THE LOGISTICS TREND RADAR

6.0

Delivering insight today, creating value tomorrow.

Powered by
DHL Trend Research

WHY CONFORM?

WHY NOT DO THINGS DIFFERENTLY?

WE ARE A LOGISTICS COMPANY THAT DOES JUST THAT

ALWAYS CONNECTING WITH VISIONARIES

ALWAYS DISCOVERING NEW WAYS TO

DELIVER OUT OF THE BOX THINKING

JOINTLY CREATING TANGIBLE,

REAL-WORLD INNOVATION

THAT CAN ONLY COME FROM ZIGGING WHEN OTHERS ZAG

SHOWCASING SUCH FORWARD THINKING

THROUGH OUR INNOVATION CENTERS
AROUND THE GLOBE

DHL

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DHL

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The Era of Logistics is here.

Never has the importance of supply chains been more widely acknowledged by societies in connecting people and improving lives. On an unprecedented level, we are seeing businesses transform logistics from a quiet, back-end operation into a strategic asset and value driver. At the same time, more technology visionaries than ever before are beginning to understand the vast, ripening opportunities in the logistics industry to develop and apply their innovative solutions around the world.

At DHL, we believe that success in this new era requires innovation: inspiration, open exchange, and deep collaboration. By sharing *The Logistics Trend Radar 6.0*, we invite you – our customers, colleagues, and partners – to connect with us and jointly shape the **Era of Logistics**.

KATJA BUSCH
**CHIEF COMMERCIAL
OFFICER DHL & HEAD OF DHL
CUSTOMER SOLUTIONS &
INNOVATION**

DHL

INTRODUCTION

DR. KLAUS DOHRMANN
VICE PRESIDENT, HEAD OF INNOVATION & TREND RESEARCH
PROJECT DIRECTOR & CO-AUTHOR

In introducing the very first version of *The Logistics Trend Radar*, we stated: "The logistics industry is busy reshaping itself, and potentially disruptive innovation is coming into focus." Today, nearly 10 years later, the transformation of logistics and supply chains is undisputed, and, maybe even more than expected, innovation is taking center stage to enable this revolution.

In recent years, we have seen the growing importance of 4 megatrends – globalization, digitalization, e-commerce, and sustainability – and we have witnessed numerous macro forces, such as the Covid-19 pandemic, accelerating the speed of transformation.

Many technologies outlined in the first edition of *The Logistics Trend Radar*, including those in the fields of robotics, artificial intelligence (AI), and the Internet of Things (IoT), have since matured and can be seen today in many solutions scaled across supply chain networks, inspiring future innovation. Additionally, many social and business trends, such as demographic change, environmentalism, and social justice, have since gained traction to influence and change business practices within the logistics industry, impacting the workforce, partner organizations, and consumers.

Believing in a customer-centric innovation approach, we at DHL have also identified a significant change in customer expectations. Customer requirements are no longer one- or two-dimensional. Instead, today's customer has a broad and complex set of sometimes competing needs and values, including speed, quality, personalization, environmental sustainability, convenience, reliability, visibility, flexibility, and cost efficiency, among others. Until this point, the dominant supply chain narrative has been efficiency and operational excellence. Now this is complemented by an understanding that the supply chain is the essential driver of tangible value creation, literally delivering the customer promise and experience in a sustainable way.

Against this background, the future of logistics is unfolding at a spectacular new pace.

Logistics leaders will need to identify, understand, embrace, and harness the power of trends. They must also foster collaborative environments across value chains to fully realize the opportunities that lie ahead and to actively shape the industry.

Since the introduction of *The Logistics Trend Radar* in 2013, we have showcased a decade's worth of innovation

insights, and our objective remains the same. We aim to bring a valuable resource to you – our customers, colleagues, and partners – with key insights into the trends, both near and far, that impact the supply chain. With this sixth edition, we remain committed to providing a tool for the global logistics community and beyond that helps reflect the direction of businesses, societies, and technologies.

The spirit of what we continue to call 'participatory knowledge' lives on with our philosophy of staying 'close to customers, close to technology, and close to operations.' This is the engine that powers DHL's Trend Radar, a dynamic tool and recognized benchmark for strategy, innovation, and education.

We hope this latest edition invigorates your own journey, galvanizes collaboration and exchange across ecosystems, and fosters our joint success in the Era of Logistics.

Please enjoy the discovery and inspiration of the latest trends influencing the logistics industry. We welcome you to connect with the open DHL innovation ecosystem, and we look forward to creating impact together through true innovation – beyond potential.

BEYOND POTENTIAL

DELIVERING EXCELLENCE THROUGH TRUE INNOVATION

Discover, inspire, connect, create. These four pillars make up DHL's platform to spearhead the future of logistics and drive customer-centric innovation across the world. We are driven by our core belief in an open innovation ecosystem based on collaboration and sharing, as well as our ambition to create impact with real-world innovative solutions. Coupled with our research-based approach and customer proximity, these values empower us to deliver excellence and go beyond potential.

> "I am impressed by the outcome of our workshop at the Innovation Center, which not only described a possible future vision, but also milestones and first concrete steps to get into action mode."

– HEAD OF LOGISTICS, GLOBAL RETAIL CUSTOMER

THE DHL INNOVATION CENTER NETWORK

With our four DHL Innovation Centers located in Germany, Singapore, the US, and the UAE, we spearhead the future of logistics and drive customer-centric innovation around the world. This global network enables us to consider regional socio-economic differences and actively participate in local innovation ecosystems. Every year, we welcome tens of thousands of customers, partners, and other innovative thinkers and visionaries to engage with DHL experts and each other. Through these creative hubs, we facilitate and lead workshops, innovation center tours, events, and joint innovation projects to better understand customer needs and identify actions to solve key supply chain challenges. We also take a focused, user-centric, and systematic thought leadership approach to discovering impending developments, emerging best practices, potential industry applications, and the implications of these trends on logistics. Leveraging customer insights and research findings, we test, create, customize, commercialize, and scale innovative solutions for the benefit of our customers and our colleagues.

EUROPE
COLOGNE, GERMANY

MIDDLE EAST & AFRICA
DUBAI, UAE

AMERICAS
CHICAGO, USA

ASIA-PACIFIC
SINGAPORE

OUR PHILOSOPHY

It is our core belief that delivering meaningful innovation can only be achieved by staying close to customers, close to technology, and close to operations:

Close to Customers

We cultivate honest conversations and engagement with our customers about business strategies, future needs, and pain points in order to validate ideas, develop use cases, and leverage technologies and expertise. We achieve success through strong customer buy-in and close collaboration.

Close to Technology

We connect the logistics and the digital worlds, tracking and engaging visionary developers and providers of all kinds and staying at the forefront of emerging technology and supply chain innovation. This enables us to identify and co-create new solutions beneficial to our customers.

Close to Operations

We leverage our own global DHL logistics operations to improve logistics efficiency, quality, and safety. The significant time we spend on site with facility managers and workers to visualize and implement solutions benefits both our customer and colleagues.

"

The Logistics Trend Radar **has enabled our business to have important conversations both internally and with customers on future collaboration, ensuring our ability to deliver for them and their priorities moving forward."**

– ERETAIL & FASHION CUSTOMER

DRIVING INNOVATION

Our end-to-end innovation project approach starts with customer engagements, technology scouting, and research, which helps us understand social and business trends, as well as technological breakthroughs. This forms the basis of our Logistics Trends Radar and additional thought leadership trend reports. With a finger on the pulse of the relevant trends, we run proof of concept projects in real-world supply chain settings with our customers and within the DHL network of operations to fully understand the benefits and challenges of applications. Successful projects open up opportunities for productization and scaling, so that these solutions are available internally across DHL operations and commercially to customers.

Megatrends

Major movements and patterns – namely globalization, e-commerce, digitalization, and sustainability – have gradually transformed the logistics industry over the past decades and will continue to do so in the future. We inspect how these megatrends further shape the needs of societies and industries and the supply chains that serve them.

Macro Forces

As drivers of change extending beyond whole industries, macro forces influence the acceleration and importance of trends and their placement on our Trend Radar. We evaluate the growth and decline of macro forces over the last two years, as well as how they compound or conflict with one another. They are numerous, but some examples are societal values, demographics, climate change, the Covid-19 pandemic, urbanization, consumer behavior, geopolitical events, and labor shortages, among many others.

Innovators

Researchers, inventors, developers, visionaries, and providers of technologies play a crucial role in the advancements that revolutionize the logistics industry. By collaborating with such innovators early on, we here at DHL derive invaluable insights into sophisticated technological breakthroughs and new possibilities on the horizon.

DEVELOPING THE RADAR

We update *The Logistics Trend Radar* every two years to reflect how we at DHL view the key social, business, and technology trends within the logistics industry. Our unique and integrated customer-centric innovation approach empowers us to harness the most relevant perspectives for logistics transformation directly from our valued customers and colleagues engaged in daily operations. We complement these insights using classic research methodologies, and incorporate the work of multiple experts, including key opinion leaders from influential think tanks, renowned consultancy firms, and top-tier academia from around the world.

DHL's Trend Radar is very insightful when it comes to providing insights into the technology, as well as social and business, trends that will potentially transform the Auto-Mobility sector in the near future."

– AUTO-MOBILITY CUSTOMER

CONSIDERATIONS

Trend Positioning

Our Trend Radar reflects 40 trends intersecting the logistics industry on a global level. We understand that trends develop or influence world regions at varying degrees and points in time, impacting supply chains differently in, say, Scandinavia than the way they would in Southeast Asia. Therefore, we aim to balance regional expertise and outlooks across the world to produce a guiding tool useful for all players in the logistics industry.

Trend Composition & Naming

Across all editions of *The Logistics Trend Radar*, it is our goal to make the trends as clear as possible to our customers, colleagues, and partners to drive fruitful conversation and innovative collaboration. We recognize that many trends have some components that overlap – robots and bionic enhancements often rely on AI or IoT devices to operate, for example. However, at the core of each trend is an important idea that we name using common terms understood within the industry. We also provide definitions to help clarify each trend's name and defining characteristics.

Trend Movement

Megatrends and macro forces are constantly fluctuating, accelerating the development of trends or slowing down their adoption. Our Trend Radar is a snapshot of these changes produced biennially, and much can happen between editions. While trends may appear static on our Trend Radar, in reality, they are quite dynamic. This should be noted when using the Trend Radar as a guiding tool.

NAVIGATING THE RADAR

This latest edition of *The Logistics Trend Radar* provides both developed and new ways to navigate the future of logistics. At the heart of this publication is a detailed graphic which illustrates the breadth and depth of our research and findings. We hope the following short navigation guide proves useful for first-time and returning readers alike, enabling discovery, insight, and inspiration from the 40 trends.

TYPE OF TREND
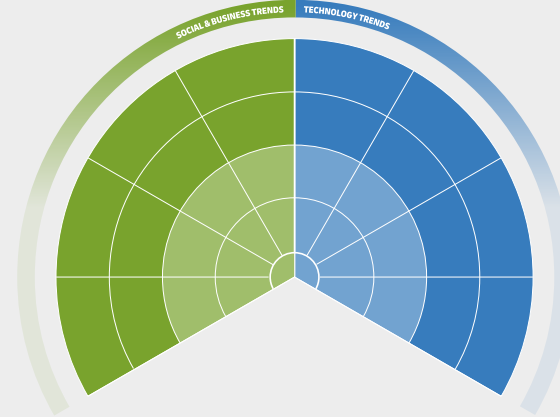
Firstly, the Trend Radar is divided into left and right halves. On the left are the **Social & Business** trends in **green**, highlighting the top priorities and opportunities for logistics organizations and the communities they strive to serve. These trends reflect the direction of business strategies, new ways of working, and maturing societal values often brought about by technological advancements. On the right are the **Technology** trends in **blue**, showcasing the development and adoption of new materials, tools, and devices relevant to the logistics industry. These trends respond to the more pressing needs of organizations and societies and are often shaped and accelerated by them.

REALIZATION
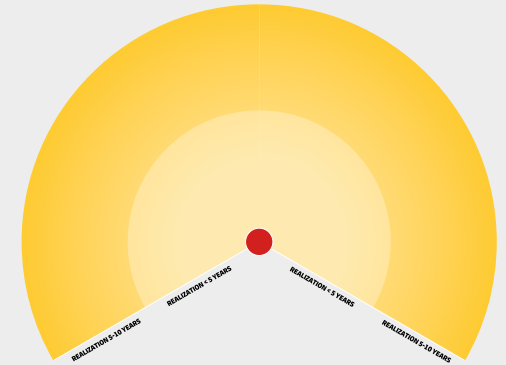
Secondly, each of the 40 trends is placed between the center and the outer edges of the Trend Radar. The **red center dot** represents the logistics industry as a whole today. The **Realization** timeline signifies when a trend is anticipated to become a non-trend, or the standard way of operating, within a 10-year span. Trends in the **inner half** of the Trend Radar will be realized **within 5 years**, as they feature more scalable use cases and more applicable implementation opportunities in supply chains today. Meanwhile, trends in the **outer half** will be realized **within 5 to 10 years**, as integral technologies and business cases are often not yet fully developed and, right now, may be undergoing testing and verification.

IMPACT
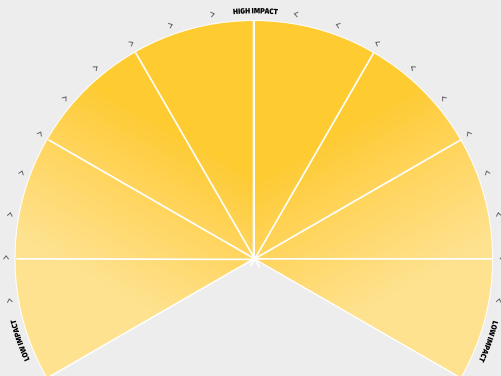
Thirdly, the Trend Radar is divided into 8 slices – 4 on the left and 4 on the right. The **Impact** scale starts from both ends of the Trend Radar and spans its curvature until meeting at the top. It reflects how much a trend will change both the inner workings and face of supply chains for management, workers, and customers. Trends with **High Impact** involve applications that are potentially disruptive to supply chains. These are in the **highest** slices. Trend with **Low Impact** encompass evolutionary changes with incremental improvements. These are in the **lowest** slices.

PERSPECTIVES & LENSES
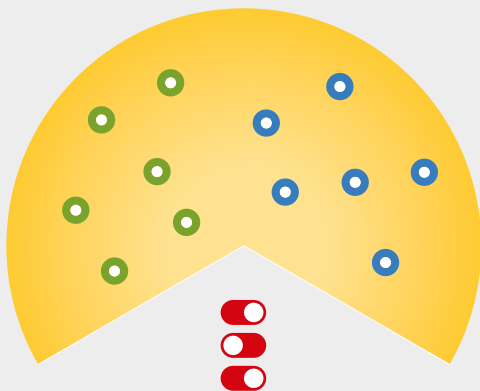
The 40 trends in this edition of *The Logistics Trend Radar* are further grouped into different categories to help structure and facilitate forward-thinking conversations and innovative collaboration. In total, there are **3 perspectives**, each reflecting different ways in which the world and its trends are organized and perceived. Each perspective consists of **6 lenses** that further refine and classify a particular outlook. In turn, each lens highlights the trends that are at the core and pertinent to the category.

Perspectives
1. The **Focus Areas** perspective frames trends on both sides of *The Logistics Trend Radar* using lenses that reflect various strategic goals and opportunities in logistics and supply chains.
**2.** The **Trend Clusters** perspective filters the social and business trends and technology trends with lenses that represent different technology groups.
3. The **Sectors** perspective highlights trends across the Trend Radar using lenses that correspond to different industrial sectors with substantial and distinct supply chains.

 To experience all these interactive perspectives and lenses, please visit the Trend Radar online.

AT A GLANCE: THE LOGISTICS TREND RADAR

SOCIAL & BUSINESS TRENDS

TECHNOLOGY TRENDS
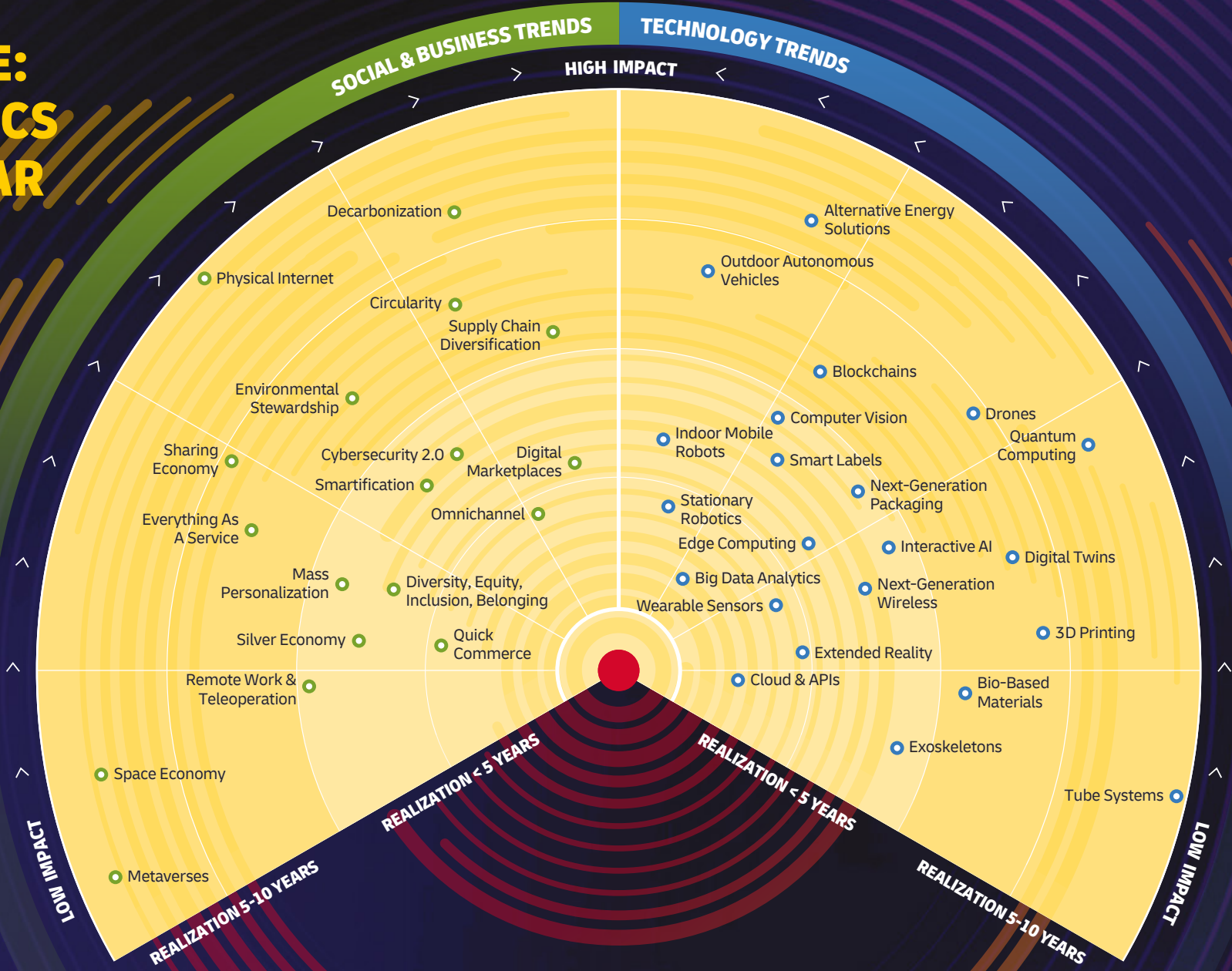
HIGH IMPACT

High Impact
Revolutionary applications that are potentially disruptive.

Low Impact
Evolutionary changes with incremental improvements.

Realization
The normal way of operating and doing business in the logistics industry.

Decarbonization

Physical Internet

Circularity

Supply Chain Diversification

Environmental Stewardship

Sharing Economy

Cybersecurity 2.0

Digital Marketplaces

Smartification

Everything As A Service

Omnichannel

Mass Personalization

Diversity, Equity, Inclusion, Belonging

Silver Economy

Quick Commerce

Remote Work & Teleoperation

Space Economy

Metaverses

Alternative Energy Solutions

Outdoor Autonomous Vehicles

Blockchains

Computer Vision

Drones

Quantum Computing

Indoor Mobile Robots

Smart Labels

Stationary Robotics

Next-Generation Packaging

Edge Computing

Interactive AI

Digital Twins

Big Data Analytics

Next-Generation Wireless

Wearable Sensors

3D Printing

Extended Reality

Cloud & APIs

Bio-Based Materials

Exoskeletons

Tube Systems

REALIZATION < 5 YEARS

REALIZATION < 5 YEARS

REALIZATION 5-10 YEARS

REALIZATION 5-10 YEARS
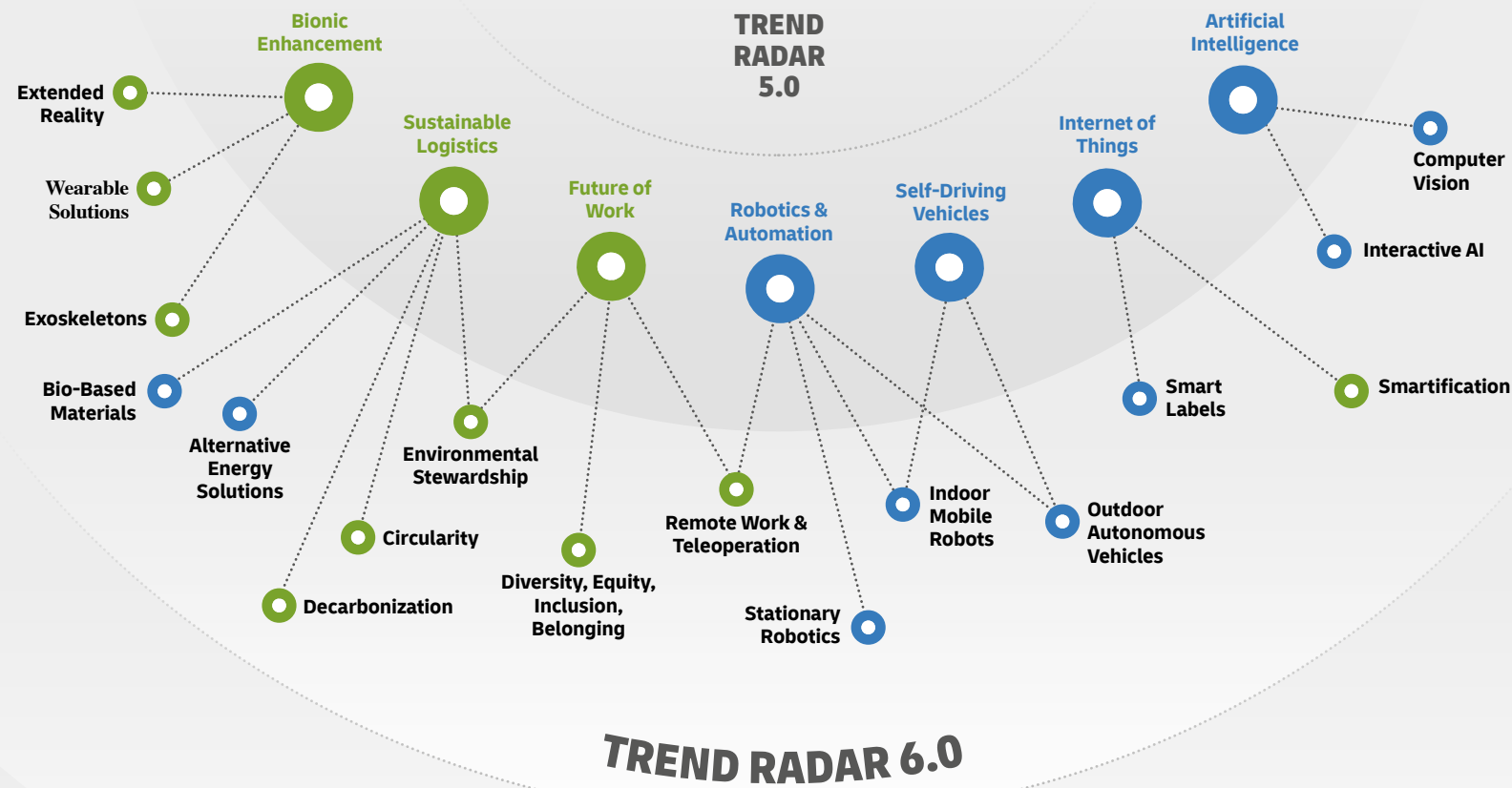
LOW IMPACT

LOW IMPACT

WHAT'S NEW

The DHL Trend Research team has been closely monitoring the various social, business, and technology trends over the past two years. Since the launch of the previous edition of *The Logistics Trend Radar*, we have witnessed several interesting developments that have influenced trends' realization and impact on the logistics industry. Additionally, through conversations with customers, colleagues, and partners, we have identified ways to improve the user experience of the Trend Radar to drive deeper discussions and more innovation collaboration. Overall, this has led to several changes in the design, approach, and composition of Trend Radar 6.0, of which the most noteworthy are categorized here.

