LOGISTICS TREND RADAR

Delivering insight today.
Creating value tomorrow!

Version 2016

Powered by DHL Trend Research

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"Staying ahead of the curve requires inspiration, innovation, and a commitment to explore new trends early on. This industry-acclaimed Logistics Trend Radar helps DHL and our customers to prepare for tomorrow's challenges and opportunities, and to shape the logistics of our future."

Bill Meahl
Chief Commercial Officer DHL

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PREFACE

When looking back at some of the biggest trends from the past, it's interesting to see that some but not all had significant impact on logistics. What about the others; why weren't they cut out to influence logistics to the same extent? Trends are notoriously difficult to predict. It's hard to know in the moment which trends will have a lasting impact and which ones will be nothing more than a short-lived fad.

So how do we best prepare ourselves, you may ask? To understand early on which trends have true game-changing potential (and which ones are mere hype), we established DHL Trend Research, a program that helps us apply a customer-centric and open approach to identifying trends.

DHL Trend Research regularly publishes a key instrument for the global logistics community – the Logistics Trend Radar. Now in its fourth year, the Logistics Trend Radar is a dynamic, living tool that captures the development of society, business and technology trends. It has become an inspiring benchmark for strategy and innovation in the logistics industry and has triggered a number of successful, award-winning pilots both inside and outside of DHL in close collaboration with our customers and partners.

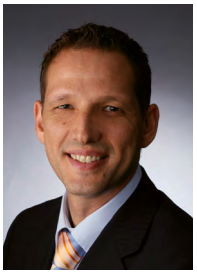
Since the last update of the Logistics Trend Radar, we have conducted 'deep dives' into multiple specific logistics trends and the findings are published in the form of individual trend reports. Recent reports include *The Internet of Things*, *Robotics*, *Omni-channel* and *Fair & Responsible Logistics*. These DHL trend reports contain not only an in-depth analysis of each trend but also showcase first application ideas. As such, their insights are fueling numerous round-table discussions among industry experts.

By identifying and following changes in trends, we recognize and acknowledge that business is always changing, always growing. Our update confirms some familiar trends while also providing valuable glimpses of upcoming trends that are likely to shape the future of logistics, from the adoption of self-learning systems to leveraging the possibilities of smart energy logistics.

We are excited to now invite you to review this latest edition, which features extended content and refreshed design. We hope this publication will inspire and assist you once again in deriving innovative solutions for the world of logistics.

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

Yours sincerely,



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LOOKING BACK:
TRENDS THAT TOOK CENTER STAGE IN LOGISTICS INNOVATION

It's time to review the trend predictions from the last update of the acclaimed Logistics Trend Radar and see which trends have now advanced and materialized in the logistics industry. By turning research into practice and taking a proactive approach to leveraging trends, companies can stay ahead of the curve by securing first-hand insights on potentially game-changing trends. Let's start by taking a look at some key technologies that have become hot topics in logistics innovation over the last few years, followed by social and business trends that are transforming the way we will do logistics in the near future.

AUTONOMOUS LOGISTICS IS ON THE RISE – BOTH ON THE GROUND AND IN THE AIR

Autonomous logistics has undoubtedly created the largest amount of media noise in recent years. Its diverse definition and representation in the media shows that this trend requires a clear distinction to be made between self-driving and unmanned aerial vehicles – an insight that is also reflected in this year's update of the trend radar.

Self-driving vehicles have already made inroads in logistics, reaching a level of maturity for commercial use in warehouse operations. First generations of autonomous shuttles and forklifts (e.g., Linde and Balyo) are being deployed in clearly defined and controlled areas of the warehouse, unlocking new levels of process efficiency and performance.

Figure 1: Google's self-driving car project; **Source:** Google

The next step for self-driving vehicles in logistics will be to overcome regulatory and security challenges to deploy autonomous vehicles on public roads.

Figure 2: DHL Parcelcopter for express delivery; **Source:** DHL

Looking up to the skies, **unmanned aerial vehicles** (UAVs), or drones, still require a bit more time before mainstream adoption. The commercial use of UAVs is heavily regulated in most countries; however first tests have demonstrated the future potential of UAVs especially in rural delivery scenarios. DHL's Parcelcopter, for example, has been successfully tested; it delivered medications and other urgently needed goods to an island as well as to a remote mountain region in Germany. Experiences gained from such projects will help to further improve the technology and accelerate adoption.

INTERNET OF THINGS – HYPE OR REVOLUTION?

Another trend causing a lot of buzz is the **Internet of Things** (IoT) and its potential to connect virtually anything to the Internet and accelerate data-driven logistics. It is estimated that by 2020, more than 50 billion objects will be connected to the Internet, presenting an immense $1.9 trillion opportunity in logistics.[1] New dedicated IoT networks such as LoRaWAN™[2] are also emerging to increase the speed of IoT adoption. Therefore it is no surprise that IoT has become a priority on the agenda for most major companies. However, only a few logistics applications with substantial business impact have materialized so far.

[1] http://www.cisco.com/c/dam/en_us/services/portfolio/consulting-services/documents/consulting-services-capturing-ioe-value-aag.pdf
[2] LoRaWAN™ – Long Range Wide Area Network

This is largely due to a shortage of standards in the industry, security concerns, and the fact that recent IoT innovations have mainly been developed for the consumer market. Therefore, logistics will have to wait until similar ruggedized versions that meet business requirements come to market.

MACHINES JOIN THE LOGISTICS WORKFORCE – A NEW FORM OF COLLABORATION

In contrast to IoT, significant strides are being made in the area of machine-human interaction and collaboration in logistics. **Augmented reality** (AR) accessed via smart glasses has exceeded predicted levels of impact. So far mainly adopted for order picking in logistics (also known as 'vision picking'), smart glasses enable intelligent, hands-free operations. First productive deployments have delivered promising results. A pilot by DHL and Ricoh in the Netherlands showed a 25% efficiency increase as well as strong positive feedback from the users.[3]

Figure 3: Vision picking using smart glasses; **Source:** DHL

A similar development can be seen in the area of **robotics and automation**. Complex logistics operations and cost sensitivity were key barriers to the adoption of industrial robots in the past. Next-generation robots have changed – they have become lighter, more flexible, easier to program, and more affordable.

Successful tests by DHL using collaborative robots have already demonstrated that robots can work side-by-side with employees, supporting repetitive and physically demanding tasks in logistics operations.

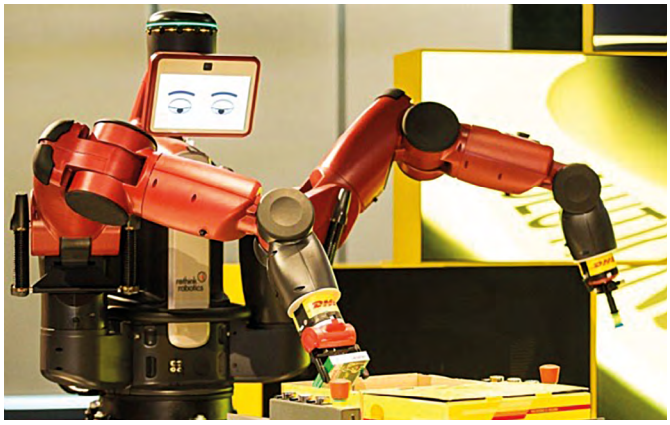


Figure 4: Collaborative robots in logistics; **Source:** DHL

DELIVERY OF ANYTHING, ANYTIME, ANYWHERE – THE FUTURE OF RETAIL LOGISTICS

While the transformative power of new technologies can be showcased in a relatively straightforward and tangible way, social and business trends, which are often a bit more difficult to grasp, have equal importance in redefining the future of the logistics industry.

One major trend that will make or break retailing and e-commerce in the future is **omni-channel logistics**. The modern shopper's journey now cuts across different channels including offline and online options. It is shifting from a sequence of actions in a single channel to a seamless variety of actions across multiple channels.

Logistics, as the backbone of retail, needs to react and offer innovative omni-channel solutions that satisfy the demand for more personalized, dynamic delivery options as well as fulfillment services at a competitive price level.

Over the past two years, this has led to the development of new solutions to facilitate last-mile delivery such as same-day and even same-hour delivery models (e.g., Amazon Prime), individual parcel lockers (e.g., DHL Paketkasten), and even delivery-to-car-trunk concepts.

[3] http://www.dhl.com/en/press/releases/releases_2015/logistics/dhl_successfully_tests_augmented_reality_application_in_warehouse.html

RISING DEMAND FOR FAIR AND RESPONSIBLE SUPPLY CHAINS

Besides the need for faster and individualized services, there is a growing movement towards **fair and responsible logistics**. Driven by megatrends such as sustainable consumption, digitalization, and globalization, companies now increasingly focus on turning social and environmental challenges into opportunities by creating fair and sustainable solutions that generate social as well as business value along the supply chain.

Fairphone, as one example, is a Dutch startup that has manufactured modular smartphones built from conflict-free minerals. The social enterprise focuses on supply chain transparency and traceability and, in the past several years, has sold over 60,000 units, highlighting the consumer demand for fairer products.[4] Looking ahead, this trend will increase transparency within supply chains, and require new circular economy concepts in logistics. A report on the subject, recently published by DHL, illustrates the first specific use cases in logistics.

These are only some of many trends that will impact or perhaps even disrupt the logistics industry over the coming years. Therefore, it is essential to continuously identify and assess trends in order to detect changes in time, react, and even directly influence the future of logistics. The upcoming section describes the four key sources of inspiration used to identify and evaluate trends in this year's update.

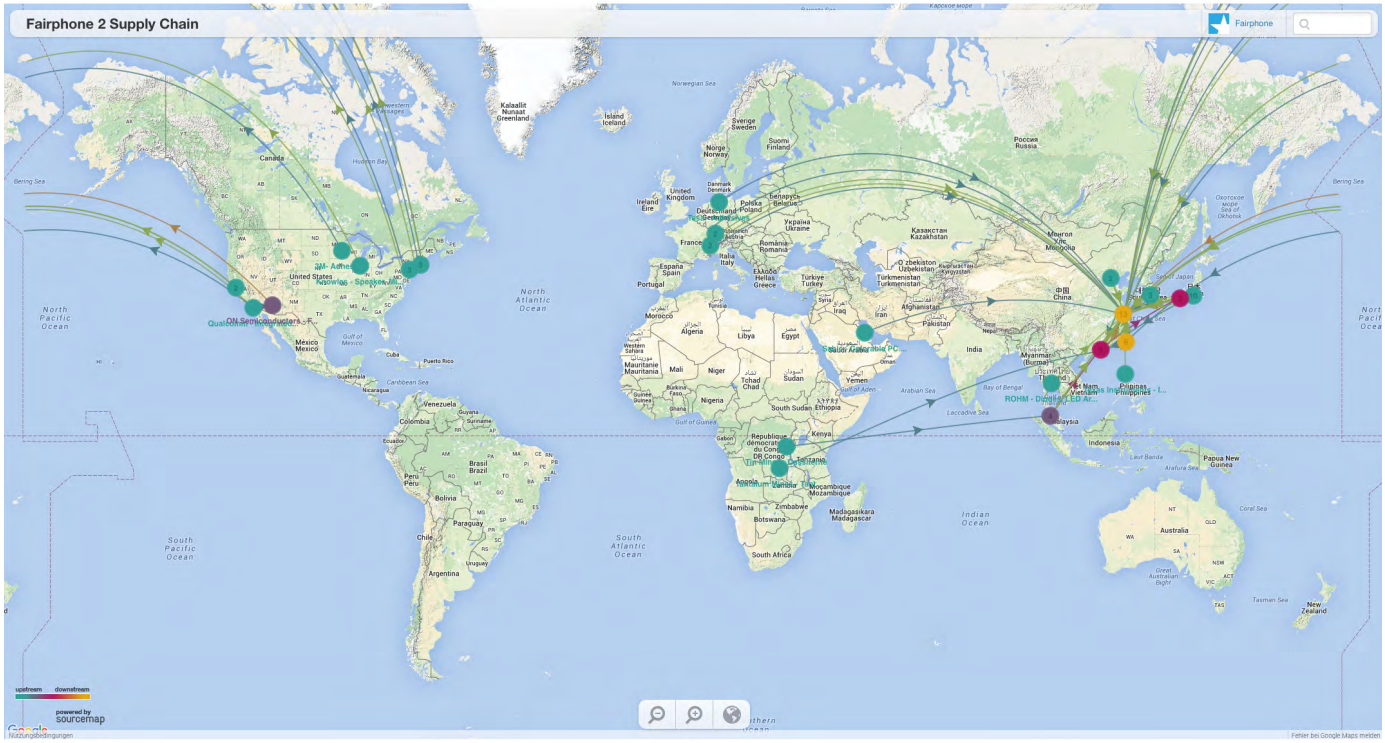


Figure 5: Creating supply chain transparency; **Source:** Fairphone

[4] https://www.fairphone.com/roadmap/

RIGHT HERE, RIGHT NOW:
FOUR SOURCES OF INSPIRATION FOR OUR LOGISTICS TREND RADAR

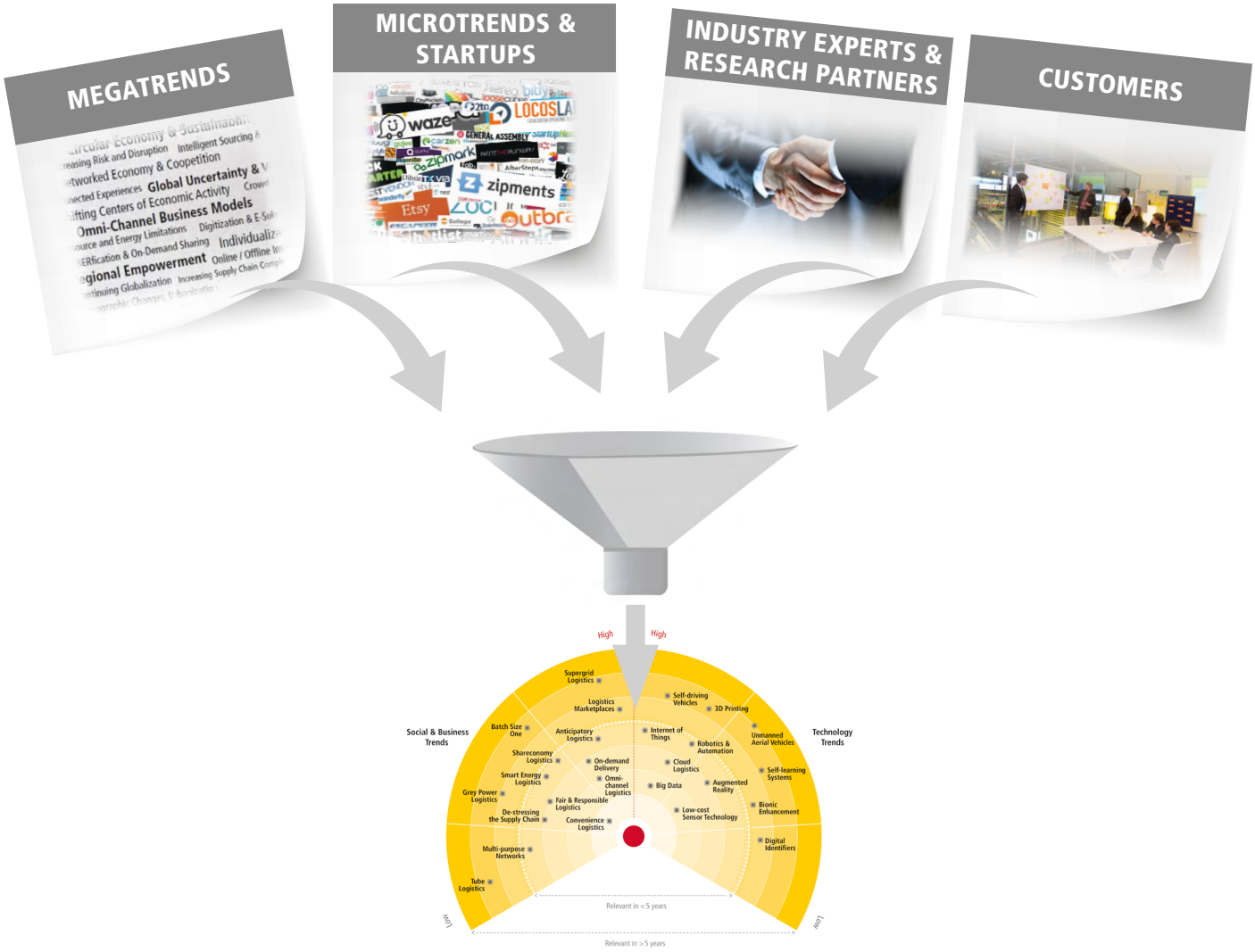


Figure 6: Key sources of trend identification; **Source:** DHL

HOW DO WE IDENTIFY TRENDS?

