revenue streams for future growth as well as social and environmental value
- Reducing resource consumption and waste (e.g., from packaging) leads to lower operational costs
- Potential to increase customer and shareholder loyalty and brand perception

KEY CHALLENGES

- No universal definition for the terms fair and responsible
- Social benefits vary widely from region to region, and are difficult to measure
- Shift in business mindset required to perceive it as a profitable venture rather than as a cost driver or CSR initiative

Ensuring Responsible Supplier Behavior in Global Supply Chains – DHL Supply Watch

- DHL Supply Watch focuses on mitigating supplier risks in the supply chain, and ultimately encourages fair and responsible behavior from suppliers
- This system utilizes artificial intelligence (AI) to analyze vast and diverse data sources for telltale indicators of potential supplier problems
- Risks ranging from environmental to labor, social, and even crime are identified and used in strategic business continuity planning processes

Source: DHL Resilience360



Trend Assessment

Timeframe: < 5 years

Impact: Medium

Sector Relevance: Below



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4. <https://www.theguardian.com/environment/2018/jan/16/eu-declares-war-on-plastic-waste-2030>

5. <http://www.cbc.ca/news/technology/c40-cities-climate-change-buses-1.4183579>

Fresh Chain

Online shopping of everything from groceries to pharmaceuticals is driving growth in the fulfillment and delivery of temperature-controlled goods through standard networks. This in turn creates new challenges to pick, package, and deliver single shipments with temperature integrity. To enable this new fresh chain of single shipments, companies will need to develop and implement special processes, innovative cold chain packaging, fast networks, and optimized infrastructure.



KEY DEVELOPMENTS & IMPLICATIONS

Already today in the US, it is estimated that almost half of shoppers buy groceries online, with the highest adoption by millennials at 61%.⁶ This trend will continue to grow with online shopping of fast-moving consumer goods projected to become a 170 billion-dollar business by 2025.⁷ The demand for convenience is adding logistics complexity in the fulfillment of small, time- and temperature-sensitive deliveries of groceries, pharmaceuticals, and medical products. Logistics providers will need to continuously advance the supply chain with innovations in packaging, tracing, and authenticating cold-chain shipments.

On-demand delivery of fresh goods is reinventing the B2C relationship with retailers focusing on easy payment methods and delivery (e.g., Amazon, JD.com). As logistics networks are increasingly shared, single shipments requiring special conditions (such as cold chain) will be bundled to reduce time and cost pressures. New models will also include more last-mile delivery solutions (e.g., Fresh Turf delivery to storage lockers), automated subscription (to receive fresh

goods or medicines) with scheduled deliveries, and in-home delivery with access enabled by smart locks.

End-to-end cold-chain networks are becoming more reliable, enabling larger delivery volumes of sensitive goods. A prerequisite for customers will be assurance of product integrity, especially at critical points such as consignment switches from one transport mode to another. Temperature-controlled fleets must demonstrate regulatory compliance, and this will be enabled by improved data transparency, real-time monitoring, and end-to-end live support (e.g., DHL LifeTrack). Visibility and product authentication can be further enhanced using IoT and blockchain technologies.

Temperature-controlled packaging innovations allow goods to be transported via standard parcel networks and last-mile delivery services, reducing the need for climate-controlled trucks and containers. New concepts include reusable thermos boxes, smart packaging solutions controlling oxygen, humidity and/or pressure, and labeling innovation indicating “freshness” of each single shipment.

KEY OPPORTUNITIES

- New business opportunities for temperature-controlled last-mile delivery
- Increases collaboration across the entire supply chain to achieve end-to-end cold chain networks
- Higher product security through packaging innovation and real-time monitoring

KEY CHALLENGES

- Thermal packaging, in-transit monitoring devices, and intervention services drive up costs
- Adds complexity to the supply chain (e.g., at critical points, direct-to-consumer model) and to warehouse management
- Requires dependable network of cold chain partners to ensure high quality standards and efficient cooperation

Delivering Farm-to-Fork Delivery – Die Bauerntüte

- This German company connects farms with customers, creating a new distribution channel for farmers
- Uses DHL’s expertise to deliver fresh food within a day in temperature-controlled reusable boxes
- Meets growing local demand for direct access to regional and organic foods produced in a fair and responsible manner

Source: Die Bauerntüte



Trend Assessment

Timeframe: < 5 years

Impact: Medium

Sector Relevance: Below



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6. <https://www.forbes.com/sites/deborahweinswig/2018/03/01/online-grocery-set-to-boom-in-2018-as-amazon-acknowledges-online-grocery-a-tough-market-to-crack/#5dd7446e520b>

7. <https://www.kantarworldpanel.com/cn-en/news/Globa--e-commerce-grocery-market-grows-30>

Green Energy Logistics

With continued growth in global trade and ecommerce fueling parcel delivery volumes, there is a growing need for environmentally and neighborhood friendly solutions to last-mile delivery in cities and logistics operations. This development coupled with an increasing shift towards renewable or 'green' energy sources (solar, wind, etc.) is propelling the development of electric mobility and facility solutions for logistics, helping the industry go green.



KEY DEVELOPMENTS & IMPLICATIONS

The growing shift towards sustainability is driven largely by consumer demand and by regulations requiring companies to reduce carbon emissions and production waste. Governments are also setting ambitious targets. For example, Germany has launched a campaign to put 1 million e-vehicles on the road by 2020.⁸ Translating this awareness into logistics, renewable technologies will be leveraged for further 'electrification' and energy autonomy in the supply chain. Widespread adoption will also soon pave the way for new smart energy logistics services.

Green highways are becoming reality as large trucks use eco-friendly fuels to reduce emission and noise levels. With increased battery reach and faster battery charging, e-trucks are an attractive option. Established automotive manufacturers (e.g., Volvo, Navistar) as well as new market players (e.g., Tesla, Thor) are developing hybrid and full-electric trucks over the next 5 to 10 years. In future, e-roads equipped with overhead lines that transmit electrical energy to trucks are an option for electrification in the realm of road freight.

Electrified last-mile vehicles are a promising solution to reduce local emissions in cities – with no limits on creativity for the electrified fleet: from handcarts and trikes to medium-size and large delivery vans (e.g., DHL StreetScooter). The eco-factor is highest when fleets generate their own power, or their overnight recharging comes solely from renewable resources. Due to city center toll charges and vehicle bans, eco-friendly means of transportation are becoming increasingly popular. In some European countries, cargo bikes already handle up to 60% of inner-city delivery routes (e.g., DHL Cubicycle).

Eco-sustainable facilities result from improving the ecological footprint through new measures and adjustments, such as switching to hydroelectric sources or state-of-the-art solar panels with high-frequency battery chargers. Green warehouses also use intelligent electrical systems with smart motion sensors to illuminate only areas in use, as well as charging forklifts in off-peak hours.

KEY OPPORTUNITIES

- Increase sustainability from emissions reduction and greener fleets
- Savings in fuel and power, and other economic factors (e.g., maintenance, wear-and-tear costs)
- Quiet, electrified fleet can enable night-time delivery

KEY CHALLENGES

- Fragmented e-infrastructure, and limited e-vehicle manufacturers
- High capital investment costs and additional supply chain complexity with micro-depots
- International e-highway standards need to be defined (e.g., voltage level, height/spacing of wire lines)
- Government and regulatory support required to invest in freight e-vehicles and charging stations

Electrification of Road Freight Transport on e-Highways – Siemens

- The world's first e-highway with electricity provided from overhead wire lines is now operational on a public road
- A roof-mounted pantograph (an electric current collector) means that each hybrid truck is independent from fossil fuel
- If used 30% of the time, e-roads can save 6 million tons of CO₂ each year, and cut energy consumption in half, compared with traditional roads

Source: Siemens



Trend Assessment

Timeframe: < 5 years

Impact: High

Sector Relevance: Below



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Grey Power Logistics

As global populations continue to age at a rapid rate, grey power logistics – the logistics for an aging society – will be required to meet the challenges of this demographic shift, particularly the provision of new services such as home delivery of medicines. This will involve integrating logistics with medical and preventative care networks to provide new services for the elderly.



KEY DEVELOPMENTS & IMPLICATIONS

The aging population is a major social challenge in decades to come, with the global population above 60 years old jumping from approximately 13% to nearly 25% by 2050.⁹ This growing demographic segment will necessitate new channels for special homecare services within cities as well as in remote areas, and will intensify labor shortages, particularly in the logistics industry. Looking ahead, specialized services that cater to the needs of an aging society will be required, such as temperature-controlled delivery of medicines to homes.

Direct-to-patient healthcare services can support the everyday life of 'silver surfers' who regularly use the internet to access online services. With the online pharmaceuticals market set to grow to \$128 billion by 2023¹⁰, authenticated online healthcare marketplaces will enable more direct-to-patient deliveries, digitalizing today's process of collecting prescriptions and medicines at pharmacies. This growth will require more cold chain networks to ensure integrity.

New value-added last-mile services, which go beyond traditional delivery services, can be offered to support the aging population. This could include services such as scheduled visits or check-ups (e.g., 7-Eleven deliveries in Japan), conducting basic cleaning and transportation services, tech support, and even simple health checks (piloted by DHL). In the future, auto-replenishment of goods will be simpler with smart devices (such as fridges and pill boxes) enabling subscription-based delivery models.

Grey power workers – people who continue to work beyond their 60s – will require new flexible HR conditions to cope with the upcoming labor shortage (e.g., opportunities for part-time employment and flexible hours). This is especially relevant for logistics where the average age of a truck driver in the US is already 49 years old.¹¹ As attracting labor becomes a challenge, the older generation will comprise a majority of the talent pool. For manual handling activities, it will be essential that operations workers are supported with technologies such as exoskeletons and collaborative robotics.

KEY OPPORTUNITIES

- New business opportunities from offering value-added logistics services
- 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 aid labor shortages

KEY CHALLENGES

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

From On-demand Transportation to Healthcare Services – Uber

- Uber is piloting on-demand delivery of vaccines and care packages, and even offering transportation services for patients and caregivers
- Partnering with healthcare organizations, a dashboard allows healthcare professionals to schedule transportation for patients
- Patients receive ride details via text message, eliminating the need for smartphones and providing ease of access for the elderly

Source: Uber



Trend Assessment

Timeframe: > 5 years

Impact: Low

Sector Relevance: Below



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9. https://esa.un.org/unpd/wpp/Publications/Files/WPP2017_KeyFindings.pdf

10. <http://www.prnewswire.com/news-releases/epharmacy-market-to-reach-us128-billion-by-2023-transparency-market-research-560938961.html>

11. <http://www.trucking.org/ATA%20Docs/News%20and%20Information/Reports%20Trends%20and%20Statistics/10%206%2015%20ATAs%20Driver%20Shortage%20Report%202015.pdf>

Logistics Marketplaces

The growing need for transparent, flexible, and easily adjustable logistics services has fostered the creation of digital brokerage platforms that match a variety of logistics demands with supply. These centralized marketplaces can provide visibility on the information, rates, and services of different logistics providers, and enable solutions to be digitally tailored to meet the needs of each customer.



KEY DEVELOPMENTS & IMPLICATIONS

While freight exchange platforms have existed for over a decade in logistics, there is a surge in the number of cloud-driven marketplaces matching demand and supply in a digitally seamless manner. These will evolve to potentially digitalize the entire end-to-end logistics process of tendering, contracting, delivering, and payment. Logistics providers can actively drive or participate in these platforms, ensuring their services remain price competitive and highly flexible.