New & Returning Trends

As technologies develop and community values change, new trends emerge and their relevance begin to intersect with the logistics industry. Meanwhile, other trends have appeared in past editions but have been removed as macro forces push them outside of the Trend Radar's 10-year realization scope. For Trend Radar 6.0, we welcome completely new trends, as well as reintroduce returning trends from previous editions, as elements of these trends become relevant to supply chains within the coming decade.
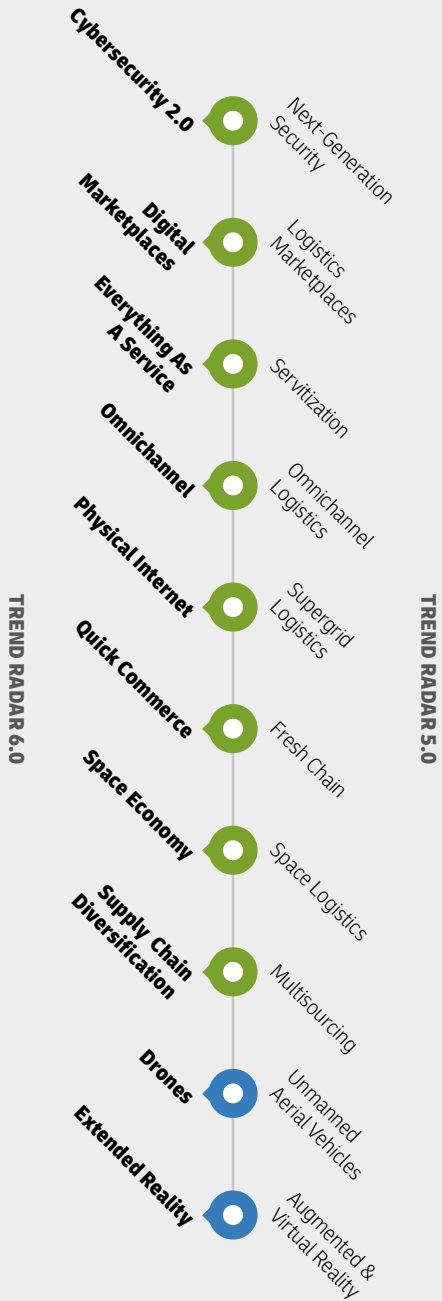
Decarbon-ization

Physical Internet

Outdoor Autonomous Vehicles

Alternative Energy Solutions

Blockchains

Environmental Stewardship

Circularity

Supply Chain Diversification

Indoor Mobile Robotics

Computer Vision

Next-Generation Packaging

Drones

Digital Marketplaces

Sharing Economy

Cybersecurity 2.0

Smartification

Stationary Robotics

Smart Labels

Digital Twins

Quantumn Computing

Omnichannel

Big Data Analytics

Edge Computing

Interactive AI

Everything As A Service

Silver Economy

Mass Personal-ization

Diversity, Equity, Inclusion, Belonging

Wearable Sensors

Extended Reality

Next-Generation Wireless

3D Printng

Metaverses

Space Economy

Remote Work & Teleoperation

Quick Commerce

Cloud & APIs

Exoskeletons

Bio-Based Materials

Tube Systems

New Trends

Existing Trends

Returning Trend

TREND RADAR 5.0

TREND RADAR 6.0

Bionic Enhancement
- Extended Reality
- Wearable Solutions
- Exoskeletons
- Bio-Based Materials

Sustainable Logistics
- Alternative Energy Solutions
- Circularity
- Decarbonization
- Environmental Stewardship

Future of Work
- Remote Work & Teleoperation
- Diversity, Equity, Inclusion, Belonging

Robotics & Automation
- Indoor Mobile Robots
- Stationary Robotics

Self-Driving Vehicles
- Outdoor Autonomous Vehicles

Internet of Things
- Smart Labels
- Smartification

Artificial Intelligence
- Computer Vision
- Interactive AI

Refocused Trends

Collecting feedback, we learned from users of the previous Trend Radar that the trends sometimes seemed unbalanced – that some trends were too broad in scope, while others were at an appropriate level to drive innovation-centered strategy and conversations. To rectify this, we have refocused the broader developments, retiring them and uplifting many of their components onto the trend level. In doing so, users can now see these previously hidden topics showcased directly on the Trend Radar.

Remodeled Trends

As part of the process, we re-evaluate all trends and their composition of logistics-related concepts. For some, we have added new opportunities and use cases that have recently developed, while for others, we have subtracted components that have lost relevancy to supply chains. For these trends, we have provided new names to better represent their recomposition. Simultaneously, some trends, while remaining consistent in their relevance and content, have been renamed to reflect more commonly-used terminology.

TREND RADAR 6.0 — **TREND RADAR 5.0**

Trend Radar 6.0	Trend Radar 5.0
Cybersecurity 2.0	Next-Generation Security
Digital Marketplaces	Logistics Marketplaces
Everything As A Service	Servitization
Omnichannel	Omnichannel Logistics
Physical Internet	Supergrid Logistics
Quick Commerce	Fresh Chain
Space Economy	Space Logistics
Supply Chain Diversification	Multisourcing
Drones	Unmanned Aerial Vehicles
Extended Reality	Augmented & Virtual Reality

New Perspectives & Lenses

We believe that innovation discussions regarding the 40 trends on the Trend Radar should be framed in more ways than just by industry sector. Therefore, we have introduced two new perspectives (Focus Areas and Trend Clusters) to accompany Sectors for users to approach and engage with the Trend Radar. Each of these perspectives has six lenses that group trends according to their respective themes. For an interactive experience with the perspectives and lenses, please visit *The Logistics Trend Radar* online.

Focus Area Perspective	Trend Cluster Perspective	Sector Perspective
Automation & Efficiency	Artificial Intelligence	Auto-Mobility
Customer Experience	Bionic Enhancements	Energy
Environmental Sustainability	Digital Backbone	Engineering & Manufacturing
Health, Safety & Future of Work	Internet of Things	E-Retail & Fashion
Physical & Digital Security	Packaging & Containers	Life Sciences & Healthcare
Visibility & Resilience	Robotics	Technology

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**New Perspective:
Trend Clusters**

SOCIAL & BUSINESS TRENDS

	Artificial Intelligence	Bionic Enhancements	Digital Backbone	Internet of Things	Packaging & Containers	Robotics
Circularity					•	
Cybersecurity 2.0			•			
Decarbonization					•	
Environmental Stewardship					•	
Everything As A Service				•		
Mass Personalization	•					
Remote Work & Teleoperation		•				•
Smartification				•	•	

TECHNOLOGY TRENDS

	Artificial Intelligence	Bionic Enhancements	Digital Backbone	Internet of Things	Packaging & Containers	Robotics
Big Data Analytics	•		•	•		
Bio-Based Materials					•	
Blockchains			•			
Cloud & APIs			•			
Computer Vision	•					•
Digital Twins	•		•	•		
Drones						•
Edge Computing			•	•		
Exoskeletons		•				
Extended Reality		•				
Indoor Mobile Robots						•
Interactive AI	•					
Next-Generation Packaging				•	•	
Next-Generation Wireless			•	•		
Outdoor Autonomous Vehicles						•
Physical Internet				•	•	
Quantum Computing			•			
Smart Labels				•	•	
Stationary Robotics						•
Wearable Sensors		•		•		

The Logistics Trend Radar provides a useful platform to reflect on technologies, ultimately impacting on where investment should go."

– ERETAIL & FASHION CUSTOMER

**New Perspective:
Focus Areas**

SOCIAL & BUSINESS TRENDS

	Automation & Efficiency	Customer Experience	Environmental Sustainability	Health, Safety & Future of Work	Physical & Digital Security	Visibility & Resilience
Circularity		•	•			
Cybersecurity 2.0					•	•
Decarbonization			•			
Digital Marketplaces	•	•				•
Diversity, Equity, Inclusion, Belonging				•		
Environmental Stewardship			•			
Everything As A Service		•	•			
Mass Personalization	•	•				
Metaverses		•				
Omnichannel		•				•
Quick Commerce		•				
Remote Work & Teleoperation	•		•	•	•	
Sharing Economy		•	•	•		
Silver Economy		•		•		
Smartification	•	•	•	•	•	•
Space Economy						•
Supply Chain Diversification		•				•

TECHNOLOGY TRENDS

	Automation & Efficiency	Customer Experience	Environmental Sustainability	Health, Safety & Future of Work	Physical & Digital Security	Visibility & Resilience
3D Printing	•					
Alternative Energy Solutions			•			
Big Data Analytics	•	•	•			•
Bio-Based Materials			•			
Blockchains	•	•			•	•
Cloud & APIs	•	•			•	•
Computer Vision	•			•	•	•
Digital Twins	•				•	
Drones	•				•	•
Edge Computing	•				•	
Exoskeletons				•		
Extended Reality	•	•	•	•		
Indoor Mobile Robots	•				•	•
Interactive AI	•	•		•		
Next-Generation Packaging		•	•			•
Next-Generation Wireless	•				•	•
Outdoor Autonomous Vehicles	•	•		•	•	•
Physical Internet	•	•	•			
Quantum Computing	•				•	
Smart Labels		•			•	
Stationary Robotics	•			•		•
Tube Systems	•					
Wearable Sensors	•			•	•	•

IN DEPTH

Figure 13

SOCIAL & BUSINESS TRENDS

Section Contents

CIRCULARITY

The trend of Circularity aims to eliminate waste and pollution by considering the full product life cycle beforehand and designing and utilizing each item and its constituent parts to be returned in the supply chain. This trend seeks to reuse, repair, remanufacture, and recycle products as much as possible and, when these processes are no longer achievable, products are broken down into reusable components and raw materials and ultimately biodegraded.

Although sustainability is a high societal priority, only 8.5% of the 100+ billion metric tons of material consumed annually worldwide are recycled into the economy. As described in the DHL white paper Delivering on Circularity, the transition to a circular economy requires a shared, concerted effort from 4 major stakeholder groups – businesses, customers, governments, and logistics players. In the past 2 years, recognizing the business opportunities, major brands have committed to circularity and made significant progress with buyback and resell programs and reusable packaging. However, as supply chains transform from a straight one-directional line into a regenerative circle, it is the logistics industry that is truly the backbone of Circularity.

As the concept of circularity requires dramatic transformation of the processes of product design, production, and recycling, supply chains are a key enabler in transporting raw resources, goods, and waste among a new network of users in a sustainable manner. Circularity as a trend is therefore anticipated to significantly impact the logistics industry, with logistics players becoming essential sources of knowledge for the transfer of best practice across sectors. Despite the growing number of industry verticals developing circularity use cases and applications, many companies in logistics are only trialing these models. It will take some time for Circularity to reach maturity and become mainstream.

Trend Overview

Impact:

HIGH

Realization:

5-10 Years

Focus Areas:

Customer Experience	Environmental Sustainability

Trend Clusters:

Packaging & Containers

Sectors:

Auto-Mobility	Engineering & Manufacturing	E-Retail & Fashion	Life Sciences & Healthcare	Technology

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Relevance to the Future of Logistics

Rise of Recommerce

Industrial sectors, especially retail, are witnessing the rise of recommerce (also known as reverse commerce), in which previously owned products, new or used, are sold and shipped to buyers who then repair, reuse, recycle, and/or resell them, extending the life span of the product. Currently, it is estimated that the recommerce and resell market is growing 11 times faster than traditional retail and that, by 2030, recommerce and resell will reach a market size of 84 billion USD, double the size of fast fashion.

The rise of recommerce has implications for those in logistics, especially as more retail giants join in. Instead of traditional return logistics, including costly cross-border returns, recommerce supply chains typically forward return shipments to in-country repair, recycle, and/or resell channels, alleviating the original retailer's freight and storage costs and related requirements. With recommerce, supply chains will overall see greater supply chain localization, particularly after the first purchase of a product. This means that supply chains can facilitate sustainability efforts not only by extending the life of a product but also by avoiding the emissions that would have resulted from manufacturing a comparable new product including the associated logistics costs.

Zero Waste in Logistics

The aim of zero waste programs is to protect the environment and human health by preventing any waste from entering the soil, water, or air. This is often seen as a key component for a fully sustainable future.

There are many opportunities for the logistics industry to support companies to work towards a zero-waste goal through the lens of Circularity. In the realm of packaging, an initiative called The Loop Alliance showcases coordination between large manufacturers, retailers, service providers, and non-governmental organizations to redesign packaging and synchronize the required supply chains to produce, clean, return, and refill containers for both in-store and e-commerce channels. Regarding transportation, ongoing improvement in carbon capture technology is enabling emissions to be filtered out more effectively from vehicle tailpipes. The collected carbon dioxide can then be sold to greenhouses, carbonated water producers, and other businesses for use as raw material.

But also, for example, the electrification of ground operations, the investment in carbon neutral buildings as well as the conversion of warehouse operations to avoid waste are measures that logistics companies have to take in order to integrate a holistic zero waste approach into their operations.

As supply chain organizations pursue zero waste using Circularity principles, they can achieve significant waste reduction and, at the same time, minimize direct and indirect costs associated with waste.
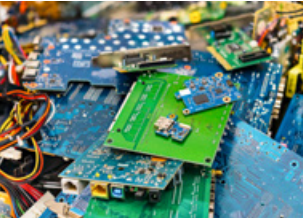
Circular Supply Chains

As more companies around the world join the circular economy to reduce waste and save costs, they will be reexamining and redesigning their supply chains to conform with Circularity principals. For organizations in logistics, from those handling storage to those delivering in the last mile, this can mean sizeable shifts in operations. To clarify, warehouses and transport vehicles will still exist, but logistics providers may see increased demand for value-adding services for products and materials they currently do not carry.

For example, last-mile courier vans may integrate more in the broader returns market, not only dropping off e-commerce packages, but also picking up depleted toner cartridges, batteries and gas cylinders from homes to then deliver to refill sites. Warehouses may see a greater throughput of secondary raw materials like fabric scrap or reprocessed lubricants and may need to reconfigure facility floorspace and operations to unload, store, and load more of these products.

Additionally, in the electronics industry, 57.4 million metric tons of e-waste were produced in 2021, with only about 20% of e-waste recycled through formal channels. This means there is a huge opportunity for better hardware return logistics – especially with the growing use of sensors, robots, and other technologies – and more parts repair, reuse, and recycling.

Overall, the logistics industry needs to anticipate and prepare for the global and local supply chain changes and value-adding opportunities that circularity will bring.
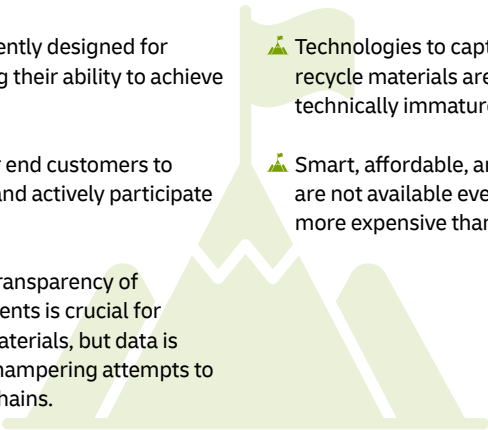
Second-life garments and smartphones produce 55-75% less emissions than new items made from virgin materials.

TYPICAL GARMENT

First life		Second life	
Virgin materials	Recycled materials	Refurbished	Reused
100	75	45	30

TYPICAL SMARTPHONE

First life		Second life	
Virgin materials	Recycled materials	Refurbished	Reused
100	70	45	25

■ Production   ■ Retail & distribution   ■ Use   □ End of life
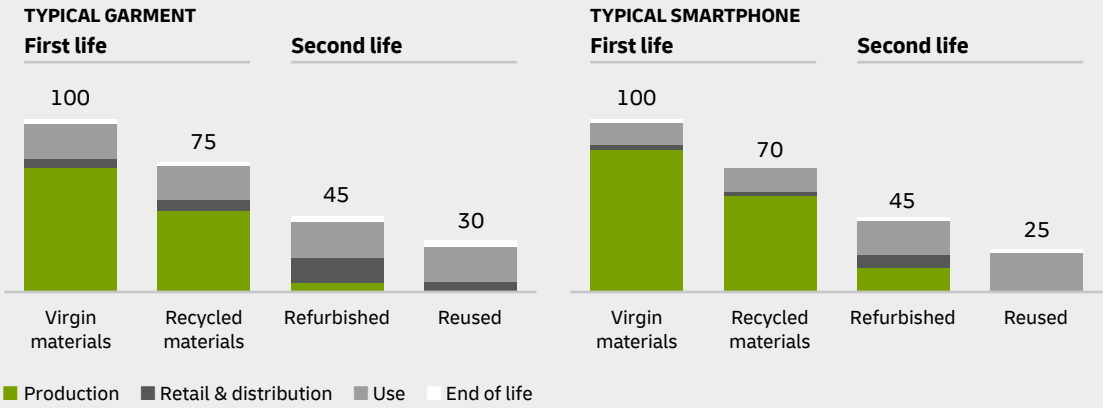
Source: DHL

DHL

Challenges

- Most products are not currently designed for reuse and recycling, limiting their ability to achieve circularity principles.

- The inhibition threshold for end customers to change their own lifestyle and actively participate in circularity is high.

- Coordinated visibility and transparency of products and their components is crucial for redirecting waste as raw materials, but data is currently severely limited, hampering attempts to close loops across supply chains.

- Technologies to capture waste products and recycle materials are advancing but are still technically immature.

- Smart, affordable, and convenient return solutions are not available everywhere, so recycling can be more expensive than using primary raw materials.

Resources

- **DHL - Whitepaper: Delivering on Circularity**
- **DHL - EV battery aftermarket solution**
- **DHL - Integrated solutions service logistics**
- **DHL – Go circular with supply chain solutions**

Outlook

This trend should be **ACTIVELY monitored,** with some use cases applicable today.

The logistics industry is the backbone of Circularity. While it will require the coordination of thousands of players and many years for all supply chains in all industries to conform to the trend's principles, individual companies, especially those in the fashion and consumer electronics market, are pursuing Circularity goals using visibility and recycling technologies.

This gradual development gives logistics organizations the opportunity to adapt and shift operations accordingly to meet the sustainability needs of customers while also reducing costs and waste in their own processes.

Related Trends

- **Decarbonization**
- **Environmental Stewardship**
- **Sharing Economy**
- **Bio-Based Materials**

Sources
Circle Economy (2022): The Circularity Gap Report.
DHL (2022): Delivering on Circularity.
TriplePundit (2020): 10 Brands That Embraced the Circular Economy in 2020.
Shopify (2022): The Rise of Recommerce: All About Buyback, Trade-In, and Upcycling in Retail.
World Economic Forum (WEF) (2021): This year's e-waste to outweigh Great Wall of China.
Multidisciplinary Digital Publishing Institute (MDPI) (2022): A Review on Global E-Waste Management: Urban Mining towards a Sustainable Future and Circular Economy.

CYBERSECURITY 2.0

The trend of Cybersecurity 2.0 encompasses the next generation of solutions, processes, and standard operating rules and regulations that leverage artificial intelligence (AI) and other advanced technologies and ways of working to protect critical systems, sensitive information, and devices against cyberthreats. It involves protection, detection, and response tools that not only prevent attacks but also actively predict and autonomously detect threats and respond to attacks.

Significant developments in collaborative online platforms, the rising number of Internet of Things (IoT) devices, and acceleration towards digitalized operations using cloud-based servers and digital processes have led to an increase in cyberattacks. As this type of crime grows in volume and sophistication, companies have increased their security budgets and adopted more advanced systems of defense. However, keeping up with the number and severity of threats continues to be a challenge. Studies show in 2021 the average number of cyberattacks and data breaches on 1,200 organizations across 13 industries and public sectors increased by 15.1% from the previous year. A quarter of all respondents additionally conveyed that the merging of digital and physical systems, as seen in IoT devices, increases their risk of threat. Reflectively, a Fortune Business Insights report shows the projected market value increase in cybersecurity reaching 376.32 billion USD by 2029, from 139.77 billion USD in 2021 at a CAGR of 13.4%.

In the logistics industry, publicly known cybercrime assaults used to occur only every few years. More recently, it seems one or two are happening every month. In May 2021, a cyberattack successfully shut down the largest pipeline system for refined oil products in the US, the Colonial Pipeline, disrupting the supply of energy to approximately half of the US east coast for about a week, costing the corporation upwards of 50 million USD.

With such an increase in incidents, paired with the negative impact of cyberattacks on global supply chains, this trend requires new levels of resilience and more focus and prioritization to ensure proactive defenses as the digital backbone of the organization.

Trend Overview

Impact:

MODERATE	

Realization:

< 5 YEARS

Focus Areas:

Physical & Digital Security   Visibility & Resilience

Trend Clusters:

Digital Backbone

Sectors:

Auto-Mobility   Energy   Engineering & Manufacturing   E-Retail & Fashion   Life Sciences & Healthcare   Technology

DHL

Relevance to the Future of Logistics

Rise of Cybercrime in Logistics

The logistics industry has been identified among the top 10 impacted sectors worldwide, as it is one of the world's largest revenue-generating industries and is increasingly targeted by hacker attacks via phishing emails, ransomware, and more. While digitalization brings advantages, the dynamic transformation of systems can leave some security factors unconsidered. Outdated servers, unpatched systems, and knowledge gaps between employees equate to cracks in the IT infrastructure which provide loopholes for cyberattack. As this applies to all aspects of the industry, including maritime, rail, trucking, supply chain, and last-mile delivery, the potential expense of this risk is high and can disrupt global supplies, while also introducing additional liabilities like the theft of sensitive customer data during a cyberattack.

Massive losses are incurred by owners when ransomware cyberattacks compromise system access. In 2020, the average cost of a security breach was 3.86 million USD. With a projected increase by 2025 to 10.5 trillion USD, this trend is clearly on the rise. Cybersecurity 2.0 solutions, processes, rules, and regulations will help companies protect themselves from such losses, while also protecting their brand and customer base.

Anticipation & Resilience

While digitalization and new technology create business efficiencies, the growth of e-commerce platforms, as well as the masses of data being stored in the cloud, drives an increasing need for cybersecurity. Anticipating cyberattacks on these platforms not only secures suppliers but also the private data of their customers. Although logistics and the supply chain continue to operate in a very hands-on manner through the physical movement of products, this requires a significant volume of data processing and information sharing along the supply chain. The typically disparate network of parties involved in the supply chain creates more ways for would-be attackers to identify weak links in cybersecurity.

It is vitally important for logistics companies to increase cybercrime resilience by implementing digital backbones and staying up to date with the cyberthreat landscape. The impact of IT system vulnerabilities on business processes, products, employees, and customers alike must be constantly monitored in order to preserve the value chain, keep the global supply chain moving, and ensure a position of cyber resilience.

Digital Security in Operations

As intelligent security expands in operations through the adoption of technologies such as computer vision, IoT devices, and AI-powered autonomous surveillance systems, so too does the possibility for cyberattack, and the level of risk increases when these technologies are deployed in cloud-based solutions which capture data on employees in logistics operations as well as data on customers. Privacy protection has therefore become one of the most pressing issues for supply chain organizations; the importance of safeguarding employee and customer data can occasionally outweigh the importance of the shipments themselves.

Implementing new cybersecurity solutions and increasing the robustness of existing solutions using blockchain technology can add layers of security to combat potential threats. Failure to do this would risk major disturbance and disruption in the global supply chain network. Physical operational security can also be enabled through computer vision technologies to identify in-facility threats so long as the organization takes adequate cybersecurity steps to protect sensitive operational information from hackers.

Types of attack on the logistics industry.