The Logistics Trend Radar is a dynamic, living tool that changes over time through regular insights gathered from our four key sources of inspiration.

The first source is **megatrends**, which are often global, stable, long-term changes that determine broader social, technological, and economic frameworks. The second source is the exact opposite; they are **microtrends and startups**. Today's small trends and innovations from start-ups could be tomorrow's source of growth or disruption, playing a major role in shaping the future of logistics. The third source is our broad network of **industry experts and partners** such as research institutes and technology companies. This enables us to understand the next generation of logistics and technology research and development. And of course, our fourth and most important source is our **customers**. Frequent and open discussion with customers on the future of their industries enables us to anticipate trends that are affecting their lines of business and consider the impact of this on logistics.

The next section illustrates what insights we have gathered from these key sources, which will then be aggregated and structured in this new edition of the Logistics Trend Radar.

MEGATRENDS

Starting with the assessment of global developments, well-established megatrends such as globalization, urbanization, and demographic change continue to rise in importance. Alongside these, we also observe great momentum and dynamic growth in the following three megatrends.

GROWING SECURITY AWARENESS

High-profile data breaches and hacking of data systems as well as even physical objects (such as cameras and self-driving cars) are a worrying reminder of growing security vulnerabilities in our digitalized world. In increasingly IT-rich supply chains, eliminating security risks has become a top priority to avoid harmful attacks that could bring entire operations to a standstill. This mounting security awareness is in turn decelerating the adoption of cloud logistics, despite its substantial cost and efficiency benefits.

In parallel, continued global market volatility and regional instability have led to tightened security regulations that require higher levels of supply chain transparency and integrity. As a reaction to this, companies are weighing security against risk, increasingly de-stressing the supply chain by making tactical 'slow-downs' that prioritize operational security over speed. To help raise the level of security and resiliency in logistics, innovative digital identifiers that allow unambiguous, tamper-proof identification of items and individuals could be deployed.

Figure 7: Growing importance of cyber security

NEW ENERGY LANDSCAPE

Energy will be redefined over the next decade, especially in the context of coping with the limited availability of energy resources and the movement towards sustainable energy use.

Figure 8: Smart energy is on the rise

Although sustainability has been on the agenda for a while, its urgency was fueled by the 2015 United Nations 'Paris Agreement', a global commitment to restrict greenhouse gas emissions and halt climate change. Regulations that require companies to adhere to these new targets will present challenges as well as opportunities in logistics in the coming years. One prospect is to embrace the use of energy harvesting technologies to reduce reliance on the grid and save costs.

Furthermore, there is an accelerated movement away from the use of fossil fuels towards renewable energy sources, such as solar and wind power. This could reduce volumes of fossil fuel transportation and help to decentralize energy supply chains, which in turn will transform logistics requirements.

Furthermore, the shift to sustainable energy has also given rise to growing e-mobility solutions such as e-vehicles and bikes which will require totally new logistics concepts to support, for example, the full end-to-end lifecycle of lithium batteries.

DIGITALIZATION OF LOGISTICS

The digitalization of everything is a phenomenon that is changing and, in many cases, disrupting almost all established industries. The postal sector learned first-hand the transition from analog to digital through the advent of email and online communications; these services have diminished mail volumes over the last 15 years. But is this the fate of other logistics services as well? Will physical transportation be displaced by an exchange of bits and bytes?

It may sound far-fetched but 3D printing could impact goods transportation in much the same way as email impacted letters. Some products will no longer be manufactured in large mass-production facilities and shipped around the globe. Instead, product schemes will be digitized and sent to small factories where products will be 3D printed closer to the customer. This allows for a hyper-customization of products, resulting in 'batch size one' production, accompanied by subsequent new logistics service concepts.

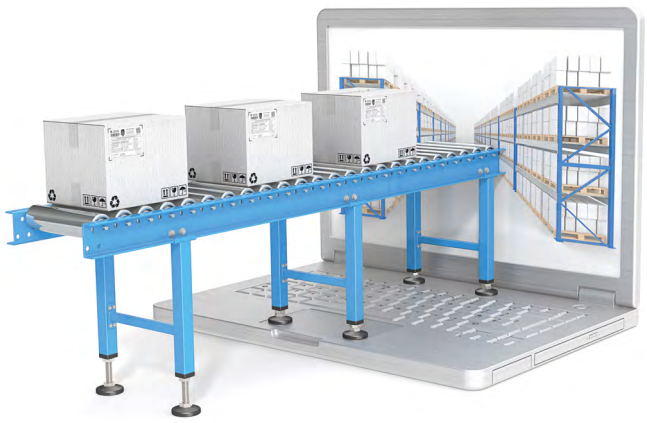


Figure 9: Digital transformation of logistics

Moreover, further technologies such as big data analytics, Internet of Things, and self-learning systems will continue to digitalize logistics processes, enabling new ways of increasing process efficiency, enhancing interaction with customers, and driving new business models.

Logistics, International Trade, and the New Global Economy – A World Bank Perspective

The World Bank monitors logistics as the engine of an increasingly complex global and regional production and supply chain. It is one of the key sectors that we actively track through our Logistics Performance Index (LPI). In the coming years we anticipate two major changes that will impact this industry.

First, logistics will be greatly affected by a global shift in economic power of E7[5] countries over the next decade[6] as well as regional changes, especially in Asia-Pacific which has quickly grown to now account for 50% of international trade.[7]

Key developments worth highlighting are the major investments being made by the Chinese government in trade lanes to Europe. Also known as the 'One Belt, One Road' strategy, this could significantly foster further trade growth between China and the European Union.[8] In addition, the Trans-Pacific Partnership (TPP) agreement, if ratified, could raise trade by 11% in member countries until 2030.[9] The TPP will expand market access, easing tariffs, imports, and customs requirements. It will also increase supply chain integration by encouraging greater consistency in standards and regulation.

Second, logistics will experience a systemic change in terms of workforce and technology adoption. Logistics will be challenged by increasing competition as well as a growing shortage of skilled workers as the baby boomer generation retires.[10] To solve these challenges, logistics is entering a phase of technical transition. Adoption of automation technologies like collaborative robotics will significantly rise in order to meet increasingly complex customer needs and to cope with the aging workforce and skills shortage.

In summary we are in a period of rapid change. Macroeconomic volatility and shifts in trade patterns will result in the rebalancing of global logistics and trade. In addition, structural changes in terms of workforce demographics and technological innovation will determine the shape and the speed of change within logistics.

Jean Francois Arvis
Senior Economist
Trade and Competiveness
Global Practice
The World Bank

[5] E7 is a group of seven countries with emerging economies (China, India, Brazil, Mexico, Russia, Indonesia, Turkey)
[6] http://www.pwc.co.uk/issues/megatrends/shift-in-global-economic-power.html
[7] http://data.worldbank.org/data-catalog/eap-economic-update
[8] http://trade.ec.europa.eu/doclib/docs/2006/september/tradoc_122530.pdf
[9] https://www.worldbank.org/content/dam/Worldbank/GEP/GEP2016a/Global-Economic-Prospects-January-2016-Spillovers-amid-weak-growth.pdf
[10] Statista, 2016: Alterungsprozess in Deutschland, China, Indien und den USA bis 2030

MICROTRENDS AND STARTUPS

It's not only long-term megatrends that play a role in shaping the tomorrow of logistics; microtrends and startups can also instigate change over a much shorter time span. Recent years have witnessed startups that have managed to disrupt mature industries in a matter of years, not decades. One example is the hospitality industry and the peer-to-peer lodging site Airbnb. Since its founding as a startup in 2008, Airbnb estimates that over 30 million guests used Airbnb, bypassing traditional hotel rooms.[11]

Could something like this happen in logistics as well? Over the past few years, there has been a structural change of market mechanisms and dynamics in the startup sector. New market entrants profit from a fresh culture of investment, making capital available through new and unconventional streams such as venture crowd funding. Startups are usually also liquid in terms of assets, which enables them to react in an agile manner to new market dynamics.

This has created what can be called the unbundling of logistics services (see figure 10). Established supply chain services can be unbundled into singular solutions that can be delivered better through tech-savvy startups.

One key area developing fast is asset-light, 'on-demand' brokerage platforms that easily match demand and supply for logistics services such as Uber Rush for on-demand delivery services in cities. The ultimate vision for these platforms is a supergrid coordinating multiple marketplaces.

Beyond the recent hype, the degree of disruption to established players remains uncertain due to the complexity and fragmented nature of the logistics industry. Key questions still need to be answered: Is an unbundling of physical transportation and marketplaces really possible, and to what degree; and is it feasible to broker complex bundles (e.g., bundles from a forwarding product portfolio) through a standardized and automated interface?

How Startups are Redefining Logistics – A 500 Startups Perspective

As one of the most active venture capital fund and startup accelerators in the world, we at 500 Startups see the logistics industry increasingly becoming an attractive target market for investment. In fact, since 2014, over $1 billion in venture capital has been invested into startup freight-forwarding companies, almost twice the amount invested in the five years prior.[12] What makes logistics so attractive? In brief, logistics is the backbone of global trade, but at the same time has been a fragmented industry and a slow adopter of new technologies. The underdeveloped market potential along with the potential of harnessing technology to meet this need make this industry a target for disruption.

Typical trends in logistics include disintermediation of brokers, aggregation of shipments, and Software-as-a-Service (SaaS) replacing antiquated processes. Hence, what makes startups in logistics successful is technological advancement and increasing transparency in the market. This is how *Eyes On Freight* disrupts the marketplace for brokers; it helps shippers and shipping companies find one another in a global marketplace based on preference, budget, and needs, saving companies up to 30% of shipping expenses.

In stark comparison, large, established companies are often left with legacy IT systems that make globally streamlined IT services difficult to achieve. From our own investments, we see that logistics startups are in particular focusing on owning the 'logistics interface', creating online marketplaces that connect logistics demand with supply yet owning none of the assets and infrastructure. Another great example for logistics is *Shippo*, a recent 500 Startups investment, based in San Francisco; its shipping API for e-commerce bundles shipments from small and medium enterprises together so they can be shipped with lower negotiated rates.

In summary, can startups really disrupt established industry giants? Definitely in some service segments, but logistics providers do not have to take a reactive approach to startups. Some are already partnering with startups, while others are acquiring startups or are even breeding their own startups in in-house incubators. Thus, they themselves can drive rapid innovation in logistics.

Ed Spiegel
Entrepreneur in Residence
500 Startups

[11] http://blog.airbnb.com/wp-content/uploads/2015/09/Airbnb-Summer-Travel-Report-1.pdf
[12] Pitchbook Data (2014)

STARTUPS UNBUNDLING THE LOGISTICS INDUSTRY

Figure 10: Startups unbundling the logistics industry; **Source:** DHL

INDUSTRY EXPERTS AND RESEARCH PARTNERS

Logistics is a service industry by nature. That's why open collaboration and innovation with a strong global partner network is crucial to keep up with the latest trends and developments in technology. Being the economic backbone of a globalized and interconnected world, logistics has a strong position on the agenda of research institutions and technology providers around the globe. And close cooperation with these partners enables us to look at the future through a different lens.

Whereas most past research collaborations have been characterized by detailed, formalized contracts and intellectual property frameworks, today there is a push towards getting projects underway faster with more agility and risk. Research institutes and technology companies are becoming more open in sharing their ideas and prototypes, increasing the chances of getting solutions quicker to market. Some have also become open to sharing research data. One example is the open-access pool of logistics-related data in megacities, run by the Massachusetts Institute of Technology (MIT) in the US.

Experience in recent years has shown that cross-industry collaboration and joint initiatives with research institutes deliver promising results. For example, the Fraunhofer Institute and RWTH Aachen University in Germany are demonstrating the importance of the practical application of scientific research. One very successful outcome of cooperation between industry and academia is a custom-designed electric delivery van called StreetScooter jointly developed by RWTH Aachen University and DHL – the first prototype was released in 2012 and today more than 100 vehicles have been deployed.

Figure 11: E-vehicle StreetScooter; **Source:** Aachener Zeitung

Relatively Fundamental: Logistics Research in Times of the Fourth Industrial Revolution – A Fraunhofer IML Perspective

"Logistics is a pervasive force penetrating all physical and its movements. It is also an expression of mankind's determination to set things in motion."[13]

Logistics characterized by the fourth industrial revolution faces a central task as industry and science: It combines the »macroscopic« view of the virtual, normative world with the »microscopic« view of the real, operative world. This involves a wide range of implications and raises fundamental questions. One key question is how to best transfer the (deterministic) planning to a clientele of (probabilistic) autonomous, cyber-physical systems? Or put it another way, how can a crowd of autonomous containers or 'inBins' be lined up in the right order for loading onto a truck? This is certainly not a trivial question, in particular, if there is no central authority anymore, but at the same time the boisterous »chatting« of hundreds of inBins has to be avoided.

Even more fundamental are the logistics-related issues arising from human-machine interaction. Today, machines can already be controlled by voice commands or gestures. In future, people will communicate with complex robots and even with swarms of simple cyber-physical systems like inBins or »intelligent« mobile shelves. Communication won't be unilateral anymore. Machines will also approach humans, for example, in order to trigger replenishment activities or schedule maintenance work. To put it straight: machines will be able to make decisions. This causes two fundamental questions: What role will humans play in the decision-making of the machines and how will responsibilities be shared between humans and machines?

This demonstrates how fundamental and metaphysical the entitlement of logistics is as scientific discipline in times of the fourth industrial revolution. Logistics more and more considers itself as driving force for both scientific and technological progress. Key driver is the implementation of the Internet of Things in terms of the self-organization of future supply chains on the basis of cyber-physical systems like intelligent containers, vehicles, and drones. This new world calls for logistics, as a new, interdisciplinary form of research and development in which logistics acts as an intermediary between informatics, statistics, mathematics, economics and engineering science. Looking ahead, logistics should not only search for new business models, but also recognize itself as a driving force behind the fourth industrial revolution.

Prof. Dr. Michael ten Hompel
Chair of Materials Handling and Warehousing at TU Dortmund University
Managing Director at Fraunhofer Institute of Material Flow and Logistics IML

[13] ten Hompel, M.: Menschen und Dinge bewegen – Ein Memorandum. In: Forschungsagenda Logistik, Ausgabe Issue 1/2013, p. 12-14.

CUSTOMERS

Open innovation is pivotal to incorporating early feedback from customers and to understanding their challenges. This approach is the best way to develop solutions for the future. Being closer to customers and their industries is ever-more important as supply chains become more complex, requiring tailored solutions that are industry- or even customer-specific.

To achieve this customer-centric approach to innovation, logistics providers require new platforms to exchange ideas and jointly discover innovations that can be prototyped and tested. The DHL Innovation Centers in Germany and Singapore are examples of such platforms; they are focused on driving discussion with customers on future trends and challenges in their specific industries.

Figure 12: DHL Innovation Center in Germany; **Source:** DHL

Looking ahead, logistics providers have to adapt their organizations to cater for the specific needs and challenges of different sectors (e.g., automotive, life sciences, retail, and technology, to name a few). The automotive sector, for example, is being transformed by the shift towards electric mobility which could require new solutions for battery logistics. In life sciences, increasing temperature-controlled shipments will entail higher levels of security and integrity in transportation. And in the technology sector, changing consumer buyer behavior and sales channels combined with increasingly shorter product lifecycles will require flexible solutions to address peaks in transportation and goods storage. As illustrated, each industry has its own set of trends, which in turn could have important implications for logistics requirements as well as opportunities for first-movers.