Freight marketplaces match companies looking to ship freight using one or multiple modes of transport (road, air, ocean, and/or rail) with suppliers or brokers of logistics capacity. Customers profit from better comparability and transparency of proposals, optimized price/performance ratios, and high security through member certification and rating systems. Logistics providers can use these platforms to digitalize internal processes as well as maximize cargo capacity. The integration of logistics marketplaces with central planning, reporting, dispatching, and tracking tools will further enhance impact.

Warehousing marketplaces offer flexible, on-demand warehouse space and enable seamless quote comparisons. This contrasts current processes which tend to be time consuming and typified by long-term contracts with limited flexibility. Similar to the Airbnb concept, warehousing marketplaces offer agile access to space, countering peaks in warehousing requirements and allowing customers to flexibly distribute goods across locations.

Last-mile delivery marketplaces offering same-day/same-hour pick-up and other delivery services are growing due to consumer demand for convenience. Consumers can compare quotes, book upfront, and receive auction-style bids from on-demand delivery agents. In many of these peer-to-peer delivery marketplaces, a flexible workforce of private individuals acts as the delivery agent. Such platforms require a critical mass of individuals to participate as agents as well as sufficient platform volume to ensure a sustainable business model (see shutdown of UberRush).

KEY OPPORTUNITIES

- Real-time quoting and flexible execution of transactions
- Easier online access to a broader customer and supplier base
- Flexible sourcing of externally operated services instead of long-term partnerships and dependencies
- Optimized capacity utilization, acquisition of additional capacity, and reduction of empty rides
- Increased price transparency through multiple comparisons in the digital marketplace

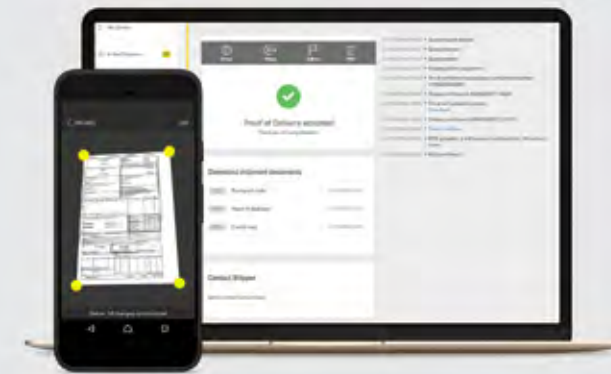
KEY CHALLENGES

- Security, insurance, liability, and fraud concerns
- Difficulties in guaranteeing the quality and availability of carrier capacity
- Forwarding business is potentially too complex to automate via an online marketplace

Freight Marketplace Enabling Easy Access to End-to-end Transportation – Saloodo!

- DHL developed and launched a digital logistics platform in 2017 that offers easy and safe end-to-end road freight transportation services, focusing on small to medium-sized enterprises
- Shipping companies are validated prior to contractual agreements to maximize security
- Platform currently involves 4,900+ shippers, 200,000+ trucks and operates in 17 countries

Source: DHL



Trend Assessment

Timeframe: < 5 years

Impact: High

Sector Relevance: Below



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Omni-channel Logistics

The next generation of retail (including 'webrooming', showrooming, and no-line commerce concepts) requires logistics networks tailored to the needs of each single channel. This new face of retail will require logistics providers to maintain an integrated view of all customer channels and inventory, along with dynamic delivery and fulfillment options and seamless customer service interactions.



KEY DEVELOPMENTS & IMPLICATIONS

The convergence of offline and online commerce has resulted in an 'anytime, anywhere, from any device' mentality for customers expecting a seamless omni-channel experience. With global B2B ecommerce sales overtaking B2C sales in 2017¹², logistics providers need to meet demands for more flexibility and visibility. This will require increasingly faster and varied fulfillment services – especially in terms of last-mile delivery options and seamless returns processes.

Omni-channel warehousing and fulfillment centers will require more flexibility in size, services, and location to react to demand in the shortest amount of time possible. This could involve logistics providers offering more postponement services, treating stores as final-mile fulfillment centers (e.g., Jack & Jones), renting out shared warehouse spaces to cover peaks (e.g., Hollaspace), or even turning warehouses into showrooms (e.g., IKEA).

'Anytime, anywhere' delivery models will be required to meet the promises made by companies to final consumers (e.g., same-day

and even same-hour delivery). To satisfy customer expectations, companies will have to go beyond today's last-mile delivery options and also provide new services that facilitate easy returns as well. Growing B2B ecommerce will also require specialized last-mile delivery services especially for high-value, time-critical deliveries. Already today innovative concepts are being explored, such as try-and-buy models (e.g., Taykit), delivery to car trunks, and smart locks enabling drop-off to houses even if no-one is at home.

Cross-channel omni-channel platforms shared between manufacturers, retailers, and logistics providers will be essential to gain complete visibility of customer interactions and – more importantly for logistics – a global overview of inventory. With the mix between offline and online channels, it will be essential for data and inventory between warehouses and other platforms to easily shift to meet peaks in demand. Here, advanced analytics and artificial intelligence will play a crucial role in such platforms, allowing logistics providers to stay agile and shift supply chain requirements as per anticipated demand.

KEY OPPORTUNITIES

- Competitive advantage through a seamless omni-channel supply chain
- New business opportunities for innovation in omni-channel warehousing, fulfillment, and transportation services
- Cross-channel inventory visibility reduces costs through inventory optimization, and can enable agile logistics networks

KEY CHALLENGES

- High diversity of concepts targeted at integrating online and offline commerce
- Significant investment to upgrade IT infrastructure across warehouses for real-time connectivity and visibility
- Enabling ease of returns can add time and cost pressures to supply chains

Making Online Returns Easy – ZigZag Global

- Platform helps retailers manage and resell returned stock in local markets in a fast, cost-efficient manner
- ZigZag grades retailers' returned products and offers stock consolidation, refurbishment, local redistribution, recycling, and reselling internationally with a revenue-share model
- Returned items are intelligently allocated to one of 200 ZigZag warehouses globally
- Estimated to reduce returns cost by 50% and cut waste and CO₂ emissions by 65%

Source: ZigZag



Trend Assessment

Timeframe: < 5 years

Impact: High

Sector Relevance: Below



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Servitization

Servitization is the process of transforming traditional manufacturing strategies to focus on delivering product-enabled service models. By moving from a product-based to a services-based business model, servitization creates strategic and closer links to the customer while also providing valuable insights into product usage which may not be visible today. To enable servitization concepts, logistics will be critical in ensuring product uptime and efficiency.



KEY DEVELOPMENTS & IMPLICATIONS

Competition from low-cost economies, skills shortages, high-tech automation technologies, and changing consumer expectations are challenging the competitiveness and sustainability of traditional manufacturing businesses.¹³ First movers are already shifting from being a provider of transactional products to being a provider of long-term services, deploying innovative business models (e.g., pay per hours of uptime) and new value-added services (e.g., analytics-as-a-service).

These servitization models require a high degree of integration into the customer's operations and permeate all aspects of business including processes, quality control, and aftersales service and repair. To leverage the full potential of servitization, supply chains must be adapted and redesigned. Logistics providers play a critical role in ensuring availability and distribution of inventory to ensure maximum uptime in an advanced services business model.

Co-located and distributed service logistics facilities will be critical to attaining closer

proximity to the manufacturer's customer. It enables faster responsiveness to conduct maintenance activities and deliver vital parts for repairs. Workshops, service centers, and service technicians must be located near or within customer operations. Reviewing workforce requirements and roles is key to ensuring connection to the customer's needs. Spare parts networks need to be redesigned including reviewing inventory positioning and potential inventory pooling opportunities. On-demand 3D printing of spare parts could become a viable option for spare parts management as the technology matures.

Supply chain resiliency and reliability are paramount in order to support critical customer operations. In a servitization model, disruptions can have a more damaging impact than in a product-based model as losses stem from failure to deliver on the terms of a services-based contract. This will require the intelligent use of data to accurately forecast and plan aftermarket/spare parts demand, mitigate supply chain risks, and eventually conduct predictive maintenance of products.

KEY OPPORTUNITIES

- More sophisticated, longer, higher-value contracts with customers based on outcomes
- Less upfront investment needs for customers in a servitization model
- Strengthens the manufacturer's customer relationships through integration and co-location with each company's operations
- Insights for manufacturers on post-purchase product usage can be leveraged for further product and service innovations
- Competitive advantage for manufacturers as services are harder to replicate than products

KEY CHALLENGES

- Vertical operational manufacturer-customer integration is costly and complex
- Breakdown in service can result in potentially significant losses
- Ensuring optimal balance of inventory and supply chain coverage
- Significant change management required

Pay for Power-by-the-Hour – Rolls Royce

- Rolls Royce's "Power-by-the-Hour" service changed the linear, transactional purchase of an engine to a ten-year contractual relationship with customers
- This is done by guaranteeing the operational time of the engine and insuring against downtime from equipment failure
- Rolls Royce connects with its customers to do remote monitoring and maintenance and offers further value-added services, including engine health monitoring using on-board sensors

Source: Rolls Royce



Trend Assessment

Timeframe: > 5 years

Impact: Medium

Sector Relevance: Below



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13. One survey estimated that 77% of surveyed UK CEOs are worried about the relevance of their products or services three years from now. <http://www.delivered.dhl.com/en/articles/2017/06/the-challenge-of-responding-to-disruptive-technology.html>

Sharing Economy

The societal shift from ownership to asset sharing has been one of the most groundbreaking trends in recent years. Everything from underutilized parking spaces to heavy industrial equipment can now be shared via digital platforms. Logistics providers can help facilitate these networks and can also participate in sharing platforms to fully utilize logistics networks and assets, achieving new levels of efficiency and value creation.



KEY DEVELOPMENTS & IMPLICATIONS

Since 2008, digital marketplaces that own merely the mobile user interface between demand and supply (e.g., Airbnb, Uber) are changing the way people consume products and services. Given the abundance of idle assets, infrastructure, and knowledge, the 'new normal' for logistics will be sharing instead of owning. Inroads into logistics are already being made: 41% of US consumers have used sharing economy offerings of same-day, expedited, or on-demand delivery services.¹⁴ Looking ahead, solving issues of risk liability, insurance, transparency, and workforce protection will be critical to ensuring the long-term success of key sharing economy logistics models.

Urban sharing economy networks can be facilitated by logistics providers to grow overall demand for their services. For example, peer-to-peer goods sharing platforms can enroll logistics service providers for pick-up, handling, delivery, and returns. Logistics providers can also leverage on-demand delivery networks in cities (e.g., Postmates, Lyft) to augment first- and last-mile coverage and services in more cost-efficient ways.

Transport capacity sharing via digital platforms enables real-time data flow and communication between shippers and carriers, and thus provides seamless matching of loads with available capacity. Particularly in the road freight industry, this can reduce idle time from traffic delays, loading operations, communication lag, and process inefficiencies around quoting, pricing agreement, shipment tracking, and payment collection. Further benefits may be achieved through 'co-opetition' between competitors that have similar supply chain requirements.

B2B and B2C sharing of resources, logistics assets, and infrastructure can increase capacity utilization while reducing costs and the logistics carbon footprint. Logistics providers can participate and share their own underutilized assets such as delivery vehicles and forklifts as well as warehousing space with an on-demand approach. Logistics providers can also leverage an on-demand workforce (e.g., Wonolo) to hire temporary labor covering seasonal peaks in demand.