- 27% Malicious links
- 5% Targeted fraud
- 33% Phishing
- 35% Malicious attachments
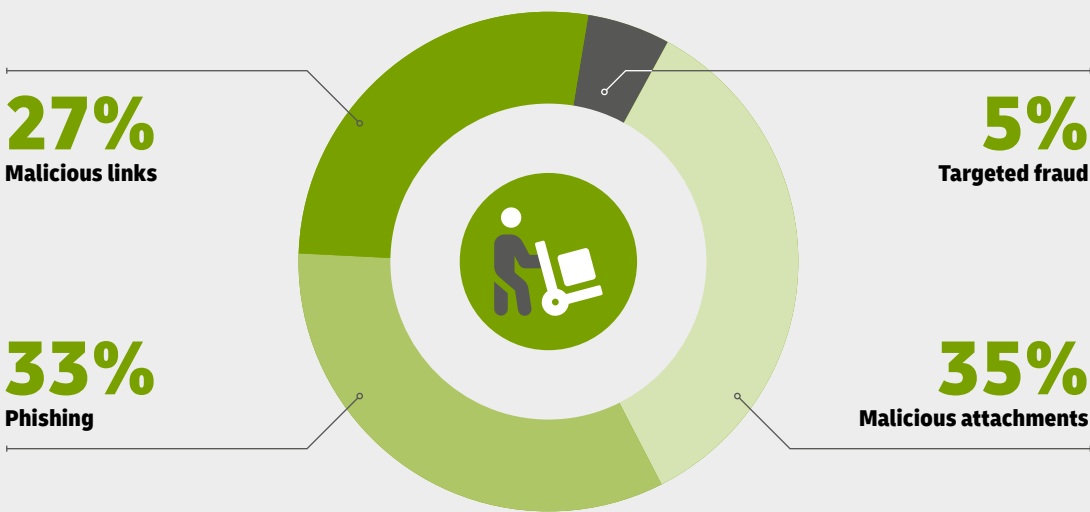
Source: Hornet Security

DHL

Challenges

- Legacy infrastructures in logistics operations may be relatively unsophisticated which prevents integration of the latest cybersecurity features; the organization must allocate sufficient budget to ensure robust operation and cyber resilience.

- Only as strong as its weakest link, the organization must dedicate resources to proactively train and inform employees about cybercrime and how to remain alert to potential threats; special exercises may be necessary, for example sporadically imitating phishing attempts.
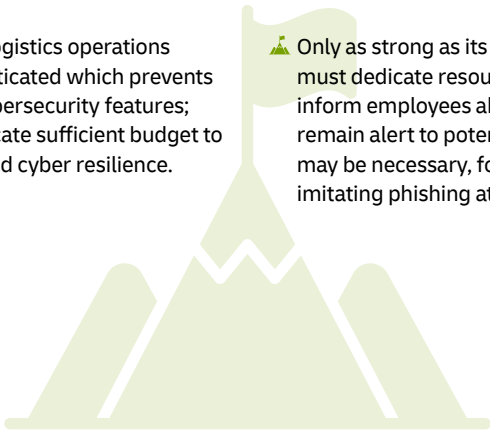
Resources

DHL - Cybersecurity: Why 'password1' is asking for trouble

Outlook

This trend should be **ACTIVELY monitored,** with imminent developments and applications.

The logistics industry has been cautiously advancing towards widespread adoption of newly emerging technologies, as any logistics or supply chain disruption or network outage can have global impact. Robust and collaboratively tested technologies that do not cause vulnerabilities to the IT infrastructure and network are incorporated and implemented to improve operations and efficiency. However, cybersecurity must remain at the forefront of strategic decision making to ensure each organization maintains high safety standards across the logistics industry.

Related Trends

| Blockchains → | Cloud & APIs → |
| Computer Vision → | Edge Computing → |

Sources
Forbes (2022): Alarming cyber statistics for mid-year 2022 that you need to know.
ResearchGate (2022): Cyber security in the logistics industry.
American Global Logistics (2022): Cybersecurity breaches stand to disrupt supply chain operations in 2022.
Cyber Protection Magazine (2022): Cyber resilience for transport and logistic supply chain.

DECARBONIZATION

The trend of Decarbonization is the movement towards reducing the amount of carbon dioxide (CO_2) and carbon dioxide equivalents (CO_2e) in the atmosphere. This involves burning less and burning clean to reach carbon neutrality, as well as actively removing existing CO_2e in the environment to become carbon negative.

International concern about climate change and its effects on the planet has put environmental sustainability, and particularly decarbonization, into the spotlight for businesses, governments, and consumers. This is particularly true for logistics – supply chains generate around 60% of all carbon emissions globally, and about 90% of a product's emissions derive from its supply chains. As more B2B and B2C customers demand sustainable products and services, and as transparency legislation comes into force, like the EU's Sustainable Finance Disclosure Regulation (SFDR) in 2023, logistics organizations must act to properly account for emissions and decarbonize their supply chains to stay competitive and relevant in an environmentally conscious world.

The Decarbonization trend has high impact as practically all segments of the supply chain will be altered to eliminate CO_2e emissions from operations. However, while pressure to decarbonize has reached the top of the agenda for B2B and B2C customers and many more companies have set zero emissions targets, tangible action has started but will need to further increase for the goal of decarbonized supply chains to be achieved. Here at DHL we see this trend accelerating once regulations require disclosure of the carbon footprint of products and services. This will create another point of comparison and competition between organizations.

Trend Overview

Impact:

HIGH

Realization:

5-10 Years

Focus Areas:

Environmental Sustainability

Trend Clusters:

Packaging & Containers

Sectors:

Auto-Mobility | Energy | Engineering & Manufacturing | E-Retail & Fashion | Life Sciences & Healthcare | Technology

Relevance to the Future of Logistics

Carbon Accounting & Tracking

Today, comprehensive accounting of Scope 1, 2 and 3 product emissions (direct, indirect, upstream and downstream, respectively) remains a challenge. Many businesses, including logistics organizations, do not account for these emissions at all. The ones that do may rely on various secondary sources of carbon calculation with generalized values and assumptions, and often fail to factor in emissions by second-tier and third-tier players. This makes it difficult for B2B and B2C customers to accurately compare and choose suppliers and service providers that meet their environmental standards, especially when evaluating on a product-level basis.

However, steps are being taken to address this customer need. For organizations that currently struggle with carbon accounting, we here at DHL offer carbon calculators, estimates, and externally verified reports. This enables companies to account for Scope 3 emissions from a single shipment across all trade lanes, including data from our third-party service providers.

In future, more granular data will be obtained. As sensor technology rapidly permeates the supply chain, it will be possible to accurately calculate and track at shipment level and even product level how much CO_2e a truck or airplane emitted, as well as how much total energy was used to move a shipment through a facility. With this sensor data, logistics providers will not only provide companies with more accurate carbon footprint figures but also identify areas along the supply chain for decarbonization improvements.

Carbon Capture

Whether offsetting CO_2e emissions elsewhere through insetting or making the supply chain carbon negative, carbon capture technology helps logistics organizations meet sustainability goals. While today much attention is on newly constructed experimental facilities specifically designed to absorb CO_2 from the air, logistics professionals can apply several existing and upcoming practical solutions to the supply chain.

American startup Remora, for example, has developed a truck tailpipe filter that is able to capture up to 80% of CO_2 emitted, while Aramco is looking into adapting its own car-based carbon capture solution to ocean freighters. Solutions such as these often deliver a favorable return on investment (ROI) for interested logistics organizations as both the collected CO_2 and the associated carbon credits are commodities that can be sold to recoup costs. In this way, carbon capture technology can provide lower-cost solutions for decarbonizing supply chains.

Vehicle Electrification

Before COVID-19, freight transportation accounted for almost 10% of all global carbon emissions. While this stalled a bit during the pandemic due to travel restrictions, carbon emissions from freight transportation are projected to climb as the global economy recovers and e-commerce booms. To play an active part in the trend of Decarbonization, logistics organizations must focus on reducing emissions from vehicles in first-, middle-, and last-mile operations.

Electrification is an effective go-to solution across all transportation modes. In 2021, DHL Express ordered 12 electric airplanes from Israeli company Eviation to achieve emissions-free regional flights. In that same year, truck manufacturer Continental Automotive broke a world record with its electric delivery truck travelling almost 1,100 km (682 mi) on a single charge, while in early 2022, Ford released its E-Transit courier vans with a range of about 200 km (126 mi), 70% more than the average daily service range needed for such vehicles in the US. Furthermore, electric bicycles, tricycles, and scooters have been scaled in delivery operations around the world.

Although electrifying fleets is a powerful way for logistics industry players to reduce the carbon footprint, each transportation mode has different time horizons for viable electric alternatives. This means that for some modes, especially those carrying heavier loads and covering greater distances, it may make more sense for logistics leaders to investigate alternative fuels as near-term solutions to reduce, but not eliminate, carbon emissions in their supply chains. These can range from traditional biofuels like ethanol to renewable diesel, as well as sustainable aviation fuels (SAF) that act as 'drop-in' fuels to be mixed with traditional fossil jet fuel.
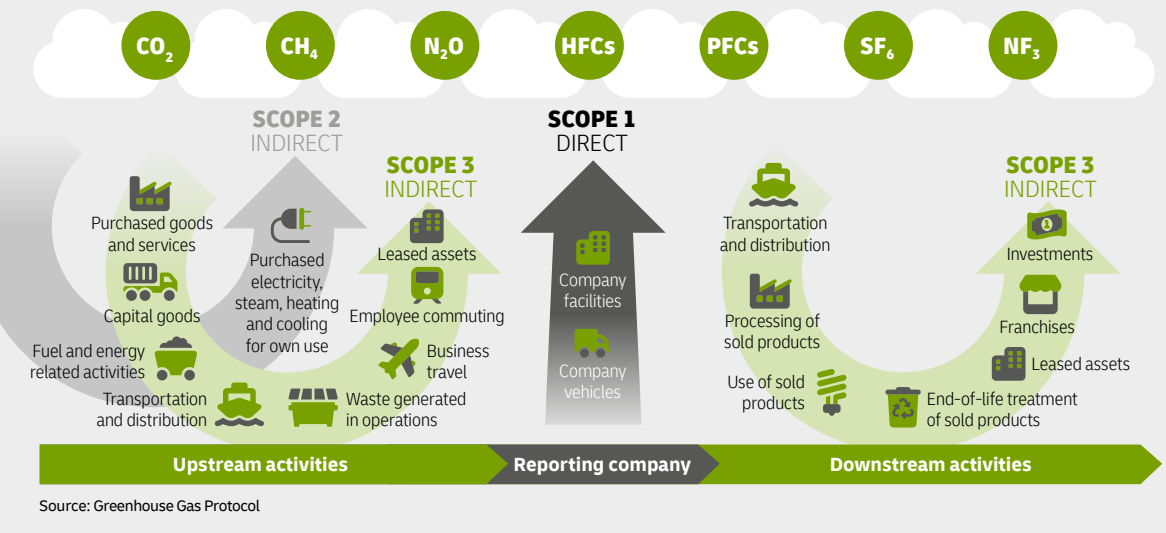

Optimizing Operations

Environmentally friendly solutions may be overlooked or rejected because of higher initial costs than more wasteful alternatives. Although many logistics organizations may want to replace whole truck fleets with electric models or cover an entire warehouse rooftop with solar panels, moves like this represent a significant investment. However, with customer demand for greater sustainability in the supply chain and with CO_2e emissions becoming more commoditized and framed as operating costs, logistics players are finding ways to simultaneously reduce expenditure and waste.

For example, last-mile service providers can use German startup Greenplan's route optimization software to reduce the distance vehicles travel. In doing so, they save on time, fuel, wear and tear, and maintenance costs, plus they achieve a reduction in CO_2 emissions that is almost proportional to the travel saved. Similar principles can be applied when upgrading machinery to more efficient models – a unit of resource (electricity, gas, paper, etc.) is utilized more fully and with fewer emissions when manufacturing and using the new model.

Scope 1, 2, and 3 emissions, as according to the GHG Protocol corporate standards. They encompass all activities upstream and downstream of a reporting company.

CO_2 CH_4 N_2O HFCs PFCs SF_6 NF_3

SCOPE 2 INDIRECT

SCOPE 1 DIRECT

SCOPE 3 INDIRECT

SCOPE 3 INDIRECT

Purchased goods and services

Capital goods

Fuel and energy related activities

Transportation and distribution

Purchased electricity, steam, heating and cooling for own use

Leased assets

Employee commuting

Business travel

Waste generated in operations

Company facilities

Company vehicles

Transportation and distribution

Processing of sold products

Use of sold products

Investments

Franchises

Leased assets

End-of-life treatment of sold products

Upstream activities — **Reporting company** — **Downstream activities**

Source: Greenhouse Gas Protocol

Challenges

⛰ Electrified alternatives are not yet available for every vehicle and device so, until these gradually come to market, other carbon-reducing steps are needed.

⛰ A supportive ecosystem is essential for electrification and this can be costly; electric vehicles need chargers, different repair equipment, and perhaps staff retraining, along with sufficient space and infrastructure in the supply chain.

⛰ Data to calculate product carbon footprints (PCFs) and logistics emissions is often inconsistent, generalized, decentralized, and opaque across supply chains; this makes it difficult to assess and compare values.

⛰ Decarbonization solutions often require heavy upfront investment and potential implementation downtime.

⛰ As logistics providers invest in decarbonization solutions to meet demand, customers may see higher prices for products and services.

This trend should be **PASSIVELY monitored,** with applications still mostly being developed or explored.

Outlook

The pressure to be carbon neutral or even carbon negative in the logistics industry is stronger today than ever before. Given that supply chains lie at the heart of decarbonization conversations and agendas, it is imperative that logistics organizations make the necessary moves early. They should adapt to the changes to come, ensuring they deliver in an era of sustainability.

Resources

📄 **DHL - DHL's 2050 emissions commitment** →

📄 **DHL - DHL Express' roadmap to decarbonization** →

📄 **DHL - Decarbonization levers: the far-distant future is here** →

Related Trends

Bio-Based Materials →

Circularity →

Environmental Stewardship →

Alternative Energy Solutions →

Sources
Accenture (2022): How sustainable supply chains can unlock net zero emissions.
Harvard Business Review (2022): Digital ecosystems: a data-driven approach to decarbonizing supply chains.
Our World in Data (2020): Cars, planes ,trains: where do CO_2 emissions from transport come from?
Ford (2022): 2022 e-transit.
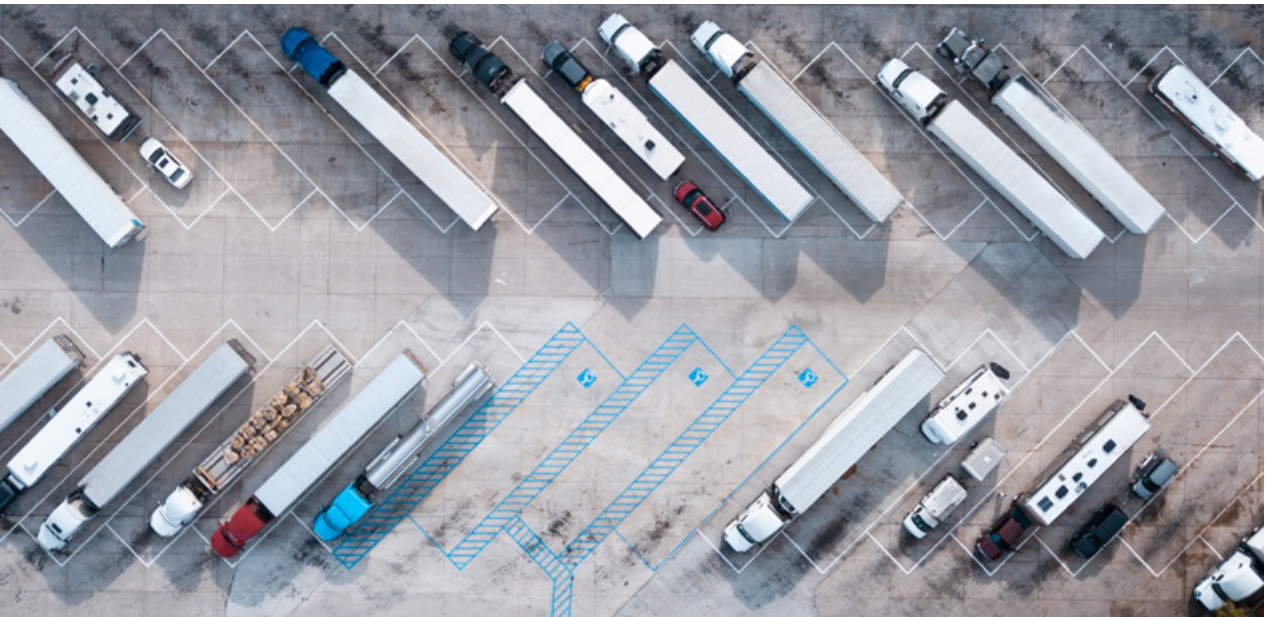
DIGITAL MARKETPLACES

The trend of Digital Marketplaces incorporates digital brokerage platforms that match demand for products and services with available supply. These platforms give suppliers and customers access to a greater market while also offering them comprehensive transparency and additional services.

Customers value the ease of comparing shipping options and pricing in a digital logistics marketplace. Due to growing demand for online logistics marketplaces, logistics providers have expanded their offerings in recent years and new, specialized marketplaces have emerged. For example, companies can now access available logistics labor during peak seasons. Many of these digital platforms are becoming more versatile thanks to increased usage and deeper data analysis, increasing transparency and creating a better customer experience.

Digital marketplaces are having a significant impact on the logistics industry, especially because of increasingly complex supply chain networks and countless options of logistics services and providers. These marketplaces take transparency to a new level. However, there is a shortage of scalable solutions in some areas, like in the matching of available workforces and logistics providers. This means it will take another 3 to 4 years before logistics marketplaces achieve market maturity at scale.

Trend Overview

Impact:

HIGH

Realization:

< 5 YEARS

Focus Areas:

Automation & Efficiency	Customer Experience	Visibility & Resilience

Trend Clusters:

None

Sectors:

Auto-Mobility	Engineering & Manufacturing	E-Retail & Fashion	Life Sciences & Healthcare	Technology

DHL

Relevance to the Future of Logistics

Transparent Freight Forwarding

In today's highly competitive and fragmented freight forwarding market, it is difficult for shippers to get a comprehensive overview of the variety of logistics providers, their services, and related costs. The transparency of digital freight forwarding marketplaces is therefore a big attraction for companies.

Another important feature of digital freight marketplaces, which also distinguishes them from traditional freight exchanges, is that they are deeply rooted in all process steps of freight allocation, including booking, tracking, and invoicing. Digital freight marketplaces can access everything from the transport request through to invoicing data and can crunch this information using smart algorithms to obtain critical insights. For example, Saloodo!, DHL's digital freight platform, is operating in over 55 countries across 4 continents and uses this big data to optimize truck return runs.

The need to seamlessly connect road freight networks in different markets and across national borders using digital freight platforms will become increasingly important for companies operating on a global scale.

On-Demand Warehousing

On the one hand, warehousing and storage providers are not fully utilizing space in facilities, with vacancy often reaching 25% while waiting for long-term, high-volume contracts. On the other hand, to meet customer demand it is increasingly important for manufacturers and retailers to be flexible and agile in times of market volatility, from predictable demand fluctuations to unexpected geopolitical events. On-demand warehousing, delivered via a digital marketplace, benefits both sides.

Companies like Warehouse Exchange in the US and SpaceFill in France link retailers with warehouse providers under agreements more fluid in terms of timeframes and volumes than is normally expected with warehouse rentals. With these on-demand warehousing and fulfillment solutions, retailers and manufacturers can rapidly respond to disruptions and dynamic market demands, shifting goods quickly from one warehouse to another. Meanwhile, logistics companies can make more use of each facility, reach out to a much wider pool of potential customers, and realize higher margins from short-term or low-volume commitments.

Labor Gap Alleviation

As detailed in DHL's recent Future of Work in Logistics Trend Report, the aging workforce and greater labor shortages are having a major impact on the global logistics industry, especially in warehouse operations and truck driving. For instance, the American Trucking Associations (ATA) has projected a shortage of 175,000 truck drivers by 2026.

Establishing workforce marketplaces that connect logistics providers with available workforces for a short period of time can help these organizations optimize personnel resources and address the volatility of workforce demands across regions and seasons. Czech company Liftago, as one example, offers an emergency network of local drivers to help logistics companies meet acute delivery demands during peak seasons. With labor shortages forecasted for the next few years, these marketplaces for labor solutions can help logistics organizations avoid headcount deficiencies, better manage volatility, and keep up with customer demand.

B2B buyers are planning to purchase on digital marketplaces. Suppliers have built, are planning to build, or are considering building a marketplace.

60%
of B2B buyers are planning to purchase on digital marketplaces.

79%
of suppliers have built, are planning to build, or are considering building a marketplace.

Source: McKinsey & Company

DHL

Challenges

- In logistics, digital marketplaces must guarantee that sensitive customer data is kept confidential.

- Digital marketplaces require a minimum level of demand and supply to operate successfully and this can prove difficult to attain, especially in remote locations and for specialized logistics solutions.
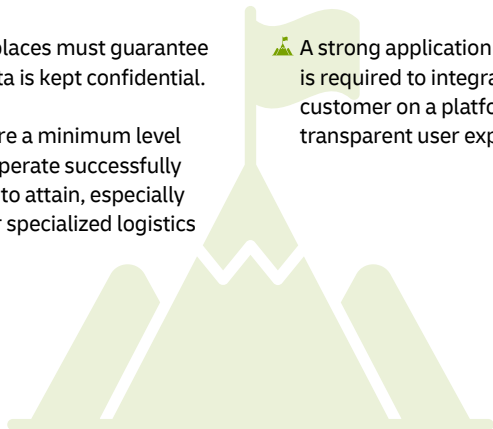
- A strong application programming interface (API) is required to integrate every single supplier and customer on a platform and provide a seamless, transparent user experience.

Resources

DHL - Launch of Saloodo! in South Africa promises better road freight optimization →

Saloodo!'s freight forwarding platform →

This trend should be **ACTIVELY monitored,** with imminent developments and applications.

Outlook

Digital marketplaces are already having a major impact on the logistics industry. In the future, platform providers will be able to use big data and smart algorithms to even better forecast and match supply and demand as well as tailor the best possible solutions for customers.

Related Trends
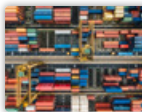
Physical Internet →

Sharing Economy →

Supply Chain Diversification →

Big Data Analytics →

Sources
Here (2020): Waste not want not: SpaceFill helps you turn warehouse space into profit.
Datex (2021): 2021 supply chain labor shortages and the role of technology.
Forbes (2022): Supply chain predictions for the coming year.

DIVERSITY, EQUITY, INCLUSION & BELONGING

The trend of Diversity, Equity, Inclusion & Belonging, otherwise known as DEIB, refers to four concepts that work jointly to bolster the effectiveness, productivity, dynamics, and creativity of an organization while ensuring individuals have equal opportunities and feel valued. Guided by mutual respect, trust, openness, and honesty, this trend's focus both encompasses and extends beyond the borders of gender, race, religion, age, different ability, sexual orientation, national origin, and other characteristics protected by law.

One of the most rapidly developing social and business trends in the last two years, DEIB has evolved from Diversity & Inclusion to now also recognize individuals as being a long-term and integral part of the organization. This is the frame in which employment seekers consider potential employers.

Companies shift towards including DEIB as part of corporate culture in order to attract talent and retain employees. Here at DHL we additionally see this trend developing from the individual level to the organizational level, recognizing that companies now choose to interact with and support businesses owned by minority groups and businesses that break stereotypical bounds of how certain industries were once run in the past.

The relatively imminent realization of this trend shows people and companies understand the importance of increasing DEIB awareness. Within logistics and the supply chain – realms that were previously predominantly male – we here at DHL are seeing a movement towards greater inclusivity of women not only in leadership but also in operations. This alters the ways in which team members interact within the workplace. Employee engagement increases as inclusion is realized and, in turn, this increases the need to belong. Ultimately, inclusion and belonging lead to better results.

Belonging in the workplace is a powerful addition to the dimensions of diversity, equity, and inclusion. It can be seen on the one hand as "longing to be" and on the other hand as "being for long." This introduces an affective and sequential dimension, bringing a shift towards psychological safety and real inclusion.