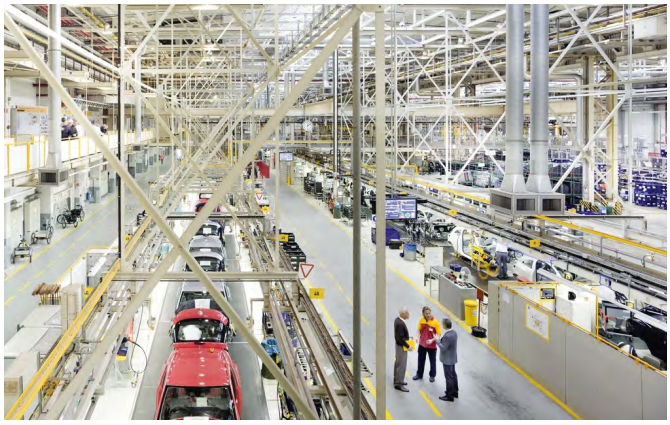


Figure 13: How will production change in the future?; **Source:** DHL

In summary, these four sources enable us to understand trends and developments from a variety of different perspectives to build a holistic view of the future of logistics. The input gathered from these sources through research, interviews with industry experts, and dialog with our customers is reflected in the new Logistics Trend Radar, which is explored in the upcoming section.

Customer Centricity and Innovation in the Technology Sector – An HP Perspective

Customers at the Center of Agile Development

Like all companies, and especially those in the technology sector, HP has been affected by ever-increasing pressures to shorten time-to-market and increase the level of innovation and value delivered to our customers. The only way to be successful is rooted in deep understanding of our customers and ensuring that we have very strong value propositions that serve their needs in unique ways.

The key to staying ahead is constantly validating that we are meeting customer value objectives and that customer judgment is embedded from concept development through to the point of launch and delivery. At HP we do this in a variety of ways and the results have led, in certain cases, to surprising outcomes. In one case, it resulted in the formation of a new business division because breakthrough ideas were uncovered by listening very carefully to a visionary customer and being bold enough to deliver on this customer's wishes.

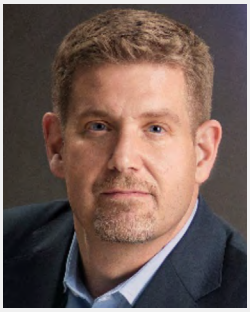
Continued on next page

The Rise of 3D Printing

At HP, we are starting the journey of developing 3D printing solutions with the express objective of delivering parts that are acceptable for final production. Imagine a world where you can use the same technology for prototyping, for market testing of short runs, for ramp production, series production and for critical and long-tail spare parts. Imagine being able to use the same machines for a wide variety product types without the need for hard tooling. This would mean much more flexible, efficient capital investment, which could be distributed to put supply closer to demand. The impact to product cycle times and logistics demands would be dramatic.

But there are some problems that have to be solved before this vision can be realized. HP will make a great contribution to the industry with the introduction of our disruptive 3D printing technology, Multi Jet Fusion™, but this alone is not adequate to effect a market transformation. Changes will be needed to the design tools so they accommodate a much greater range of capabilities. More changes will be needed in the standards and protocols, and – maybe most of all – big changes will be needed in the cost of inputs to help the 3D printing market reach its fullest potential. By taking a very collaborative and open approach, HP aims to help the entire industry advance.

In many ways, the challenges facing the current 3D printing market are very similar to those that faced the printing market created with the advent of the personal computer in the 1980s. Cost, interoperability, consistency of output, ease of use, and the number of uses and applications were all major enablers that helped the market expand. Back then, HP made key contributions to help grow that market to its current state, worth in the hundreds of billions of US dollars, and here now we see a similar opportunity to contribute to the future of 3D printing.



Joseph Scott Schiller
VP, Global Head of Market Development HP 3D Printing
Hewlett-Packard Company

WHAT'S IN – WHAT'S OUT? CHANGES IN THE LOGISTICS TREND RADAR

Since the last major update of the Logistics Trend Radar, the world of logistics has greatly evolved and the consequent changes are reflected in this year's edition.

New trends have emerged whilst others have evolved. One new trend that has been identified and captured on our radar is 'batch size one' which follows the megatrend of hyper-customization. In future, manufacturing and retail strategies will change to adapt to increasing consumer demand for product personalization. This will require agile supply chains ready to adapt to changes in time and place of batch size one production. Early movers can leverage this trend to their competitive advantage by providing, for example, new postponement and delivery services.

At the same time, some trends like crypto-currencies and crypto-payment have fallen off the radar as new insights and developments have reduced their relevance and potential in logistics. Several others have matured and have become the 'new normal', no longer qualifying as true trends. Finally, some trends that still contain high relevance for logistics like localization & local intelligence have been phased-out as a singular trend and instead will be monitored on a broader context through overarching trends such as the Internet of Things.

For this 2016 edition, each individual trend description has also been updated to reflect the latest developments and implications and also includes the projected sector relevance based on the opinions of logistics experts.

We now would like to introduce you to the new Logistics Trend Radar and hope this serves once again as a valuable source of insight and inspiration!

SOCIAL AND BUSINESS TRENDS: NEW ADDITIONS AND MAJOR UPDATES

BATCH SIZE ONE: New customer demands such as hyper-customization are changing the manufacturing industry. The handling of 'batch size one' (i.e., only one item is produced) requires highly automated production sites and imposes complex new requirements on supply chains.

ON-DEMAND DELIVERY: Formerly named 'crowd logistics', this trend has significantly advanced over the last two years. Triggered especially by the entry of Uber Rush, this trend covers a broader variety of crowd-sourced delivery applications.

SMART ENERGY LOGISTICS: The shift to e-mobility, new energy regulations, and harvesting technologies will result in decentralized energy supply chains that drive new business opportunities in logistics as well as more sustainable logistics services.

TUBE LOGISTICS: Propelled by technological progress in driving systems, and by growing traffic volumes on road and rail networks due to urbanization, there is renewed and growing interest in the use of existing and new tube infrastructures for cargo transportation.

TECHNOLOGY TRENDS: NEW ADDITIONS AND MAJOR UPDATES

BIONIC ENHANCEMENT: This trend was called 'wearable technology' in our last update and has since developed beyond its former focus to incorporate the dimension of exoskeletons. Especially in logistics, expanding the boundaries of our physical limitations enables new ways to increase process efficiency and improve health and safety.

DIGITAL IDENTIFIERS: Smart sensors tags and biometrics are pushing logistics processing towards a new level of granularity; this evolution means that single units, components and even individuals can be securely identified through unique, digital codes.

SELF-LEARNING SYSTEMS: Strong advancements in algorithms, computational power, and hardware are enabling new forms of machine learning applications in logistics. This offers immense potential for autonomous data-driven decision making and process optimization in logistics.

UNMANNED AERIAL VEHICLES AND SELF-DRIVING VEHICLES: The relevance and maturity of autonomous logistics has advanced over the past few years. That's why this report now splits this trend into two complementary topics: unmanned aerial vehicles and self-driving vehicles. Developments open a totally new perspective on time slots and routes for delivery services.

PHASE-OUTS

NEAR- & X-SHORING: Feedback from the global logistics community reveals that this trend has already arrived in the logistics industry and is no longer a singular trend to be included on the radar. It is instead reflected in the trends of batch size one and 3D printing.

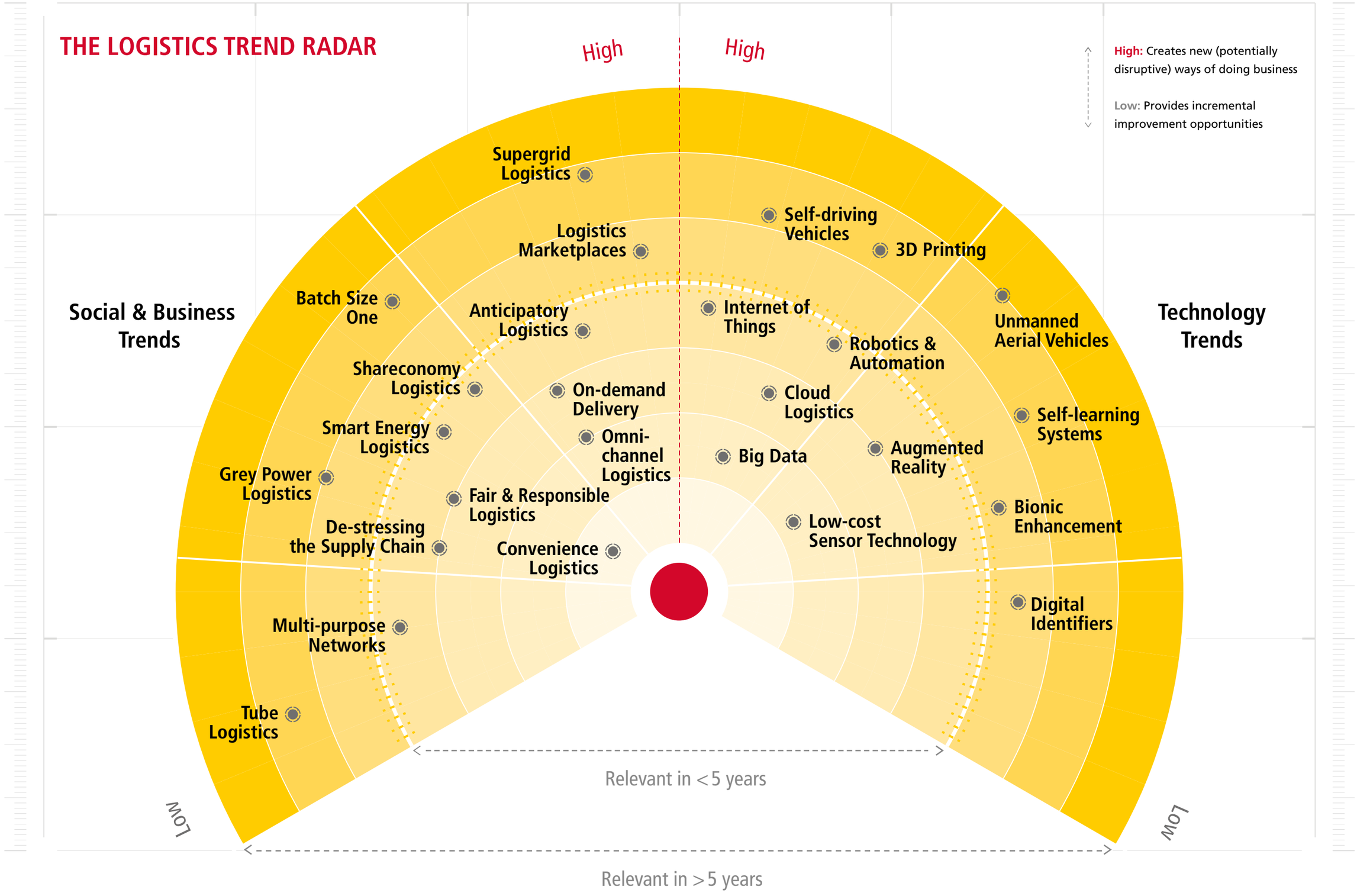
REAL-TIME SERVICES: With real-time order and asset tracking having been adopted over many years, developments in real-time services will be continuously tracked via other trends such as cloud logistics, the Internet of Things, and digital identifiers.

URBAN LOGISTICS: Although still highly relevant and important in logistics, this trend is a broad term which covers many urban logistics services already being offered today. Trends such as the shareconomy, omni-channel, and on-demand delivery will now reflect the next evolution of urban logistics.

CRYPTO-CURRENCIES & CRYPTO-PAYMENT: This trend is now considered out of scope, as it is unlikely to be widely adopted in the logistics industry within the 5-10 year timescale of the radar.

LOCALIZATION & LOCAL INTELLIGENCE: This trend still contains high relevance for logistics but has been phased-out as a singular trend as it has been integrated into other technology trends such as the Internet of Things and big data.

THE LOGISTICS TREND RADAR



OVERVIEW: TRENDS SUMMARY

LOGISTICS TREND RADAR: SOCIAL & BUSINESS TRENDS

TREND	IMPACT	TIMEFRAME	SUMMARY
Anticipatory Logistics	**High**	**< 5 years**	Powered by big data-based predictive algorithms, anticipatory logistics enables logistics providers to significantly boost process efficiency and service quality by predicting demand before it occurs, to achieve faster delivery times and enhanced capacity and network utilization.
Batch Size One	**Medium**	**> 5 years**	Increasing consumer demand for personalization could lead to the mass production of highly customized goods tailored to the individual, resulting in decentralized 'batch size one' production. This will require supply chains to adapt rapidly to changes in time and place of production.
Convenience Logistics	**Medium**	**< 5 years**	Online shoppers enjoy not just the price advantage of purchasing online, but also 24/7 availability and convenience. With increasing consumer trust in purchasing groceries and pharmaceuticals online, there is high demand for new cold-chain packaging and delivery solutions.
De-stressing the Supply Chain	**Medium**	**< 5 years**	De-stressing aims to reduce supply chain complexity by using the right mix of transportation modes to operate sustainably at lower cost with higher quality. For example, a tactical transportation 'slow-down' can balance the supply chain, cut storage costs, and even reduce the carbon footprint.
Fair & Responsible Logistics	**Medium**	**< 5 years**	The intersection between the need to remain competitive and the need to increase sustainability has given way to a new strategy called fair and responsible logistics. Logistics providers can meet these demands by providing new services that generate revenue while also improving the welfare of society and the environment.
Grey Power Logistics	**Medium**	**> 5 years**	In five or more years' time, the first wave of digital natives will enter the aged population segment. Grey power logistics – the logistics for an aging society – will offer new services (e.g., home delivery of medicines) to answer the resulting challenges of this demographic development.
Logistics Marketplaces	**High**	**> 5 years**	The growing need for transparent, flexible and easily adjustable logistics services fosters the creation of disruptive digital brokerage platforms that match a variety of logistics demands with supply. Such centralized marketplaces can provide visibility on the information, rates, and services of different logistics providers.
Multi-purpose Networks	**Low**	**< 5 years**	Multi-purpose networks refer to the utilization of standard, existing networks and city infrastructure to transport and store goods, especially those that are temperature-sensitive. This is enabled by innovations in transportation, packaging, and real-time supply chain monitoring.
Omni-channel Logistics	**High**	**< 5 years**	The next generation of retail requires logistics networks tailored to the needs of each single channel. This 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.
On-demand Delivery	**High**	**< 5 years**	Delivery is no longer owned by larger players who set limitations on delivery times and locations. New on-demand last-mile delivery concepts utilize the power of the crowd and flexible courier workforces to enable customers to have their purchase delivered when they need it, where they need it.
Shareconomy Logistics	**Medium**	**< 5 years**	The societal shift from ownership to asset sharing has been one of the most ground-breaking trends in recent years. Everything from cars to driveways can now be shared on platforms. Besides facilitating these new peer-to-peer sharing networks, logistics providers can also share their existing resources to become more cost- and time-efficient.
Smart Energy Logistics	**Medium**	**< 5 years**	The increasing shift towards renewable energy sources is propelling the adoption of electric mobility solutions in logistics. It also provides opportunities for logistics solutions that facilitate new energy supply chains. Innovative energy harvesting, storage and distribution concepts can also be leveraged to reduce reliance on the grid.
Supergrid Logistics	**High**	**> 5 years**	Going beyond 4PL logistics, supergrid logistics will bring up 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.
Tube Logistics	**Low**	**> 5 years**	Propelled by technological progress in driving systems and growing congestion in megacities, there is renewed interest in the use of existing and new tube infrastructures for cargo transportation. New innovations such as the Hyperloop could one day provide rapid cargo transit networks within and between cities.