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 sharing of assets
- Improve resourcing planning through 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
- Trust issue between users can limit adoption

Enabling Innovative Discreet Modes of Warehousing in Cities – Parcelly

- Parcelly platform enables city dwellers including businesses to turn redundant storage space into parcel storage and pick-up points
- Consumers can choose their preferred pick-up location from over 1,500 Parcelly points across the UK, enabling greater flexibility and convenience
- Logistics companies benefit from augmenting their existing networks with additional service points to improve service to customers and coverage

Source: Parcelly



Trend Assessment

Timeframe: < 5 years

Impact: Medium

Sector Relevance: Below



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Smart Containerization

Adoption of the standard container revolutionized global cargo shipping, bringing vast improvements in efficiency and ease of trade. However growing need for volume flexibility and increasing time and cost pressures will necessitate new container formats and processes, especially in the context of shared logistics networks and urban delivery. New packaging formats are also essential to handle the rise in single shipment volumes from ecommerce.



KEY DEVELOPMENTS & IMPLICATIONS

With increasing global trade and complexities in supply chains, new smart container formats (modular, flexible, connected) will help improve process efficiency and enable shipment monitoring and visibility. As city delivery volumes grow, smaller container formats and even new packaging can help standardize urban logistics across a multitude of networks. Such new forms will require significant adoption to enable standardization and maximize benefits in the logistics industry.

Connected containers equipped with sensors will enable real-time visibility and monitoring of goods, especially for those requiring special conditions (e.g., temperature control, high security). Concepts such as the Physical Internet (PI) are encouraging companies to test IoT-enabled standardized modular containers with real-time tracking capabilities. This envisions a model of smart containers moving across shared networks of lanes and distribution centers¹⁵, ensuring product quality, reducing losses, and achieving more agile and transparent logistics networks.

New modular container formats can increase the efficiency and effectiveness of urban logistics, enabling the use of multiple networks (e.g., utilizing city infrastructure and networks to transport and store goods). The benefits include direct goods loading, bundling to reduce transportation runs, and increased flexibility. For example, a truck loaded with several containers can transport goods to the outer rim of a city, with final-mile containers being dispersed via more city-friendly modes (e.g., DHL Cubicycle). In future, containers could be autonomously loaded onto autonomous bots or self-driving vehicles.

Smart packaging concepts will be necessary to complement these new container formats which can be used for inbound deliveries and stored to collect shipments for outbound. Various companies (e.g., Bosch and Dole) are testing the combination of smart containers with sensor-based packaging to track shipment conditions, even allowing remote intervention to adjust conditions if necessary.¹⁶ Sustainability and reuse of packaging will also be areas for optimization.

KEY OPPORTUNITIES

- Improve handling capability and cost reduction through more efficient container formats
- Optimize load capacity for standard networks with enhanced capabilities (e.g., temperature control)
- Flexibility to use containers for deliveries as well as to store and collect outbound shipments

KEY CHALLENGES

- True industry standardization requires alignment and adoption across multiple parties (industries, sectors, etc.) impacting potential benefit
- Difficult to achieve compliance between cooperating competitors using the same network/container capacities
- Conflicting regulations that restrict storage and transportation methods for special goods

Urban Container Cubes – DHL Cubicycle for Eco-friendly Delivery

- The eco-friendly DHL Cubicycle can carry 125-kg containers for inner-city deliveries across several European cities
- This optimized container format replaces 60% of inner-city vehicle journeys
- Custom dimensions enable quick and easy transfer across different modes of transport (vehicles or cycles)
- Container can also be reloaded for outbound shipments, increasing sustainability and enabling circular economy concepts

Source: DHL



Trend Assessment

Timeframe: > 5 years

Impact: Medium

Sector Relevance: Below



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15. <https://logisticsviewpoints.com/2016/08/02/decoding-the-physical-internet/>

16. <https://blog.bosch-si.com/industry40/container-4-0-smart-transport-high-seas/>

Supergrid Logistics

Going beyond 4PL logistics, supergrid logistics will raise a new generation of logistics companies with primary focus on the orchestration of global supply chain networks that integrate swarms of different production enterprises and logistics providers. This opens up new business opportunities for different logistics branches – 4PL providers, companies with special expertise in complex or specific services, and even small local couriers and startups.



KEY DEVELOPMENTS & IMPLICATIONS

Customers can increasingly choose from a large variety of logistics services globally, thanks to the cloud-powered online marketplaces and startups that are unbundling traditional logistics integrators. A logistics supergrid concept spanning the entire globe can smoothly and flexibly integrate all parties along multiple supply chains enabling collaboration of modular services for all types of customer, maximizing efficiency and reducing costs. Looking ahead, this will require standardized service modularization and seamless information management to enable an orchestrated ad-hoc coupling and de-coupling of logistics partners. Blockchain technology can also improve transparency and security with new trust-building measures in global supergrid networks.

Market segmentation splits the logistics provider market into new actor categories such as service specialists, users, configurators, orchestrators of logistics solutions, and service mall owners. Logistics malls will establish a new degree of market transparency and give small local companies access to the global market.

Global players will focus primarily on cross-border integration, premium services, and orchestration of regional and local service providers (cooperative competition) in a global supergrid.

Interoperability is a main driver of supergrid logistics due to the need for a modularly configurable logistics service portfolio. Internally operated or external services can be seamlessly selected, orchestrated, and executed on demand. Based on logistics-as-a-service (LaaS) models, smart business networks can be created and individual intermodal, multimodal, and synchromodal solutions can be executed quickly and cost efficiently.

Logistics 'eforwarders' can offer customers end-to-end logistics services through broker platforms or similar concepts to connect shippers and carriers. Services with high complexity and development costs (e.g., risk management/security, customs clearance, compliance) will be developed by only a few specialists. Premium eservices (ebilling, ecompliance, eclearance) will develop as new critical differentiators.

KEY OPPORTUNITIES

- New business opportunities for global players to enhance their networks and service levels
- Increased B2B and B2C relationships and higher product security through enhanced data transparency and traceability
- Reduction of infrastructure and service development costs, rapid time-to-value, and scalability of services
- Faster and cost-efficient configuration of customized solutions

KEY CHALLENGES

- Easy interoperability of services from different providers is still a major challenge; only a few standards exist
- There are currently only a few cross-company, cross-industry supergrid pilots
- Full logistics-as-a-service or related business models are yet to be validated

Building a Global Logistics Network – Alibaba

- Within 18 years, Alibaba has risen to become the world's largest and most valuable retailer with operations in more than 200 countries
- Beyond its ecommerce activities, Alibaba is continuously increasing its reach into the logistics realm by heavily investing (more than \$US 15 billion within next 5 years) to build a global logistics network¹⁷
- The ambition is to build the most efficient logistics network around the world, heading towards a supergrid approach

Source: Alibaba



Trend Assessment

Timeframe: > 5 years

Impact: High

Sector Relevance: Below



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Tube Logistics

Propelled by technological progress in driving systems as well as growing congestion in megacities, there is renewed interest in the use of existing and new tube infrastructures for cargo transportation. Innovations such as the Hyperloop could one day provide rapid cargo transit within and between cities for express shipments or even passenger traffic.



KEY DEVELOPMENTS & IMPLICATIONS

Tube logistics is a visionary trend which has received increased media attention in recent years mainly due to key announcements to build a Hyperloop network between San Francisco and Los Angeles in which passengers and freight would be transported in pods propelled at supersonic speeds. The 600-km journey could take less than 30 minutes.¹⁸ Furthermore, cities, startups, retailers, and postal providers such as Swiss Post are also exploring underground cargo alternatives due to slowing and more expensive road transport in urban areas. Logistics providers could soon utilize these breakthroughs for faster modes of inner- and intercity transportation.

Long-distance Hyperloop systems can accelerate capsules in a tube using magnetic propulsion technology to potentially reach speeds of over 1,200 km per hour. A similar technology is already being successfully used in Maglev trains. The spread of these systems could one day enable ultra-express delivery between major cities (e.g., for medical deliveries).

Underground urban freight systems consist of special, dedicated freight pipeline networks that are either newly built or integrated into modified and existing pipes. Driverless freight pods can be loaded with euro-pallets or parcels and can run autonomously in dedicated tracks (e.g., between consolidation centers located in the outer rim of cities and to inner city nodes). This enables high-volume movement of freight into highly congested areas with no impact on surface transportation systems (see Mole Solutions). Further benefits can be reaped from reductions in noise and air pollution.

Utilizing capacity on public metro systems to transport goods is already happening in megacities such as Tokyo and New York City.¹⁹ During off-peak hours, for example during the night, freight capsules or existing trains can be loaded with cargo for delivery. This is especially practical in cities where night-time street-level delivery is not permitted due to noise pollution.

KEY OPPORTUNITIES

- Express delivery between and within cities for urgent goods without relying on costly air freight options
- Underground concepts reduce the land demand for road freight lanes, parking lots, and other facilities
- Systems could operate around the clock without impacting noise levels, and also reducing accident risk
- Environmentally friendly

KEY CHALLENGES

- Tube logistics systems are still difficult and expensive to build
- Depots and storage premises would be needed wherever the tubes surface
- Tube systems require additional first- and last-mile delivery services; these create additional transportation costs

Delivering the Future – Delft Hyperloop

- Delft Hyperloop was the winner of the SpaceX Hyperloop competition – it can reach speeds of over 1,200 km/h and can carry both passengers and freight
- Aim of the Hyperloop project is to significantly reduce travel time between two locations and be more cost effective than other means of transportation
- DHL was the logistics partner and assisted Delft University to determine the potential impact of Hyperloop on the logistics industry

Source: DHL



Trend Assessment

Timeframe: > 5 years

Impact: Low

Sector Relevance: Below



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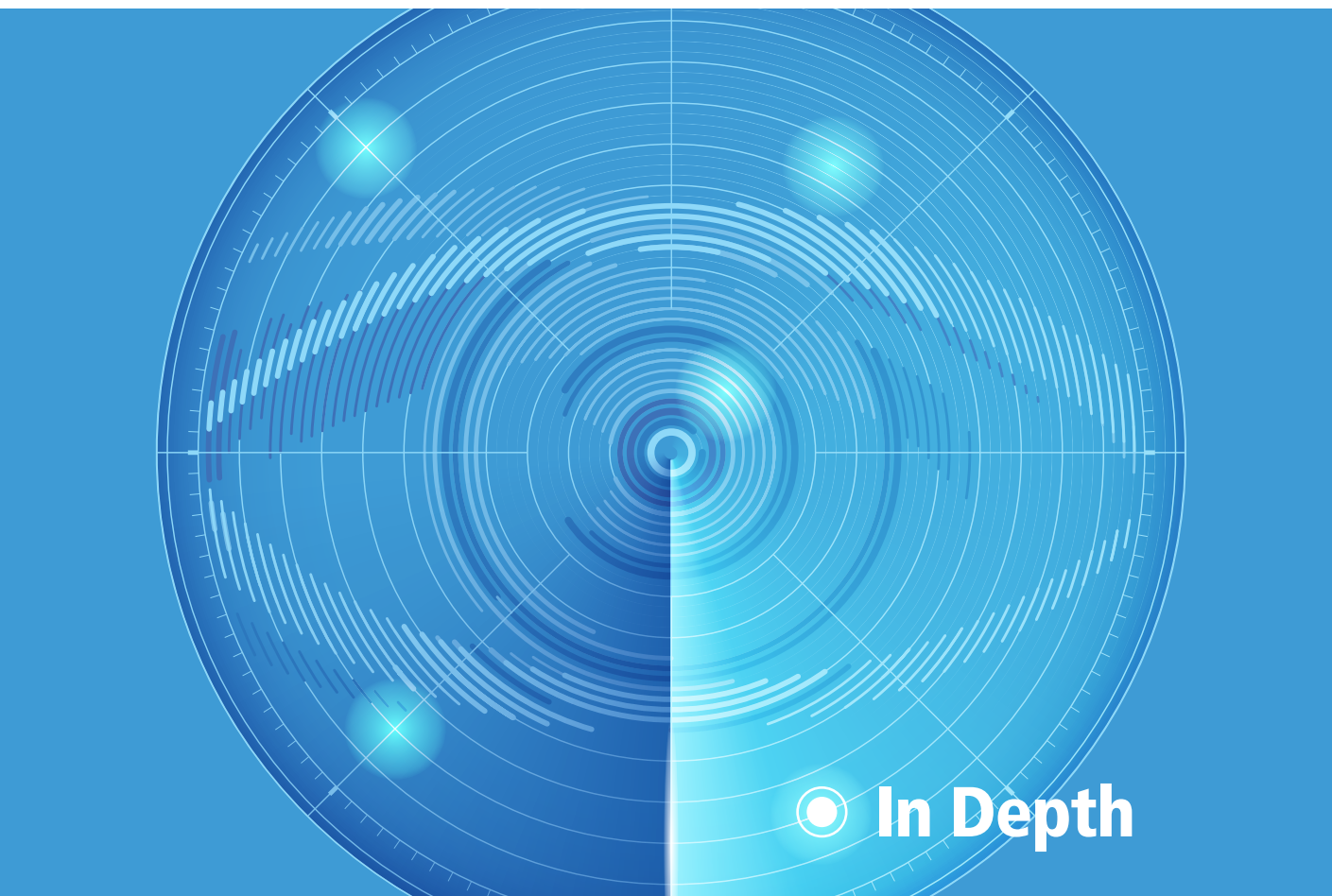
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18. <http://www.techtimes.com/articles/99369/20151027/elon-musk-ultra-high-speed-hyperloop-bullet-train-to-begin-construction-in-november.htm>

19. <https://www.fhwa.dot.gov/publications/publicroads/94fall/p94au21.cfm>



In Depth

Technology Trends

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.