When the individual recognizes the HR department prioritizes DEIB, especially the belonging dimension, they are less likely to leave. A 2021 study found 40% of respondents with a strong sense of belonging rarely think about looking for a job in another company, versus 5% of respondents with a low sense of belonging.

Trend Overview

Impact:

MILD

Realization:

< 5 YEARS

Focus Areas:

Health, Safety & Future of Work

Trend Clusters:

None

Sectors:

Auto-Mobility | Energy | Engineering & Manufacturing | E-Retail & Fashion | Life Sciences & Healthcare | Technology

Relevance to the Future of Logistics

Diversity in Leadership

Diversity in leadership enables greater depth and breadth of experience, perspective, and knowledge, which equips leaders to better relate to employees, customers, and prospective customers. This, in turn, helps the business to grow. In order for companies to retain market position within their sectors, the ability to share experience and relate is what facilitates change and innovation.

Having women in leadership – for example, in predominantly male-dominant industries such as logistics and the supply chain – positively changes the perspective of potential female employees. Similarly, by diversifying leadership roles to enable growth and development for members of minority groups from the perspective of race, sexual orientation, and different ability, companies encourages employees in those groups to bring their skills and talent to the workplace. Seeing diversity in a leadership team acts as a catalyst that empowers and enables the entire team. According to a McKinsey study, 64% of millennials say they will not work for companies that perform poorly on corporate social responsibility; diversity is one of the focus topics of CSR.

In unprecedented times of challenges or uncertainty, leadership teams come together to make collective decisions on the way forward. When that team can leverage diversity in such a situation – the rich kaleidoscope of perspectives, different vantage points, and a diverse range of experiences – the conversations can be more candid and decisions more innovative.
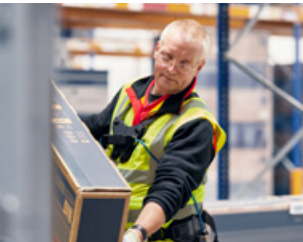
Talent Inclusion Through Technology

Traditionally, many industries are male dominated at all levels of seniority, including logistics. Today this is changing and often thanks to technology.

For example, by using exoskeletons in a warehouse, people with less physical strength than the average man can now lift heavy objects with relative ease, broadening the pool of potential candidates for that warehouse role. Similarly, robotics that automate operations within a distribution hub can easily be supervised by differently abled people to ensure workflows run smoothly.

The talent pool expands exponentially when a company commits to DEIB – all can be included and all should belong – and technology-enabled innovations inspire positive change across the organization, encouraging more people to apply for work in logistics and the supply chain.

Diversity in Vendor Selection

In recent years, there has been a significant rise in companies preferring to trade and do business with diverse companies. Vendor selection and the process of auditing a potential supplier now focus more keenly on social responsibility and enabling minority-owned businesses to thrive.

Companies use supplier diversity programs to unlock new value; for example, to drive vendor competition, enhance brand perception, encourage innovation, positively impact the local economy, and improve the bottom line.

These programs also help promote diversity across each company's ecosystem. Research suggests industry-leading companies globally are aware of this, as they have committed more than 50 billion USD to partner with minority and women-owned business enterprises (MWBEs) in the next decade. Further boosting the economy, MWBEs are 67% more likely to employ minority talent and develop these people into higher positions. Per McKinsey, if spending with certified MWBEs doubled, so 2 trillion USD rather than the current 1 trillion USD, this could generate 280 billion USD in additional income and 4 million jobs for minority populations and women. Corporations have the potential to add value and help boost the global economy by prioritizing MWBE vendor selection, evidenced by the tech giant Google pledging to spend 2.5 billion USD with diverse suppliers in 2022.

Vendor diversity benefits everyone. Companies gain new value and minority-run businesses gain opportunities.

The number of people globally with the title Head of Diversity more than doubled (107% growth) between 2017 and 2022.

2017   2022

75%
increase with title of Director of Diversity

68%
increase with title of Chief Diversity Officer

71%
increase worldwide in all diversity and inclusion roles between 2017 and 2022

41% of organizations believe unconscious bias inhibits diversity in the workplace, particularly during recruitment processes or career advancement conversations.

26% of organizations say there is still not enough support from company leadership to expand staff diversity.

32% of employees and employment seekers say they would not apply to a company that lacks employee diversity.

Source: Glassdoor

Challenges

- Some company leaders do not fully support team diversification; they may consider other issues have higher priority and may be uncomfortable about changing the status quo.

- A key challenge in achieving workforce diversity is failure to attract a diverse range of talent, a surprising fact since potential employees say DEIB is so important when selecting which company to work for.

- In order to facilitate change and drive DEIB, organizations need to address underlying unconscious bias and enable open dialog during recruitment and career advancement conversations.

- When it comes to human behavioral habits and subconscious responses, change management needs more time.

Resources

DHL - DPDHL brings together people from a wide range of societies and cultural backgrounds →

DHL - DPDHL Group receives awards for diversity, inclusion and equal opportunity →

How DHL Express is leveraging the power of D&I to drive the business forward →

Outlook

This trend should be **ACTIVELY monitored,** with imminent developments and applications.

Diversity, equity, inclusion, and belonging go far beyond HR concepts. When successfully embedded in the organization's core values, they leverage the collective backgrounds and experiences of everyone in the organization and this inspires new ways of thinking and sparks fresh ideas. When DEIB is at forefront of a job applicant's mind and is a priority item on a business agenda, this is pivotal to the company's future success.

Related Trends

Environmental Stewardship →

Supply Chain Diversification →

Remote Work & Teleoperation →

Exoskeletons →

Sources
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Forbes (2021): 14 important benefits of a more diverse leadership team.
McKinsey & Company (2022): Expand diversity among your suppliers- and add value to your organization.
ManpowerGroup (2022): Top challenges to implementing workplace diversity and how to overcome them.
Glassdoor (2022): 40+ stats for companies to keep in mind for 2021.
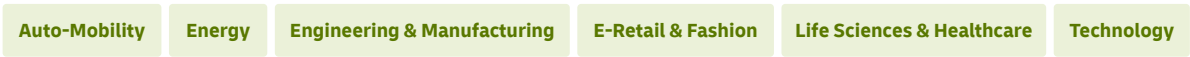
ENVIRONMENTAL STEWARDSHIP

The trend of Environmental Stewardship refers to major behavioral changes at collective and individual levels across industries, governments, and societies to minimize environmental degradation and maximize protection. Conscious individual choices and changed daily habits, paired with environmental targets and certified programs, demonstrate the shift towards sustainable living choices and methods of working.

After almost a century, the momentum of environmental stewardship has reached a tipping point. Public and private attitudes are shifting against further climate change, habitat destruction, and biodiversity loss. Individuals as consumers and investors expect sustainable options for products and services ('conscious consumerism'), and individuals as workers want employers to demonstrate environmental stewardship. Together, this has pressured businesses and governments to reduce emissions and waste. At the center of this, connecting and contributing these areas of activity, are supply chains which produce about 60% of the world's total carbon emissions and generate about 50% of the world's plastic waste from the process of manufacturing to consumption.

Given this central position in the Environmental Stewardship trend, the logistics industry is under pressure to reform operations and transform processes to meet new levels of expectation. But as many logistics providers are only just beginning to embrace environmental stewardship, this trend is likely to impact in a few years' time and occur in progressive stages, not all at once, slightly buffering the industry from dramatic changes by this trend.

Trend Overview

Impact:

MODERATE	

Realization:

5-10 Years

Focus Areas:

Environmental Sustainability

Trend Clusters:

Packaging & Containers

Sectors:

Auto-Mobility | Energy | Engineering & Manufacturing | E-Retail & Fashion | Life Sciences & Healthcare | Technology

DHL

Relevance to the Future of Logistics

Green Laws & Regulations

In politics, increased awareness around climate change has spurred urgency among general populations and policy makers. Although government environmental protection measures may increase the cost of living, citizens are more supportive than ever before.

Logistics companies should anticipate new regulations and prepare for compliance while also recognizing this as an opportunity for first-mover advantage. Some regulations, like the EU's upcoming Sustainable Finance Disclosure Regulation (SFDR) and the UK's Green Claims Code, push for transparency in carbon emissions and other environmental metrics that many logistics players currently lack, despite heavy customer demand. Other pieces of legislation incentivize electrification, with some countries even banning the sale of new gas and diesel cars within the next decade – commercial trucks are likely to be next. Meanwhile, singular policies can affect whole supply chains, like California's new law to phase out single-use plastics and China's ban on importing all solid wastes in 2021, prompting new ecosystems of buyers and sellers.

By foreseeing the implementation of these laws and their gradual spread from region to region, logistics organizations can gain competitive edge and benefit from early compliance.

Environmentally Conscious Customers

Logistics players are feeling unprecedented pressure of meeting customers' environmental stewardship expectations, with many in the logistics industry beginning to commit to zero-waste pledges, new electric fleets, and more to remain competitive.

From a B2B customer perspective, logistics providers are crucial in helping drive corporate sustainability agendas, as about 90% of product emissions derive from supply chains. Today, B2B customers frequently ask about carbon footprint accounting procedures and carbon-neutral operations and transportation modes. Sustainable services are becoming the expectation and not the exception for their end customers, with 85% of consumers shifting purchase behavior in the last 5 years towards more sustainable options. Packaging and last-mile delivery are aspects of the supply chain most visible to B2C customers, and both are scrutinized heavily for environmental friendliness by end users.

Logistics providers whose services meet the sustainable stewardship standards of companies and individuals will see business opportunities grow, while those who do not will become less competitive.

Attracting & Retaining Talent

With the growing labor shortage, it is imperative for the logistics industry to do what it can to attract and retain talent. While there are many levers and areas for improvement, logistics organizations should recognize environmental stewardship is becoming a valued magnet for talent.

Recent studies have shown that younger workers are almost 3 times more likely to leave their jobs within 2 years if they are not satisfied with their employer's commitment to sustainability, and are equally more likely to stay beyond 5 years if they are satisfied. Many employees are also aware of 'greenwashing' (the act of spending more resources on marketing sustainability credentials than on minimizing environmental impact) and are more wary and suspicious of employer claims than ever before. To be in line with these new employee expectations, logistics organizations should take clear positions on environmental topics and provide employees with directional agendas, programs, and training that work towards goals.

By sincerely pursuing environmental stewardship, logistics organizations can better attract and retain talent and stay more relevant in a more sustainable world.

Rise of 'Buy Local'

There has been a gradual shift in B2B and B2C customer behavior to supporting local producers and suppliers, service providers, and business owners instead of purchasing good from overseas. This 'buy local' movement is propelled by various needs, primarily reducing the carbon footprint in supply chains and also encouraging local entrepreneurship and diverse community economies for better resilience in the face of challenging global events.

Regardless of the motive, the logistics industry will need to adjust to accommodate the growing localization of supply chains. Global connections will still be essential – not all raw materials and products can be harvested or manufactured in a cost-competitive way in every region of the world – but to remain relevant, logistics organizations may need to focus more energy in or shift attention to developing local ecosystems. This includes cultivating, partnering with, and acquiring local logistics services, as well as better understanding the supply chain needs and routines of smaller local businesses and communities.

By doing this, logistics players can provide quality logistics services to 'buy local' participants while also reaping the potential environmental and resilience benefits of the 'buy local' movement.

Millennials' satisfaction with their organization's commitment to sustainability can have a great impact on an organization's retention of talent.

Not satisfied at all — 48% | 17%

Very satisfied — 17% | 51%
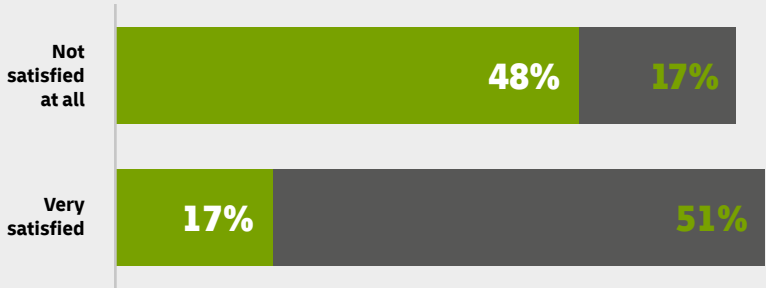
■ Leave within 2 years ■ Stay beyond 5 years

Source: Deloitte

Challenges

⛰ Logistics organizations wanting to become perfect environmental stewards may lack the necessary technologies; these may not yet be scalable or may not even exist for every aspect and segment of the supply chain.

⛰ The ramifications of policies and regulations can be hard to predict, turning bets on technologies and new markets into potential financial risk.

⛰ The overhaul required to meet all customer sustainability demands may be too expensive or disruptive for the logistics organization, forcing small-step implementations at a speed and magnitude that fails to match customer expectations.

Outlook

This trend should be **MODERATELY monitored,** with some use cases applicable today.

The trend of Environmental Stewardship will be a continuous undercurrent to supply chain development globally. As the logistics industry is challenged to meet the extensive sustainability demands of governments, customers, investors, and workers, it is in a unique position to drive and enable change.

By embracing a leadership role in this, logistics organizations can facilitate a transformation to more sustainable, efficient, cost-effective, and resilient supply chains.

Resources

DHL - Clean operations for climate protection

DHL - DPDHL Group invests EUR 7 billion in climate-neutral logistics until 2030

DHL - A selection of our green logistics solutions

Related Trends

Circularity

Diversity, Equity, Inclusion, Belonging

Alternative Energy Solutions

Bio-Based Materials

Sources
Accenture (2022): How sustainable supply chains can unlock net zero emissions.
Harvard Business Review (2022): Digital ecosystems: a data-driven approach to decarbonizing supply chains.
Business Wire (2021): Recent study reveals more than a third of global consumers are willing to pay more for sustainability as demand grows for environmentally-friendly alternatives.
Deloitte (2022): Striving for balance, advocating for change: the Deloitte Global 2022 Gen Z & Millennial Survey.

EVERYTHING AS A SERVICE

The trend of Everything as a Service, otherwise known as 'XaaS' or 'Servitization', is the shift away from buying and selling products towards the vending of services to achieve an outcome. In this economic model, instead of committing to a one-off purchase of a product, the customer would consistently pay on a per-unit basis, like the amount of time utilized, the number of products produced, or the number of tasks fulfilled, for results that meets their needs.

XaaS business models bring a new way of doing business to B2B relationships. For instance in the medical field, we here at DHL see change in how hospitals acquire medical capabilities. While in the past CT scanning equipment had to be purchased, now many hospitals buy the service of that equipment and only pay per CT scan. Altering the patterns of consumer behavior and the way customers engage with products, individuals and companies alike can opt to pay for equipment usage for a specified period of time or output, and not pay when equipment sits idle or broken. For example, rather than buying air-conditioning (AC) units, XaaS allows the user to pay for the number of cooled hours. As such, companies with XaaS business models must consider the life cycle of their product offerings, as well as any required maintenance and logistics services.

Technology providers now offer robotics, drones, warehouse management systems (WMSs), and more to the logistics industry as a service. This enables logistics professionals to redirect their focus from acquiring hardware and software to meeting demand and reaching strategic customer engagement goals.

While the foreseen impact is not very strong on logistics and the supply chain, this trend will greatly impact end users. Companies can keep customer experience at the core of their business by choosing everything as a service, building resilience to external disruption and its potential damage to their business.

Shifting existing product-based traditional business models to everything- as- a- service models is already well underway, however full transition will require further developments foreseen in the next 6 years. Only then will this become a new norm for business operations. Still being in early stages of wider adoption, this business model requires specialized IT skillsets that are still scarce, as well as strong IT infrastructures for billing processes to flow seamlessly.

Trend Overview

Impact:

MILD

Realization:

5-10 Years

Focus Areas:

Customer Experience   Environmental Sustainability

Trend Clusters:

Internet of Things

Sectors:

Auto-Mobility   Engineering & Manufacturing   Technology

DHL

Relevance to the Future of Logistics

Co-Located & Distributed Service Logistics Facilities

As product ownership and responsibility for uptime remains with the XaaS service provider rather than with the user, the response time for necessary predictive maintenance is a key differentiator. One solution to faster response times is co-located and distributed service logistics facilities.

Co-located and distributed facilities and spare parts networks, including inventory positioning, must be a strategic building block in support of the business. As such, logistics plays a vital role in this new equation as the seamless supply and delivery of parts is critical to maintaining asset or fleet performance when provided as a service. The need for co-located inventory may be reduced, however, by onsite on-demand 3D printing and there may be no need for a technician to visit if they can instead use augmented reality (AR) to provide remote repair and maintenance support.

Logistics Services Diversification

Companies are broadening the lens of business potential to things that can be obtained as a service, and the providers of these services may choose to outsource operational processes to logistics organizations – introducing a new level of diversification. For example, companies may opt to use construction machinery as a service for a certain period of time with the aim of lowering costs and cutting capital outlay. This will require a logistics company to deliver the machinery to the customer's site and bring it back. Multiple assets may be required, which explains the growth of solutions like the Wacker Neuson OnSite Box, which includes a variety of tools and equipment needed during construction. The user accesses the mobile container using a chip. Once the selected item has been removed from this container, the rental period starts and it terminates when the equipment in returned to the container. The customer is charged only for usage time. In this type of use case, the logistics provider supports the rental equipment company by mobilizing delivery of its solution.

Service Billing Models & Tools

As companies transition from selling products to providing them as a service, new service billing models and tools are required. Rather than managing inventory to record the products that have been sold, companies moving to XaaS must enable more complex usage-based invoicing. This is achieved with accounting tallies across multiple users on predetermined bases (per hour, per kilowatt, per kilometer, per use, per pick, etc). Smart contracts using blockchain technology can automate complicated processes in a transparent way, performing steps when pre-agreed conditions are fulfilled.

XaaS business models redefine asset management across industries and provide a more flexible customer experience.

Source: Acefone

Challenges

- To integrate, deploy, and manage an XaaS platform in what is still an emerging field requires adequate yet scarce IT skills; development will therefore come with initial high costs.

- Companies using XaaS seek partnerships with XaaS suppliers supportive of their business challenges, goals, and data security needs yet only 4 in 10 report being "extremely satisfied" with their supplier's performance reliability, IT integration, and utilization optimization.

- XaaS increases the complexity of the billing model and therefore requires a strong IT infrastructure to ensure resilience.

- For the XaaS supplier, data analytics capabilities are crucial to business success, providing insights into customer behavior patterns as well as asset maintenance and inventory management.

Resources

| The power of XaaS in manufacturing: New business models boost productivity and generate recurring revenues | → |

| DHL - White Paper: The Future of Services Supply Chain | → |

This trend should be **MODERATELY monitored,** with some use cases applicable today.

Outlook

The Covid-19 pandemic accelerated digitalization across all industries, particularly in logistics and the supply chain as demand for goods increased to record breaking highs. In this context, the global XaaS market expanded from 436.82 billion USD in 2021 to 545.35 billion USD in 2022, with a growth projection of 2,378.07 billion USD by 2029 based on a 2022-2029 CAGR of 23.4%.3 This imminent market development means business models are changing B2C and B2B relationships from product-centric to user-centric, altering business interactions globally.

Related Trends

| Omnichannel | → |

| 3D Printing | → |

| Blockchains | → |

| Extended Reality | → |
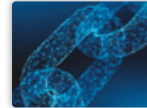
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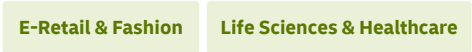
MASS PERSONALIZATION

The trend of Mass Personalization refers to the creation of highly personalized commercial experiences for individual customers that are designed to be applied on a mass scale. This trend utilizes advanced analytics of customer data, from geographic region to past customized purchases, to detect patterns at both the individual level and collective level and offer bespoke products and services.

Personalization differs from customization, which is when customers can choose from a set of attributes or amenities, like the color of their next sneakers or their seat position on a flight. Rather, personalization is when organizations proactively tailor the customer experience based on individual user data and aggregated data such as demographic categories and past customization choices, in attempts to make the user feel more special and valued. This personalization is already apparent in some e-commerce realms, like movie streaming services recommending certain films after analyzing one's selection history and fashion marketplaces suggesting styles based on one's age and gender.

As 71% of online shoppers expect companies to deliver personalized interactions, there is a growing need for businesses to incorporate artificial intelligence (AI) and big data analytics to help seek patterns and fine tune these personalized journeys on a mass scale, especially as a company's consumer base grows to thousands and millions of interactions. The logistics industry is by no means immune to this B2C consumer expectation, and supply chain leaders are already looking into how their organizations can better utilize data to improve the customer experience. Also, logistics players are the enablers of their B2B customers' personalization strategies and must anticipate the shifting agendas of these customers to ensure high quality service and cost-efficient offerings.

The trend of Mass Personalization has a relatively low impact on the logistics industry. While particularly relevant for B2C logistics engagement, the trend has so far only seen limited application in B2B logistics relationships. Supply chains should be capable of adapting to handle more customized products, and overall operational changes for the logistics provider are not anticipated to be disruptive. However, offering the right logistics services to companies with more complex product portfolios will be crucial to stay relevant for certain customers. The trend of Mass Personalization has a realization of about 5 years – significant progress is being made in improving personalization algorithms and further tailoring customer experiences, but it will take time for the logistics industry to adopt this trend and train these algorithms.

Trend Overview

Impact:

MILD

Realization:

< 5 YEARS

Focus Areas:

Automation & Efficiency   Customer Experience

Trend Clusters:

Artificial Intelligence

Sectors:

E-Retail & Fashion   Life Sciences & Healthcare

DHL

Relevance to the Future of Logistics

Tailored Logistics Services

Logistics providers themselves can be adopters of mass personalization strategies for their own B2B and B2C customers to stay competitive and earn revenue. In ways, many logistics leaders already do this on a rudimentary level for B2B relationships, offering specific services to companies based on their industry and the products being handled. To quickly illustrate, logistics providers offer specific services to B2B customers in the fashion industry that are very different to those offered to, say, manufacturers of space satellites. That said, the future of mass personalization will include fine tuning to enable more diverse offerings to B2B customers based on more granular differentiators such as business size, location, agenda, and more.

On the B2C end, there is a lot more opportunity for logistics organizations to offer personalization, given the greater

data pool and varied preferences. Many logistics organizations already have websites where consumers can customize their shipments, like choosing delivery dates and types of packaging. However, logistics organizations can use more data and undertake deeper analysis to proactively create a more tailored customer experience. For instance, if a customer has a history of selecting greener options like recycled packaging, the logistics provider can also recommend other environmentally friendly options – like carbon-neutral shipping and delivery by cargo bikes – before the customer reaches the payment stage. Additionally, an organization can analyze its supply chain data to evaluate regions based on the incidence of damaged packaging and theft. If a customer selects a shipment destination in a higher-risk region, the logistics provider could recommend safeguard services like tailored insurance plans and smart locks to this customer.

Overall, logistics providers can achieve competitive differentiation by providing more personalized services to B2B and B2C customers. By tailoring offerings based on each customer's needs and preferences, players in the logistics industry can increase customer retention while possibly also increasing revenue from value-added services.

Enabling B2B Customer Agendas

Many manufacturers and retailers are exploring and implementing mass personalization techniques to enhance the customer journey in different channels. Logistics organizations will be expected to collaboratively support these agendas, providing a newer, wider range of offerings to B2B customers.

For some logistics providers, this may mean holding an inventory of more products for quick fulfillment. To illustrate, personalized vitamin subscriptions – in which dozens of vitamins and supplements are combined in pre-dosed packets and delivered monthly or even daily to customers based on their health needs – are becoming popular and are offered by nutritional supplement giants GNC and Nature Made and startups like Perelel, Persona, and Ritual. Unlike typical purchases, when products may come from different fulfillment centers and be delivered individually, these subscription service purchases require the logistics organization has the right stock available in larger volumes at a single fulfillment center.

Furthermore, logistics companies may feel increased pressure from B2B customers to offer more sustainable and quicker delivery services. As younger consumers show higher willingness to pay more for sustainable goods, e-commerce retailers are actively seeking greener packaging and delivery mode alternatives to include these as personalized recommendations to customers.

We here at DHL predict retailers will offer more delivery options to customers based on their needs and demographic data, as many digital marketplaces already do. This can be in the form of different delivery times, from free 5-day shipping to premium same-day shipping, as well as the ability to drop the shipment off at a neighbor's address or a nearby parcel locker. We recognize that, in order to provide these offerings, retailers will be pressuring logistics partners to develop such services; if the partner cannot do this, the retailer will turn to other logistics companies that can meet these requests.