LOGISTICS TREND RADAR: TECHNOLOGY TRENDS

TREND	IMPACT	TIMEFRAME	SUMMARY
3D Printing	**High**	**> 5 years**	3D printing is a disruptive technology that will change tomorrow's logistics by adding new diversity to manufacturing strategies. Innovative logistics providers can become thought leaders in orchestrating complex networks that include traditional and 3D manufacturers.
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, AR empowers workers by providing the right information, at the right time, and in the right place.
Big Data	**High**	**< 5 years**	Logistics is being transformed through the power of data-driven insights. Unprecedented amounts of data can now 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.
Bionic Enhancement	**Medium**	**> 5 years**	Wearable technologies and exoskeletons expand the boundaries of current physical barriers. Smart clothing, bionic arms, and even smart contact lenses have the potential to support the logistics workforce in areas such as communication, process execution, and minimizing health and safety risks in the supply chain.
Cloud Logistics	**High**	**< 5 years**	Ideal for complex, volatile environments, cloud computing enables 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.
Digital Identifiers	**Low**	**> 5 years**	New generations of digital identifiers such as digital watermarking and disposable smart labels increase transparency and traceability in the supply chain. Biometrics can also provide new methods of identification and can increase security in operations.
Internet of Things	**High**	**< 5 years**	The Internet of Things empowers smart objects to be active participants in self-steering, event-driven logistics processes. Logistics is one of the major industries that will benefit from the intelligent conjunction of information and material flows.
Low-cost Sensor Technology	**Medium**	**< 5 years**	Established consumer sensor technologies enable new applications within the logistics industry. With access to low-cost sensors, logistics is likely to increase the use of sensors, creating smart infrastructures for monitoring, inspecting, and volume scanning in the supply chain.
Robotics & Automation	**High**	**< 5 years**	Robotics and automation technologies support zero-defect logistics processes and enable new levels of productivity. The new generation of collaborative robots and automated solutions with significantly improved performance and enhanced sensing capabilities offers a genuine alternative to manual handling.
Self-driving Vehicles	**High**	**> 5 years**	Breakthroughs in sensor and imaging technologies have resulted in a new generation of self-driving vehicles that are more flexible and reliable than ever before. From autonomous forklifts to driverless trucks, self-driving vehicles will transform logistics by unlocking new levels of safety, efficiency, and quality.
Self-learning Systems	**Medium**	**> 5 years**	Self-learning or 'machine learning' systems will become a game-changing enabler for completely autonomous data-driven optimization in logistics. With minimal/no human intervention, a self-learning system will adapt and improve its algorithms as it receives more data, improving its results over time.
Unmanned Aerial Vehicles	**Medium**	**> 5 years**	Unmanned aerial vehicles (UAVs) or 'drones' could change tomorrow's logistics by adding a new form of express delivery via carefully coordinated air networks. While UAVs won't replace traditional ground-based transportation, they will provide value in areas of high traffic congestion and in remote locations.

In-depth: Social & Business 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.

AUTOMOTIVE
AUTO

ENGINEERING & MANUFACTURING
E&M

TECHNOLOGY
TECH

ENERGY
ENERGY

LIFE SCIENCES & HEALTHCARE
LSH

RETAIL & CONSUMER
RET&CON

ANTICIPATORY LOGISTICS

Powered by big data-based predictive algorithms, anticipatory logistics enables logistics providers to significantly boost process efficiency and service quality, shortening delivery times by predicting demand before a request or order is even placed. In addition, new predictive maintenance and supply chain risk concepts will further optimize logistics operations.

KEY DEVELOPMENTS & IMPLICATIONS

Anticipatory logistics continues to be strongly driven by increasing customer demand for shorter lead times from order to delivery. First experiments are being made by retailers to anticipate demand. In an industrial context, predictive maintenance will continue to become a key area of focus thanks to the Internet of Things which is enabling new applications through intelligent machines and vehicles capable of predicting a logistics or maintenance need.

- **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. In future, prediction-based shipping will run alongside the traditional order-based delivery – the challenge will be to integrate both methods in the network.

- **Predictive maintenance** using the data gathered from real-time monitoring of smart assets (such as machines and vehicles) can be analyzed to predict maintenance needs; this will reduce downtime both for logistics providers and their customers. These intelligent assets can also anticipate spare parts logistics. For example, the general wear of certain heavy machinery components would be predicted ahead of time so that replacements can be delivered at the right time and to the right place.

- **Predictive supply chain risk management** supports the logistics provider in detecting risks in trade lanes and potential damages to cargo (e.g., monitoring shock movements) to take corrective action and minimize operational delays.

- **Smart capacity planning** using anticipatory algorithms can be used to match the right level of logistics resources to meet demand (e.g., accurately predicting the required logistics capacity for peak shopping seasons).

KEY OPPORTUNITIES

- Increases customer satisfaction through improved order and delivery experience (e.g., reduces lead times)
- Lean inventory management through accurate prediction of demand
- Efficient resource and capacity utilization based on improved precision in planning

KEY CHALLENGES

- Requires open data exchange between the logistics provider and customer to enable anticipatory services
- Scarce skills and resources for understanding and handling advanced analytics methods and tools
- Costly and complex analyses of massive amounts of data
- Issues of compliance with data security and privacy regulations (e.g., tracking online behavior)

The Future of Trucking – Volvo Maintenance on Demand

- A commercially viable truck integrated with a variety of smart sensors to identify where and when maintenance is required
- Solution enables the possibility of just-in-time spare parts delivery
- Decreases logistics costs and increases vehicle uptime

Source: Volvo

TREND ASSESSMENT

Timeframe: < 5 years | Impact: High

Sector relevance:

AUTO E&M TECH ENERGY LSH RET&CON

BATCH SIZE ONE

Increasing consumer demand for personalization could lead to the mass production of highly customized goods tailored to the individual, resulting in decentralized 'batch size one' production. This requires supply chains to adapt rapidly to changes in time and place of production, and also offers new postponement service opportunities for logistics providers.

KEY DEVELOPMENTS & IMPLICATIONS

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

- **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 their customer. 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.

- **Agile batch size one delivery concepts** are triggered by the increasing number of single orders, and shorter delivery routes as production becomes more decentralized. These concepts enable reduced lead times, efficient last-mile delivery, additional loading points, smaller loads/charges, higher service volumes, more frequent delivery, and individualized services. With new supply chain processes, logistics providers will be able to offer customers the added value of near-instant delivery services – a differentiation that will demand strong cooperation with partners and workforce flexibility, along with state-of-the-art IT capabilities such as dynamic route optimization and open interfaces.

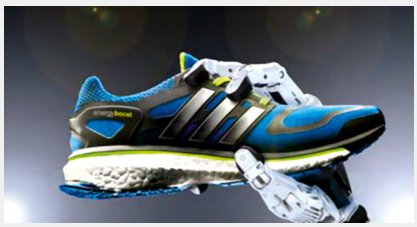
KEY OPPORTUNITIES

- 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
- Supply chain complexity and workforce flexibility are likely to increase cost

Batch Size One Production – Adidas Speed Factory



- Adidas is developing a worldwide network of high-tech low-distance manufacturing facilities or 'speed factories'
- Located within regional sales markets, significantly reducing freight costs
- Enables 'on-the-spot' automated production and shipping; batch size can reduce to a single unit

Source: Adidas

TREND ASSESSMENT

Timeframe: > 5 years | Impact: Medium

Sector relevance:

AUTO E&M TECH ENERGY LSH RET&CON

CONVENIENCE LOGISTICS

Online shoppers enjoy not just the price advantage of purchasing online, but also 24/7 availability and convenience. With increasing consumer trust in purchasing groceries and pharmaceuticals online, there is high demand for new cold-chain packaging and delivery solutions that maintain the integrity and traceability of temperature-sensitive products. This fosters innovative forms of climate-controlled supply chains that cater to these special requirements.

KEY DEVELOPMENTS & IMPLICATIONS

Growing consumer demand for shopping convenience is adding to delivery volumes of climate-controlled products. Between 2010 and 2014, delivery volumes of fresh foods (e.g., refrigerated foods, specialty items) rose by 40% and continued growth is expected in the coming years.[14] Delivery volumes are also increasing in life sciences and healthcare – by 2018, global sales of biopharma cold-chain products are expected to increase annually by 13%.[15] To fulfill demand, logistics providers will need advanced supply chains with innovative technologies for controlling, tracing, packaging, and authenticating cold-chain products.

- **On-demand delivery of fresh foods** is growing in popularity, with established supermarket chains and new market entrants such as Amazon and Instacart responding with rapid grocery delivery services and easy payment methods. In addition, the B2C relationship is being reinvented by 'farm-to-fork' business models that directly connect food producers to consumers. To support the expansion of these companies, logistics providers will need to provide more cold-chain and last-mile delivery solutions.
- **End-to-end cold-chain networks** are becoming more reliable, enabling increases in delivery volumes of sensitive goods (e.g., chilled and frozen foods, and pharmaceuticals). Customers require the assurance of product integrity especially at critical points (e.g., when a consignment switches transport modes). Specialist cold-chain logistics providers can support these customers to achieve regulatory compliance but using new data transparency, packaging innovation and end-to-end live support (e.g., by using DHL's LifeTrack cold-chain management platform).
- **Advanced cold-chain packaging innovation** allows goods such as frozen foods, pharmaceuticals, and sensitive high-tech products 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 and smart packaging solutions that report and control oxygen, humidity and/or pressure.

KEY OPPORTUNITIES

- Higher product security through data transparency and around the clock expert support
- Potential reduction of cost through widespread, optimized data-driven cold-chain management
- Increases collaboration across the entire supply chain to achieve end-to-end cold chain networks

KEY CHALLENGES

- Thermal packaging, in-transit monitoring devices, and intervention services drive up costs
- Adds complexity to the supply chain (e.g., at critical control points) and to warehouse management
- Requires a dependable strategic partnership to ensure high quality standards and efficient cooperation

Farm-to-Fork Delivery – "Die Bauerntüte"

- 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

Source: Die Bauerntuete

TREND ASSESSMENT

Timeframe: < 5 years | Impact: Medium

Sector relevance:

AUTO E&M TECH ENERGY LSH RET&CON

[14] http://www.oliverwyman.de/content/dam/oliver-wyman/global/en/2014/sep/MUN-MKT20101-011_screen12.pdf
[15] Statista 2016, pharmaceuticalcommerce.com

DE-STRESSING THE SUPPLY CHAIN

Supply chain complexity and varying customer needs require the right mix of transportation modes and services. De-stressing is achieved by adjusting logistics to operate sustainably at lower cost with higher quality. For example, a tactical transportation 'slow-down' can balance the supply chain, cut storage costs, and achieve regulatory compliance by reducing the carbon footprint. For some shipments, it may be preferable to prioritize operational security over speed.

KEY DEVELOPMENTS & IMPLICATIONS

Supply chains are stressed by advancing digitization, growing demand for speed and new capacity, and fierce competition. Logistics providers can potentially reduce this stress by considering customer shipping priorities and adjusting supply chain services on a differentiated basis to meet specific needs. Some shipments must achieve the highest levels of speed, cost, security, and environmental sustainability, while others can tolerate lower levels without risk to the business.

- **Logistics slowdowns** are suitable when customers can accept longer delivery times; in some circumstances, these can even positively impact the bottom line. For example, in sea freight, a small speed reduction shows already significant impact on fuel costs and carbon footprint. And a longer transportation time is ideal when delivered goods are only likely to languish in a warehouse; later delivery at the right time could avoid warehousing costs.

- **Synchromodality** is more efficient and environmentally friendly than the use of fixed transportation modes with pre-defined routes and schedules. It is the process by which logistics providers ensure optimal, flexible, and sustainable deployment of different transportation modes and services to fit customer needs. It allows dynamic interchangeability of modes (road, rail, air, and ocean) at any point in the supply chain and at any time.

- **Ad-hoc flexibility and dynamic route optimization** are achieved with big data and math-driven technologies; this supports de-stressing by creating smart reaction and prediction strategies. They enable immediate adjustments according to critical events such as strikes, weather conditions, and accidents, and increase risk management capabilities. For example, dynamic route optimization can be achieved by calculating potential solution scenarios in real time immediately after an incident.

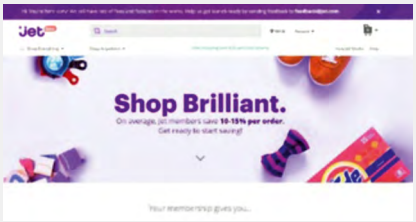
KEY OPPORTUNITIES

- Can serve different customer priorities and wishes with tailored solutions
- Reduces costs and optimizes operational quality by orchestrating transportation and warehouse schedules
- Lowers logistics risk and gives access to emergency capacities for urgent items
- Optimizes transport volumes, enabling better capacity utilization and faster response times

KEY CHALLENGES

- 'Slow-down' capabilities are not yet fully and sufficiently mature
- Legacy IT software and algorithms typically cannot handle items with differing priorities

Location vs. Speed vs. Price – Jet.com



- Online marketplace that enables smarter shopping through location-based pricing and logistics efforts
- Uses a real-time pricing algorithm to price shopping cart contents based on the various distribution centers where the items are currently stocked
- Customers can lower the cost of their purchase by selecting multiple items from the same distribution center

Source: jet.com

TREND ASSESSMENT

Timeframe: < 5 years | Impact: Medium

Sector relevance:

AUTO E&M TECH ENERGY LSH RET&CON

FAIR & RESPONSIBLE LOGISTICS

The intersection between the need to remain competitive and the need to increase sustainability has given way to a new strategy called fair and responsible logistics. Logistics providers can meet these demands by providing new services that generate revenue while also improving the welfare of society and the environment. Key application areas will focus on logistics advancing the circular economy and facilitating fair access, production, and trade.

KEY DEVELOPMENTS & IMPLICATIONS

In recent years there has been a surge in the number of consumers who base their buying decisions on whether a product was sourced, manufactured, and transported in a fair and responsible manner. This is encouraging companies to move from traditional corporate social responsibility (CSR) practices to placing sustainability at the core of the business model. Looking ahead, logistics providers can use their networks and supply chain expertise to provide new supply chain services that create business and social value, and simultaneously support their customers' transition to becoming fairer and more responsible.

- **Circular economy logistics** focuses on providing new reverse logistics and sustainable packaging solutions. First ideas include integrating recycling and logistics infrastructure; for example, delivery trucks that pick up items for recycling on their return routes (e.g., broken consumer electronics) and drop these off at warehouses that have dedicated areas for inspection and recycling. Logistics providers can offer eco-efficient packaging solutions (e.g., space-saving modular containers and biodegradable items) to reduce the carbon footprint.

- **Fair access** to basic necessities and logistics services has the potential to improve living conditions and economies in both developing and developed regions. 'Go local' initiatives can empower local businesses that provide fair and regionally produced products with high-end logistics transportation solutions. Logistics providers can also use their global reach to deliver aid (e.g., vaccines, basic medicines) to hard-to-reach communities.

- **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 in global supply chains by providing services such as spot checking to identify responsibility risks, and can certify processes to confirm they are conducted in a responsible manner (e.g., acceptable working conditions, pricing, and 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 what is fair and responsible
- Social benefits vary widely from region to region, and are difficult to measure
- Requires a shift in business mindset to see it is a profitable venture rather than a cost-driver or CSR initiative

Tracing Materials Back to the Source – Fairphone

- Founded in 2013, Fairphone is building a movement for fairer electronics by tracing all raw materials and parts in the phone
- Company has produced and sold about 60,000 phones so far
- The latest Fairphone 2 model is modular, so consumers can replace single parts, prolonging product life

Source: Fairphone

TREND ASSESSMENT

Timeframe: < 5 years | Impact: Medium

Sector relevance:

AUTO E&M TECH ENERGY LSH RET&CON

GREY POWER LOGISTICS

In five or more years' time, the first wave of digital natives will enter the aged population segment. Grey power logistics – the logistics for an aging society – will offer new services (e.g., home delivery of medicines) to answer the resulting challenges of this demographic development. 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 one of the key social challenges facing the logistics industry. Today, approximately one quarter of the population in Europe is above 60 years old and this will rise to more than one third by 2050.[16] This growing demographic segment will increase demand for new channels to access special medication, food, and care services within cities as well as in remote areas. In future, this will require specialized logistics services that cater to the needs of the aging society such as scheduled, temperature-controlled delivery of medicines to homes and preventative care supported by logistics.

- **Direct-to-patient healthcare services** will be required to support the everyday life of 'silver surfers' who regularly use the Internet to access online services. Today's process of collecting a prescription and picking up the medicines at a local pharmacy could be entirely digitized in future. Authenticated online marketplaces for medical goods and pharmaceuticals will enable direct-to-patient deliveries. This will require increased cold-chain networks for the supply of medicines and other sensitive goods and specially trained delivery employees to ensure the integrity of these deliveries.
- **New value-added last-mile services**, which go beyond the delivery of traditional mail and parcel services, can be offered in parallel with the "classical" delivery process to support the aging population. This includes services such as parcel pick-up, home delivery of groceries, conducting basic cleaning and transportation services, and even simple health checks, a concept which has already been piloted by DHL.
- **Grey power workers** – people who continue to work beyond their 60s – will require new flexible HR conditions to cope with the upcoming worker and skills shortage (e.g., opportunities for part-time employment and flexible hours). In particular it will be essential that operations workers are supported with bionic enhancement technologies such as exoskeletons to support their manual handling activities.