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Automotive & Mobility



Engineering & Manufacturing



Technology



Energy



Life Sciences & Healthcare



Retail & Consumer

3D Printing

Encouraged by opportunities for greater customization, less waste, and more localized manufacturing and delivery, 3D printing will impact logistics by adding new diversity to manufacturing strategies. Some companies may stop traditional fabrication, but most will combine 3D printing with mass production techniques. Logistics providers can orchestrate complex hybrid manufacturing networks and utilize networks of 3D printers to offer new logistics services.



KEY DEVELOPMENTS & IMPLICATIONS

3D printing has become a trusted technology across various sectors, from printing of customized pills and medical devices to the manufacturing of aviation components. As the technology continues to develop and, more importantly, overcomes challenges surrounding liability and certification, the 3D printing market is expected to grow tremendously with some estimates projecting the industry to be worth \$550 billion by 2025.¹

3D printing will be highly applicable in areas such as spare parts production and will significantly impact related logistics services and volumes. A comprehensive 'dematerialization' of physical flows of manufactured goods is, however, still far off.

Regional logistics networks will become more complex with an increasing shift from off-shoring to near-shoring strategies, impacting regional/local supply chains and distribution. The varying degree to which industries apply 3D printing will make it necessary to carefully evaluate the impact on a company's supply chain strategy.

B2B 3D printing services can enable new logistics services especially in aftermarket supply chains (the warehousing and distribution of spare parts). Instead of managing multiple warehouses stacked with spare parts that are typically rarely ordered, logistics providers can set up a global 3D printing infrastructure coupled with a software database of digital models. Parts can then be printed only on demand at the nearest 3D printing facility (e.g., airport hub) and be delivered to the right location. Enabling parts to be manufactured on demand ensures speed of delivery, reduces lead times, and cuts inventory costs.

Hyper-personalization can be accelerated by logistics providers offering postponement services by operating local distribution centers equipped with 3D printers (see Batch Size One). The final configuration of goods can be achieved by on-demand 3D printing, enabling shorter lead times for highly individualized products (e.g., customizing and assembling products closer to demand).

KEY OPPORTUNITIES

- Logistics providers can become orchestrators of complex and fragmented supply chains for raw materials and end products
- New business opportunities (e.g., on-demand spare parts printing and delivery)
- Reduce transport costs and time by creating products closer to the point of use

KEY CHALLENGES

- Restrictions on materials and the speed of 3D printing could delay full adoption of this technology
- Authors of digital design templates could be targeted by hackers and incur copyright infringement
- Need to solve the certification and liability of 3D printed parts

3D Printing Spare Parts On-demand – Daimler Trucks

- As part of its aftersales services, Daimler offers 3D-printed spare parts for selected vehicles
- Currently over 30 units of 3D-printed parts are available for high-grade plastic components, expanding to metallic parts as well
- Customers are guaranteed rapid supply of each part even after several decades, reducing the need for storage of parts

Source: Daimler



Trend Assessment

Timeframe: > 5 years

Impact: High

Sector Relevance: Below



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1. <https://www.mckinsey.com/business-functions/operations/our-insights/3-d-printing-takes-shape>

Artificial Intelligence

Artificial intelligence (AI) is rapidly transforming the way logistics providers operate as a result of the ongoing trend towards automation and continued improvements in computing. AI will augment human expertise through systems that help generate novel insights from big data and eliminate difficult tasks. In logistics AI will enable back-office automation, predictive operations, intelligent logistics assets, and new customer experience models.



KEY DEVELOPMENTS & IMPLICATIONS

Performance, accessibility, and costs of AI continue to improve thanks to major advances in big data, algorithmic development, connectivity, cloud computing, and processing power. AI will enable a more proactive and predictive approach to help amplify the human components of global supply chains. Networks can be orchestrated to an unparalleled degree of efficiency, redefining industry behaviors and practices. Looking ahead, IoT will be a key trend that feeds critical data into AI-based systems. Business, society, and government bodies must develop standards and regulations to ensure positive use of AI.

Back-office AI presents a significant opportunity to streamline the internal functions of logistics corporations such as accounting, finance, human resources, and IT. Here, cognitive automation can be applied to critical logistics tasks such as ensuring the most updated customer addresses to bolster successful deliveries.

Predictive logistics can be enhanced by AI to shift the logistics industry from operating reactively

with planning forecasts to proactive operations with predictive intelligence. An example is predictive demand planning using data from online shops and forums to predict unexpected volume spikes for trending products. Logistics providers and suppliers can then avoid costly overstocks or out-of-stock situations that result in lost sales for both the supplier and the consumer.

Seeing, speaking & thinking logistics assets empowered by AI can greatly relieve the physical demands of modern logistics work. Applications include the use of AI-powered robotics solutions and AI-based computer vision systems which can augment much of today's logistics operations such as material sorting, handling, and inspections.

AI-powered customer experiences can further personalize customer touch points, drive shipment volumes, and increase customer loyalty and retention. For example, the use of conversational AI interfaces (e.g., Amazon Alexa) can enable logistics providers to streamline interactions and be more attuned to their customers' needs and developments.

KEY OPPORTUNITIES

- Competitive advantage through data-driven decision making and shift towards a predictive AI-powered supply chain
- Reduction in costs through highly efficient and effective processes
- Increase 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 use of AI
- Resistance from regulatory bodies and workforces affected by automation

Seamless, Voice-enabled Customer Interactions – DHL Parcel

- Voice-based service to track parcels and provide shipment information using Amazon Alexa
- Customers with an Amazon Echo speaker can ask DHL where their parcel is and receive shipment updates by speaking their alphanumeric tracking number
- Further planned enhancements include information on outlet locations, opening hours, products and prices

Source: DHL



Trend Assessment

Timeframe: > 5 years

Impact: High

Sector Relevance: Below



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Augmented Reality

Blurring the lines between the digital and physical worlds, augmented reality (AR) will provide new perspectives in logistics planning, process execution, and transportation. By adding virtual layers of contextual information onto a heads-up display or other digital device, AR empowers workers by providing the right information at the right time and in the right place.



KEY DEVELOPMENTS & IMPLICATIONS

AR enables its users to intelligently understand their surroundings by integrating contextual information into their field of view through smart glasses. "Vision picking" (order picking using smart glasses in warehouse operations) will be a key application area for AR as first deployments have already demonstrated significant potential. With the latest developments in contextual computing and enterprise AR devices, AR is becoming an attractive tool to increase process efficiency and quality in complex logistics activities. Breakthroughs in the robustness and image recognition capability of AR hardware will enable wider adoption of this technology in logistics.

AR-powered warehouse operations utilize smart glasses for the hands-free operation of various tasks within a warehouse such as product picking, packing, sorting, and even assembling. Already today, smart glasses have the ability to display task information, read barcodes, and support indoor navigation, and can be integrated into warehouse management systems for real-

time operations. User-friendly interfaces can also incorporate elements of gamification (e.g., virtual scores for successful picks) to speed up processes and increase job satisfaction.

Safer and smarter driving can be achieved for vehicle operators by utilizing AR as the next generation of navigation and driver-assistance systems. Windshields can be used as heads-up displays to project virtual layers of navigation information, as if this data is overlaid on the real environment. AR can also highlight road hazards to the driver.

Intelligent last-mile operations can use smart glasses for the entire delivery process. Workers equipped with smart glasses can conduct completeness checks of each shipment using object-recognition technology. AR can also be utilized to virtually highlight inside a vehicle to display the optimal internal loading sequence of each shipment (taking account of route, weight, fragility, etc.). On delivery, AR can help in last-meter navigation to correctly locate entrances.

KEY OPPORTUNITIES

- Hands-free operation (e.g., barcode recognition) results in higher efficiency and error-free processes
- Reduces costs while simultaneously improving quality and performance
- Faster training due to user-friendly interface and language flexibility; potential for gamification of work

KEY CHALLENGES

- Integration into existing warehouse management systems (WMS) requires new standards and interfaces
- Customer-defined requirements of standards and disclosure are difficult to meet with current solutions
- Robustness and reliability of current AR devices and systems needs to be further explored

Creating a New Standard of Order Picking – DHL

- First vision picking deployment at DHL completed with customer Ricoh demonstrates a 25% performance increase when using smart glasses in logistics
- Benefits come from real-time connectivity of the devices to the WMS, the innovative user interface, and hands-free operation
- Smart glasses are now being used in several operations globally

Source: DHL



Trend Assessment

Timeframe: < 5 years

Impact: Medium

Sector Relevance: Below



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Big Data Analytics

Logistics is being transformed through the power of data-driven insights. Thanks to the vast degree of digitalization, unprecedented amounts of data can be captured from various sources along the supply chain. Capitalizing on the value of big data offers massive potential to optimize capacity utilization, improve customer experience, reduce risk, and create new business models in logistics.



KEY DEVELOPMENTS & IMPLICATIONS

Big data has already begun to make inroads in the logistics industry by turning large-scale data volumes into a valuable asset. Moving forward, harnessing the full potential of big data will require mastering the integration of structured and unstructured data (social, images, video, etc.) from multiple data streams. Here, data lakes will play an important role in enabling easy access of enterprise data especially in fragmented IT landscapes. Furthermore, the advancement of analytics and computing technologies (see Artificial Intelligence) will unlock exciting new ways to monetize data-driven operating and business models.

Dynamic, real-time route optimization

through the intelligent correlation of data streams (shipment information, weather, traffic, etc.) can enable more efficient scheduling of assignments, optimization of load sequences, and 'down-to-the-minute' prediction of the estimated time of arrival (ETA).

Smarter forecasting of demand, capacity, and labor through big data analytics can significantly optimize planning and resource utilization, process quality and performance, and can reduce unnecessary costs in the supply chain.

Anticipatory shipping can be used by online retailers who have analyzed their customers' purchasing behaviors to predict an order before it occurs. This can then be used to move goods to distribution centers that are closer to a customer who is likely to purchase the products. It can enable retailers to offer same-day or even one-hour deliveries.