Overall, to stay competitive, logistics organizations will need to expand service capabilities, from enabling more efficient and flexible inventory space to ensuring greener varieties of delivery options.

Personalized shopping experiences can make significant impacts on consumer behavior.

Repeat purchases for 49% of consumers.

**Consumers spend up to 80% more.**

Source: Twilio Segment

Challenges

- Realizing a mass personalization approach requires comprehensive knowledge of customer preferences and a deep understanding of data analytics.

- Reacting to changing customer preferences necessitates flexible production lines and supply chains in order to fulfill customer needs on time.

- Logistics companies must be able to maintain the same cost-to-serve level for individualized goods and even partially customized goods as for standard products.

- Data collection and analysis is not enough for mass personalization; logistics organizations must also have varied offerings to suggest and recommend to customers to make their experience feel tailored and unique.
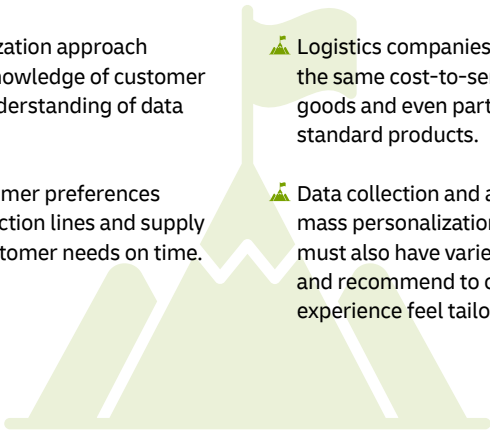
Resources

| DHL - Welcome to the world of hyper-personalization → | DHL - Personalization in B2B E-commerce: Top tips to boost your conversions → |

This trend should be **ACTIVELY monitored,** with imminent developments and applications.

Outlook

The trend of Mass Personalization will continue to progress as the customer expectation and demand for tailored experiences grows. Logistics organizations can be the enablers of their B2B and B2C customers' mass personalization strategies but need to adapt service offerings to these customers in order to also fulfill demand for customized logistics services including capabilities in AI and big data analytics.

Related Trends
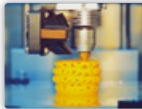
| Everything As A Service → | 3D Printing → |
| Big Data Analytics → | Interactive AI → |

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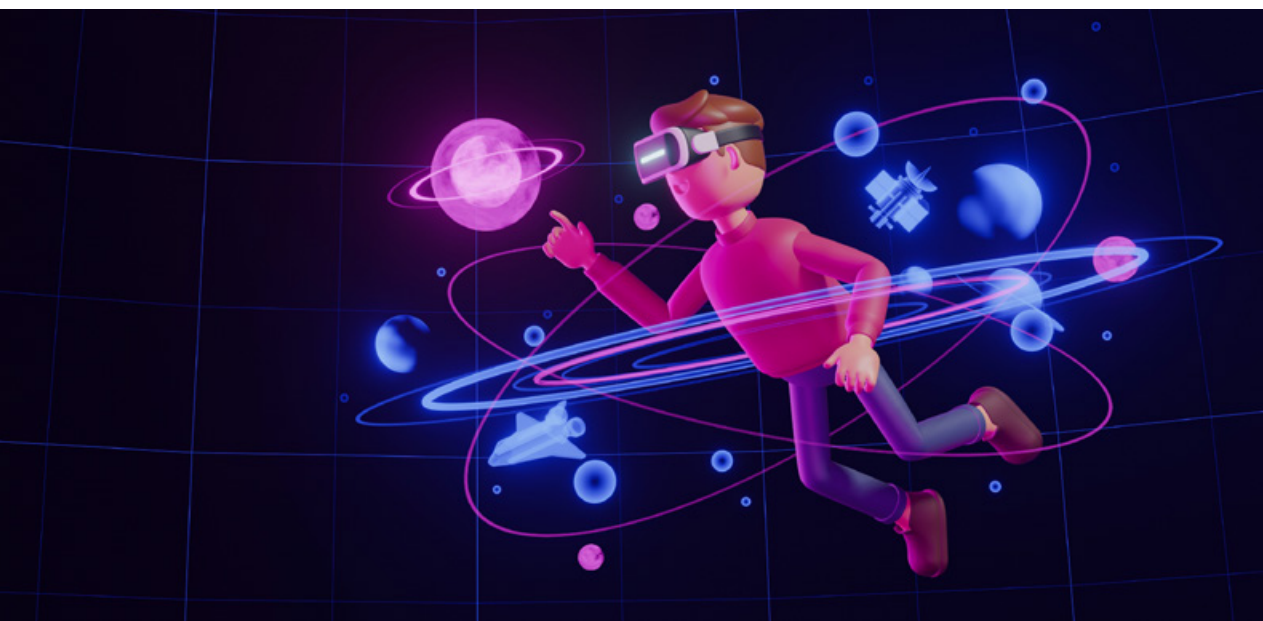
METAVERSES

The trend of Metaverses encompasses virtual worlds that exist in parallel with physical reality in which users adopt avatars to experience and live their digital lives. Metaverses are 3D models of the internet where users can explore, gain knowledge, enjoy entertainment, interact with each other, and buy, sell, and consume assets and services.

First realized in online video games in the early 2000s, the metaverse concept has been positioned as the next stage of social connection and engagement after the internet. The metaverse differs from virtual reality (VR) in that VR primarily occurs in contained digital environments usually for targeted functionalities like employee training and is experienced only via VR headsets. In contrast, a metaverse is typically built on VR technology but consists of open, shared, and immersive worlds connected to the wider online ecosystem and it can be accessed with or without a VR headset.

Furthermore, mimicking the physical world, metaverses have intricate economies. One major activity in many, but not all, metaverse economies is the trade and sale of blockchain-supported non-fungible tokens (NFTs). On the front end, NFTs can take many forms, like digital artwork and representations of real-world objects such as clothes and cars; on the back end, they are digital non-interchangeable receipts that act as proofs of ownership of digital or physical assets. Together, with major brands jumping on board, including Sotheby's and Christie's auction houses, virtual and physical global metaverse market was valued at 41 billion USD in 2021 and is expected to quadruple to 1.6 trillion USD by 2030.

The trend of Metaverses is relatively distant in terms of realization and low in impact for the logistics industry. While metaverses currently exist, it is almost like the beginnings of the internet in the 1990s – many corporate leaders in logistics and other industries are unsure how metaverses will impact core business. However, here at DHL, we believe that within 10 years, the trend's relevance to logistics and the supply chain will become better understood; the impact of this trend will clarify as metaverses develop further.

Trend Overview

Impact:

LOW	

Realization:

5-10 Years

Focus Areas:

Customer Experience

Trend Clusters:

None

Sectors:

Auto-Mobility   E-Retail & Fashion   Technology

Relevance to the Future of Logistics

New Customer Channels

Metaverses are becoming another legitimate channel for retailers and other organizations to drive more customer engagement and business. The Roblox platform, for example, has 54.7 million active daily users, while Fortnite has 24 million. As more people begin to spend time and money in metaverses, the localized economies of selling and trading virtual products and NFTs of both digital and physical assets is also anticipated to grow, and businesses are looking to see how they can take part.

In 2021, Gucci successfully sold a wide range of digital goods, from virtual sneakers to a 5-minute video, as part of its first virtual product line. Meanwhile, Nike is seemingly committing to a virtual future, filing metaverse-related patents, acquiring startups focusing on virtual fashion, launching a Nikeland metaverse showroom, and starting its own studio to design virtual products. Other virtual commodities being sold in metaverses include furniture, cars, events, and real estate, the last of which is expected to reach 1 billion USD in sales in 2022 and increase 31% annually through 2028.

For logistics organizations, the implications are not so clear. While some NFTs will be of physical assets that can be shipped to a new owner, most transactions will be of digital assets that do not require delivery services as they are imported directly into a user's digital wallet. However, logistics companies can use metaverses to open virtual stores and showrooms to display products and advertise services. Customers in metaverses may be able to purchase NFTs like stamps and packaging and exchange NFTs for products in the real world, having them automatically delivered to an address.

Supply Chain Simulations

It can be difficult and costly for supply chain managers and planners to test out changes and explore new ideas that may disrupt their current operations. Metaverses provide an opportunity to assess proposals without reconfiguring the physical world.

While no commercially available metaverse currently supports this, it is speculated that metaverses will act as environments to house and experiment with digital twins – exact virtual replicas of physical world assets and systems. Data from sensors measuring characteristics of the physical object will help duplicate a virtual one in the metaverse in real time. For logistics leaders, these digital twins could be everything from a single conveyor belt system or a whole facility to an entire supply chain or network. Users would be able to enter the metaverse and interact with the digital twin, running different scenarios to evaluate the best solution, whether this is rearranging a facility floor or adding another distribution center to a network.

In this way, metaverses provide a space for logistics managers and planners to visualize, plan, and collaborate on upcoming changes without compromising real-world operations.

Warehousing Services for Collectibles

As metaverses grow, so too will their economies and the exchanging and purchasing of NFTs. Not every NFT will represent a digital asset – a proportion will act as proofs of ownership for physical goods, particularly high-value products like luxury items and collectibles. Many customers will not want to risk damaging or losing these products during delivery to a new owner every time an NFT is traded.

One solution is the creation of secure and insured vault-like warehouses specifically built for storing high-value goods. eBay, for instance, launched a temperature-controlled, 24/7 secured vault for collectible trading cards with its own special digital marketplace in 2022. While ownership of the cards may change hands, the cards remain in place, safe and protected, unless owners request them to be delivered. In 2023, eBay plans to expand this service to other collectible categories and luxury products, storing up to 3 billion USD in assets in its vault.

Overall, we here at DHL foresee more retailers and third parties following in eBay's footsteps and creating additional services to safely store physical products for NFT customers.


Metaverses sometimes utilize, but are independent from, blockchain or virtual reality (VR) technologies.

Source: vincos.it

Challenges

⛰ In a digital world where assets and payments can be instantly sent from one owner to another, the role for digital logistics services is currently unclear.

⛰ While today's users can access several metaverses which are continually expanding, the potential of metaverses as important retail channels is uncertain.
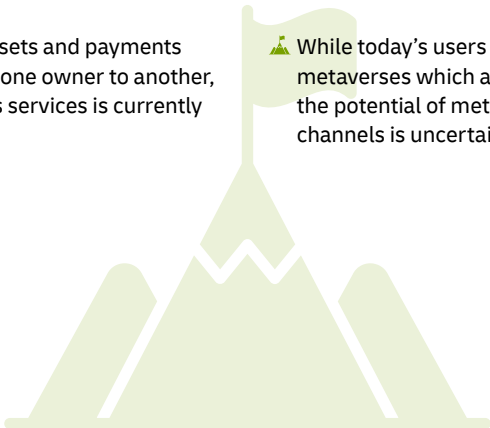
Resources

📄 **DHL - How the metaverse will revolutionize e-commerce** →

This trend should be **PASSIVELY monitored,** with applications still mostly being developed or explored.

Outlook

The trend of Metaverse is exciting, but the development opportunities are not yet fully understood. Although metaverses now represent a rapidly growing channel with tens of millions of potential users, the role of the traditional logistics industry and the supply chain is unclear. Nonetheless, as this trend matures and more individuals and companies participate in metaverse economies, we here at DHL expect to gain greater insight.

Related Trends

Digital Marketplaces →

Blockchains →

Digital Twins →

Extended Reality →

Sources
Globe Newswire (2022): Metaverse market size to worth around USD 1,607.12 Bn by 2030.
Vincos (2022): Map of the metaverse.
CNBC (2022): Metaverse real estate sales top $500 million, and are projected to double this year.
Ebay (2022): eBay launches its vault for trading cards.

Trend Overview

Impact:

HIGH

Realization:

< 5 YEARS

Focus Areas:

Customer Experience   Visibility & Resilience

Trend Clusters:

None

Sectors:

Auto-Mobility   E-Retail & Fashion   Life Sciences & Healthcare   Technology

OMNICHANNEL

The trend of Omnichannel refers to the progressive synchronization and combination of all product sales, distribution, and return channels accessible to a customer. This trend goes further than a multichannel system in which the customer is exposed to many channels but must buy and return through the same channel. Omnichannel systems empower the customer to browse in all channels and select any channel for purchase, product receipt, and return.

The seamless integration of online and offline channels with a clear focus on the end customer is at the heart of a successful omnichannel strategy. For example, 1/3rd of US shoppers said that, since the pandemic, omnichannel features such as the ability to buy online and pickup in store (BOPIS) have become part of their regular shopping routine. The start of 2022 with the reopening of brick-and-mortar stores has also shown that retail stores still have high value for end customers and companies, as retailers are also increasingly using stores as strategic distribution channels. Only by exploiting and connecting all potential channels can an omnichannel strategy be established successfully, especially in the e-commerce retail and fashion sector. While this is a challenging task, it opens up a very lucrative market – the total global value of omnichannel distribution is expected to increase every year by 7%, reaching up to 840 billion USD by 2025.

In recent years, more and more companies have recognized the great potential of implementing omnichannel strategies. Traditional brick-and-mortar retailers are investing heavily in e-commerce programs; for example, Walmart announced an investment in the Indian e-commerce company Flipkart of 1.2 billion USD in 2020, and e-commerce companies are investing in traditional store retail concepts that leverage the offline channel as well, like Amazon's chain of convenience stores Amazon Go and supermarket chain Whole Foods Market. This illustrates the importance of this trend to corporate agendas. Omnichannel strategies require sophisticated supply chain management to deliver the promised customer experience as, for example, planning, lead times, inventory levels, and locations become more complex. However, it will still take 2 to 3 years before most companies are able to design and implement a comprehensive omnichannel strategy for day-to-day operations, transport networks, and IT systems.

Relevance to the Future of Logistics
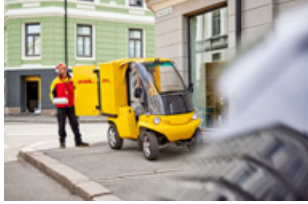
Logistics As An Omnichannel Differentiator

The successful implementation of an omnichannel strategy today depends, above all, on the online presence of companies and their e-commerce sales channel.

For companies that are adopting an omnichannel strategy, a key differentiator is logistics. Logistics service providers play an important role in the entire customer journey. Research shows they even influence the final purchase decision, as 46% of online customers abandon online shopping carts if required to wait too long for delivery of their purchase. There is also clear evidence that customers want the ability to track the shipment of their purchases right to their pickup point or front door.

To ensure a superior customer experience, the key to success is end-to-end integration of supply chain planning involving all relevant stakeholders. After all, an omnichannel strategy can only be successful if there is continuous visibility of product locations and quantities as well as seamless integration of all relevant platforms and service providers. Furthermore, a successful omnichannel strategy includes giving customers the options to choose their preferred logistics providers and services, as well as delivery time and location, regardless of whether they use one or multiple channels throughout their entire customer journey.

The realization of various delivery options requires the omnichannel strategy is taken into account when planning the supply chain network in close cooperation with the logistics service provider. In future, a combination of 'dark stores' which are small micro-fulfillment centers near city centers and strategically positioned distribution centers will be of enormous importance for fast and cost-efficient delivery.

Companies can benefit from the know-how of logistics service providers and improve the customer experience through this collaboration to achieve long-term customer retention.

Inventory Movement

With the reopening of retail stores in the wake of the COVID-19 pandemic, the relevance of brick-and mortar stores as a place for customer engagement and brand building has become more visible again. New delivery and return models such as BOPIS or in-store return options have led many retailers to increasingly use their brick-and-mortar stores as fulfillment centers.

This is evidence of a clear trend towards omnichannel solutions, so that online and offline channels are becoming more and more complementary and connected, and are no longer seen as substitutes. A central aspect of the implementation of an omnichannel strategy is the movement of inventory, which requires a high degree of precision and even more flexibility to respond to fluctuations in demand. Strategically, this also means a shift from large distribution centers to a more decentralized setup, local micro fulfillment centers or even using brick-and-mortar stores as inventory hubs. This shift was first accelerated during the COVID-19 pandemic, when retailers began using their retail storefronts as fulfillment centers when they were not allowed to open them.

Currently, the decision on warehouse locations and quantities is primarily made by humans. However, companies are increasingly aiming to automate these decisions in regards to internal movement of inventory using smart algorithms based on various data points, such as regional weather changes or online customer behavior.

The challenges for logistics are finding the ideal logistics solution for the respective shipments and, above all, to adapt the more flexible, smaller-scale movement of inventory to route planning, as exact information about delivery options (eg, specific delivery periods and zones within inner cities) as well as measurements to help select the right means of transportation (eg, small van or large truck) are necessary for efficient planning. Only in this way can effectively shared inventory be realized across the various channels, online and offline, and an omnichannel strategy be successfully implemented.

Anytime & Anywhere: Last-Mile Omnichannel

The growth of e-commerce during the Covid-19 pandemic has accelerated developments of comprehensive omnichannel offerings. Companies recognized pandemic-favored delivery options such as 'buy online, pick up in-store' (BOPIS); in fact, the use of BOPIS services in the US increased by 106.9% in 2020. Other new omnichannel examples include a kiosk solution from collaboration between e-commerce software provider Shopify and Portuguese kiosk manufacturer PARTTEAM & OEMKISOSKS. Designed for use in brick-and-mortar stores, this digital kiosk presents customers with a complete online store selection, including individual offers and discounts. After making a purchase, the customer can opt to have their goods delivered or decide to take them directly from the store, if this option is available.

Customers appreciate this flexibility and particularly like choosing their delivery location. This could be the nearest branch, a smart locker solution such as the DHL Packstation, or even delivery to a neighbor. They also want to select the most convenient delivery time.

To offer this level of flexibility, companies must have an accurate inventory management system, one that is connected to all retail stores as well as warehouses and production facilities, with seamless connection to the logistics service provider.

In future, autonomous deliveries via drones and vehicles such as the Nuro delivery vehicle can help further personalize last-mile services, enabling a fully anytime, anywhere solution.
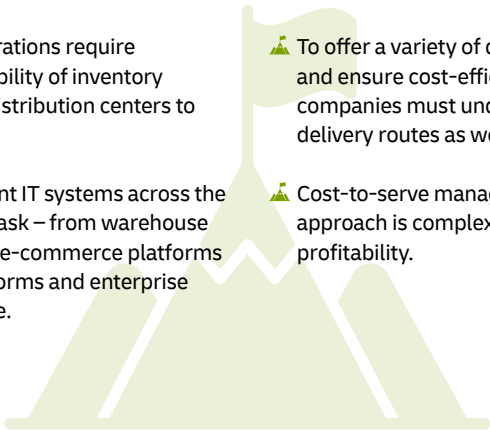
An ideal omnichannel logistics network requires active communication, visibility, and coordination between many players and engagement point with customers.
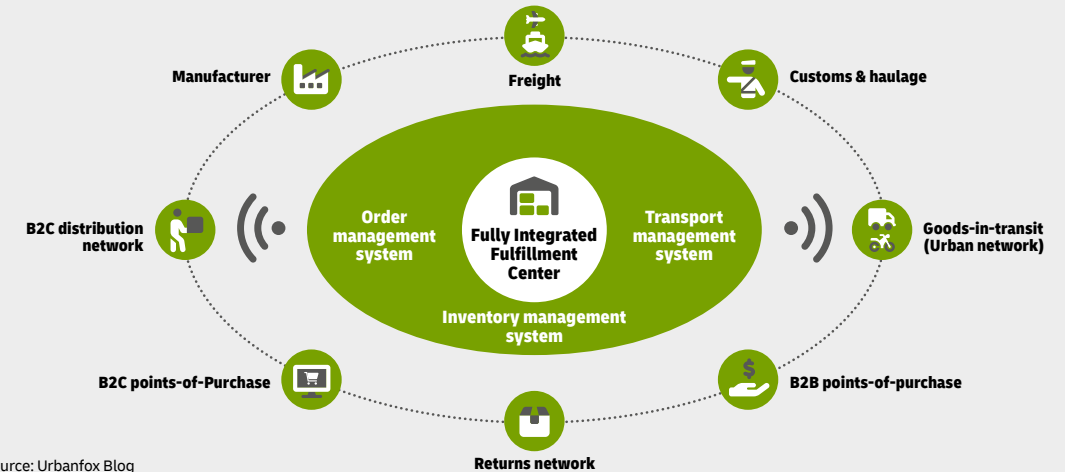
Source: Urbanfox Blog

Challenges

- Omnichannel logistics operations require complete and accurate visibility of inventory across all locations, from distribution centers to retail stores.

- Integration of many different IT systems across the supply chain is a complex task – from warehouse management systems and e-commerce platforms to retail point-of-sale platforms and enterprise resource planning software.

- To offer a variety of delivery and return options and ensure cost-efficient transportation, companies must undertake complex planning of delivery routes as well as accurate forecasting.

- Cost-to-serve management of an omnichannel approach is complex but crucial for maintaining profitability.

Resources

DHL - Opening of 10,000th Packstation in Germany →

DHL - European fulfillment network: On demand fulfillment across Europe →

This trend should be **CLOSELY monitored,** with implementations available for many use cases today.

Outlook

Omnichannel strategies will remain highly relevant to the success of companies in the future, as indicated by a survey of 100 e-commerce decision makers in Europe and North America, 20% of whom rated an omnichannel strategy as quite important and 47% as very important to their organization in 2021.

Logistics will continue to play a major role in omnichannel concepts and collaboration between companies and logistics service providers is essential to the success of an omnichannel strategy. New, emerging customer channels such as the Metaverse and growing customer expectations in terms of speed and convenience of delivery will continue to shape omnichannel strategies in the future and, accordingly, also place new demands on the supply chain and logistics services.

Related Trends

Quick Commerce →

Mass Personalization →

Big Data Analytics →

Cloud & APIs →

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TechCrunch (2020): Walmart leads $1.2 billion investment in India's Flipkart.
McKinsey (2022): The five zeros reshaping stores.
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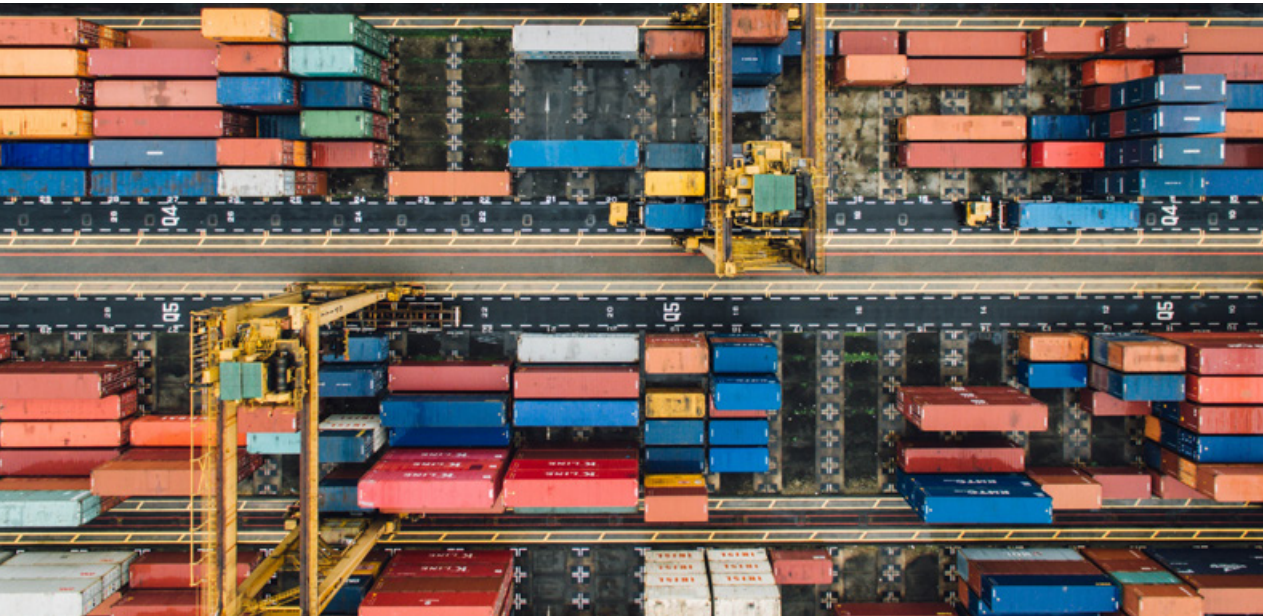
PHYSICAL INTERNET

The trend of Physical Internet is a new logistics paradigm envisioning a worldwide open network that is hyperconnected physically, digitally, and operationally. Mimicking how data packets are efficiently handled by the digital internet between senders and receivers, the physical internet seeks to improve supply chains through the standardization of interfaces and protocols, the synchronization of modes and channels, and the modularization of containers.