KEY OPPORTUNITIES

- New business opportunities (e.g., transportation of the elderly and the proactive supply of convenience and health goods)
- Development of online shopping platforms for the elderly could result in increased transport volumes and individualized delivery schedules adapted to the daily routines and ad-hoc needs of customers

KEY CHALLENGES

- Business models for new logistics healthcare services are not yet validated
- Supply chains must respond quickly to provide adequate healthcare services
- Logistics providers must cope with future personnel shortages in logistics operations

Preparing For the Future – Homecare Services For the Elderly

- 'Homecare Services' project by Fraunhofer IML and partners aims to explore new communication, order, and delivery services for the aging population
- Concept provides two modules: a 'senior mall' which gives the elderly online access to order products, and a 'control center' for allocation and route planning

Source: Effizienzcluster LogistikRuhr

TREND ASSESSMENT

Timeframe: > 5 years | Impact: Medium

Sector relevance:

AUTO E&M TECH ENERGY LSH RET&CON

[16] http://www.un.org/esa/population/publications/worldageing19502050/pdf/81chapteriii.pdf

LOGISTICS MARKETPLACES

The growing need for transparent, flexible and easily adjustable logistics services fosters the creation of disruptive digital brokerage platforms that match a variety of logistics demands with supply. Such 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

In recent years, a number of online, cloud-driven marketplaces for a broad variety of services such as hotel bookings, insurance contracts, and car rentals have disrupted traditional ways of business. In logistics, freight exchange platforms already exist; however in future these B2B marketplaces will greatly evolve to potentially take over the traditional tendering and contract process for logistics services. Logistics providers can react by actively driving or participating in these platforms, ensuring their services remain price competitive and as flexible as possible.

- **One-stop B2B logistics platforms** are two-sided online marketplaces that match the demand for and supply of logistics services through digital interfaces. All processes are centrally managed by the brokerage platform, are highly automated, and have a relatively self-service character. Customers now have the opportunity to find the right carrier for their logistics requirements by choosing from a wide range of large and small service providers; they profit from better comparability and transparency of proposals, optimized price/performance ratios, and high security through member certification and rating systems.

- **M2C (manufacturer-to-consumer) and B2C logistics marketplaces** are developing due to growing consumer demand for cheap, reliable, company-independent courier and transportation services. Consumers can compare quotes, book upfront, name their own prices, and receive auction-style bids from logistics providers ranging from independent owner-operators to the world's largest freight carriers and brokers.

- **Next-generation freight exchange platforms** utilize the latest connection technologies and interfaces to provide real-time interaction between small to even the largest of logistics players. These platforms offer the chance for logistics providers to find additional shipments to reduce empty running, and find fast and efficient additional cargo capacity. They also improve collaboration between logistics companies.

KEY OPPORTUNITIES

- Digital platforms enable real-time quotes and flexible execution of broker deals
- Easier access to a broader customer base online
- 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 on the digital marketplace

KEY CHALLENGES

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

The World's Largest Marketplace for Ocean Shipping – INTTRA

- This worldwide network comprises more than 220,000 shipping professionals
- These professionals work with 50 leading carriers and over 100 software alliance partners
- With over 650,000 container orders, INTTRA represents 24% of global ocean container trade

Source: INTTRA

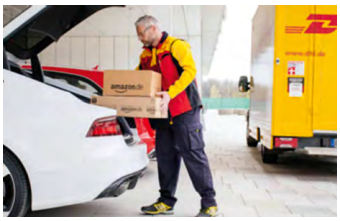
TREND ASSESSMENT

Timeframe: > 5 years | Impact: High

Sector relevance:

AUTO E&M TECH ENERGY LSH RET&CON

MULTI-PURPOSE NETWORKS



Sector-specific or even customer-specific logistics chains will become a thing of the past through the rise of multi-purpose networks. This involves the utilization of standard, existing networks and city infrastructure to transport and store goods, especially those that are temperature sensitive. This is enabled by innovations in transportation, packaging, real-time supply chain monitoring, as well as collaboration between different sectors.

KEY DEVELOPMENTS & IMPLICATIONS

Today, logistics networks coexist with each serving different sectors (e.g., automotive, health) with different goods (e.g., parts, medicines). For example, a cold-chain truck for life sciences goods would not usually be shared to transport fresh groceries, despite the fact that both require cold-chain services. However, due to increasing time and cost pressures, there is a growing shift towards collaboration between and within sectors, resulting in new possibilities for network sharing. Additionally, it is possible to utilize non-logistics networks (e.g., public transport) for logistics purposes.

- **Multi-purpose usage of standard networks** can be applied to goods requiring special transport and warehouse conditions (e.g., temperature control, high security) that currently necessitate individual time- and cost-intensive solutions and special network capabilities. In future, standard network providers will enhance their capabilities to enable wider temperature-sensitive transport and handling services. These capabilities can then be re-used (e.g., innovative cold-chain packaging solutions shared between multiple sectors). Standard logistics providers opening their networks for multi-purpose usage will have to include reliable identification and authentication services, and obtain special certificates (e.g., cold-chain delivery of groceries in a standard parcel network).

- **Integration of public infrastructure** (such as car parks and metro systems) for logistics purposes enables flexible use of existing capacities to quickly adapt to new demands and requirements. For example, logistics providers can install temporary 'pop-up' warehouses in public or even private spaces to manage seasonal logistics peaks and to shorten lead times. One significant development in recent years is optimized pickup and drop-off (PUDO) procedures in urban areas (e.g., using multi-purpose lockers, private vehicles, and taxis with integrated parcel loading spaces).

KEY OPPORTUNITIES

- Optimize load capacity for standard network trucks with enhanced capabilities (e.g., temperature control)
- Save cost with better resource efficiency and capacity utilization
- Increase handling capabilities of different logistics volumes at peak times through multi-purpose infrastructure
- Added flexibility with new logistics channels

KEY CHALLENGES

- Low volume for special and dangerous goods versus high initial investments for capability enhancement
- Conflicting laws and regulations that restrict space, timing, and transport and storage methods for special goods
- Difficult to achieve compliance between cooperating competitors using the same network capacities

Combining Passenger and Parcel Transport – Postbus

- Postbus is Germany´s first provider of combined passenger and parcel transport for B2B and B2C customers
- It provides a same-day courier service between Berlin and Hamburg for urgent deliveries
- Service users drop their package at the bus terminal; recipients pick up their item at the nearest Postbus station

Source: Deutsche Post DHL Group

TREND ASSESSMENT

Timeframe: < 5 years | Impact: Low

Sector relevance:

AUTO E&M TECH ENERGY LSH RET&CON

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 consumers who want a seamless omni-channel experience from companies. For example, studies have now revealed that the majority of consumers no longer access online stores via their computers but instead via their smartphones and tablets, giving them the mobility to shop 24/7.[17] This demand for flexibility will result in increasingly faster and varied fulfillment services – especially in terms of last-mile delivery options and seamless return 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, and companies renting out space in shared warehouses to cover peaks, or even turning warehouses into retail showrooms (e.g., IKEA's approach) or pick-up points for orders.

- **'Anytime, anywhere delivery models'** will be required to meet the promises made by retailers to their customers (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 return of purchases. Already today innovative concepts are being explored, such as personal parcel lockers, delivery to car trunks, and crowd-based delivery concepts.

- **Cross-channel omni-channel platforms** shared between manufacturers, retailers, and logistics providers will be essential to gain complete visibility of customer interactions and – most importantly for logistics – a global overview of inventory. With the mix between offline and online shopping, it will be essential for inventory between warehouses and even stores to easily shift to meet peaks in demand. First retail concepts base pricing on the proximity of inventory to the shopper.

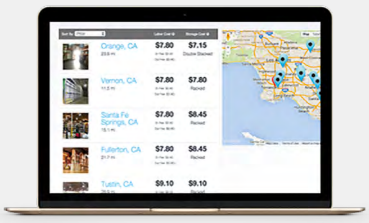
KEY OPPORTUNITIES

- Further increases volumes in the area of B2C delivery
- New business opportunities in omni-channel warehousing, fulfillment, and transportation services
- Cross-channel inventory visibility reduces costs through inventory optimization

KEY CHALLENGES

- High diversity of concepts targeted at integrating online and offline commerce
- Significant downstream investment required to enable further delivery options

Flexible Warehousing to Cover Peaks – Flexe



- First-of-its-kind online marketplace for renting warehousing space
- Via a cloud-based software platform, it matches those needing flexible warehousing with warehouse owners with available space
- Flexe customers can locate a warehouse that best meets their specific needs, and then manage their inventory from their desktop without committing to a long-term lease

Source: Flexe

TREND ASSESSMENT

Timeframe: < 5 years | Impact: High

Sector relevance:

AUTO E&M TECH ENERGY LSH RET&CON

[17] https://www.shopify.com/blog/15206517-mobile-now-accounts-for-50-3-of-all-ecommerce-traffic

ON-DEMAND DELIVERY

Delivery is no longer owned only by larger players who set limitations on delivery times and locations. New on-demand last-mile delivery concepts utilize the power of the crowd and flexible courier workforces to enable customers to take delivery of each purchase when they need it, where they need it. With the latest technologies for real-time location and routing and app-based analytics, this will bring significant changes to parcel delivery over the next few years.

KEY DEVELOPMENTS & IMPLICATIONS

Today's consumers expect faster last-mile delivery with more options to suit their 'on the go' lifestyles. Advancements in location services, data analytics, and mobile connectivity have enabled the creation of flexible, on-demand delivery grids. Startups in particular are leveraging these new technologies as well as crowd-based concepts to offer innovative same-day, even same-hour delivery services. This includes instant booking, real-time tracking, steering, and re-routing of deliveries, while utilizing existing infrastructure to create asset-lean, scalable services.

- **On-demand courier-hailing platforms** match people who need to send something with delivery couriers, just at the click of a button. Platform owners do not necessarily own any fleet but instead hire drivers using often flexible, demand-dependent contracts. Private businesses or individuals can use these platforms, flexibly booking delivery services through a mobile app or easy-to-use web interface and tracking their shipment right from dispatch to reception at the other end.

- **Crowd-based parcel delivery services** use dynamic and flexible networks comprising everyday residents of a city to enable 24/7 courier services to all parts of the city and allow rapid delivery of goods. Local residents can transport packages or pick up groceries along their daily routes and deliver these items to the requestor in their neighborhood, for a small fee. DHL has already tested this concept with the DHL MyWays solution.

- **Parcel delivery rerouting** is increasingly demanded by consumers. Online shoppers want the flexibility to choose easily when and where their packages are delivered and have options to reroute packages up to the very last moment. This new flexibility is strongly supported by real-time location services and route optimization technologies. New delivery and pickup concepts provide consumers with the freedom to receive packages even when they are not at home (e.g., residential package boxes).

KEY OPPORTUNITIES

- New business opportunities using crowd-based logistics solutions with larger supply and demand
- Premium pricing can be applied to cover the costs of greater customer convenience
- Improved last-mile delivery networks make deliveries faster and increase customer satisfaction

KEY CHALLENGES

- HR frameworks regulating the market are reactive and not proactive, raising workforce issues
- Potential efficiency challenges as there need to be sufficient delivery workers to meet demand
- Theft and safety concerns when it comes to using a crowd-sourced workforce

On-Demand Delivery Fleet for Small Businesses – UberRUSH

- Easily connects consumers and small businesses with an Uber courier who picks up and delivers items across a city
- Individual driver profiles including ratings are visible and the consumer can choose
- Shipments can be tracked via an app and will be delivered directly to the intended recipient or left with a designated other

Source: Uber

TREND ASSESSMENT

Timeframe: < 5 years | Impact: High

Sector relevance:

AUTO E&M TECH ENERGY LSH RET&CON

SHARECONOMY LOGISTICS

The societal shift from ownership to asset sharing has been one of the most ground-breaking trends in recent years. Everything from cars to parking spaces on driveways and home electronics can now be shared via dedicated platforms. Besides facilitating these new peer-to-peer sharing networks, logistics providers can also share their existing corporate and private resources (such as containers and served routes) to be more cost- and time-efficient.

KEY DEVELOPMENTS & IMPLICATIONS

The trend of sharing was initiated by startups that created peer-to-peer sharing platforms. These in turn generated new forms of collaborative consumption business models (e.g., Airbnb, TaskRabbit). However in recent years, established companies have also begun to embrace this approach (e.g., BMW DriveNow). Logistics can also participate in the shareconomy by sharing assets, warehousing capacities, and even truckloads. This enables companies to bridge efficiency gaps, avoid under- and over-capacities, reduce the cost of specialized services, and foster horizontal collaboration.

- **Facilitation of peer-to-peer sharing networks** is one opportunity that logistics providers can leverage. Users of sharing platforms may require logistics companies to pick up, wrap, and deliver their goods, as well as can return an item after usage. Logistics providers can support this by not only offering standard services but also opening up their facilities (such as parcel pickup points and parcel lockers) to enable consumers to drop off their goods for a small fee.

- **Coopetition supply chains** represent one of the major concepts of collaborative logistics. From the industry perspective, this means cooperating with competitors who often have similar supply chain requirements, in order to save on logistics costs. For instance, PepsiCo and Nestlé jointly bundle the warehousing, co-packing, and outbound distribution of their fresh and chilled food products to retail stores. This lowers costs, increases efficiency, and also reduces the carbon footprint of their supply chains.

- **Sharing of logistics assets and infrastructure** with other logistics providers can increase capacity utilization and reduce costs. First ideas include the sharing of forklifts with competitors or local businesses on weekends, offering warehouse space with an 'on-demand' approach, and leasing delivery vehicles to local communities for special purposes.

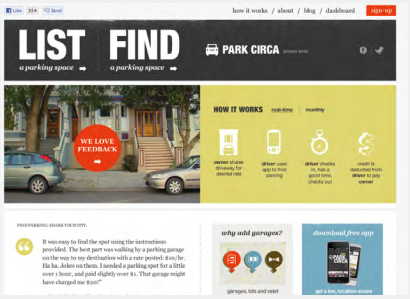
KEY OPPORTUNITIES

- Potential new business models based on crowd-based logistics solutions
- Bundling supply chain networks enables logistics providers to deliver better cost and value to customers
- Increase in capacity utilization, and reduction in costs and carbon footprint, through sharing of assets

KEY CHALLENGES

- Laws and regulations (security, insurance, liability, fraud and tax topics) hinder peer-to-peer services
- Horizontal integration of collaborative logistics in existing business models remain difficult among competitors

The Shareconomy of Parking Spaces – Park Circa



- Online marketplace that connects those searching for parking in congested cities and those that have available parking spaces to share
- Enables residents to share their unused car parking space, driveway, or garage and earn credits
- Registered parking spaces have dynamic market rate pricing, based on time of day, location, etc.

Source: Park Circa

TREND ASSESSMENT

Timeframe: < 5 years | Impact: Medium

Sector relevance:

AUTO E&M TECH ENERGY LSH RET&CON

SMART ENERGY LOGISTICS

The increasing shift towards renewable energy sources (solar, wind, etc.) is propelling the adoption of electric mobility solutions in logistics. It also provides new logistics opportunities for smart energy logistics solutions that facilitate new supply chains (e.g., e-battery supply chains). New energy harvesting, storage and distribution concepts for example can be leveraged to also reduce reliance on the grid and fossil fuels.

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.[18] Translating this awareness into logistics, renewable technologies will be leveraged for further "electrification" and energy autonomy in the supply chain. Its widespread adoption will also pave the way for new smart energy logistics services in the coming years.

- **Smart energy logistics services** will arrive as a result of the decentralization of traditional energy production and transportation networks. A mainstream switch to e-mobility and widespread adoption of energy harvesting technologies (e.g., solar cells on homes, cars, buildings) could, for example, result in less production and globalized transportation of petrol. It could also increase the transportation and return of batteries which will require new complex reverse logistics solutions. Logistics providers could also provide new supply and delivery concepts for on-demand mobile power stations to houses or businesses that want to reduce reliance on the grid or fossil fuels.