End-to-end supply chain risk management

can be improved by evaluating current conditions with existing data pools. Big data can be used to mitigate risks by detecting, evaluating, and alerting all potential disruptions on key trade lanes, caused by unexpected events such as growing port congestion or high flood risks. This can be further enhanced through the integration of data from IoT devices.

KEY OPPORTUNITIES

- Enhanced operational efficiency, visibility, and control over supply chains, assets, and staff
- New business opportunities through data-based intelligence services
- Increased customer satisfaction due to individual and data-driven logistics offers and services
- Greater added value can be achieved by combining different data streams

KEY CHALLENGES

- Strong business and IT alignment is required for implementation
- Anticipatory service requires open data exchange between the logistics provider and customer
- Privacy concerns regarding data collection and protection
- Data quality and appropriate data science skills

Using Data to Drive Supply Chain Visibility – ClearMetal

- Uses machine learning algorithms and intelligent analytics to deliver predictive supply chain solutions and enable data-driven decision making
- Provides visibility, alerts, and ETAs to alert the user to predicted issues and disruptions
- Focuses on data quality by cleansing unstructured data and feeding this into the system

Source: ClearMetal



Trend Assessment

Timeframe: < 5 years

Impact: High

Sector Relevance: Below



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Bionic Enhancement

Bionic enhancement technologies such as advanced wearables and exoskeletons have the potential to expand the boundaries of current physical barriers. Smart clothing, bionic arms, and even futuristic brain-computer interfaces can support the logistics workforce, especially older workers, in areas such as training, communication, process execution, and optimization. Most importantly, they can also minimize health and safety risks in the supply chain.



KEY DEVELOPMENTS & IMPLICATIONS

Aging workforces and labor shortages in mature markets are driving the need for exoskeletons with the market projected to exceed a billion dollars within the next decade, up from around \$200 million in 2017.² Initial logistics use cases will focus on improving health and safety, particularly in reducing the stress and strain caused by repetitive movements in manual handling activities. This is a key issue in transportation and warehousing which has one of the highest rates of occupational injury and illness in the US private sector.³

Beyond exoskeletons, breakthroughs in sensors and nanotechnologies have allowed for previously unimaginable bionic solutions. Initial industrial trials of advanced solutions in human augmentation have become prevalent in the market, such as using implants for security and access control and innovative interfaces that allow for steering computers through brain waves (e.g., Neuralink). Forward-thinking companies will utilize bionic enhancements to support the workforce in coming decades.

Exoskeletons are robotic suits that boost the wearer's strength and endurance, greatly reducing the physical strain of manual handling activities. They are becoming increasingly applicable and demanded in logistics to replace bulky tools to lift heavy objects. Various solutions focusing on parts (or all of) the body are being developed for mass adoption (e.g., Panasonic Power Loader Suit).

Human augmentation is the use of technology to boost the physical and cognitive abilities of humans and enable new forms of human-machine interaction. Smart contact lenses and smart chip implants can be used for security procedures as well as access control. Advanced chips are also being used to "connect" humans for exchanging concepts without the necessity of speech. Brain-computer interfaces that focus on using brain waves for controlling machines could potentially enable new ways of immersive interaction between humans and machines.

KEY OPPORTUNITIES

- 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
- Significant reduction and even elimination of work-related injuries, raising health and safety standards

KEY CHALLENGES

- No cost/benefit indicators available so far as this trend is, at best, in its early stages of industrial adoption
- Most bionics are currently immature for enterprise usage but are developing quickly
- Ethical challenges with human enhancements

Enabling New Hands-free Operations – Samsung Contact Lens

- Samsung has patented a smart contact lens with a built-in camera, which is controlled by blinking
- The camera projects an image onto the contact lens which augments the user's view; antennas allow the user's vision to be projected to an external device for processing
- In logistics, smart contact lenses could one day become ubiquitous and used for secure identification and augmented reality applications

Source: Samsung



Trend Assessment

Timeframe: > 5 years

Impact: Low

Sector Relevance: Below



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2. <https://qz.com/971741/robot-exoskeletons-are-finally-here-and-theyre-nothing-like-the-suits-from-iron-man/>

3. www.bls.gov/web/osh/cd_r44.xlsx

Blockchain

Evolving beyond its association with bitcoin, blockchain and other distributed ledger technologies can remove significant layers of complexity from global supply chains. It can facilitate greater trust and transparency between supply chain stakeholders, supporting the automation of administrative and commercial processes. Smart contract concepts will also create opportunities for new services and business models in logistics.



KEY DEVELOPMENTS & IMPLICATIONS

Blockchain is a nascent technology which at its core represents a fundamental shift from a centralized to a decentralized and distributed database system. By sharing information on a blockchain-based system, the technology can support collaboration and transparency in the highly fragmented logistics industry. The greatest application area lies in global trade, where solutions that reduce supply chain trade barriers can increase global GDP by nearly 5% and global trade by 15%.⁴ Looking ahead, industry adoption, governance of standards, and interoperability will be critical to the success of this technology in enterprise applications.

Faster and leaner logistics in global trade

using a common blockchain-based system creates transparency for all supply chain parties as they can view progress of goods, status of customs documents, and other data (e.g., Maersk/IBM joint venture). Key trade documents such as the bill of lading can be digitalized with participants issuing, transferring, and receiving the original document through a blockchain network (e.g., ZIM e-bill of

lading). Industry-wide adoption will have significant impact, reducing delay, fraud, and costs across the supply chain.

Improving traceability and transparency

of goods across the supply chain, from point of origin to last-life will be possible with blockchain technology. Several initiatives are monitoring goods provenance, from how they were made to how they are being managed. This data is stored permanently and shared across decentralized networks, enabling comprehensive track-and-trace beyond current capabilities. Users can verify if products are authentic or have met handling requirements (e.g., Walmart pilot on food tracking).

Automating commercial processes

with blockchain-based smart contracts can greatly enhance payment times and reduce invoicing errors through instantaneous payment once agreed conditions are met (e.g., initiating payment as soon as a pallet arrives at the right location). A key application area in future will be machine-to-machine payments (e.g., IoT).

KEY OPPORTUNITIES

- Higher levels of transparency can drive internal process optimization and better visibility for the customer
- Process efficiencies and cost savings through the adoption of smart contract principles
- New business opportunities and models (e.g., new track-and-trace capabilities)

KEY CHALLENGES

- Technical limitations such as scalability and power consumption need to be overcome to enable sustainable, large-scale deployment
- Industry adoption will be critical which is difficult to achieve in the fragmented logistics industry
- Governance and standards body will be required to ensure regulations and interoperability

Fighting Counterfeit Drugs through a Single Source of Truth – DHL

- DHL and partners developed a prototype to explore the use of blockchain for track-and-trace pharmaceuticals
- The vision is to authenticate the movement of a pharmaceutical item from point of manufacture and serialization to final delivery for consumption
- With the data securely stored on a shared network, customers can also check the authenticity and condition of each item

Source: DHL



Trend Assessment

Timeframe: > 5 years

Impact: Medium

Sector Relevance: Below



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Cloud Logistics

Ideal for complex, volatile environments, cloud computing enables a variety of new 'logistics-as-a-service' (LaaS)-based business models. Logistics providers can activate and deactivate customizable, modular cloud services on demand using a pay-per-use approach. This allows highly scalable service and management capabilities without requiring the traditional development, setup, and maintenance costs of own IT infrastructure.



KEY DEVELOPMENTS & IMPLICATIONS

In recent years, logistics providers have begun to embrace cloud logistics as it enables rapid, efficient, and flexible access to IT services for innovative supply chain solutions. Already today, more than 50% of logistics providers use cloud-based services and a further 20% are planning to do so in the near future.⁵ Looking ahead, open and web-based APIs will form the basis of modular on-demand cloud logistics services, replacing outdated, legacy communication systems (such as EDIs). Furthermore, edge computing will continuously enhance cloud logistics by utilizing computing power close to the data, drastically reducing bandwidth requirements.

Modular cloud logistics platforms offer open, web-based access to a choice of flexible, configurable on-demand logistics-related IT services that can be easily integrated into supply chain processes. Cloud-based transport management systems can assimilate orders, billing, and track-and-trace services in one combined platform. Pay-per-use models enable small and medium-sized logistics providers as

well as larger companies to react more flexibly to market volatility, paying only for the services they actually need and use, instead of having to invest in a fixed-capacity IT infrastructure. Companies using cloud-based solutions can budget for this as operating expenditure.

Cloud-powered global supply chains virtualize information and material flows by moving all supply chain processes into cloud. With complex and fragmented global supply chains, logistics providers often have to deal with a variety of transactions taking place between multiple parties, using different warehouse and transport management systems. Cloud allows for the coordination and orchestration of this information into one integrated view, making it a key enabler of a virtual 'control tower', providing 360-degree management dashboards. Furthermore, cloud gives companies more precise control over their global inventory levels and the location of shipments and assets. Ultimately, this paves the way for sophisticated supergrid logistics networks.

KEY OPPORTUNITIES

- Agile, flexible, and elastic business models enabled by high on-demand scalability of IT services
- Improved ability to control supply chain processes through digitized processes and easily shared real-time data
- Increased price transparency for users of LaaS software through pay-per-use or renting models
- Integration of services in central platforms using open APIs

KEY CHALLENGES

- Data migration and security issues need to be verified (e.g., keeping control of sensitive data)
- Compatibility and integration of modular cloud services into supply chain management systems remains a challenge
- Performance concerns such as latency triggered by increased data volumes and real-time requirements

Spotlight: Transport Management System from the Cloud – Freightly

- Real-time, cloud-based logistics and transport management system (TMS) that makes logistics services affordable, especially for small and medium-sized companies
- Service covers all logistics processes from procurement and shipping to billing and has cross-device availability with views and dashboards tailored to the user

Source: Freightly



Trend Assessment

Timeframe: < 5 years

Impact: High

Sector Relevance: Below



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Internet of Things

The Internet of Things (IoT) has the potential to connect virtually anything to the internet 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; they can use the data from the connected objects to generate actionable insights that drive change and new solutions.



KEY DEVELOPMENTS & IMPLICATIONS

IoT presents an immense \$1.9 trillion opportunity in logistics.⁶ However, until now only a few IoT applications in logistics have experienced widespread adoption, due to the total cost of deployment, security concerns, and an absence of standards in the fragmented logistics industry. With the global connected logistics market estimated to substantially grow to \$27 billion at a CAGR of 7.6% until 2023⁷, breakthroughs in the development of low-cost IoT networks (see Next-generation Wireless) and continually falling sensor prices will enable large-scale IoT deployments in logistics. Furthermore, early adopters will have exciting opportunities to develop new, IoT-based business models.

Connected warehouses can increase the transparency of all assets through the tagging of individual items, pallets, and operational equipment. These smart items can transmit information about their current task, condition, and position, enabling powerful analytics to improve planning and visibility, process efficiency and asset utilization, as well as maintenance. IoT

can also drive higher levels of worker health and safety through a connected workforce concept, and may be additionally used to optimize facility management through the integration of IoT in the warehouse infrastructure.

Intelligent transportation solutions can increase transparency and integrity in the supply chain through innovative smart truck concepts. For example, in-vehicle telematics can collect data on movements and idle time to maximize fleet and asset utilization as well as dynamic route planning and optimization. IoT can also be used to reduce vehicle downtime via the prediction of asset failure and automated maintenance scheduling.

The connected consumer and the proliferation of smart homes (e.g., smart locks) will enable new IoT-based delivery concepts such as secured in-home delivery services. This can offer more visibility to the consumer and help to avoid unnecessary deliveries.