Conceptualized in 2011, the physical internet was modelled on the digital internet in hopes of reaping efficiency benefits similar to those in digital communication. In the digital internet, information to be sent is perfectly encapsulated by data packets, and only these packets, not the information inside, are handled by the communication system. The packet itself contains identification data, as well as the important information needed to route it to the correct destination. Additionally, these packets are only built for a specific transmission; when they reach their destinations, they are disassembled to reveal the sent information they once contained.

Furthermore, the digital internet has protocols that enable each packet to travel with ease along different types of medium like copper wire and fiber optics and be processed by different equipment, such as cloud servers and wireless routers, regardless of where the packet was generated. Perhaps most importantly, with the digital internet, users do not have to care so much about how the information is sent but rather that the information arrives uncompromised, in perfect condition, and on time.

Described and portrayed this way, similarities to supply chains become apparent as shipments of palletized or containerized goods travel through hubs and along highways to the doorsteps of customers with high expectations. However, unlike the digital internet, the physical world of logistics is fragmented into thousands of players along and across supply chain networks with different standards and protocols, numerous private vehicles and facilities, and only limited levels of data sharing and communication. While some standardization exists, like 20-foot equivalent unit (TEU)-scaled shipping containers and pallet sizes, many industry leaders are imagining a physical internet in which logistics partnerships can be further integrated and synchronized to achieve seamless and efficient delivery of goods as in the communication of data in the digital internet.

Once materialized, the trend of Physical Internet will have high impact on logistics. It will greatly influence how the supply chain operates, shifting from closed networks to open, agnostic ones with a hyper level of connectivity in a more globalized world. However, this trend will take perhaps decades to fully develop and be realized, but we here at DHL believe experimentation with some components of this trend will begin within several years.

Trend Overview

Impact:

MODERATE	

Realization:

5-10 Years

Focus Areas:

Automation & Efficiency   Customer Experience   Environmental Sustainability

Trend Clusters:

Internet of Things   Packaging & Containers

Sectors:

Auto-Mobility   E-Retail & Fashion

Relevance to the Future of Logistics

Smart & Modular Containers

Today, products and packages are continuously loaded in often inefficiently sized boxes and containers, unloaded, re-consolidated into smaller groupings, and then loaded again in similarly inefficiently sized containers. The physical internet hopes to address these inefficiencies and decrease the amount of shipped air in a box or container, as well as eliminate the need for (de-/re-) palletizing in the supply chain.

At the core of this concept are next-generation containers called physical internet (pi)-containers. Pi-containers are ideally made of sustainable material, connected digitally via sensors and other smart technology, and easy to store, handle, and transport. Most important to the idea is that they come in a standardized set of modular, interlocking boxes between 10 cm (4 in) and 12 m (39 ft) along one side – this better suits the volume of encapsulated shipments to intended destinations than current boxes, pallets, and TEU-scaled containers. Overall, pi-containers are often visualized as an efficient hybrid between stackable LEGO® blocks and nesting Russian dolls that can easily and individually snap off from a consolidated batch and continue towards its final destination.

While these idealized pi-containers do not exist yet, various companies are working towards this ideal from different angles. Netherlands-based CargoShell and 4FOLD, as well as American-based Staxxon, produce certified collapsible containers that reduce space when stored empty or transported in return streams. Meanwhile, Swiss unit load device (ULD) management company Unilode has developed and deployed devices within thousands of its ULDs to achieve one of the first aviation-compliant Bluetooth roaming networks, increasing real-time visibility of containers during flights. In addition, various companies are looking into nonconventional container formats to better accommodate smaller shipment volumes, like the DHL Cubicycle cargo bicycle, as well as the DHL City Hub trailer, that accommodates a container volume of 1 cubic meter (35 cubic feet) and creates an internal system of easily swappable, smaller containers.

Agnostic Hubs & Logistics Infrastructure

Operating in a fragmented industry with a multitude of players, logistics organizations are, on the one hand, often limited in terms of reach and capability by their partner network; some regions lack the services of certain providers as these would be too costly to support from the network's distribution center or hub due to great distance or other barriers. On the other hand, logistics organizations in some other regions, especially metropolitan areas, are often supported by many providers offering very similar services, and this adds to urban congestion, inefficient delivery patterns, and low margins in a tightly competitive space.
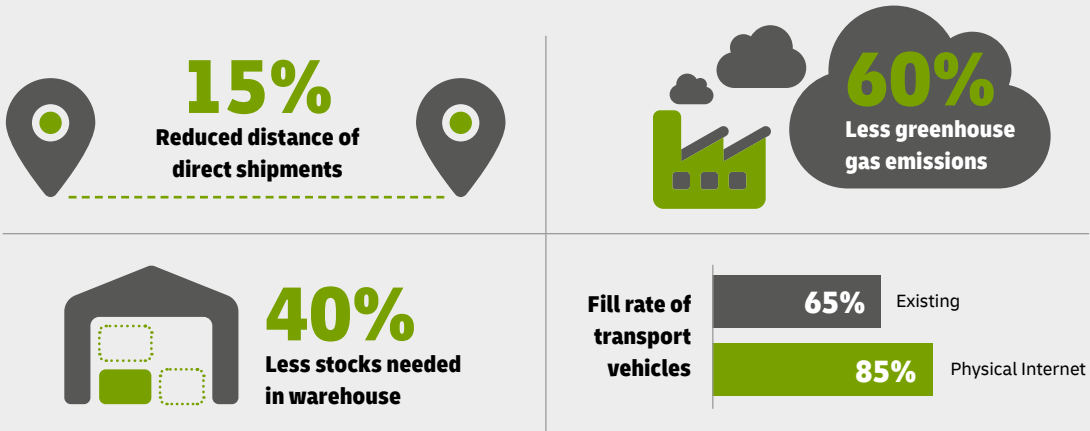
The solution lies in the physical internet. Hubs and other facilities and pieces of the infrastructure would ideally be agnostic and shared by all players and partnership networks. In underserved regions, this would encourage more competitive logistics service offerings as each provider could use a closer facility, one that did not previously belong in their network. Meanwhile, in urban areas, agnostic hubs and locker stations would allow more experienced and specialized last-mile delivery players to make more efficient and coordinated deliveries by bundling multiple shipments, and this would alleviate last-mile burdens like congestion on middle-mile services.

In 2021, Singapore launched one of the world's first open-access nationwide parcel locker networks with about 1,000 parcel lockers. The network is carrier-agnostic and will be progressively accessible to all logistics service providers and digital marketplace customers. With most residents able to access a locker within a 5 minutes' walk of their home, the parcel locker network seeks to improve delivery companies' fulfillment reliability and productivity. Meanwhile, in the Netherlands, the Goederen Hubs organization recently created a network of 20 logistics facilities around the country focusing on bundling freight flows for urban recipients. One of its newest hubs near Groningen was purposely built just outside the city near the highway and airport to help middle-mile truck shipments avoid city traffic and to provide last-mile delivery providers with easy access to the city.

Hyperconnected Transportation Networks

In some ways, we can already see that steps have been taken towards the physical internet in supply chain transportation. Today, for example, it is not so uncommon for shippers to utilize digital logistics marketplaces and other means to combine several less-than-truckload (LTL) shipment orders from customers, reducing costs and optimizing shipment utilization.

However, the physical internet imagines an even higher level of coordination and synchronization across transportation modes and providers. Modularly sized, yet standardized, containers of shipments would be easily transferrable between airplanes, ships, trains, trucks, cargo bikes, scooters, and hand trucks with minimal effort needed. Like public transit systems, logistics

vehicle routing would be calculated to intersect rather than follow siloed paths or territories, generating network benefits as intersections would act as potential shipment transfer points. To illustrate, an urban courier van with a mix of shipments could meet up with an outbound truck passing through the outskirts of a city, and shipments destined for an out-of-region address would be immediately transferred from the courier van to the truck without having to be delivered to a local hub. This would save time and, after the transfer, both vehicles would continue their delivery journeys.

As inter-operational communication between logistics providers is currently lacking, this optimization opportunity of the physical internet has yet to be fully explored by the industry. However, as partnerships and data sharing trends strengthen, we here at DHL anticipate seeing experiments with this use case in a few years.

Using a physical internet system of 50 hubs instead of utilizing existing dedicated warehouses to supply actual demand, the experiences of two major French retailers show dramatic supply chain improvements across several metrics.

15% Reduced distance of direct shipments

60% Less greenhouse gas emissions

40% Less stocks needed in warehouse

Fill rate of transport vehicles

65% Existing
85% Physical Internet

Source: The Consumer Goods Forum

This trend should be **PASSIVELY monitored,** with applications still mostly being developed or explored.

Outlook

To bring about the next level of efficiency, the trend of Physical Internet will greatly rearrange supply chain networks and alter how logistics organizations provide services and interact with one another. However, with great change comes great challenge, including the coordination and integration of a multitude of players along and across the supply chain, significant investment, and new regulations to permit and enforce standardization. We here at DHL are eagerly waiting to see how this trend will develop and materialize, including all the small steps towards this new way of operating.

Resources

The Physical Internet: Rethinking Logistics

The future of logistics with Physical Internet

Related Trends

Metaverses

Smartification

Space Economy

Big Data Analytics

Challenges

- Pi-containers will need to pass international regulatory standards and testing rigor, and gain acceptance by multiple players along the supply chain, before widespread adoption.

- Implementing physical internet concepts like agnostic facilities and parcel lockers requires coordination between multiple players in both the public and private realms.

- Logistics organizations aiming to improve the supply chain using physical internet concepts will probably need to invest in the overhaul of existing infrastructure, operations, and networks.

- The physical internet requires data transparency and sharing between participants to create hyperconnected networks, but both the risk and impact of cyberattack grow with the size of the network.

- Like firewalls on the digital internet, international borders and customs unions may prove to be barriers to the physical internet, limiting its benefits across regions.

Sources
Infocomm Media Development Authority (2021): Nationwide parcel locker network launched.

QUICK COMMERCE

The trend of Quick Commerce, sometimes referred to as on-demand delivery, is the next generation of e-commerce, involving convenient online ordering, accurate order fulfillment, and speedy delivery within an hour of order placement.

The market for Quick Commerce solutions saw very strong growth particularly in urban areas during the COVID-19 pandemic, and this trend is likely to continue in the post-pandemic era. To illustrate, by 2025, the quick commerce market is expected to almost triple to 72 billion USD. It is not just grocery deliveries that benefit from the Quick Commerce trend; more and more industries, from pharmaceuticals to fashion, are analyzing how it can help meet increasing customer demands and expectations for faster, more accurate delivery. In Western Europe alone, for instance, 30 new quick commerce companies emerged within just 10 months in 2021.

Quick commerce solutions for food and grocery delivery are already prevalent in most urban areas around the globe. As more customers expect similar services in other consumer segments, these solutions are capable of quickly expanding to other product categories without requiring substantial adaption. Overall impact on the logistics industry, however, will be mild, as the trend of Quick Commerce is applied primarily in B2C fulfillment and last-mile segments of the entire supply chain.

Trend Overview

Impact:

MILD	

Realization:

< 5 YEARS

Focus Areas:

Customer Experience

Trend Clusters:

None

Sectors:

E-Retail & Fashion

Relevance to the Future of Logistics

Expansion of Dark Stores

The hallmark of quick commerce is super-fast fulfillment and delivery. With last-mile delivery being the most expensive segment of a fulfillment supply chain, large, traditional warehouses – set up to achieve economies of scale – are usually a barrier as they are typically located on the edge of a city, far from the primary customer base.

As a result, many quick commerce providers are opening and operating so-called 'dark stores' (micro-fulfillment centers housed in what used to be retail space) in central neighborhoods or at the back of large suburban retail stores. By opening many dark stores, a quick commerce provider gets closer to customers and ensures promised delivery times. This significant shift towards decentralization is reflected in the growth of a dark store ecosystem offering specialized services specifically for these facilities. For example, Mapbox helps companies pinpoint the perfect location for their next dark store.

Overall, dark stores allow for faster picking and delivery, as well as lower costs per pick and delivery, with their more specialized product assortment and closer proximities than larger traditional warehouses. While dark stores may have higher fixed costs when renting these centrally located properties, their savings can make all the difference in last-mile delivery.

Everything & Anything Delivered Quickly

Quick commerce providers currently specialize in delivering food and groceries, but some are expanding into other fast-moving consumer goods (FMCG) like beauty products, clothes, and office supplies.

Japanese fashion and home goods company MUJI, for instance, is a frontrunner in this space, partnering in 2022 with Meituan, China's leading food delivery shopping platform, to offer instant delivery services within China for its product line, from fashion items to kitchen appliances.

We here at DHL anticipate a future where most FMCG retailers and even companies providing many luxury and specialized goods, like expensive handbags and large furniture, will offer quick commerce options to customers. With this rising trend, retailers will have two possible strategies to stay competitive. They can either follow MUJI's example and partner with an existing quick commerce provider or create their own in-house fast-delivery solution. In both scenarios, as more and more different product types are offered for delivery in shorter time spans, supply chain teams must anticipate how their supply chains will change not just in the last-mile, but also in upstream supply chain segments as well, to accommodate quick commerce.

Meeting New Customer Expectations

E-commerce surveys consistently find that repeat customers are closely associated with positive delivery experiences, which shows how logistics providers now act as key differentiators among online marketplaces and platforms. Therefore, supply chain teams must analyze customer expectations and adjust strategies and operations to meet them. That is why quick commerce is the ultimate discipline for designing an outstanding end-to-end customer experience.

An analysis of end-customer data by instant-delivery startup Ohi found that orders delivered within 2 hours had a 61% higher repurchase rate than standard shipping and even 24% higher than same-day delivery. Implementing a seamless, hassle-free online shopping experience within a time span of one hour from order to delivery helps companies build customer retention and loyalty. The switch to quick commerce, however, carries risk that should not be underestimated. The transition is costly and, once a company promises to meet the customer expectation of hassle-free delivery within an hour, failure to deliver on that promise risks loss of business, competitiveness, and relevance.

In addition to fast, on-time delivery, most customers today also demand live shipment status tracking and updates. The ability to track the path of the quick commerce delivery from goods packing in the dark store to the mapped delivery destination adds to a positive customer experience, involving the recipient virtually with their order in the supply chain. Logistics providers can facilitate this through efficient inventory control, effective demand forecasting, optimized delivery routes, the installation of sensors, and other digitalization tactics.

The new baseline for deliveries may be 2-3 days, but food delivery apps may be cultivating new future expectations from customers with their instant delivery services.

90% of consumers now see 2 or 3-day delivery as the baseline.

40 minutes - average maximum waiting time expected by customers on food delivery apps.

30% of consumers expect same-day delivery.

45% of customers abandon carts if they discover they need to wait longer than expected for delivery.

Sources: McKinsey & Company; US Foods

Challenges

- Just one negative delivery experience, like failing to deliver on time, can lose a customer.

- The profitability of quick commerce delivery remains unverified; many players currently operate unsustainably using high levels of investor finance.

- With more products flowing to distributed and specialized urban micro-fulfillment centers, cost and operational effort are passing up the supply chain to the middle-mile logistics providers that have to travel deeper into urban areas.

- Reconfiguration of the supply chain may be essential as consumers increasingly expect 1-hour delivery as the norm.

- Setting up an in-house quick commerce solution without any collaboration carries higher risk and investment for retailers.

- As dark stores increase in number, neighborhood residents are pushing back and advocating for tighter regulation; this may limit the service potential of dark stores.

Resources

PDF — **DHL - European fulfillment network solution for Jamoona** →

Outlook

This trend should be **CLOSELY monitored,** with implementations available for many use cases today.

Quick commerce will continue to grow as post-pandemic e-commerce increases and retailers across consumer goods segments seek to meet new customer expectations. The dominant players in this crowded and competitive space remains to be seen, however.

Success in the trend of Quick Commerce will likely depend on one's ability to provide delivery services across multiple retailers and product types while continually striving to bolster brand loyalty.

Related Trends

Mass Personalization →

Omnichannel →

Big Data Analytics →

Cloud & APIs →

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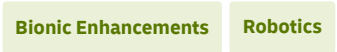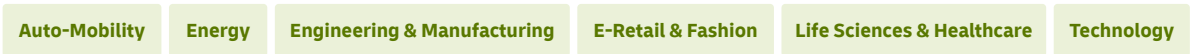
REMOTE WORK & TELEOPERATION

The trend of Remote Work & Teleoperation refers to the global shift from the notion that employees must work in the workplace to the idea that employees can work from their homes, different workplaces, and elsewhere to get tasks done. Remote work implies availability of the technologies, infrastructure, and policies needed to support office-based tasks away from the workplace, while remote teleoperation focuses on the requirements and developments for collaborative operations-based responsibilities.

Acceleration of the Remote Work & Teleoperation trend is predominantly a response to the Covid-19 pandemic. As companies globally redefine the parameters of where we work, new structures are being implemented across industries to give workers the post-pandemic option of going back to work in an office or continuing to work remotely. This is causing rapid growth of innovative technologies which provide new capabilities supporting employee preferences.

Similarly, technological innovation is enabling remote teleoperation capabilities. To better control a device or machine remotely, companies are increasingly using robotic technologies, autonomously moving vehicles, and digital twins. An example of this can be seen from Plus One Robotics, who have developed a software solution called Yonder that enables employees to control multiple warehouse robots from any location. Yonder demonstrates the "Human-In-The-Loop" remote supervising and controlling of robotics application. Digitalization and automation are the driving forces of this trend, remotely protecting operations from disruption.

The transportation and logistics segment of the global teleoperation market accounted for 83.8 million USD in 2020, and is set to increase at a considerable CAGR of 22.7% by 2030.

While the realization timeline for this trend foresees ubiquitous adoption within the next 5 years, the impact on logistics and the supply chain will be relatively low. When a company introduces remote work and teleoperation, this will not necessarily impact the supply chain, other than perhaps to increase the number of final delivery destinations.

The impact of remote work on logistics companies is no greater than for companies in other industries, and to gauge the impact of remote teleoperation will require existing use cases to be scaled. Therefore, while the way of working will continue to change, there is no anticipated major change to the supply chain. With the developing adoption of collaborative technologies – which enable employees to interact with each other without being in the same room – the demographic of suitable people to fill operational roles expands and, at the same time, the ability to operate machinery and robotics remotely opens up an even wider pool of talent.

Trend Overview

Impact:

LOW

Realization:

< 5 YEARS

Focus Areas:

Automation & Efficiency	Environmental Sustainability	Health, Safety & Future of Work	Physical & Digital Security

Trend Clusters:

Bionic Enhancements	Robotics

Sectors:

Auto-Mobility	Energy	Engineering & Manufacturing	E-Retail & Fashion	Life Sciences & Healthcare	Technology

DHL

Relevance to the Future of Logistics

Remotely Controlled Vehicles

The pandemic saw desk-based workers change their working environments to homes or other remote locations, but on-site operational workers still needed to be physically present and maintain social distance. This presented an opportunity for tech providers to tackle how operations could continue running while ensuring employee safety in a warehouse environment. Many of these jobs are rooted in the physical realm; however start-up companies such as Phantom Auto developed remote operation software that can be integrated with unmanned vehicles, from delivery robots to forklifts and yard trucks. Employees can then use a digital platform to monitor and control fleets from far away and map an area for robots to follow. Without causing any disruptions to workflows or the supply chain, this type of solution ensures customer demands are met while keeping employees safe.

Another area of opportunity for vehicle remote control is training new operations personnel. In the past, to prepare drivers for yard truck driving, a trainer and trainee would sit together inside the truck cab. A socially distanced solution is for the trainer to sit alone in the cab while the trainee sits at a remote console observing and learning how to operate the truck remotely. Changing the day-to-day working lives of employees who can now operate vehicles autonomously also opens up the talent pool that companies can draw from as they can employ staff from any remote location.

Remote-Controlled Operations Using Digital Twins

Digital twins can drive further efficiency in teleoperation, enabling the remote operation of machinery, automation, and ultimately entire production systems. For difficult-to-access locations, a digital twin eliminates the need for a human to physically go to the location to operate a machine or undertake any other task; instead, they can operate at the location remotely. Energy giant Shell, for instance, has partnered with tech solution provider Kongsberg Digital, using its software-as-a-service solution for a digital twin of the Shell upstream, integrated gas, downstream, and manufacturing business lines. This cloud-based digital twin solution named Kognitwin will provide integration, visualization, and analytics capabilities to Shell's facility assets globally by contextualizing real-time sensor data. The adoption of this technology provides access to a company's portfolio of assets from anywhere, expanding the scope of remote operations.

In logistics and supply chain operations, digital twins can be implemented to harmonize the physical space with the virtually created twin. This enables remote operation and management of a wide range of logistics activities across warehouses, sorting centers, and other facilities.

Teleoperation as a Safety Fallback

Teleoperation can be of assistance for a vehicle that operates largely autonomously in a scenario where it cannot cope alone. One of the main setbacks to scaling out and implementing autonomous vehicles is that decision-making artificial intelligence models need to be trained. This training ensures vehicles respond correctly to a vast array of driving condition scenarios and situations that may occur, and covering every possible real-world scenario is practically impossible. In order to bridge this gap, teleoperators must guide the autonomous vehicle when it encounters unnavigable new scenarios and situations. Serving as a technological bridge, teleoperation acts as a connector, bringing existing automation technologies more rapidly onto roads and into operations.

A common scenario would be a double-parked delivery vehicle. The autonomous vehicle is prevented from driving over a solid line on its own, so it will remain where it is until a teleoperator intervenes. Another example is a construction site that has yet to be incorporated into the automated system. A teleoperator would need to guide all vehicles safely into and out of this location.

The future role of teleoperators will be supported by a specific setup comprising monitors, user interfaces, and headsets. Each teleoperator can sit together with others in a control center or alone at a remote location while guiding autonomous vehicles through difficult situations at multiple geographical locations.

Decentralized Last-Mile Delivery

Remote work will change supply chains, especially in busy urban cores.

When most people worked in the office, mail and day-to-day business deliveries were centralized but as some people now work from home, these services are becoming decentralized. For example, laptop deliveries for new employees who work from home now get mailed to HR. Also as fewer people are in the office, the volume of food deliveries to corporate cafeterias is decreasing – work-from-homers eat in their own kitchens or near where they live. These changes require realignment in the logistics industry.

Businesses that service downtown workers are also decentralizing or changing location. For example, the sandwich shop franchise Pret a Manger is closing downtown restaurants and opening up suburban ones to cater for the rising number of people who work from home; the company is therefore developing a more decentralized supply chain.

Urban spaces will see a shift in utilization as 30% of the workforce is expected to work remotely after the pandemic. In the average downtown area, 71% of buildings are offices (90% in Chicago and NYC), and so workforce decentralization will certainly impact the socio-economic urban landscape.

Across the entire supply chain, a significant number of devices can be operated remotely, ranging from machinery to autonomous vehicles, forklifts, and drones.

Roads

Sidewalks and buildings

Logistics yards and warehouses

Off-road and machinery

Source: EE Times Asia

This trend should be **ACTIVELY monitored,** with imminent developments and applications.

Outlook

With a significant rise in demand for autonomous vehicles and growing adoption of remote-controlled operations in logistics, this trend is likely to evolve into ubiquitous adoption in the coming 5 years. With the help of remote teleoperation, the transportation and logistics industry is capable of managing a wide array of tasks with improved efficiency and safety.

Challenges

⛰ The absence of physical sensing makes it difficult for the teleoperator to take an informed decision on behalf of an autonomous vehicle.

⛰ When remotely operating both autonomous vehicles and machinery, the lack of human cognition and perception may present a "blind spot" in situational awareness, spatial awareness, and/or depth perception.

⛰ If there is a malfunction that cannot be supported or resolved remotely, this introduces a security and IT risk; a flexible, agile response would be required from the human operator.