- **New vehicle-to-grid business models** change the direction of energy *to vehicles* into energy *from vehicles* and consequently offer new business opportunities for fleet operators. E-vehicles are essentially a mobile energy storage system and, as most delivery vehicles sit idle for most of the evening, surplus energy can be sold back to the grid. AC Propulsion is already enabling such concepts.

- **Electrified logistics fleets** are already being used in the form of electric delivery vans and bicycles for last-mile delivery operations. E-vehicles for inner-city deliveries can significantly reduce air pollutants, noise emission, and transportation costs; they can also extend service possibilities (e.g., night-time delivery without any motor engine noise).

KEY OPPORTUNITIES

- Renewable energy reduces CO_2 emissions and energy costs along the entire supply chain
- Possibility for night-time deliveries enlarge the time window for deliveries, expanding logistics services
- New business potential for logistics services through the decentralization of energy production

KEY CHALLENGES

- Most energy harvesting technologies such as solar cells are not yet sufficiently (cost-)efficient
- High battery prices are an economic challenge to widespread adoption of electric fleets
- Requires a sufficient network of charging stations for reliable day-to-day operations in logistics

Harvesting the Power of Solar – Wattway Solar Road

- Colas has developed Wattway – a smart road surface that enables the harvesting of solar energy
- It is estimated that road surfaces are only occupied by vehicles 10% of the time
- 20 m² of Wattway patented panels can supply the electricity requirements of a single home

Source: Colas

TREND ASSESSMENT

Timeframe: < 5 years | Impact: Medium

Sector relevance:

AUTO E&M TECH ENERGY LSH RET&CON

[18] https://www.bundesregierung.de/Webs/Breg/DE/Themen/Energiewende/Mobilitaet/podcast/_node.html

SUPERGRID LOGISTICS

Going beyond 4PL logistics, supergrid logistics will bring up 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 special services, and even small local couriers and startups.

KEY DEVELOPMENTS & IMPLICATIONS

Customers today 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 services. A logistics supergrid spanning the entire globe can integrate smoothly and flexibly all parties along multiple supply chains. This enables centralized coordination and collaboration of modular services for a variety of customers, 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.

- **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 its modularly configurable logistics service portfolio. Internally operated or external services can be 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 end-to-end logistics services to their customers by using broker platforms or similar concepts to connect shippers and carriers. Services with constantly growing complexity and high development costs (such as risk management and security, customs clearance, and compliance) will be developed by only a few specialists. Premium e-services (e-billing, e-compliance, e-clearance) will become the new 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 are still a major challenge; only 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 still to be validated

Amazon's Way Towards Operating a Global Supergrid

- Amazon is able to connect thousands of sellers and logistics providers with millions of buyers worldwide
- Recent developments indicate Amazon will also begin to operate parts of production and logistics, effectively expanding its operational capabilities and heading towards a supergrid approach

Source: Amazon

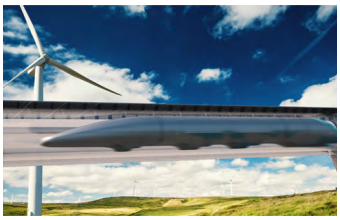
TREND ASSESSMENT

Timeframe: > 5 years | Impact: High

Sector relevance:

AUTO E&M TECH ENERGY LSH RET&CON

TUBE LOGISTICS



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

KEY DEVELOPMENTS & IMPLICATIONS

Tube logistics is a visionary trend which has received renewed media attention in recent years mainly due to key announcements to build a so-called Hyperloop between San Francisco and Los Angeles where passengers and freight would be transported in pods propelled at supersonic speeds. The 600 km journey could take less than 30 minutes.[19] 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 up to 1,200 kilometers per hour. Similar technology is already being successfully used without tubes 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 on dedicated tracks (e.g., between consolidation centers located in the outer rim of cities to inner city nodes). This enables high-volume movement of freight into highly congested areas with no impact on surface transportation systems. It can also reduce 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.[20] During off-peak hours such as during the night, freight capsules or existing trains can be loaded with cargo for delivery which 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 round the clock without impacting noise and air pollution, and also reduce accident risk

KEY CHALLENGES

- Tube train systems are still difficult and expensive to build
- Depots and storage premises would be needed wherever the tubes surface
- Tube systems can often not deliver precisely to the final destination, which creates additional transport costs

Future of Tube Logistics – Mole's Freight Pipeline System

- Mole is a part of the UK government's Transport Systems Catapult – a program to support local startups
- Aims to test sending freight capsules through a series of underground tubes
- Pipelines can be laid beside and under existing or new transport infrastructure
- Capsules run on an electric track, propelled by magnetic fields

Source: Mole Solutions

TREND ASSESSMENT

Timeframe: > 5 years | Impact: Low

Sector relevance:

AUTO E&M TECH ENERGY LSH RET&CON

* **Image Source:** Hyperloop Transportation Technologies

[19] http://www.techtimes.com/articles/99369/20151027/elon-musks-ultra-high-speed-hyperloop-bullet-train-to-begin-construction-in-november.htm

[20] 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.

AUTOMOTIVE
AUTO

ENGINEERING & MANUFACTURING
E&M

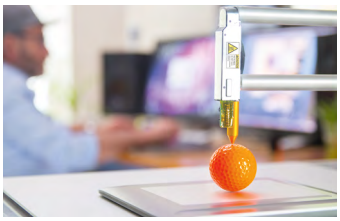
TECHNOLOGY
TECH

ENERGY
ENERGY

LIFE SCIENCES & HEALTHCARE
LSH

RETAIL & CONSUMER
RET&CON

3D PRINTING



3D printing (or additive manufacturing) will disrupt logistics by adding new diversity to manufacturing strategies. Some companies may stop traditional fabrication, but most will combine 3D printing with mass production techniques. Leveraging this shift, innovative logistics providers can orchestrate complex hybrid manufacturing networks, as well as utilize networks of 3D printers to offer new logistics services.

KEY DEVELOPMENTS & IMPLICATIONS

3D printing has already become a trusted technology in the healthcare sector for printing customized prosthetics and medical devices, as well as in the aviation sector for the production of aircraft components. Although conventional manufacturing technologies will not be replaced by 3D printing, in segments where it is applied (such as spare parts production) it will significantly impact some logistics services as well as volumes. 3D printing is a key enabler for 'batch size one' production. A comprehensive 'dematerialization' of the physical flows of manufactured goods is, however, still far off.

- **Regional logistics networks** will become more complex due to a growing number of manufacturing strategies and a shift from global/intercontinental to more regional/local supply chains and distribution. The varying degree to which industries will apply 3D printing (from completely replacing traditional fabrication, to using it for selected parts) will make it necessary to carefully evaluate the impact on a company's supply chain strategy, planning, and execution.

- **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 often rarely ordered, logistics providers can set up a global 3D printing infrastructure coupled with a software database of digital models. Spare parts can then be printed only on-demand at the nearest 3D printing facility (e.g., a hub or airport) and be delivered to the right location. This would reduce lead times and cut inventory costs.

- **Hyper-personalization** can be accelerated by logistics providers offering postponement services by operating local distribution centers equipped with 3D printers. The final configuration of goods can be achieved by on-demand 3D printing, enabling shorter lead times for highly individualized products (e.g., a personalized design or addition of a name onto the product).

KEY OPPORTUNITIES

- Logistics providers can become orchestrators of complex and fragmented supply chains for raw materials and end products
- 3D printing creates new market segments and value creation opportunities (e.g., digital warehouses, trusted service provision of 3D data hosting and exchange)
- Reduce transport costs and time by creating products closer to point-of-use

KEY CHALLENGES

- Restrictions on materials and 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 questions of liability in the event of faulty 3D printed products

3D Printing on the Fly from Amazon

- Amazon has patented the concept of mobile 3D printing delivery trucks to deliver products even faster to the consumer
- When a shopper orders a selected product from Amazon, this triggers the nearest truck to 3D print and deliver the product to the consumer, effectively removing the need for any storage

Source: Amazon

TREND ASSESSMENT

Timeframe: > 5 years | Impact: High

Sector relevance:

AUTO E&M TECH ENERGY LSH RET&CON

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, AR empowers workers by providing the right information, at the right time, and in the right place.

KEY DEVELOPMENTS & IMPLICATIONS

AR enables the user 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. Now with the latest developments in contextual computing, AR is continuing to emerge as an important logistics asset capable of increasing process efficiency and quality, reducing risk, and lowering the stress of manual handling.

- **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 assembly. Already today, smart glasses have the ability to display task information, scan 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 be used to 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 used to virtually highlight inside a vehicle the optimal loading sequence of each shipment (taking account of route, weight, fragility, etc.). On delivery, AR can be used for last-meter navigation to correctly locate entrances.

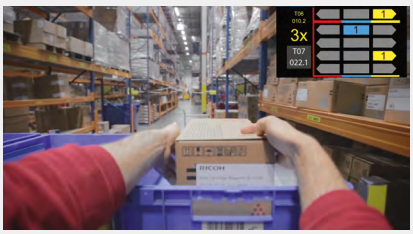
KEY OPPORTUNITIES

- Hands-free operation (e.g., barcode recognition) results in higher efficiency and error-free processes
- Shorter warehouse handling times
- Reduces costs while simultaneously improving quality and performance
- Faster training due to user-friendly interface and language flexibility

KEY CHALLENGES

- Integration into existing warehouse management systems requires new standards and interfaces
- Customer-defined requirements of standards and disclosure are difficult to meet with current solutions
- The robustness and reliability of current AR devices and systems has to be further explored

Creating a New Standard of Order Picking at DHL



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

Source: DHL

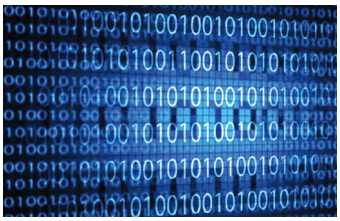
TREND ASSESSMENT

Timeframe: < 5 years | Impact: Medium

Sector relevance:

AUTO E&M TECH ENERGY LSH RET&CON

BIG DATA



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 to boost efficiency in areas such as capacity planning and vehicle route optimization. Moving forward, logistics providers will need to master the integration of structured and unstructured data (social, images, video, etc.) from multiple data streams to harness the full potential of big data. This coupled with the advancement of analytics technologies will further unlock exciting new ways to monetize data-driven operating and business models (e.g., anticipatory logistics and the logistics supergrid).

- **Operational efficiency** can be improved by using big data to optimize resource utilization, process quality, and performance, and to increase speed and transparency in decision making. For example, in transportation the intelligent correlation of data streams (shipment information, weather, traffic, etc.) can enable real-time scheduling of assignments, optimization of load sequences, and 'down-to-the-minute' prediction of the estimated time of arrival (ETA).
- **Customer experience** can be enhanced by leveraging big data to create an integrated view of all customer interactions and operational performance indicators. This enables precise customer segmentation, and the targeting and tailoring of service levels. Further incorporation of sentiment analytics can be applied to proactively maintain customer loyalty and retention.
- **End-to-end supply chain risk management** based on predictive analytics can increase the resiliency of global supply chains. Big data can be used to mitigate risk by detecting, evaluating, and alerting all potential disruptions on key trade lanes (e.g., growing port congestion or high flood risks).
- **New business models** emerge for logistics providers to expand revenue streams and deliver new data-based products. Examples include environmental intelligence on road quality or network coverage provided by logistics fleets, and local intelligence on delivery preferences in specific city areas based on demographics.

KEY OPPORTUNITIES

- Enhanced operational efficiency, visibility, and control over supply chains, assets, and staffing
- Improved forecasts and real-time adjustments to demand and capacity fluctuations
- Increased customer loyalty and retention through data-driven logistics services
- New business opportunities through data-based intelligence services

KEY CHALLENGES

- Business and IT alignment required as foundation for use case implementation
- Privacy concerns regarding data collection and protection
- Data transparency and access
- Data quality and appropriate data science skills

'The World of Organized Logistics' – LogiNext

- A big data analytics platform developed by a startup to help courier companies increase route optimization and enable real-time tracking of their resources
- Product features: delivery location clustering based on dynamic capacity, delivery planning with preferred time window per order, predictive delay alerts, and real-time ETA updates

Source: LogiNext

TREND ASSESSMENT

Timeframe: < 5 years | Impact: High

Sector relevance:

AUTO E&M TECH ENERGY LSH RET&CON

BIONIC ENHANCEMENT

Bionic enhancement technologies such as wearables and exoskeletons expand the boundaries of current physical barriers. Smart clothing, bionic arms, and even smart contact lenses have the potential to support the logistics workforce in areas such as communication, process execution, optimization and, most importantly, minimizing health and safety risks in the supply chain.*

KEY DEVELOPMENTS & IMPLICATIONS

Breakthroughs in sensors and nanotechnologies have enabled previously unimaginable bionic solutions. Forward-thinking companies are exploring ways to adopt wearables such as health trackers and exoskeletons in the enterprise. 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 the transportation and warehousing sector which had the highest rate of occupational injuries and illnesses in the US private sector in 2014.[21] Smart wearables and ergonomically designed bionics could be the solution in eliminating work-related injuries.

- **Smart wearables** in the form of sensor trackers, digital heads-up displays, gesture controls, and smart fabrics can support working routines and increase health and safety in all parts of the supply chain. In particular, smart glasses or contact lenses that digitalize task information into the user's field of view (part of the augmented reality trend) and devices that integrate new forms of gesture control (such as control via muscle movements) are paving the way for the future of hands-free operations in logistics. Innovations in smart clothing concepts such as connected helmets and vests can be used to locate employees in large logistics operations and be used for a wide variety of safety applications (e.g., alerts on increasing temperatures or nearby moving vehicles).
- **Exoskeletons** can be understood as robotic suits that boost the wearers' strength and endurance, greatly reducing the physical stress and strain of manual handling activities. Increasingly applicable and demanded in logistics, exoskeletons reduce worker dependency on bulky tools (such as vacuum technologies) to lift heavy objects and enable people to repeat manual handling tasks for longer, with less physical strain. This increases productivity and safety in logistics. Innovative solutions are already coming to market such as Panasonic's Power Loader suit which the company has been testing for two years in its distribution warehouses.[22]

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 in its early stages of industrial adoption
- Most bionics are currently immature for enterprise usage but developing quickly
- Continuous power supply to ensure reliable functionality is currently inadequate for broad implementation

Robo-Mate Exoskeletons – Empowering the Workforce

- The Robo-Mate exoskeleton enables manual handling of items that are too heavy to be lifted by a worker
- By enhancing work capabilities for load workers and maintaining a consistent work performance, Robo-Mate can increase productivity
- Physical support decreases work-related injury and disease, making logistics a safer place to work

Source: Robo-Mate

TREND ASSESSMENT

Timeframe: > 5 years | Impact: Medium

Sector relevance:

AUTO E&M TECH ENERGY LSH RET&CON

* **Image Source:** Ekso Bionics

[21] http://www.bls.gov/news.release/pdf/osh2.pdf

[22] http://news.panasonic.com/global/topics/2014/28635.html

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, companies use cloud computing to gain ad-hoc access to local logistics IT specialists who, in turn, benefit from easier access to global markets when their services run on cloud platforms. In future, the key focus will be on 'cloud readiness', especially in terms of security as well as the technological performance of cloud in real-time, large-scale operations.

- **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 (e.g., orders, billing, and track & trace services). Pay-per-use models allow 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 them as operating expenditure.

- **Cloud-powered global supply chains** virtualize information and material flows by moving all supply chain processes into the cloud. Operating parts of complex, fragmented global supply chains, logistics providers often deal with a variety of transactions taking place between multiple parties using different warehouse and transport management systems. The cloud's ability to coordinate this information into one integrated view is a key enabler of a 'control tower' which coordinates and orchestrates the supply chain and provides 360-degree management dashboards. Furthermore, the cloud gives companies more precise control over their global inventory levels and the location of shipments and assets. And ultimately, this paves the way for sophisticated supergrid logistics networks.