KEY OPPORTUNITIES

- Increases the transparency, traceability, and reliability of logistics operations
- More operational efficiency and less cost with automated decisions in complex environments
- Real-time connectivity helps to improve service quality, optimize asset utilization, and increase operational security
- Creation of more dynamic and customized delivery services for customers

KEY CHALLENGES

- High levels of fragmentation within the logistics industry require the development of a logistics IoT standard
- Data and security concerns in the IoT-powered supply chain
- Achieving seamless indoor and outdoor tracking and roaming at a low cost of deployment
- IoT hardware needs to be further ruggedized for large deployments in logistics, especially in terms of battery life

Visualizing Operational Data through IoT – DHL Smart Warehouse

- Aggregates operational data from sensors on scanners, operating equipment, and the warehouse management system
- Assets are localized and tracked through triangulation via the existing Wi-Fi infrastructure
- Visualization platform is utilized to immediately re-engineer processes or warehouse layouts to boost operational efficiency and address potential safety blind spots

Source: DHL



Trend Assessment

Timeframe: < 5 years

Impact: High

Sector Relevance: Below



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6. http://www.cisco.com/c/dam/en_us/services/portfolio/consulting-services/documents/consulting-services-capturing-iot-value-aag.pdf

7. <https://www.prnewswire.com/news-releases/global-connected-logistics-market-expected-to-reach-27722-million-by-2023---allied-market-research-675151133.html>

Low-cost Sensor Solutions

Sensor technologies that were originally developed for consumer electronics such as wearables, smartphones, and even gaming consoles enable exciting new applications within the logistics industry. These low-cost sensor solutions can digitally enhance cumbersome manual logistics activities. Dimensioning, quality control, and visualization are some examples of applications bringing new levels of intelligence, safety, and efficiency to logistics operations.



KEY DEVELOPMENTS & IMPLICATIONS

The global smartphone population is nearing 3 billion devices and, with an average of 14 sensors per device, this has created a mass market for low-cost sensors as performance increases with each new smartphone release.⁸ Consumer electronics sensors (accelerometers, gyroscopes, temperature, humidity, etc.) will expand significantly in the future, enabling new consumer-to-industrial applications. Sensors for depth sensing and imaging (e.g., Intel RealSense, Microsoft Kinect) are already in use with automated volume-measurement applications. Further, smartphones and wearables are bringing efficient and cost-effective computing capabilities to more areas of logistics operation. Sensors that can detect environmental quality and even odors should be available within the next 5-10 years, unlocking further areas for innovation.

Dimensioning with the use of 3D camera technologies and sophisticated software algorithms is being used in a variety of applications for the fast and efficient measurement of freight. Such systems will further automate supply

chain processes such as dynamic load capacity optimization and volume-based pricing. Consumers themselves will use similar technology with mobile apps allowing self-preparation of shipments (e.g., measuring parcel dimensions at home).

Assisted visual inspections with advanced computer vision will further open opportunities to improve accuracy and quality in operations. With 3D vision and deep learning, operations can automate inspection of outbound or returned goods far beyond human capabilities; up to 100 quality parameters can be accurately assessed in a few seconds. The combination of advanced computer vision and deep learning could also be used for cycle counting individual items on a shelf.

Worker wearables are increasingly being adopted in the logistics industry to improve health and safety practices and to enable real-time operational analytics with proactive correction capabilities. Successful pilots have tested a range of use cases from smart watches monitoring worker heart rates and location to smart necklaces to monitor driver drowsiness.

KEY OPPORTUNITIES

- Real-time dimensioning has further potential to develop new services (e.g., volume-based pricing and billing enforcement) to enhance operational efficiency and quality control
- Sensor-equipped devices are ideal for real-time monitoring and control of logistics processes
- Cost savings will be achieved compared to industrial-grade or conventional scanner systems

KEY CHALLENGES

- Scalability of dimensioning solutions will largely depend on achieving trade certifications
- Concerns surrounding security and reliability of cloud-based applications and consumer devices may slow adoption

SPOTLIGHT: Scalable 3D Computer Vision Solutions for the Logistics Industry – Aquifi

- Start-up piloting 3D computer vision devices with embedded deep learning for dimensioning, assisted visual inspection, and automated stocktaking
- This low-power, low-cost solution builds full-color 3D models of an object in seconds
- Deep-learning-assisted visual inspection enables quick evaluation of products for quality and cosmetic defects with high precision

Source: Aquifi



Trend Assessment

Timeframe: < 5 years

Impact: Medium

Sector Relevance: Below



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Next-generation Wireless

Breakthroughs in existing wireless network technologies and the rise of entirely new networks are accelerating IoT applications in both the consumer and enterprise environments. In logistics, these intelligent networks can enable cost-effective seamless indoor and outdoor connectivity and localization of shipments and assets. The vision of a connected supply chain with complete transparency and traceability becomes more and more tangible.



KEY DEVELOPMENTS & IMPLICATIONS

While there are many promising use cases for IoT in logistics, many of the applications have not yet materialized largely due to limitations in device battery life and the cost of localizing, tracking, and analyzing vast amounts of connected devices. While current cellular networks are highly suitable for roaming, they are geared towards high data throughput which is not optimal in logistics where small data sets are sent to the network (such as location and status). The adoption of IoT networks, the upcoming 5G standard, and low-orbit satellite deployments will expand the possibilities and viability of IoT applications in logistics. A combination of all these technologies and right applications can deliver huge cost savings and new business models.

Low-power wide area networks (LPWANs) such as Sigfox, LoRa, and Narrowband IoT are promising in their development due to low energy demands which greatly increase device battery life and wide area geographical coverage. This is essential especially for logistics asset monitoring and tracking where device battery life plays a key role in the business case of IoT deployments.

5G is the next-generation mobile network beyond 4G. Compared to its predecessor, it offers vast improvements especially in the area of energy consumption and provides higher data rates and capacity for more devices. Due to its low latency, 5G is a key enabler for autonomous driving, which greatly benefits the logistics industry. At the same time, the wide range of low-energy benefits of 5G allows new globally utilizable tracking and condition monitoring capabilities for parcels and devices.

Low orbit satellites are essential technology elements in the provision of global network coverage, reducing white spots to a minimum which is important for logistics operations in remote areas. In contrast to current network infrastructure, low orbit satellites can be deployed to offer immediate, high-performance network access.

KEY OPPORTUNITIES

- Full E2E connectivity around the world without white spots (100% internet access)
- Extended battery life for IoT devices can accelerate asset monitoring and tracking in logistics
- Seamless indoor and outdoor connectivity and localization can strengthen business cases

KEY CHALLENGES

- Deployment of 5G is not yet foreseeable on a global scale
- LPWAN coverage will take time due to capital investments required to build new network
- Interoperability between networks, some of which have proprietary standards
- Preparations for large-scale IoT deployment can be time intensive

Building the Largest IoT Network in the World – Sigfox

- Available in 45 countries, Sigfox enables large volumes of connected devices to send small amounts of data without needing much battery power, allowing them to be deployed in larger numbers over long periods of time
- It is compatible with Bluetooth, GPS 2G/3G/4G, and Wifi
- By combining other connectivity solutions with Sigfox, business cases and user experience can be drastically improved

Source: Sigfox



Trend Assessment

Timeframe: > 5 years

Impact: Medium

Sector Relevance: Below



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Robotics & Automation

The first wave of automation using collaborative 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. Robots in particular will adopt collaborative roles in the supply chain, assisting workers with warehousing, transportation, and even last-mile delivery activities.



KEY DEVELOPMENTS & IMPLICATIONS

The rise of ecommerce is requiring logistics providers to operate faster and more efficiently to rapidly process small individual orders, and at the same time the industry is facing rising labor shortages. Robotics will be essential to operate in this new dynamic and, with 80% of warehouses today being manually operated⁹, this presents immense potential for automation. Looking ahead, robotics solutions will continue to become faster, more accurate, flexible, and affordable due to swift progress in grip and sensor technologies. With an improved price/performance ratio, the adoption of robotics solutions will accelerate over the next three years.

Flexible automation in warehousing and fulfillment can use a fleet of intelligent robotics to upscale and downscale operations as needed. Stationary piece-picking robots (e.g., from Rethink Robotics) and automatic guided vehicles (AGVs) which can intelligently sense the environment around them to assist workers with tasks such as picking, packing, and sorting are seeing first major deployments in logistics. They could

also be moved from warehouse to warehouse to cover changing peak seasons and be used to conduct replenishment, cycle counting, and cleaning activities overnight. Looking ahead, breakthroughs will ensure mobile piece-picking robots play a major role in future warehouse operations.

Trailer and container unloading robots are still nascent in maturity but will have a significant impact in logistics by automating this physically strenuous and repetitive task. Low-cost image recognition technologies and progress in computing power are enabling first solutions that use robotics arms equipped with powerful sensors and grippers to locate single parcels, analyze their size and shape, and determine the optimal unloading sequence.

Assistance robots for local delivery can be used to follow delivery personnel to transport heavy items (e.g., Deutsche Post PostBot), pre-sort shipments inside delivery vehicles, and autonomously deliver shipments to dedicated collection points (e.g., Robby Technologies).

KEY OPPORTUNITIES

- Increase in agility and elasticity of logistics infrastructure to cost effectively meet market fluctuations
- Increase in asset utilization and overall productivity
- Improved health and safety
- 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 as well as operational speeds
- Raises new regulatory, accountability, ethical, and legal issues, such as the appropriate level of automation versus human job security

Innovation in Order Fulfilment with Human-Robot Collaboration – Locus Robotics

- 36 mobile collaborative robots are cost-effectively deployed in a robotics-as-a-service subscription business model at a DHL operation in the US
- Productivity is more than 2 times higher using the robotics solution to support warehouse workers, and feedback from users is positive
- From this first deployment, DHL is now scaling the flexible automation solution at similar operations

Source: DHL



Trend Assessment

Timeframe: < 5 years

Impact: High

Sector Relevance: Below



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Self-driving Vehicles

With technological advancements in AI as well as increasingly heavy investments in the development of sensors and vision technologies, self-driving vehicles will soon fundamentally transform the way vehicles are assembled, operated, utilized, and serviced. From trucks to last-mile robots, self-driving vehicles will transform logistics by unlocking new levels of safety, efficiency, and quality.



KEY DEVELOPMENTS & IMPLICATIONS

In logistics, self-driving vehicles have gradually been adopted in carefully controlled environments such as warehouses and yards over the last few years. The next evolutionary step will be to deploy self-driving vehicles in shared and public spaces such as on highways and city streets to further optimize logistics operations and increase safety. Many companies are working on accelerating the acceptance of the fully driverless vehicle, with more than 40 industry players as of May 2017.¹⁰ However to have widespread deployment of autonomous trucks, last-mile delivery robots, and other autonomous vehicles, it is essential to overcome challenges of government regulation, social acceptance, and safety concerns.

Line-haul transportation involves long journeys (often overnight), significant carbon emissions, and an extremely high driver turnover rate of up to 90% in some markets.¹¹ Logistics providers can utilize various driverless technologies such as platooning and autonomous highway (manual operation only when the truck enters or leaves

the highway) to support each driver's health and safety.

Autonomous last-mile deliveries led by purpose-built vans loaded with everyday goods such as groceries, electronics, or apparel could be a reality in the future. More mobile autonomous vehicles such as drones or sidewalk delivery robots can also disrupt modern delivery service standards, providing same-day deliveries with reduced labor costs. This is particularly attractive for logistics companies as last-mile deliveries have historically been inefficient and account for almost 40% of total delivery costs.¹²

Indoor and outdoor logistics operations can leverage various forms of self-driving vehicle to perform traditionally labor-intensive tasks. Autonomous and semi-autonomous forklifts, mobile robots, and pallet movers will be able to automate container and equipment handling. This flexibility will benefit logistics providers through labor cost reduction and increased efficiency and safety through machine-human collaboration.