Resources

📄 **DHL - Trend Report: Future of Work in logistics** →

Related Trends

Digital Twins →

Drones →

Indoor Mobile Robots →

Outdoor Autonomous Vehicles →

Sources
Plus One Robotics (2022): Direct the work of many robots from any location.
VentureBeat (2020): How teleoperation could enable remote work for more industries.
Offshore Engineer (2020): Shell taps Kongsberg for cloud-based digital twin services.
SCM Startups (2021): Digital twins in logistics.
DriveU (2021): What's teleoperation got to do with it? The connection between remote driving and autonomous vehicles.

Bloomberg (2021): Pret a manger looks to the suburbs instead of skyscrapers.
Route Fifty (2022): As remote work sticks, cities seek new ways to lure people downtown.
Persistence Market Research (2021): Market snapshot.

DHL

SHARING ECONOMY

The trend of Sharing Economy refers to an ecosystem in which users (businesses and consumers) temporarily share, rent, or borrow assets or services instead of buying and owning them. This peer-to-peer system is typically facilitated by digital platforms that help connect supply and demand (for example, a platform connects owners of underutilized assets with people who want to use those assets).

The sharing economy enables businesses and consumers to reduce risk, achieve greater flexibility, cut costs, and become more sustainable. Over the past decade, sharing economy platforms have benefited from increasing digitization and brought about a shift in the way we view the procurement and use of assets and services. The best-known providers are B2C sharing platforms such as Airbnb and Turo, where private individuals can rent out their apartment or car to other people for a limited period of time. However, B2B companies have now also recognized the opportunities of sharing economy platforms – take, for example, Xometry, a B2B platform for manufacturing services. This means a growing number of organizations are offering platforms for sharing resources, services, facilities, and more with other companies.

The general principles of the sharing economy offer extensive, replicable opportunities in logistics, but we here at DHL have yet to see revolutionary industry-changing solutions take off and be realized within the next 5 years as previously anticipated. This is why the Sharing Economy trend is positioned further out in this edition of the Logistics Trend Radar compared to the previous edition.

Trend Overview

Impact:

MILD

Realization:

5-10 Years

Focus Areas:

Customer Experience   Environmental Sustainability   Health, Safety & Future of Work

Trend Clusters:

None

Sectors:

Auto-Mobility   Engineering & Manufacturing

Relevance to the Future of Logistics

Sharing Storage & Parking Space

According to statistics from the United Nations Population Fund, more than half of the world's population already lives in cities, and the figure is rising. A consequence of this rapid urbanization is limited space availability for storage and parking. Nevertheless, space exists in cities that is hardly used (or not used at all) due to a lack of transparency.

The principles of the sharing economy enable both private individuals and companies to increase space utilization. One example of a platform that tackles the problem is Stashbee, a UK-based company that connects people and businesses that need storage or parking space with others offering available space. The company does not limit its offer to sheds and basement space, but also provides the option of renting larger areas ranging from storage containers to entire warehouses.

This application example of the shared economy in logistics can inspire large supply chain companies to rethink the way they optimize existing unused space and develop new concepts.

Shared Labor

With a shortage of workers in all areas of the logistics organization, from IT personnel to truck drivers and warehouse operatives, it is time to rethink traditional labor models.

One way to offer more reliable, attractive jobs to scarce talent is through labor alliances with companies in the same or in a different industry. A logistics company could work with a manufacturer, for example, allowing employees to work in the warehouse during peak periods but switch to the manufacturer's production facility through the remainder of the year. This form of employee sharing can be extremely beneficial in times of crisis. The model was established in China during the Covid-19 pandemic, when workers from crisis-hit industries such as hospitality were able to find work in other industries such as e-commerce. With this type of shared workforce model, the original employer provides insurance and other benefits along with a share of annual salary while the other employer pays its share of the annual salary. Due to the success of this model, Alibaba's subsidiary grocery store chain Hema Fresh has opened a B2B network platform supporting employee sharing in the future.

Although this model is relatively new and not yet widespread, it offers great potential for logistics companies and could also be applied for office jobs in the area of IT or project management.

Collaborative Transportation

In the EU alone, about 1 in 5 of all freight transportation vehicle-kilometers in 2020 were comprised of empty runs. The sharing economy in the form of shared logistics transportation offers a solution. Although logistics marketplaces attempt to tackle empty runs by providing transparency of available vehicles and routes, they do not typically support collaborative bidding. The problem is that competing companies avoid collaborative transportation as they are reluctant to share sensitive data, such as transportation routes and volumes, with potential competitors. In the long term this may be outweighed by the advantage of shared transportation (better truck utilization) which leads to lower costs and an overall reduction of emissions.

Within the framework of a project called 'Exchange Mechanisms in Logistics', two Austrian universities – the University of Klagenfurt and the University of Vienna – are exploring how to remove barriers to horizontal collaboration in order to implement shared logistics transportation on a broad scale. The focus is to develop a solution for the fair and cost-effective distribution of transportation orders between logistics providers with as little information exchange as possible.

Only 6% of B2B asset sharing platforms are incumbent-driven platforms. 94% are startups new to the space.

6%
29%
29%
18%
18%

Spin-off of incumbent   Start-ups

Industrial machinery & plant engineering

Agriculture & construction

Healthcare & life sciences

Other industries & industry-agnostic
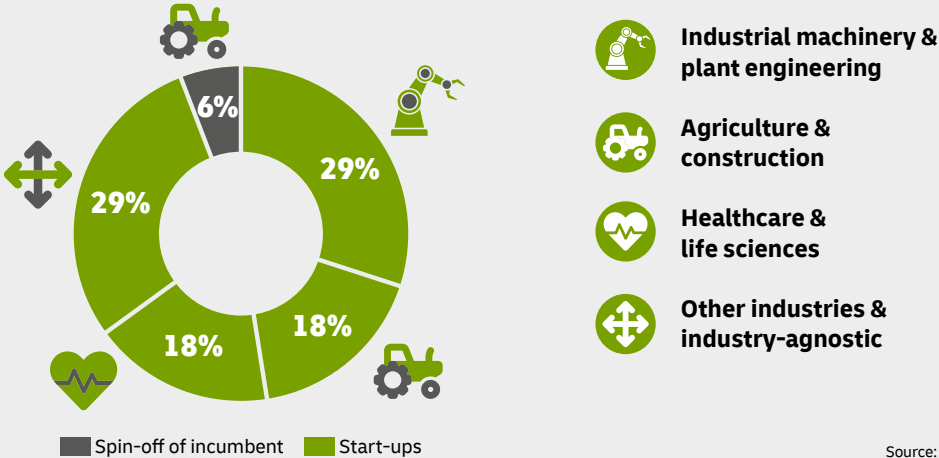
Source: Porsche Consulting

Challenges

- For the successful implementation of a sharing platform, certain minimum volumes of supply and demand are required for these platforms to function.

- For fair implementation of the sharing economy, especially for joint workforces, legal frameworks are needed that prevent workforce exploitation.

- Sharing sensitive operations data is a major risk when sharing assets and collaborating with other companies, especially in the same industry.
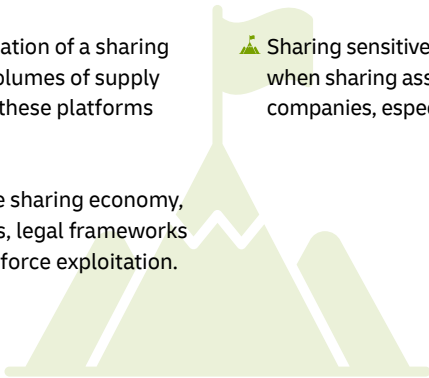
Resources

DHL - How a simple web application is tackling labor shortages →

DHL - The sharing economy has disrupted many industries. Is logistics next? →

This trend should be **MODERATELY monitored,** with some use cases applicable today.

Outlook

In general, there is significant potential in logistics to use sharing economy synergies. The benefits would be both economic and environmental. However, only a few examples can be seen in the industry so far. As companies have ever-increasing focus on cost and emissions, the shortage of warehouse space in some areas and the ongoing labor shortage, we here at DHL expect sharing economy use cases to increase in future. This development will be enabled by a growing number of platforms and larger platforms for different sharing economy purposes.

Related Trends

Circularity →

Digital Marketplaces →

Everything As A Service →

Physical Internet →

Sources
United Nations Population Fund (2022): Urbanization.
World Economic Forum (2020): Employee-sharing schemes are softening the blow for China's pandemic-hit businesses.
Eurostat (2021): A fifth of road freight kilometres by empty vehicles.
Universität Klagenfurt (2022): EMIL – exchange mechanisms in logistics.
Verband Deutscher Wirtschaftsingenieure (2021): Sharing economy: mehr effizienz in der logistik.

SILVER ECONOMY

The trend of Silver Economy encapsulates specialized demands and needs from a growing elderly population as populations around the world progressively age. This trend also includes support and services for older workers in supply chain operations.

By 2030, the number of people aged 60 years and above will grow globally to 1.4 billion, outnumbering the total of children aged under 10 years. While a significant proportion of this senior demographic category originally came from Europe and North America, it is projected that 5 times more people in this older segment will come from outside these two regions by 2050. Recognizing the changing face of the global population, industries around the world have begun distinguishing the needs of older people as workers and consumers from those of younger people, creating a specialized but sizable market in its own right – the silver economy.

As waves of experienced supply chain leaders and operational staff retire, organizations risk a brain drain of time-acquired 'tribal knowledge' in an environment of growing labor shortages. Logistics organizations are beginning to act to retain elderly employees with valuable long-tenured experience. Meanwhile, retailers are increasingly targeting the older consumer, and supply chains are adapting to handle more bespoke products and services.

Trend Overview

Impact:
MILD

Realization:
< 5 YEARS

Focus Areas:
Customer Experience | Health, Safety & Future of Work

Trend Clusters:
None

Sectors:
Auto-Mobility | Energy | Engineering & Manufacturing | E-Retail & Fashion | Life Sciences & Healthcare | Technology

Relevance to the Future of Logistics

Technology-Enabled Support in the Workplace

Employees in supply chain workplaces must always be mentally aware and often perform physically laborious tasks. This can be taxing on minds and bodies with the increasing average age of the workforce. New computer and robotic products and services can empower and encourage older workers to continue working in supply chains by improving health and safety while also reducing physical and mental stress.

Technologies like exoskeletons and teleoperated driving can reduce the risk of physical injury, while other digital support systems like augmented reality (AR) smartglasses and artificial intelligence (AI)-managed dashboards can reduce memory and cognitive demands. By supporting older employees in their tasks, supply chain organizations can retain long-tenured talent.

Flexible Workplace Policies

Supply chain workers, especially those in operations, often have arduous shifts and contracts that may not be a good fit for those who are older and considering retirement. As much knowledge can be lost when an employee retires, organizations can stop this brain drain by reviewing and reforming work policies to accommodate older employees.

Senior worker support packages, such as flexible hours and part-time employment, can help retain retiring talent in an era of labor shortages. With these accommodating policies, time-experienced employees can still support their colleagues and, in particular, extensively share their valuable knowledge and skills.

Elderly-Centric Customer Experience

With communities aging around the world, B2C logistics and delivery businesses must consider senior needs as part of the customer experience, especially in the digital realm. Recently, retailers and digital marketplaces have released 'elderly-friendly' versions of their apps, with less crowded interfaces, bigger text, navigation shortcuts, and digital connections with family to share products and manage expenses. Additionally, some older customers in the UK have the ability to notify couriers through the delivery service app the need for more time to get to the door to avoid a missed delivery.

With more than 6 in 10 of today's seniors in some countries owning a smartphone (and this is likely to increase in the future), B2C logistics players need to adapt and incorporate changes to accommodate and meet the expectations of older customers along the entire supply chain – from order placement to last-mile delivery – or risk losing market share to age-friendly competitors.

Last-Mile Value-Added Services

The lockdown policies of the COVID-19 pandemic cultivated the diversification of traditional delivery services with the aim of supporting the older population. With many senior citizens unable to leave their homes and restricted in their daily activities, businesses and governments collaborated to ensure they still received essential goods at home.

To lower the risk of virus exposure, pharmacies, grocery stores, and other businesses started offering contactless home deliveries. While lockdowns and other restricting policies have mostly been removed, last-mile services are anticipated to continue expanding beyond food and product delivery. In-home medical check-ups, home cleaning, transportation services, tech support, and auto-replenishment of goods such as medicines are speculated value-added last-mile services to be tested in the mid-term future.

Relevance to the Future of Logistics

Senior Product Flow

As the purchasing power of elderly consumers grows, the consumer market landscape is shifting towards the preferences of an older population.
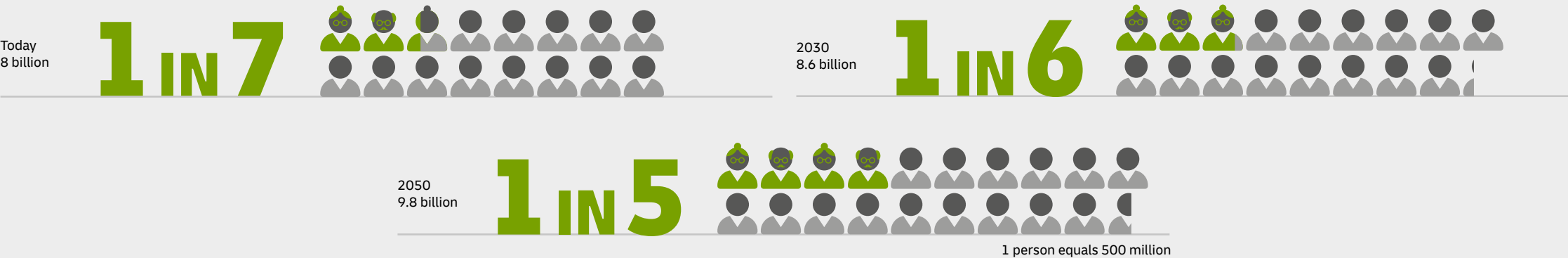
For example, European Commission reports predict substantial increases in demand for products and services in connected health, smart home solutions, wearable technology, age-friendly education, and silver tourism in the coming decades. Demand for common medical and pharmaceutical products like medication, wheelchairs, and prosthetics are also anticipated to rise.

Logistics organizations need to adequately prepare operationally for the gradual increase of these products in the supply chain and the challenges this will present, especially as providers begin offering more personalized products and bespoke services to older customers.

Challenges

- Technologies to handle or assist older workers with every physically and mentally taxing task may not yet exist or be ready for deployment at scale.

- Compared to younger employees, older employees may require a different set of resources, settings, and learning pathways to acquire fluency with new technology tools.

- Future personnel shortages, especially in seasonal peaks and line-haul transportation, will still likely result despite elderly-friendly policies.

- Creating parallel services specifically for older customers like apps or last-mile delivery will require additional time and resources.

- Business models for new logistics value-added last-mile services are not yet fully validated.

The number and percentage of people globally aged 60 and above will increase between now and 2050.

Today
8 billion

1 IN 7

2030
8.6 billion

1 IN 6

2050
9.8 billion

1 IN 5

1 person equals 500 million

Source: World Health Organization (WHO)

DHL

This trend should be **ACTIVELY monitored,** with imminent developments and applications.

Outlook

The full impact of the Silver Economy trend in supply chain workplaces and marketplaces has yet to materialize. However, as global demographics continually move toward higher ages and as more people retire, we here at DHL see this trend maturing soon, with businesses taking active steps to retain older talent and attract senior customers.

Resources

DHL – Research Brief: The supply chain talent shortage: from gap to crisis →

Related Trends

Diversity, Equity, Inclusion, Belonging →

Exoskeletons →

Stationary Robotics →

Wearable Sensors →

Sources
World Health Organization (WHO) (2019): Decade of Healthy Ageing 2020-2030.
UBS (2020): China's silver economy.
Pew Research Center (2022): Share of those 65 and older who are tech users has grown in the past decade.
European Commission (EC) (2018): The Silver Economy.

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SMARTIFICATION

The trend of Smartification refers to the process of retrofitting or producing previously disconnected analog assets with sensor and wireless technologies, making them 'smart' and connected, bridging the analog-digital divide. Smartification enables users to collect a variety of sensor data for analysis, performance measurement, simulations, and data-based decisions.

A survey of 2,400 senior executives found that 93% of the companies surveyed plan to further increase investment in the area of data and analytics. In 2021, already 11.3 billion devices were used to collect data on behavioral patterns, operations, and the utilization of assets, machinery, and facilities. This number is certainly continuing to grow as more and more companies are also integrating analog assets and systems into the IT ecosystem to obtain a holistic view of all processes and key performance indicators. Retrofitting assets with sensors in particular is therefore becoming increasingly important for a comprehensive data-based view of operations and, as the cost of sensors falls, this option becomes more scalable.

The Smartification trend will have moderate impact on the logistics industry as it drives visibility and transparency for optimization and enables data-driven decision making. However, especially retrofitting equipment and assets as well as integration in IT systems takes time. Therefore a few more years will pass before we are likely to see the widespread adoption of smartification applications across industries.

Trend Overview

Impact:

MODERATE	

Realization:

< 5 YEARS

Focus Areas:

Automation & Efficiency   Customer Experience   Environmental Sustainability   Health, Safety & Future of Work

Physical & Digital Security   Visibility & Resilience

Trend Clusters:

Internet of Things   Packaging & Containers

Sectors:

Auto-Mobility   Energy   Engineering & Manufacturing   Life Sciences & Healthcare   Technology

DHL

Relevance to the Future of Logistics

Predictive Maintenance

The availability of data is becoming more important to enable predictive maintenance. Above all, this is because companies need the ability to determine the condition of equipment and other assets in order to identify necessary repairs and maintenance at an early stage, reduce downtime and ensure stable operations. When companies in India participated in a 2020 study on smart manufacturing, they chose big data and predictive analytics as technologies they would most like to invest in over the next 1 or 2 years. It is therefore no surprise that more companies are developing retrofit solutions to implement predictive maintenance, especially for older assets that are more susceptible to repair and failure due to age.

A good example of devices that can be added to minimize downtime and unnecessary maintenance while streamlining and controlling operations comes from Waites. The company has developed sensors and nodes for monitoring machines such as conveyor belt motors that detect the slightest change in humidity and temperature and enable the system to provide early warning of anomalies. These relatively low-cost plug-and-play solutions can prevent entire facilities from failing due to defective conveyors, allowing repairs, maintenance, and service to be performed proactively rather than reactively.

Internet of Behavior

In April 2022, about 63% of the world's population had access to the internet, and this percentage is rising. As a result, the amount of data about user behavior and preferences continues to grow. Companies are eager to analyze this growing amount of data on user behavior, preferences, and patterns, especially in B2C sectors, and are doing so by increasingly adopting Internet of Things (IoT) technologies and accelerating smartification of assets, products, and systems. This data collection and analysis is now part of the so-called Internet of Behavior (IoB) as it enables companies to understand information in a new way – from a psychological point of view – and ultimately use this to adapt products, services, and processes to suit user and customer needs.

For logistics operations, an interesting IoB use case is to add telematics capabilities to vehicles. A telematics system integrates cameras and sensors in a vehicle to track detailed information such as brake patterns, information about fuel use, driving speeds, and more. Companies like UK-based Hypermile are able to retrofit trucks with their driver-assistance systems and use data analysis, computer vision, and artificial intelligent (AI) to reduce vehicle fuel consumption. This is all very valuable to fleet owners – it can help with fleet management evaluation, assessment of individual driving patterns, overall route planning optimization, and even negotiating new contracts with, for example, a car insurance company based on real-world data.

Facility Monitoring

Saving energy is not only an important item on the agenda of companies due to rising energy prices, but also due to the current climate crisis with regard to reducing CO_2 emissions. However, in order to be able to save energy, companies must first be able to identify and quantify potential savings. Although collecting and effectively analyzing data gives tremendous advantages, particularly enabling companies to make informed decisions, only 26.5% of companies see themselves as data-driven organizations.

A prime example of retrofitted data collection is equipping warehouses and production facilities with sensors to measure and ultimately manage energy consumption. Companies like Singapore-based BeeBryte can measure, predict, and even independently adjust energy consumption-related functions (such as heating, ventilation, and air conditioning) in smart production facilities, warehouses, and commercial buildings. By analyzing this data decision makers are able to draw the right conclusions based on hard facts.

With buildings, both commercial and residential, accounting for 36% of global energy consumption in 2020 alone, it is clear how important and also potentially lucrative such retrofitted monitoring and control solutions are. In the future, smartification in the area of facility management and smart buildings will help companies monitor CO_2 emissions, which will subsequently lead to economic benefits and overall improvement of the carbon footprint.

Asset Tracking & Localization

In logistics operations, the localization and tracking of assets such as pallets, forklifts, and containers can be a challenging task and therefore smartification of these types of asset is very valuable.

A use case example is DHL's roll cages which have been equipped with smart tracker sensors from French telecommunication company Sigfox and manufacturer Alps Electric Europe since 2019. This solution provides transparency on roll cage use, improving distribution to ensure there are always enough cages at every location.

To improve sustainability, more and more companies are evaluating reusable packaging but effective reuse requires consistent and repeated circulation of these materials. DHL Express uses Bluetooth low-energy beacons for its reusable EasyGreen packaging, a solution which provides an accurate view of available packages in the warehouse and helps track empty packages after delivery, ensuring appropriate redistribution across the network.

As these examples show, smartification helps ensure no assets are lost and no avoidable costs are incurred, while also enabling efficient asset inventory planning.

Relevance to the Future of Logistics

Smart Cities

Sensors for data acquisition and process improvement are already being used in many respects, both in private households and in industry, but entire cities and municipalities also want to use these technologies to develop into so-called smart cities.

The idea behind smart cities is digitalization of the metropolis in order to increase quality of life for citizens by collecting and using data. This can take a variety of forms, from smart waste management solutions that monitor the usage of public bins to traffic management through to intelligent traffic routing using smart traffic-light control.

Development towards smart cities naturally impacts logistics operations, especially for last-mile delivery. Singapore, for example, a pioneer in smart cities, creates datasets of real-time data on bus arrival timings, cab availability, traffic conditions, and car park availability and freely gives this information as open data. This can be used by logistics providers to facilitate last-mile delivery and to select and schedule ideal delivery times. In the future, smart city intelligent parking systems could assign logistics service providers the ideal parking zones and times to make swift deliveries and avoid disrupting traffic.

All in all, the use of data from smart cities can help logistics providers make last-mile delivery more efficient, effective, and ultimately more sustainable.

Challenges

- The assimilation of formerly analog assets and systems into a corporate IT ecosystem and the increasing number of connected devices raise the risk of cyberattack.

- Integrating sensors from different suppliers requires a strong IT ecosystem and various application programming interfaces (APIs) to ensure all data is linked on one platform.

- The shift towards smart facilities, connected assets, and data-driven processes is expensive as well as time intensive.

- Growing data volumes due to the smartification of assets and systems means decision makers must learn to analyze this data and draw correct conclusions from it.

- Not every analog asset can be retrofitted with sensors and wireless technologies.

The number of connected devices globally is anticipated to grow exponentially within the next decade, influencing the behavior and activity of humans both as workers and as consumers.

More connected devices than people

Year	Number of connected devices per person
2003	0.08
2010	1.84
2015	3.47
2020	6.41
2025	9.25
2030	58.31
2035	111.11
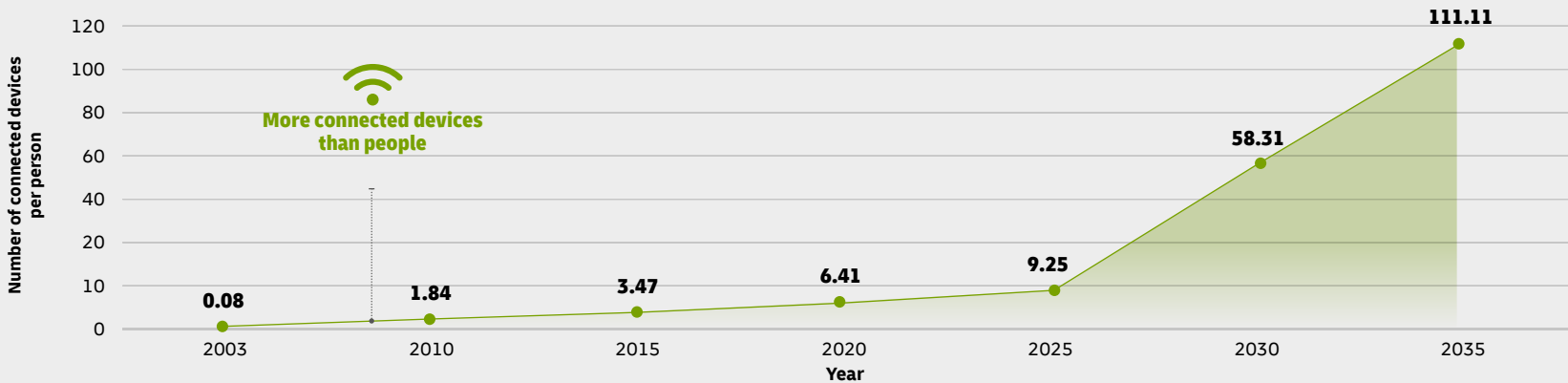
Sources: Ernst & Young; Ernst & Young; Global Alliance for Buildings and Construction; Harvard Business Review; ResearchGate; Statista

This trend should be **ACTIVELY monitored,** with imminent developments and applications.