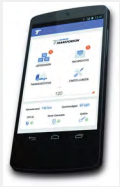
KEY OPPORTUNITIES

- Agile, flexible, and elastic business models enabled by high on-demand scalability of IT services
- Customized, personalized logistics services become affordable, especially for small and medium-sized companies
- 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

KEY CHALLENGES

- Data migration and security issues still need to be proved (e.g., maintaining 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

Logistics Services from the Cloud – Transporeon



- Cloud-based logistics platform for tendering, assigning orders, booking time slots, tracking & tracing, and more
- Simplifies transparency and communication between all parties and reduces wait times and empty trips to streamline the overall supply chain
- More than 1,000 shippers, 55,000 carriers, and 150,000 users in over 100 countries are currently connected to the platform

Source: Transporeon

TREND ASSESSMENT

Timeframe: < 5 years | Impact: High

Sector relevance:

AUTO E&M TECH ENERGY LSH RET&CON

DIGITAL IDENTIFIERS

New generations of digital identifiers such as digital watermarking (DW), disposable smart labels, and low-cost biometrics expand predictive control options for supply chain steering, asset, stock and inventory management, and end-to-end security. With the rising use and increasing maturity of different technologies for digital identification, the vision of a connected supply chain with complete transparency and traceability becomes more and more tangible.*

KEY DEVELOPMENTS & IMPLICATIONS

Over recent years, new technologies like invisible barcodes, NFC, and QR codes have enabled smart printing/tagging, and biometric devices are being adopted across various industries for more precise identification of objects and even people. By putting an identity to every batch, shipment, and asset, it is possible to pinpoint the location of specific items, deliver additional security information, and install a new generation of track and trace capabilities in global supply chains.

- **Digital product identifiers** will enable all products to be identifiable, traceable, and locatable from the point of production to the point of sale. These smart labels contain information that can be digitally captured and retrieved (e.g., a bottle of water is not just assigned to a specific batch; the smart label can contain additional details such as date, time and place of bottling, and expiration date). Thus supermarkets and wholesalers, for example, can automatically generate requests for delivery for goods close to their end-of-sale date.

- **Integrity management** of goods will lower fraud risks and support for example health management by tracing viruses back to their origin to detect and identify root causes easily and faster than today. Another health application is for pharmaceutical companies to combat product piracy. The risks for patients (as well as for the producer's reputation) are huge, and therefore companies are likely to invest in new methods of ensuring brand integrity (such as serialization based on digital identifiers) as a part of their track and trace solutions.

- **Automated access management** by identification and authentication of workers in controlled logistics environments such as warehouses and airport hubs can be ensured through new breakthroughs in biometric technologies (e.g., vein, fingerprint and iris scanning). This greatly augments the effectiveness of access management and helps to increase security and cost efficiency.

* **Image Source:** Diageo

KEY OPPORTUNITIES

- Broadens the capturing, storing, and provision of supply chain information
- Achieves new levels of transparency, traceability, and authentication for more mature management of supply chains
- Product safety increased by facilitating integrity control, fraud detection, and claim handling

KEY CHALLENGES

- Absence of international standards, privacy policies, and investment costs hinder broad application and acceptance among all supply chain providers
- Ability to receive and process additional data depends on a match between sender and receiver capabilities, which only partially exists
- Data protection is still a challenge due to many new data sources and the huge data volumes to be managed

Digimarc Supply Chain Solutions – A Barcode for Everything

- Digimarc Corp. creates invisible digital identifiers for everything from ID cards to everyday consumer products
- Digital watermarks in the form of multiple barcodes can be printed on products, but remain invisible to the eye
- This accelerates product scanning as well as security in supply chains and enables faster point-of-sale transactions

Source: Barcode.com

TREND ASSESSMENT

Timeframe: > 5 years | Impact: Low

Sector relevance:

AUTO E&M TECH ENERGY LSH RET&CON

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 that can use the data from the connected objects to generate actionable insights that drive change and new solutions.

KEY DEVELOPMENTS & IMPLICATIONS

It is estimated that by 2020, more than 50 billion objects will be connected to the Internet, presenting an immense $1.9 trillion opportunity in logistics.[23] Until now, only a few IoT applications in logistics have had substantial business impact, due to security concerns, an absence of standards in the fragmented logistics industry, and the consumer market focus of recent IoT innovations. Looking ahead, large-scale IoT deployments will require new 'logistics-ready' solutions that ensure security and common connection standards.

- **Connected warehouses** can increase the transparency and localization of all assets through the tagging of individual items, pallets, and operational hardware. These smart objects are assigned and can transmit information about their current order, content, and location, enabling automated inventory management with real-time visibility on inventory levels and item conditions. IoT can also drive higher levels of worker health and safety through a connected workforce concept, and can be additionally used to optimize lighting, heating, and cooling within facilities.

- **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. 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 products and home appliances (e.g., smart locks) will enable new IoT-based delivery concepts, such as an automatic replenishment service (e.g., a grocery order can be triggered by a smart fridge) or secured in-home delivery services. This can offer more visibility to the consumer and helps to avoid unnecessary collections.

[23] http://www.cisco.com/c/dam/en_us/services/portfolio/consulting-services/documents/consulting-services-capturing-ioe-value-aag.pdf

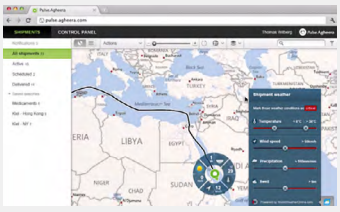
KEY OPPORTUNITIES

- IoT increases the transparency, traceability, and reliability of logistics operations
- Higher operational efficiency and cost reduction due to automating decision making in complex environments
- Real-time monitoring of items can improve service quality, optimize asset utilization, and prevent goods theft, damage, and harm
- Creation of more dynamic and customized delivery services for customers

KEY CHALLENGES

- High levels of fragmentation within the logistics industry requires the development of a logistics IoT standard
- Data and security issues and concerns in the IoT-powered supply chain
- IoT hardware needs to be further ruggedized for large deployments in logistics, especially in terms of robustness and battery life

The IoT Platform for Logistics – Agheera



- An open IoT platform that can combine telematics data from various IoT hardware devices for end-to-end integrity control of supply chains
- The platform merges multiple assets such as a connected swap body or truck into one easy-to-use portal with worldwide accessibility
- Allows logistics providers and customers to track all assets from their various devices in real-time

Source: Agheera

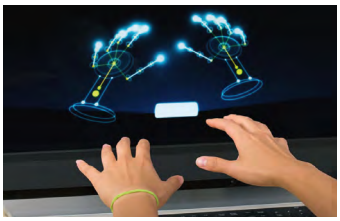
TREND ASSESSMENT

Timeframe: < 5 years | Impact: High

Sector relevance:

AUTO E&M TECH ENERGY LSH RET&CON

LOW-COST SENSOR TECHNOLOGY



Sensor technologies that were originally developed for consumer electronics such as smartphones, tablets, and even gaming consoles enable exciting new applications within the logistics industry. Logistics providers can utilize these low-cost sensors to replace expensive industrial sensor solutions and to create new smart infrastructures for monitoring, inspecting, and controlling logistics processes.*

KEY DEVELOPMENTS & IMPLICATIONS

Today's already impressive range of low-cost sensors found in everyday consumer electronics (accelerometers, gyroscopes, temperature, humidity, etc.) will expand significantly in the future, enabling new consumer-to-industrial application transfers. Sensors for depth sensing and imaging (e.g., Microsoft Kinect, Google's Tango) are already being tested for indoor navigation and automated volume-based pricing applications. Looking ahead, sensors that can detect air and food quality and even odors should be available within the next 5-15 years, unlocking further areas for innovation.

- **Using smartphones and tablets for logistics processes** is a current industry trend. The first successful use cases (e.g., barcode scanning, image documentation of freight, and signature capturing on delivery) exploit the diverse technical capabilities of mobile devices and utilize cloud-based software-as-a-service models. With the spread of NFC-compatible smartphones, new logistics uses will appear (e.g., identifying items wirelessly with RFID transponders, and scanning electronically with a smartphone camera, eliminating costly conventional scanner systems).

- **Low-cost 3D depth sensors** from gaming applications (e.g., Microsoft Kinect) can be used in a variety of applications for fast and efficient logistics operations. Successful field tests have used depth sensors found in gaming consoles to perform accurate real-time dimensioning for volume-based pricing, indoor navigation, and dynamic load capacity optimization, as well as damage checks prior to loading. Consumers themselves might use similar technology in their own next-generation smartphones for logistics processes (e.g., measuring parcel dimensions at home).

- **Bring your own device approaches** (BYOD) are growing along with the consumerization of IT. Development of mobile devices solely for professional use is declining, and this means that new private/business hardware concepts will be created to save cost and increase efficiency.

KEY OPPORTUNITIES

- Sensor-equipped mobile devices are ideal for seamless and real-time monitoring and controlling of logistics processes along the supply chain
- Using smartphones and BYOD approaches offers cost savings compared to conventional scanner systems
- Low-cost sensors increase the potential to develop new services (e.g., volume-based pricing) and enhance operational efficiency

KEY CHALLENGES

- Devices developed for consumers rarely offer the physical robustness and durability required in the everyday world of logistics
- The security and reliability of cloud-based applications may not meet business demands
- BYOD raises IT security and privacy concerns

Low-cost Dimensioning Made Easy – ParcelCube

- User-friendly and affordable static dimensioning/cubing system for simultaneous and automated dimension, weight, and ID capture
- The system costs 70% less than comparable systems, making it affordable even for small companies
- Data is captured in less than 1 second and transferred to a PC

Source: ParcelCube

TREND ASSESSMENT

Timeframe: < 5 years | Impact: Medium

Sector relevance:

AUTO E&M TECH ENERGY LSH RET&CON

* **Image Source:** Leap Motion

ROBOTICS & AUTOMATION

Logistics is on the brink of a new wave of automation. Driven by rapid technological advancements, next-generation robots and automated 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 warehouse, transportation, and even last-mile delivery activities.

KEY DEVELOPMENTS & IMPLICATIONS

The rise of e-commerce is replacing traditional push-driven distribution with consumer-driven pull for goods directly from the warehouse, requiring logistics providers to operate faster and more efficiently to rapidly process small individual orders. This new dynamic can be supported by robotics and automation technologies which have, in recent years, 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 robotic solutions is likely to intensify over the next three years.

- **Flexible automation in warehousing and fulfillment** will utilize perceptual and mobile piece picking robots which can intelligently sense the environment around them for navigation and safety. Collaborative robots equipped with high-resolution cameras, pressure sensors, and self-learning capabilities can be easily programmed to assist workers with tasks such as picking, packing, and sorting. They could also be moved from warehouse to warehouse to cover changing peak seasons and be used to conduct replenishment and cleaning activities overnight. The up- and down-scalable nature of these solutions will help logistics providers fulfill e-commerce orders more efficiently while also allowing a flexible automation approach.

- **Trailer and container unloading robots** will assist workers with physically strenuous tasks. Low-cost image recognition technologies and progress in computing power have already enabled the first solutions that use robotic 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** will be useful to meet the growing demand for convenience logistics. They could follow delivery personnel to transport heavy items, pre-sort parcels inside delivery vehicles, and autonomously deliver letters and parcels to dedicated collection points.

KEY OPPORTUNITIES

- Flexible automation solutions increase the agility and elasticity of the logistics infrastructure to cost effectively meet market fluctuations
- Automating tasks like co-packing helps to improve efficiency and reduce inventory levels and cost
- When robots are deployed on repetitive and physically strenuous tasks, warehouse workers can focus on more complex tasks and exception handling

KEY CHALLENGES

- Legal restrictions on the use of robots near human workers
- Raises new regulatory, accountability, ethical, and legal issues, such as the appropriate level of automation vs. human job security

Human-Robot Collaboration with Sawyer

- Pioneered by Rethink Robotics, Sawyer is a one-armed collaborative robot that weighs only 19 kgs and can be easily and flexibly deployed on various tasks
- Intelligent motion control allows Sawyer to work precisely (+/- 0.1 mm accuracy) in semi-structured environments, while operating safely next to human co-workers
- DHL is testing the applicability to logistics in 2016

Source: Rethink Robotics

TREND ASSESSMENT

Timeframe: < 5 years | Impact: High

Sector relevance:

AUTO E&M TECH ENERGY LSH RET&CON

SELF-DRIVING VEHICLES

Breakthroughs in sensor and imaging technologies have resulted in an exciting new generation of self-driving vehicles that are more flexible and reliable than ever before. From autonomous forklifts in warehouses to driverless trucks in line-haul transportation, 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. Although there are currently strict laws governing the use of these vehicles in public spaces, companies such as Google have performed successful tests and begun to persuade regulatory bodies to accelerate the acceptance of fully driverless vehicles.

- **Warehouses of the future** will deploy the next generation of self-driving vehicles, such as autonomous forklifts, pallet movers, and swarm conveyor belt systems. These vehicles have integrated sensors that enable navigational authority without the need for further infrastructure such as magnetic or inductive strips. This flexibility allows for various deployment scenarios and enables new use cases for machine-human collaboration.

- **Outdoor logistics operations** can utilize self-driving technologies to automate container handling at ports and the collection and loading of airfreight containers at airports. This can be achieved through self-driving carts and dollies that intelligently collect, maneuver, and reposition the containers as desired.

- **Line-haul transportation** often involves long journeys overnight and also during rough weather conditions. Logistics providers can utilize various driverless technologies to support each driver's health and safety. One concept is the autonomous highway which requires manual operation only when the truck enters or leaves the highway.

- **Autonomous last-mile** solutions such as self-driving trolleys that autonomously follow a delivery person can be used to support workers as they cope with growing parcel volumes. Self-driving parcel vehicles that use sidewalks to deliver individual orders could also enable rapid delivery services.

* **Image Source:** Fraunhofer

KEY OPPORTUNITIES

- Increased operational productivity and asset uptime through 24/7 utilization
- Greater reliability and quality by eliminating human error
- Better fuel efficiency through optimized routing with lower impact on the environment

KEY CHALLENGES

- Technology must mature before self-driving vehicles can be deployed in dynamic environments
- Legal restrictions exist in many countries regarding fully driverless vehicles
- Potential risk from hackers and software bugs
- Insurance and liability questions need to be resolved
- Social acceptance by workers and the public

Autonomous Parcel Delivery with Starship Technologies

- Self-driving robot can deliver multiple parcels within a 5 km (3 mile) radius
- Drives on sidewalks at pedestrian speed, detects obstacles, adjusts speed/stops, and safely crosses streets
- Lid is locked during journey; requires a special code to open; on-board GPS and a video camera are used to mitigate risk of theft
- Potential for local deliveries to become 5 to 10 times cheaper

Source: Starship Technologies

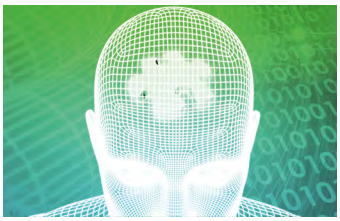
TREND ASSESSMENT

Timeframe: > 5 years | Impact: High

Sector relevance:

AUTO E&M TECH ENERGY LSH RET&CON

SELF-LEARNING SYSTEMS



Self-learning or 'machine learning' systems will become a game-changing enabler for completely autonomous data-driven optimization in logistics. With minimal/no human intervention, a self-learning system will adapt and improve its algorithms as it receives more data, improving its results over time. With supervised or non-supervised "training", the system recognizes and analyzes patterns (e.g., in speech and images) to add value in logistics.

KEY DEVELOPMENTS & IMPLICATIONS

In recent years, self-learning systems have become a vital asset for companies involved in e-commerce activities. For example, most online search engines and product recommendations are based on automated and self-modifying machine learning algorithms. In logistics, adoption of this technology has been mostly limited to smart address recognition in the postal sector; however it is expected that the era of the Internet of Things will generate vast amounts of data that can enable new opportunities for machine learning applications in the supply chain.

- **Deciphering and correcting logistics data** will become an essential application field for self-learning systems in logistics. Intelligent systems can be trained to decode written and spoken text (such as shipment information and the addresses on letters and parcels). They can also recognize and memorize frequently occurring fault and correction patterns, as well as style characteristics such as handwriting to decrease the amount of time spent on quality checks and manual analyses.