KEY OPPORTUNITIES

- Significant cost savings realized due to better fuel efficiency with optimized routing, and reduced labor costs
- Greater reliability and operational productivity by reducing human error and enabling 24/7 utilization
- Reduced greenhouse gas emissions and overall environmental impact due to more efficient fuel consumption

KEY CHALLENGES

- Security and safety concerns as a result of potential hackers and software bugs that can have detrimental consequences
- Legal restrictions in various countries / states can slow adoption
- Loss / retraining of jobs affected by driverless vehicles

SPOTLIGHT: Semi-autonomous Long-haul Transportation – Tesla Semi

- Semi-autonomous, electric powered truck with a 500-mile range on a full charge
- Enhanced autopilot feature provides an advanced driver-assistance system that includes adaptive cruise control, lane centering, and self-parking and enables the truck to be summoned from a parked position
- Tesla has planned for fully autonomous driving capabilities once regulatory, technical, and legal hurdles have been overcome

Source: Tesla



Trend Assessment

Timeframe: > 5 years

Impact: High

Sector Relevance: Below



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10. <https://www.cbinsights.com/research/autonomous-driverless-vehicles-corporations-list/>

11. <http://www.trucking.org/article/Truckload-Turnover-Surges-in-Second-Quarter>

12. <https://www.sdccex.com/warehousing/article/12314667/overcoming-lastmile-delivery-and-urban-logistics-obstacles>

Unmanned Aerial Vehicles

Unmanned aerial vehicles (UAVs) or 'drones' can be used to deliver goods in the first and last mile as well for intralogistics and surveillance operations. UAVs will not replace traditional ground-based transportation. However, they will provide value in operating safely in remote, potentially dangerous-to-access locations.



KEY DEVELOPMENTS & IMPLICATIONS

Although 'hobby drones' have become popular with consumers, the adoption of commercial UAVs is still in its early stages. Within the logistics realm, several commercial tests have been conducted over recent years (e.g., by Amazon, Google, and DHL). However, these tests have not yet proven the return on investment for delivery drones at large scale. In addition, regulations remain a major obstacle to overcome to release delivery drones in public areas. For example, many countries require line of sight between drone and operator. Hence, market analysts expect a much stronger impact of UAVs within the inspection segment and intralogistics operations.

Intralogistics operations can be streamlined by using UAVs for intra-plant transport (e.g., carrying parts to the required production facility) and urgent supplier-to-plant spare parts delivery as well as to ferry products from back rooms to the sales floor (e.g., Walmart). UAVs equipped with computer vision technology can be deployed inside warehouses to conduct inventory checks

and hence ensure frequent transparency on available stock.

Surveillance of infrastructure can be enhanced by using UAVs to, for example, check the condition of industrial buildings and inspect trade lines for damage or the need for maintenance work. Additionally, assets can be monitored for theft prevention at warehouses and yards. This increases not only the efficiency of operations but also the safety of staff conducting this work manually today.

Delivery drones have the potential to transform the way goods are delivered to rural areas, as well as within megacities. Last-mile deliveries using drones allow delivery times to be reduced while also relieving traffic congestion in densely populated cities. Rural areas benefit from UAVs as areas with difficult accessibility can receive on-demand shipments by air, even in hazardous conditions. Furthermore, systems need to be developed that prevent drones from being hijacked in transit.

KEY OPPORTUNITIES

- Faster intralogistics and surveillance operations
- Operational efficiency and flexibility of delivery networks can be increased
- Reduction in risks and accidents through automated delivery in remote areas
- More cost-efficient remote security checks of warehouses and trade lines (e.g., rail network, pipelines)

KEY CHALLENGES

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

Fully Autonomous Indoor Cycle Counting with Drones – PINC

- Cycle counting is time-consuming, costly, disruptive, requires equipment, and exposes people to safety risks
- PINC uses a fully autonomous indoor drone coupled with advanced optical, RFID, and barcoding sensor capabilities to automate cycle counting
- It contains software enabling real-time three-dimensional mapping, navigation, inventory identification, and location accuracy

Source: PINC



Trend Assessment

Timeframe: > 5 years

Impact: Medium

Sector Relevance: Below



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Virtual Reality & Digital Twins

Virtual reality (VR) technology, commercially popularized through video games, has since evolved for use in manufacturing, distribution, and supply chains. By enabling users to design, simulate, and evaluate environments in 3D, logistics providers can make better-informed decisions for optimizing material flows and monitoring processes. Digital twins of logistics operations can further unlock supply chain optimization.



KEY DEVELOPMENTS & IMPLICATIONS

With recent advancements in the development of VR hardware and software, enterprise VR has been recognized as an important logistics asset capable of enhancing planning, resource allocation, and decision making. This has been enabled through VR applications in logistics such virtual training, virtual concept creations, and digital twins. These have far-reaching implications for the logistics provider including improved monitoring of logistics processes and subsequent reduction in cost, waste, and risk when transporting and delivering goods.

Virtual training using VR will provide a much more efficient method to educate employees on logistics processes. Practical VR demonstrations involve immersive e-learning scenarios, which are particularly important for health and safety topics such as operating heavy machinery. This form of training is cost effective and its immersive nature can lead to greater employee satisfaction.

Virtual concept creations including production simulations and digital layout planning for

physical sites will be much easier to implement through VR. Material flows, infrastructure planning, new equipment simulation, and setup costs can be visualized and trialed prior to implementation. Logistics providers will be able to accurately architect test environments with a virtual “look and feel”, resulting in improved and accelerated planning processes with reduced costs.

Digital twins refers to the digital replica of a physical asset that is connected through the IoT. Logistics companies will be able to detect and respond to activities occurring in the physical world that are immediately reflected in the virtual representation. This can include maintenance activities of a forklift, utilization of a delivery truck, or recording shock events for a smart package during transportation. This allows for real-time updates on the status of goods and assets throughout the supply chain, leading to faster responsiveness, reduced waste, better inventory performance, and warehouse optimization.

KEY OPPORTUNITIES

- Cost savings can be realized through accurately testing virtual concept creations such as warehouse layout planning and production simulations
- Reduced waste and improved inventory performance with, for example, digital twins enables transparency of goods and assets throughout the supply chain

KEY CHALLENGES

- High development and investment costs required to set up VR solutions that are adaptable and have high technical performance
- Security concerns that hackers may access VR data containing sensitive information about the company’s supply chain processes
- Ensuring synchronization between numerous stakeholders throughout the VR supply chain can be complex

Transforming Logistics in the Manufacturing Industry with Digital Twins – GE

- GE has created digital twins of supply chain and factory processes
- This has resulted in significant improvements in inventory management and factory throughput
- An app allows the factory manager to communicate with the digital twin and gives visibility on everything from inventory and factory capacity to product cycle times and on-time delivery at the plant

Source: GE



Trend Assessment

Timeframe: > 5 years

Impact: Low

Sector Relevance: Below



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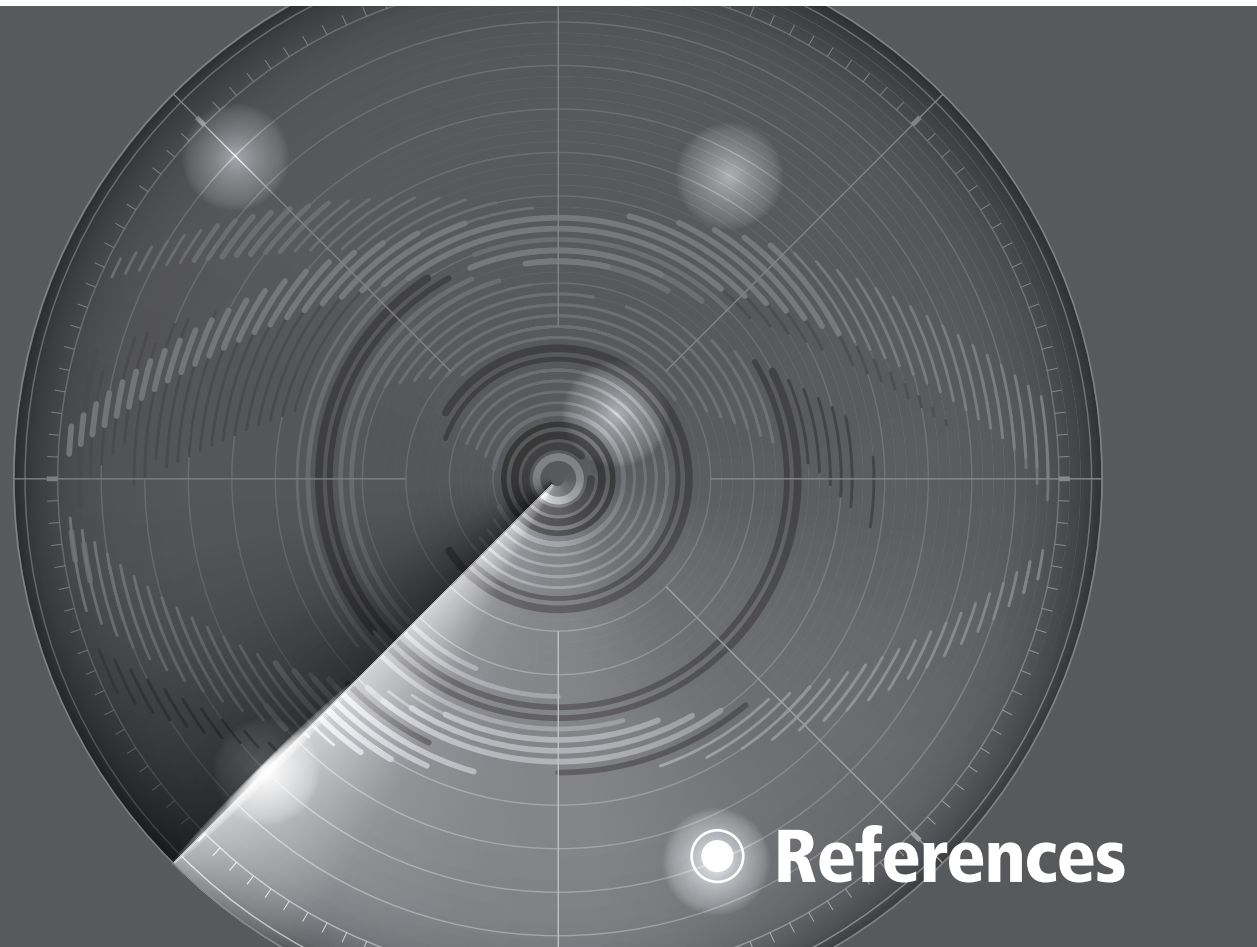
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References

SOCIAL & BUSINESS TRENDS

Batch Size One

Adidas – speed factory, Homag – economic batch size one furniture production, Fraunhofer IPT – industrial manufacture of highly individual medical products, Siemens – batch size one automation in the wood industry, B&R Automation Design – implementing “orders of one” customization in manufacturing, Softwear Automation – automating apparel manufacturing

Connected Life

Amazon Key – enabling unattended home deliveries, DHL Parcel and Daimler SMART – car trunk delivery concept for last-mile delivery, DHL and Amazon Alexa – parcel tracking using smart home devices, LG Smart Fridges – IoT-enabled refrigerators tracking expiration dates, Kwik – IoT-enabled push buttons which automate replenishment

Digital Work

Deloitte – study “automation is here to stay... but what about your workforce?”, McKinsey Global Institute – studies on automation and the future of work, Blue Prism RPA – automating tedious back-office operations, Kaggle – data analytics competition platform to enable companies to tap into data science talent, Jobdoh – platform to hire part-time, temporary, on-demand labor

Fair & Responsible Logistics

DHL Supply Watch – AI-enabled system to mitigate supplier risks, HP – closed-loop recycling of printer cartridges, H&M – LongLiveFashion initiative collects old clothing for recycling in exchange for a coupon, EcoATM – automated e-waste recycling kiosk with instant cash payouts, UnPackt – Singapore-based grocery store using a zero packaging waste approach

Best Practices & Use Cases

Best Practices & Use Cases

Fresh Chain

FreshTurf – temperature-controlled lockers for delivery of food, HealthCare atHOME – delivering cold chain medication to homes in India, Zipdrug – medicine delivery on the hour, Die Bauerntuete – online regional food delivery service, JD.Com – offering rapid deliveries for fresh food, Amazon – 2-hour delivery for orders from Whole Foods Market, DHL LifeTrack – portal offering track-and-trace capabilities for cold chain shipments, DHL Thermobox – packaging to enable cold chain delivery via standard parcel networks

Green Energy Logistics

Volvo – switching strategy to produce only electric and hybrid trucks in the future, DHL StreetScooter – electric delivery vans for emissions-free delivery in urban areas, Telsa – all electric semi-truck with auto pilot features, Germany – commitment to have only green vehicles on the roads by 2030, Qilu Group & Pavenergy – solar energy highway enabling harvesting of energy, Google Project Sunroof – solar mapping tool to help consumers save energy

Grey Power Logistics

EffizienzCluster LogistikRuhr – homecare services for the elderly project, Hometeam – startup offering home care for the elderly, 7-Eleven Japan – offers home delivery of groceries for the elderly, Seismic – exoskeleton suit designed to support legs, Silvernest – home sharing app pairing people to stay with the elderly at lower rents and fulfilling chore requirements, Uber Health – delivery of vaccines and transportation for the elderly

Logistics Marketplaces

INTTRA – the world's largest marketplace for ocean shipping, DHL Saloodo! – logistics marketplace offering end-to-end road freight transportation services, Flexport – online end-to-end freight forwarding platform solution, iContainers – end-to-end pricing tool and freight forwarding service for ocean and sea freight, FLEXE – cloud-based online marketplace to seamlessly access underutilized warehousing space

Omni-channel Logistics

DHL Parcel Metro – intelligent last-mile network that enables affordable same-day and next-day delivery options, Jack & Jones – fulfillment of online orders from nearby stores, Taykit – India-based startup collaborating with local stores to allow customers to try their online purchases before buying them, ZigZag – easing returns of goods globally, Shutl – rapid fulfillment service by connecting online retailers with local same-day couriers, John Lewis – seamless online/offline shopping

Servitization

Rolls Royce – “power-by-the-hour” service-based model for engines, Michelin – fleet solutions offering “pay-by-kilometer” services, Philips – “lighting-as-a-service” to allow customers to install more low energy consumption technology in an affordable manner, Ricoh – offers pay-per-copy instead of machine rentals, Van Der Lande – airport conveyor systems with a pay-per-baggage service

Sharing Economy

Park Circa – on-demand platform for parking spaces, Zipline – easy access to idle vehicles with a smartphone app, Tamyca – online car-sharing portal, Floop2 – provides an asset sharing and trading platform for equipment and personnel, Wonolo – on-demand platform for workers in logistics, Parcelly – repurposing existing space in urban environments for parcel storage and pick up, Crowd Companies Council

Smart Containerization

DHL Cubicycle – using cube-style containers for last-mile delivery in urban environments, Physical Internet – IoT-enabled containers with real-time tracking, Bosch – testing connected containers for temperature-sensitive shipments, P&G Supply Chain Innovation Center – modularized packaging formats to improve transportation

Supergrid Logistics

Amazon and Alibaba – expansion of logistics capabilities could head towards a supergrid approach, SAP One World Logistics project – online information and services brokerage platform where organizations operating in the area of logistics can interact and collaborate, China Smart Logistics Network – aims at building a logistic platform to accelerate ecommerce deliveries in China, LOGICAL/ InterLogGrid

Tube Logistics

Hyperloop Technologies – development of a high-speed transportation system focused on passenger and goods transport, Mole Solutions – development of an underground freight pipeline system in the UK, Loglay and Nanyang Technological University – both parties are exploring underground cargo systems in Switzerland and Singapore respectively

TECHNOLOGY TRENDS

3D Printing

Kazzata – marketplace for 3D-printed spare parts, Daimler – 3D printing-as-a-service for spare parts of selected trucks, Carbon – 3D-printing startup enables production speeds up to 100 times faster than traditional printers, HP Jet Fusion – convenient in-house 3D printing production, Fast Radius – 3D printing hub located close to UPS airports, Thingiverse – repository for object files, Amazon patent for mobile 3D-printing delivery trucks

Artificial Intelligence

Google DeepMind AI, IBM Watson AI, Nvidia – AI and computing solutions for vehicles, Facebook DeepFace – facial recognition system, Leverton – using AI to simplify the processing and management of real estate contracts, Amazon product recommendation based on past and real-time consumer behavior, Qopius – computer vision AI for warehouse inventory management, AVRL – conversational AI interfaces for logistics applications

Best Practices & Use Cases

Augmented Reality

DHL – Global Augmented Reality Program, Ubimax – wearable computing startup developing AR for warehousing, manufacturing and service operations, Microsoft – HoloLens mixed reality device, Epson – BT-2000 augmented reality device, Volkswagen – MARTA AR application for service operations, Toyota – augmented reality windshield, Boeing – assembly using smart glasses, Lenovo augmented reality smartphone, Google – ARCore application

Big Data Analytics

DHL Resilience360 – data-driven supply chain risk management, DHL SmartTruck – route optimization and address management using big data, DHL Parcel Volume Prediction, Teradata, Amazon – anticipatory shipping of products to customers before order is placed, Transmetrics – big data predictive analytics solution for transport, DHL Trade Barometer – machine learning tool to predict air freight delays, ClearMetal – analytics startup enabling supply chain visibility

Bionic Enhancement

Thalnic Labs Myo – gesture control using muscle movements, Scarab – wearable device with 16 sensors for monitoring and tracking, RoboMate EU, Panasonic Assist Suit AWN – 03, Harvard University ‘Soft Exosuits’, BMW 3D-printed thumb shields to assist workers, Ekso Bionics, Samsung Lens – smart contact lens with built in camera, Neuralink – brain-computer interface company

Blockchain

Maersk/IBM – end-to-end digitization of ocean freight documentation and processes, ZIM – project testing digitization of bill of lading for ocean freight, Walmart – end-to-end track-and-trace system for food security, DHL/Accenture – blockchain project for pharmaceutical serialization, BiTA – Blockchain in Transport Alliance

Cloud Logistics

Shipwire Enterprise Logistics Platform, Westfracht Spezialverkehre: LaaS (logistics-as-a-service.de), LogFire Cloud Solutions, Transporeon – logistics services from the cloud, Salesforce – cloud-based services for small to large enterprises, Freightly – real-time cloud-based system covering all logistics processes for transportation

Internet of Things

DHL/Cisco IoT warehouse project, DHL Smart Sensor Solutions, Agheera – the IoT platform for logistics, DHL Clever Lock – enabling unattended home deliveries with smart locks, Kwik – IoT push buttons enabling automated ordering of products, Physical Internet Initiative – smart container management with real-time monitoring, BeeBright – startup focusing on smart lighting for larger spaces such as warehouses, Volvo Maintenance on Demand

Low-cost Sensor Solutions

Intel RealSense – 3D cameras with depth sensing, BIBA Bremen – intelligent image processing in production and logistics, Metrilus – real-time dimensioning for freight, Aquifi – 3D computer vision devices with deep learning for visual inspection, Scandit – advanced barcode scanning application for smartphones and tablets, Hyco Ring Scanner & Smart Watch – for barcoding scanning and inventory display

Next-generation Wireless

Sigfox – dedicated global IoT network using long-range wide area technologies, LoRa Alliance, Telekom and Vodafone NB-IoT, DHL/Huawei – smart yard management trials through NB-IoT, 5G Alliance for Connected Industries and Automation, SpaceX – launch of low orbit satellites to provide affordable internet services

Robotics & Automation

Rethink Robotics – collaborative humanoid robots Baxter and Sawyer, Locus Robotics – mobile robots with swarm intelligence to enable assisted order picking, Autonomous transport shuttles (Dematic / Fraunhofer IML), Swisslog – Carrypick and Autostore, ABB Quiet Logistics, Fraunhofer IPA, Fraunhofer IFF, Deutsche Post PostBOT – last-mile delivery robot, Geek Plus – autonomous mobile racking systems

Self-driving Vehicles

Tesla Semi – semi-autonomous vehicle, NAVYA – fully autonomous and electric vehicle, DAF – trialing truck platooning with AI technology, Effidence – wireless follow-me robot to assist order pickers in warehouse operations, Google – Waymo driverless car, Robby Technologies – autonomous robot for parcel drop off

Unmanned Aerial Vehicles

DHL Parcelcopter project – use of quadcopters and tilt wing drones for express delivery, Amazon Prime Air – tilt wing drones for express delivery, Walmart – intra-plant drone delivery of urgent spare parts, PINC – drones for inventory management in warehouse operations, National University of Singapore/Airbus – trialing parcel delivery across university campus, EXYN – fully autonomous drones with indoor navigation

Virtual Reality & Digital Twins

Toyota Material Handling FL Simulator – VR stimulated training for forklift drivers, Bosch and TÜV Rheinland – digital twin of vehicle odometers to prevent illegal odometer manipulation, GE – implementation of digital twins for manufacturing and supply chain processes, Dassault Systèmes – building a digital twin of Singapore to enable better urban planning

Further Information

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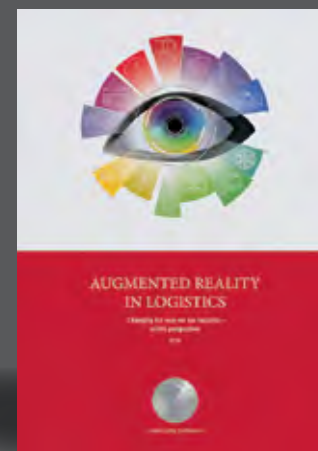
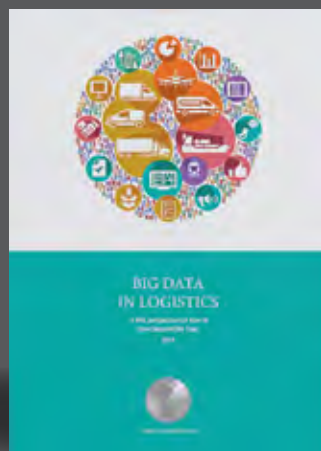
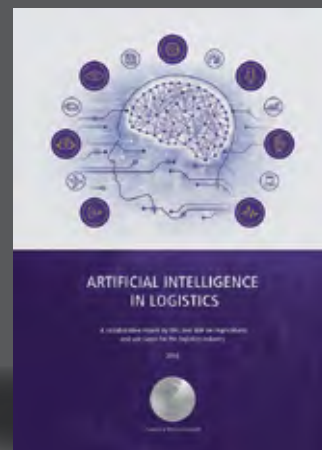
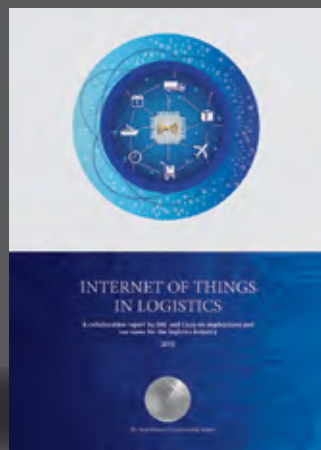
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