- **Anticipatory self-optimization** of processes can be applied in many operational fields. For example, in warehouses, self-learning systems can recognize repeatedly occurring scenarios and trends, and link these to specific customers, orders, and warehouse operators. Anticipating the content of an order, these systems can pre-pick-and-pack without first waiting for orders to be placed. In last-mile delivery, self-learning systems can monitor each step of the process to deliver dynamic route planning tailored to each recipient's daily routine.

- **Automated service support** could become a reality in logistics as self-learning breakthroughs pave the way for artificial intelligence. Using speech recognition as well as data (customer, contract, transactional, and operational information), future logistics service centers could utilize self-learning systems to interact with customers to solve simple requests, and offer manual support for more complex cases.

KEY OPPORTUNITIES

- Faster problem solving and decision making based on machine-generated insights
- Autonomous continuous improvement of logistics processes, increasing efficiency and quality
- Real-time data analysis and smart machine reactions (e.g., predictive and prescriptive analytics)

KEY CHALLENGES

- Algorithms are highly complex and require substantial future research
- Requires large amounts of relevant data and massive computing power to create a machine learning system
- High setup costs may deter early adoption in logistics

Facebook DeepFace – The World's Most Accurate Facial Recognition System

- Facebook's DeepFace uses deep learning technologies to automatically detect and match images with identities
- It is a trained algorithm with over 4 million facial images belonging to more than 4,000 identities
- According to Facebook, DeepFace has achieved an accuracy of 97.35%

Source: Facebook Research

TREND ASSESSMENT

Timeframe: > 5 years | Impact: Medium

Sector relevance:

AUTO E&M TECH ENERGY LSH RET&CON

UNMANNED AERIAL VEHICLES

Unmanned Aerial Vehicles (UAVs) or 'drones' could change tomorrow's logistics by adding a new form of express delivery via carefully coordinated air networks. While UAVs won't replace traditional ground-based transportation, they will provide value in areas of high traffic congestion and in remote locations. UAVs can potentially increase speed and customer satisfaction, lower cost and, in hostile environments, save lives.

KEY DEVELOPMENTS & IMPLICATIONS

Although 'hobby drones' have become popular with consumers, the adoption of UAVs in logistics is still in its early stages. This is largely due to technological limitations (e.g., poor stability in rough weather), regulations (e.g., approval is required on a case-by-case basis), and public concerns about the use of UAVs in densely populated areas. However, first commercial tests (e.g., Google, Amazon, and DHL) have successfully demonstrated UAV potential, and key regulatory bodies are expected to ease legislations for commercial UAV deliveries over the next few years.[24]

- **Surveillance of infrastructure** can be supported by UAVs. Equipped with cameras, they can monitor sites and assets to prevent theft and report suspected damage or maintenance requirements. They can also be used to coordinate major logistics operations on the ground.
- **Intralogistics operations** can be streamlined by using UAVs for intra-plant transport (e.g., carrying parts to the required production facility) and for urgent supplier-to-plant spare parts delivery. UAVs equipped with computer vision technology can be deployed inside warehouses to conduct inventory checks.
- **Rural delivery** using UAVs is attractive for remote regions that have limited logistics infrastructure or are hazardous to access (e.g., islands during rough weather conditions, villages located in mountain ranges). Logistics providers can set up emergency delivery services (e.g., medicines) for these communities.
- **Urban UAV networks** for first- and last-mile delivery will be required to handle single shipments that cannot be achieved in an economical way with traditional delivery vehicles. By potentially reducing the amount of vehicle movements, UAVs can provide traffic congestion relief to densely populated cities. Each UAV can be prepared for flight along with its shipment at a logistics hub or even directly at the retail store, and is likely to use fixed programmed routes to safely deliver goods at designated drop-off points.

KEY OPPORTUNITIES

- Operational efficiency of first- and last-mile logistics networks can be increased
- Reduction of risk and accidents through automated delivery in remote areas
- Increased flexibility and speed of delivery, especially in crowded megacities

KEY CHALLENGES

- Unauthorized interception or hacking of UAVs
- Privacy and safety concerns from the public
- Integration of UAV traffic in crowded airspace networks
- Regulatory restrictions

Taking Off Into the Future – DHL Parcelcopter

- Since 2013, DHL has been testing UAVs for commercial delivery of goods in remote settings
- First major project focused on the delivery of urgent pharmaceutical goods from mainland Germany to the island of Juist, 12 km away
- Currently being tested for delivery of goods to a DHL parcel locker in a remote mountainous region in southern Germany

Source: DHL

TREND ASSESSMENT

Timeframe: > 5 years | Impact: Medium

Sector relevance:

AUTO E&M TECH ENERGY LSH RET&CON

[24] http://fortune.com/2016/02/12/faa-small-drones-businesses/

REFERENCES

BEST PRACTICES AND USE CASES

Social & Business Trends

Anticipatory Logistics
Volvo – maintenance on demand for trucks, DHL Resilience 360 – risk management tool using big data analytics, DHL Parcel Volume Prediction – volume planning of parcels to be transported with big data, Amazon – anticipatory shipping of products to customers before order is placed, Transmetrics – big data predictive analytics solution for transport

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

Convenience Logistics
Die Bauerntuete – online regional food delivery service, Zipdrug – medicine delivery on the hour, Allyouneed – platform for online grocery delivery, Waitrose – online goods delivery serviced from local branches, Redmart – online discount grocery delivery platform, Toptomato, Foodstore Online, Edeka24, Sainburys

De-stressing the Supply Chain
Jet.com – online marketplace enabling location-based pricing and logistics efforts, European Gateway Services – synchromodal service provider for cargo transport, Platform Synchromodaliteit – synchromodal solution for flexible and sustainable deployment of different modes of transport, EU research and innovation funding Horizon 2020: Project MG.6.2-2014 – De-stressing the supply chain

Fair & Responsible Logistics
EcoATM – automated e-waste recycling kiosk with instant cash payouts, H&M – LongLiveFashion initiative collects old clothing for recycling in return of a coupon, HP – closed-loop recycling of printer cartridges, Ricoh – Greenline product line enhances the circular economy, Original Unverpackt – Berlin-based supermarket using a zero packaging waste approach, DHL Envirosolutions – integrated approach to waste, recycling, energy and environmental compliance, DHL Living Responsibility – GoGreen, GoHelp, GoTeach, Fairphone – modular fair-sourced smartphone, The Logistics Project

Grey Power Logistics
Effizienzcluster LogistikRuhr – Homecare Services For the Elderly Project, MIT Age Lab – translating technologies into practical solutions for improving health, 'SmartSenior' - research project to develop technologically innovative services that enable older people to continue living in their own homes longer, Abilia Smart Home Products and Services, MoPAct EU Project

Logistics Marketplaces
Fraunhofer Logistics Mall – a logistics service orientated platform, INTTRA – the world's largest marketplace for ocean shipping, Flexport – online end-to-end freight forwarding solution, Freightos – cloud-based marketplace matching freight shipper and freight forwarders, iContainers – end-to-end pricing tool and freight forwarding service for ocean and sea freight, MediPx - medical logistics marketplace, Uship – online international shipping marketplace where transporters compete for shipments, Shiply, Shareload

Multi-purpose Networks
DHL Thermobox – colf chain delivery via standard parcel network, SemProM Research Project – semantic product memory coupled with identification and authentication solution, DHL Postbus – combining passenger and parcel transportation, Amazon / DHL / AUDI – delivery-to-car-trunk concept for last-mile delivery

Omni-channel Logistics
Flexe – cloud-based online marketplace for renting flexible warehousing space, Hointer – combines the convenience of online shopping with the experience of shopping in store via a smartphone app, IKEA – mobile application allowing users to save items as shopping list, Macy's – development of My Macy's for an improved shopping experience, Heilan Home, Harvey Norman, DHL eCommerce solutions

On-demand Delivery
Shutl – rapid fulfillment service by connecting online retailers with local same-day couriers, UberRUSH - on-demand delivery network, Shyp – mobile app aiming to ease up on-demand shipping experience, postmates – on-demand app service utilizing freelance drivers and riders, UberRUSH – on-demand delivery fleet for small businesses, BringBee

Shareconomy Logistics

park circa – the shareconomy of parking spaces, carzapp – easy access to vehicles with a smartphone app, Tamyca – online car-sharing portal, Getaround – Peer-to-peer car-sharing portal on hourly or daily rentals, car2go – car-sharing services featuring one-way point-to-point rentals, Lifecycler – intuitive online platform where used yet still valuable items can be given away, Airbnd.de, Crowd Companies Council

Smart Energy Logistics

Colas – 'Wattway Solar Road' enables harvesting of solar energy, Google Project Sunroof – solar mapping tool to help consumers save energy, Tesla Powerwall – powering homes through electricity generated from solar panels, DHL StreetScooter – the electric delivery van, AC propulsion

Supergrid Logistics

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 e-commerce deliveries in China, ESSENCE Project – free ICT network for SMEs to manage and optimize their supply chains by designing own business networks, LOGICAL / InterLogGrid

Tube Logistics

Mole Solutions – underground freight pipeline system, Hyperloop Technologies – conceptual high-speed transportation system could change passenger and goods transport, Loglay – underground cargo system

Technology Trends

3D Printing

Kazzata – marketplace for 3D printed spare parts, Die Post 3D printing services, Shell Technology Center – 3D printing parts, Amazon patent for mobile 3D printing delivery trucks, DirectSpare research project (EU), Thingiverse - repository for object files, 4D Solution, Sculpteo – online 3D printing service, Shapeways, Rapitech Solutions – prototyping and casting services, MicroTec, HP 3D printing with Multi Jet Fusion technology

Augmented Reality

DHL Vision Picking Project, TUM, KNAPP: KiSoft Vision, Ubimax xAssist / xMake for manufacturing and service operations, SAP, Volkswagen MARTA – service operations using augmented reality, Toyota augmented reality windshield, Boeing – assembly using smart glasses, Lenovo augmented reality smartphone, Google Glass Explorer, Epson Moverio, Meta Spaceglasses, Atheer Labs, DAQRI smart helmet, ODG

Big Data

DHL Resilience360 – data-driven supply chain risk management, DHL SmartTruck – route optimization and address management using big data, DHL Parcel Volume Prediction, DHL Geovista,Transmetrics, Agheera: pulse. agheera, LogiNext – big data analytics startup for logistics, Teradata, Blue Yonder – cloud-based predictive applications

Bionic Enhancement

Thalmic Labs Myo – gesture control using muscle movements, KIT Airwriting – wearable handwriting recognition system, Fitbit – fitness tracker, Scarab – wearable device with 16 sensors for monitoring and tracking, Apple iWatch – wearable watch that can also enable mobile payment, RoboMate EU, Panasonic Assist Suit AWN-03, Harvard University 'Soft Exosuits', BMW 3D-printed thumb shields to assist workers, Ekso Bionics, Cyberdyne, Lockheed Martin

Cloud Logistics

Shipwire Enterprise Logistics Platform, Westfracht Spezialverkehre: LaaS (logistics-as-a-service.de), LogFire Cloud Solutions, Transporeon – logistics services from the cloud, Cloud Logistics – cloud-based transport management solutions

Digital Identifiers

Thinfilm – low-cost printed electronics, Digimarc digital watermarking, GS1, Advanced Traceability Solutions (ATS) – "Harvest to Plate" traceability solutions, Harvestmark, Biometrics: DHL Leipzig Hub – hand scanners, DHL E-POST identity solutions, NYMI – wearable heartbeat authenticator band for secure mobile payments, Zwipe – card for fingerprint-activated contactless payment

Internet of Things

DHL/Cisco IoT warehouse project, Port of Hamburg, smaRTI: Smart Reusable Transport Items research project, Agheera – the IoT platform for logistics, Fraunhofer IML: Smart container chain management (SMART-CM), Alethia – German research project on tracking and monitoring items in transit, Estimote - low-cost beacons for localization applications, Locoslab – indoor navigation and location analytics, ByteLight – smart indoor positioning, August Smart Lock – keyless home entry, Postybell smart mailbox, LoRaWAN Alliance – global spread of dedicated IoT networks using long range wide area technologies

Low-cost Sensor Technology

DHL / Fraunhofer IFF field test: Volume scanning using low cost 3D sensors, BIBA Bremen: Intelligent image processing in production and logistics, Parcelcube – low-cost dimensioning made easy, Intel RealSense, Scandit – advanced barcode scanning application for smartphones and tablets, Copilot Truck – map and direction routing application designed for professional truckers for smartphones and tablets

Robotics & Automation

Rethink Robotics – collaborative humanoid robots Baxter and Sawyer, Fetch Robotics – mobile piece picking robotics system, Universal robots – collaborative robotics arms, Multishuttle Move – cellular automation system, Autonomous transport shuttles (Dematic / Fraunhofer IML), Kuka, Swisslog – Carrypick and Autostore, ABB Quiet Logistics, Fraunhofer IPA, Fraunhofer IFF, Magazino - mobile piece picking system, Bosch, Knapp, TU Berlin, ESB-Logistikfabrik: RobLog, SSI SCHAEFER (SSI Robo-Pick), Amazon KIVA – mobile shelving solution

Self-driving Vehicles

Effidence – Self-driving trolley to assist order pickers in warehouse operations, Effizienzcluster LogistikRuhr/Fraunhofer IML: Cellular Transport Systems, Linde Material Handling, Baylo, Jungheinrich, Toyota Material Handling, Google driverless car, Starship Technologies – e-shuttles for last-mile parcel delivery, EC EUREKA Prometheus Project in collaboration with Daimler Benz

Self-learning Systems

Facebook DeepFace – the world's most accurate facial recognition system, Google DeepMind AI, University of Maryland – self-learning robots based on watching thousands of Youtube videos, Amazon product recommendation based on past and real-time consumer behavior, IBM Watson AI, Microsoft machine learning, a2ia – handwriting recognition algorithm, Lappeenranta University of Technology – self-learning wielding system

Unmanned Aerial Vehicles

DHL ParcelCopter project - use of quadrocopters and tilt wing drones for express delivery, Amazon Primeair, Google Project Wing, Matternet, AMP, Flirtey, BP - puma drone for checking infrastructure, Fraunhofer IML – drones for inventory management in warehouse operations

SPECIAL THANKS TO OUR DHL SECTOR EXPERTS

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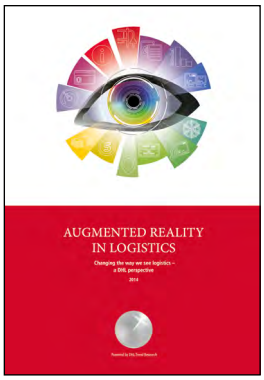
RECOMMENDED READING

AUGMENTED REALITY IN LOGISTICS

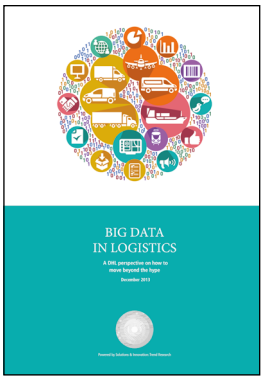


www.dhl.com/augmentedreality

LOW-COST SENSOR TECHNOLOGY

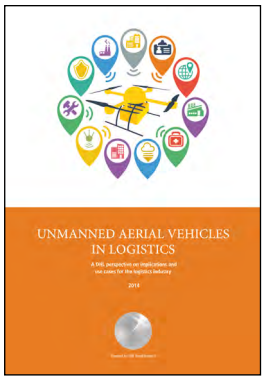
www.dhl.com/lcst

BIG DATA IN LOGISTICS



www.dhl.com/bigdata

UNMANNED AERIAL VEHICLES IN LOGISTICS



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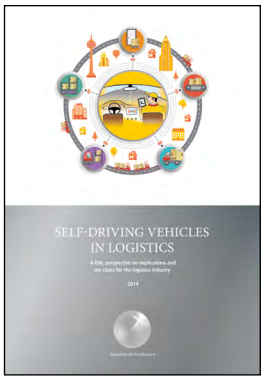
SELF-DRIVING VEHICLES IN LOGISTICS



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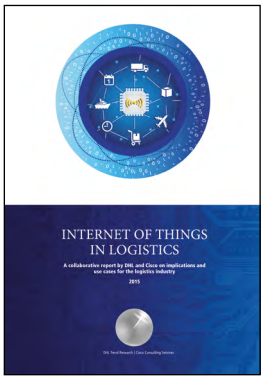
INTERNET OF THINGS IN LOGISTICS



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