Outlook

As sensor technology advances and the cost and size of sensors shrink, more and more smartification use cases are emerging. This means newly produced assets are increasingly smart from the outset and there are more and more opportunities to digitize analog assets by retrofitting them with sensors. With the general trend towards more transparency and data harvesting, the relevance of the smartification trend will continue to increase in the future.

Resources

Smart tracking for DPDHL's roll cages →

Undagrid and DHL collaboration: Real-time asset tracking →

Related Trends

Decarbonization →

Big Data Analytics →

Cloud & APIs →

Smart Labels →

Sources
Ernst & Young (2021): Global Capital Confidence Barometer, 23rd edition.
Statista (2022): Number of Internet of Things (IoT) connected devices worldwide from 2019 to 2021, with forecasts from 2022 to 2030.
Ernst & Young (2020): Big data, predictive analytics ranked as the top investment priority in technology by manufacturing firms in India – EY survey.
Statista (2022): Global digital population as of April 2022.
Harvard Business Review (2022): Why becoming a data-driven organization is so hard.
Global Alliance for Buildings and Construction (2021): 2021 Global Status Report for Buildings and Construction.

SPACE ECONOMY

The trend of Space Economy encompasses all activities of exploring, understanding, utilizing, and administrating space for various reasons, including science, telecommunications, resource extraction, manufacturing, and tourism. This trend also covers the production, transport, and storage of related materials and products on Earth, in space, and between the two.

By 2040, the space economy is poised to become the next 1 trillion USD market. Reusable parts, new rocket designs, and alternative launch technology are set to reduce launch costs by 95%, opening opportunities for space activities at a new level of magnitude. As numerous satellite constellations are installed, plans for space hotels are announced, and the race to land humans on Mars has begun, the logistics industry will see a once-small niche develop into a sizeable sector as it becomes more common for space-bound products to pass through supply chains.

The trend of Space Economy has a low impact and distant realization for logistics. Currently it is an industry niche, representing only a small percentage of the total throughput of today's supply chains, and accommodating this has not required substantial change or caused disruption to supply chains. Still, as the space economy develops into a larger market, the trend may shift its position on the Logistics Trend Radar as it starts to carry more weight in impact and realization.

Trend Overview

Impact:

LOW

Realization:

5-10 Years

Focus Areas:

Visibility & Resilience

Trend Clusters:

None

Sectors:

Engineering & Manufacturing

Relevance to the Future of Logistics

End-to-End Satellite Logistics

Tens of thousands of satellites, particularly low- and medium-Earth-orbit (LEO and MEO) devices, are expected to be launched in the next decade. These satellites will require logistics services to reach their destined coordinates in space, and we here at DHL foresee the rise of end-to-end solutions from doorsteps to orbits as the market grows.

On the ground, the end-to-end logistics provider will reserve rocket freight space on behalf of its customers and send specialist teams to pick up satellites at manufacturing sites, delivering these with care to launch sites. In space, the same provider will utilize a shuttle, like D-Orbit's ION Satellite Carrier, to rapidly transport and deploy transported satellites in their proper orbits and positions over Earth so as to save each satellite's power for operational use and not for travel. Looking ahead, the logistics provider will also be involved in transporting replacement parts and equipment for maintenance purposes (and personnel, if need be) and in satellite decommissioning at the end of a device's life.

With these end-to-end solutions, orbiting satellites can be deployed with less cost and longer operational life. Those wishing to deploy satellites will enjoy a simplified process, only needing to work with one partner for all logistics services.

Supplying Cargo

As human activity expands beyond Earth's surface, it will be necessary to transport more provisions, fuel, equipment, and materials into space ('upmass') to support this growth and in some cases, like with waste, transport items back down to Earth ('downmass'). Players in this logistics industry niche must heavily scrutinize shipments for the products and packaging contained within, accounting for dimensions, weight, moisture content, and each item's endurance in terms of pressure, extreme temperature, and the lack of gravity.

Additionally, somewhat like ground transportation but less flexible, logistics providers must also limit deliveries governed by stringent space and weight restrictions on rockets and shuttles, planning far in advance the shipments to be loaded. We here at DHL anticipate a growth of shipments destined for space. With this, we foresee an increased diversification of products delivered and also modular standardization of packaging and containers that adequately protect products while minimizing volume and weight. Meanwhile, development of bigger space vehicles and alternative launch mechanisms will help transport more cargo, reduce lead times, and enable cost reduction through economies of scale.

Satellite-Powered Supply Chains

The development of satellite constellations – groups of satellites working together – in space provides opportunities and benefits for supply chains on the ground.

Global connectivity is the biggest use case, with constellations like Starlink currently being installed to provide internet access in places that currently lack good connection. For logistics providers, this will enable continuous real-time updates from sensors, even if a shipment is in the middle of a desert or an ocean.

Another use case is forecasting and resilience. With improving camera and computer vision technology, satellite constellations can monitor developments on the ground and send data for analysis. For example, tracking crop growth can help supply chain teams forecast the number of trucks needed to meet this year's agricultural harvest. Similarly, observing the growth and direction of forest fires and hurricanes can trigger supply chain diversions to mitigate risk.

Satellite constellations can also improve privacy through quantum communication. Devices have already successfully transmitted unhackable information from China to Europe via a quantum satellite. A network of this type of satellite can safely pass highly sensitive supply chain information between any two points on the planet.

Through their collected data, satellites can help logistics providers optimize supply chains and provide better services to customers.

Space logistics alone can generate more than 20% of the total revenue from the space economy by 2040.

$8 BILLION — Commercial space station
$8 BILLION — Space tourism
$11 BILLION — Space exploration
$12 BILLION — Moon & asteroid mining
$14 BILLION — Microgravity R&D & engineering
$21 BILLION — Space logistics
$23 BILLION — Space-based solar power

Source: Citi

Challenges

- Extreme temperatures, zero gravity, and other special conditions limit which products and materials are permitted and how they are transported.

- Launch vehicle dimensions and weight constraints may not allow for economies of scale.
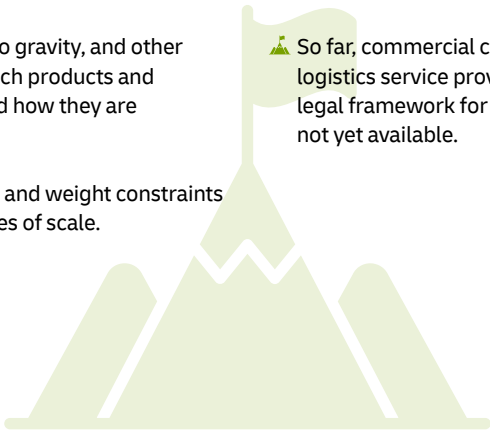
- So far, commercial cost-benefit propositions for logistics service providers are untested and the legal framework for logistics operations in space is not yet available.

Resources

The space economy is booming →

This trend should be **PASSIVELY monitored,** with applications still mostly being developed or explored.

Outlook

Overall, the trend of Space Economy brings exciting opportunities to the logistics industry. As we humans begin to expand our existence beyond Earth's surface, a time will come when products will be wholly manufactured and distributed in space and perhaps shipped back down to Earth. Supply chains, as they do on the ground, will be there to support and enable these developments and further endeavors.

Related Trends

3D Printing →

Next-Generation Wireless →

Quantum Computing →

Tube Systems →

Sources
Morgan Stanley (2022): A new space economy on the edge of liftoff.
CNBC (2022): The space industry is on its way to reach $1 trillion in revenue by 2040, Citi says.
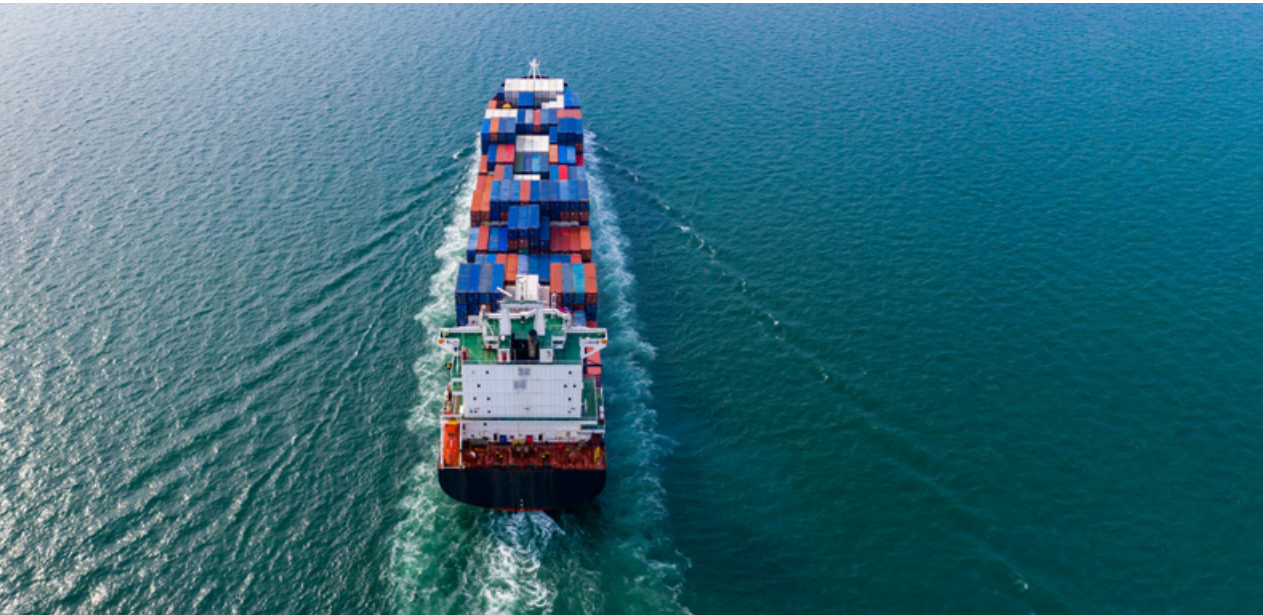
SUPPLY CHAIN DIVERSIFICATION

The trend of Supply Chain Diversification refers to the reconfiguration of the supply chain to broaden the supplier ecosystem and expand manufacturing and distribution networks, with the aim of increasing resilience, agility, responsiveness, and competitiveness. This trend encompasses related concepts like multisourcing (partnering with multiple competing suppliers) and multishoring (selecting providers in more or different countries or regions).

Globalized supply chain networks have given a tenfold boost to worldwide merchandise trade volumes since 1980, exceeding 28 trillion USD in 2021. In recent years, patterns of protectionism, intense natural disasters, and infrastructure congestion, as well as the Covid-19 pandemic and geopolitical crises, have collectively pressured organizations to adjust their supply chains, embarking on a new path of resilience rather than receding from the global stage.

Many industries have already begun the realignment of sourcing practices, manufacturing footprints, and distribution networks to maintain service levels and exploit regional cost differences in labor, materials, energy, and more. For example, Taiwan Semiconductor Manufacturing, the world's leading silicon wafer foundry, announced plans to build a 12 billion USD plant in Arizona to serve its customers in the US, while Mazda has shifted production of some auto components from China to Mexico.

The trend of Supply Chain Diversification will have high impact on logistics operations, from connecting new regions upstream to changing existing transportation modes. However, the realization of such a trend will not be immediate. While some aspects could be implemented in a few weeks, like contracting with a redundant carrier, the larger components of Supply Chain Diversification – those with the greater benefit to resilience, like building another factory closer to a consumer market – will require years to come to fruition.

Trend Overview

Impact:

HIGH

Realization:

5-10 Years

Focus Areas:

Customer Experience	Visibility & Resilience

Trend Clusters:

None

Sectors:

Auto-Mobility	Energy	Engineering & Manufacturing	E-Retail & Fashion	Life Sciences & Healthcare	Technology

DHL

Relevance to the Future of Logistics

Multiple Suppliers

Usually out of simplicity and economies of scale, many organizations often rely on a single supplier for particular resources, assets, or labor. Geopolitical events over the last few years have strained global supply chains, slowing production and delivery times for millions of customers and highlighting the need for logistics organizations to reduce dependency on just one source of supply.

Multisourcing is a popular go-to solution for supply chain leaders, as it typically involves minimal adjustment to the supply chain with newly added suppliers tending to service the same hubs and ports as the existing supplier. However, simply adding suppliers in the same country or region may only improve resilience to a certain degree, proving fruitful in the event of a local flood but less so in the event of regional conflicts or large natural disasters like the 2004 Indian Ocean tsunami.

Although requiring more calculations and planning, supplier multishoring can increase the resilience benefit by broadening the geographic pool of suppliers. Recent political and commercial uncertainty led many businesses across industries to pursue a 'China Plus One' strategy, in which components and pieces are dual-sourced from China and another country, like Mexico, India, or Thailand. Whether a B2B customer is pursuing China Plus One or any other multishoring strategy, logistics service providers will need stricter supply chain management with increased visibility. For such use cases and to meet these increased demands, DHL offers customers its specifically designed Inbound-to-Manufacturing solution, as well as its Lead Logistics Partner solution.

Technology-Powered Localized Manufacturing

Frustrated by longer and less reliable delivery times for customers, many businesses in various industries have moved or are considering moving some or all manufacturing locations closer to customer markets. For instance, in 2022, 70% of surveyed US businesses intended to bring production closer to the US, while many European textile companies have already began exploring more European and North African countries as potential production site locations.

One major enabler of this growing shift is the advancement of automated technology in manufacturing. While initial investments may be high, next-generation robotic solutions in a factory located in more expensive region have pushed down costs per manufactured unit to a level where that facility can effectively compete with the lower manual labor costs in less expensive regions. For some task-specific robotic devices, returns on investment (ROI) have been achieved in less than 2 years.

Parallel to this, the steady development of 3D printing may eventually bring about a future of hyperlocalized manufacturing, in which whole products can be cost-effectively made and assembled in a customer's local neighborhood.

Overall, the benefits of greater resilience and faster time-to-market encourage many manufacturers to reconsider production closer to market. Organizations that are mature and have long-established supply chains, are more likely to supplement rather than fully replace existing production sites. Additionally, as raw materials may still need to be sourced from far away and be delivered to a factory or 3D printer, supply chain organizations need to continuously monitor upstream supply risk. DHL's partner Everstream Analytics does exactly this, leveraging advanced analytics and artificial intelligence to assess the risk to customers' global supply chains in real time.

Redundant Freight Lanes & Carriers

As many organizations across industries focus on finding redundant nodes, like factories and raw materials suppliers, in the supply chain to improve resilience, an alternative approach involves the diversification of freight lanes between nodes. The easiest method for organizations exploring this approach is to partner with multiple same-mode carriers along a lane between an origin and a destination. In other words, instead of relying only on one trucking company to deliver products from Mexico to the US, the organization would rely on two or more trucking companies, spreading the risk across all partners in the event of an isolated incident like a truck breakdown. However, the resilience benefits are limited as this method may not be immune to larger forces like a closed border or a fuel shortage.

A more diversified strategy is to adopt bimodal or multimodal redundancies in freight lanes. In this strategy, at least two modes make deliveries side by side within a freight lane. Besides the resilience benefits, this redundancy strategy also opens opportunity for new diverse offerings. To illustrate a scenario, consider the retailer that has traditionally transported spare parts in bulk shipments from India to the Netherlands via cargo ship. Due to increasing congestion in ocean freight, the retailer recently began sending parallel shipments via freight train to maintain its customer delivery schedule. However, realizing there is a market for emergency spare parts, the retailer has also been experimenting with same-day air delivery to the Netherlands to provide new offerings to customers.

As such, some modes, like the cargo ship or freight train in this example, are chosen to purposely operate in a generally well-understood and predictable environment, compared in terms of efficiency and cost to serve, while other modes, like the airplane, are adopted to improve agility and speed or explore new solutions that address and solve uncertainty such as unexpected changes in demand or external shocks. Running various solutions in parallel can leverage the advantages of them all. In future, however, experts see a need for companies to not only become at least bimodal but also prioritize multimodality, quickly recognizing possibilities and building the ability to solve problems posed by the unexpected.
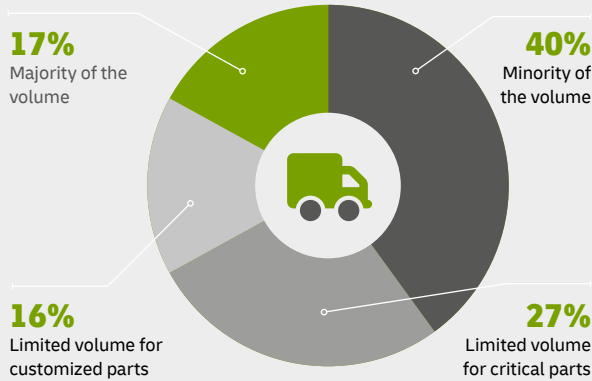
As supply chains continue to be exacerbated, much focus has been placed on increasing resiliency.
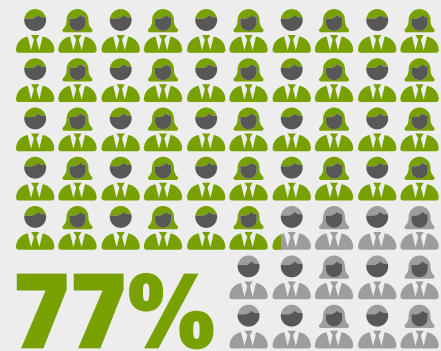
77%

of surveyed businesses plan to increase the total number of suppliers in the next 24 months.

Sources: Buck Consultants International; Ernst & Young

Onshoring and nearshoring are popular tactics to build supply chain resilience, but they will replace only a part, not all, of the business.

17% Majority of the volume

40% Minority of the volume

16% Limited volume for customized parts

27% Limited volume for critical parts

Challenges

- Sourcing and pre-qualifying, as well as onboarding and managing a higher number of suppliers, requires time and resources; it also introduces more complexity into the supply chain.

- Building a new supplier infrastructure in a different country or region requires the acquisition of new organizational knowledge and skills.

- Changing the manufacturing footprint takes time and requires significant investment.

- Diversified supply chain setups can increase the costs to serve and therefore reduce profitability.

- Diversifying the source of components and materials may cut the risk of a complete backlog in manufacturing or retail, but it can also increase the chance of partial disruption as each source experiences its own set of risk factors.

This trend should be **MODERATELY monitored,** with some use cases applicable today.

Outlook

Supply chain diversification occurs as organizations depart from agendas driven purely by cost efficiency and service levels to additionally focus on resilience, agility, and flexibility. This shift requires more sophisticated management of logistics operations, including design and inventory control, and may necessitate more investment and longer-term planning. Some say this indicates a weakening of globalization but, to be clear, we here at DHL see this as the result of a more globalized economy.

Resources

DHL - Covid-19 accelerates multimodal logistics →

Everstream provides actionable insights on supply chain risks →

Related Trends

Big Data Analytics →
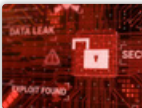
Cybersecurity 2.0 →

Digital Marketplaces →

Omnichannel →

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FashionUnited (2022): Nearshoring to Europe: textile machinery manufacturers see rising demand.
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TECHNOLOGY TRENDS

IN DEPTH

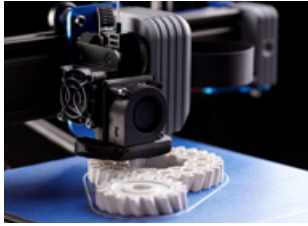## Section Contents

3D PRINTING

The trend of 3D Printing, otherwise known as 'additive manufacturing' or 'AM', refers to the production process in which a 3D object is fabricated from a digital model file with physical materials typically being added together or etched layer by layer. 3D printing processes vary greatly, and they can involve a wide range of materials, such as plastics, metals, ceramics, and paper, to influence the strength, durability, accuracy, surface finish, and other attributes of the finished product.

3D printing was initially used for rapid prototyping to accelerate product design processes. With the technology further developing, its adoption and maturity has grown across automotive, medical, and aerospace industries into larger batch sizes as well as a wider variety of objects and materials. The reason for this is the ability to save on the weight of parts, as well as the capability to 3D print complex parts in one piece. Today, products that can be 3D printed range from custom-made climbing shoes and printed dentures to fully 3D-printed wind turbines. Already in 2015 GE Aviation started producing at scale 3D-printed fuel nozzles for aircraft engines. By the time the 100,000th turbine shroud was made from ceramic matrix composite (CMC) using an additive manufacturing process, these items proved to be 25% lighter and 5 times more durable than traditionally produced parts.

The 3D printing landscape has grown in diversity and complexity. As a consequence, the trend has evolved from niche applications to become a widely applicable production technology that we here at DHL expect will grow in adoption in the coming years.

Increase in adoption brings more opportunities for logistics providers, namely growth in the scale and complexity of regional logistics networks capable of supporting print production and of business-to-business (B2B) printing services and delivery. While a world of widespread 3D printing is still in its early stages, there is already a need to supply polymers and raw materials, and here logistics providers must adapt their services.

Trend Overview

Impact:
MILD

Realization:
5-10 Years

Focus Areas:
Automation & Efficiency

Trend Clusters:
None

Sectors:
Auto-Mobility | Energy | Engineering & Manufacturing | Technology

Relevance to the Future of Logistics

Mass Personalization & Customization

In 2020 83% of consumers expected products to be personalized within moments and hours and today, with 27.6% of the world's population buying products and services online, businesses need to rethink manufacturing and distribution to meet customer demands. By enabling mass customization of products, 3D printing brings value to a vast range of applications that benefit both industries and consumers. From automotive to aerospace and from semiconductor capital equipment manufacturers to healthcare providers, 3D printing is capable of improving efficiency by simultaneously producing numerous customized end-user parts. The increase in demand for mass personalized products provides an opportunity for businesses to adopt and leverage the capabilities of 3D printing technology. Strong and agile local supply chain networks will be needed to accommodate efficient distribution of on-demand mass personalized products.

Decentralized Production

Effective spare parts management is crucial for maintaining product uptime, especially with the shift towards servitization (when customers pay for the use of equipment rather than buy it themselves), to avoid high costs and reduce the risk of lost sales if machines stand idle because spare parts are unavailable. The irregular and still hard to predict demand for spare parts coupled with the need to keep stock for the duration of a product's lifecycle (depending on the longevity of the product) present a challenge for aftermarket logistics. Creating and storing digital part files on cloud and printing these on demand will give companies flexibility in managing the supply chain, reduce inventory, optimize warehouse storage space, and achieve shorter lead times. This can be attained by setting up decentralized local 3D printing facilities. A logistics company can take advantage of this opportunity and build servicing capability by, for example, partnering with local 3D printing services or producing spare parts in-house, and can use its supply chain network to deliver parts on time.


Environmental Sustainability

3D printing can play an important part in enabling companies to reach their sustainability strategy targets, as it reduces waste through the process of building a product layer by layer, rather than subtracting and discarding materials, which is the common process in traditional manufacturing. 3D printing is also an enabler for decentralized production and offers ways to optimize product design by eliminating the design constraints of traditional manufacturing, which in turn reduces material use. Increased investment in material research and development has resulted in the creation of environmentally friendly materials such as ABS and bio-based materials which help reduce the carbon footprint. Leveraging 3D printing therefore results in less need for waste logistics and reduces overall carbon emissions during the printing process. Within logistics and the supply chain, the benefits of advances in the field of material science (such as using more lightweight materials to build airplane parts and sustainable packaging material) also bring more opportunities to reduce the carbon footprint.

Seven ways 3D Printing helps a logistics organization become more environmentally sustainable.

- More efficient design
- Make parts locally
- Streamline manufacturing
- Repairability & spare parts
- Smaller, quieter factories
- Less raw materials
- Eliminate inventory
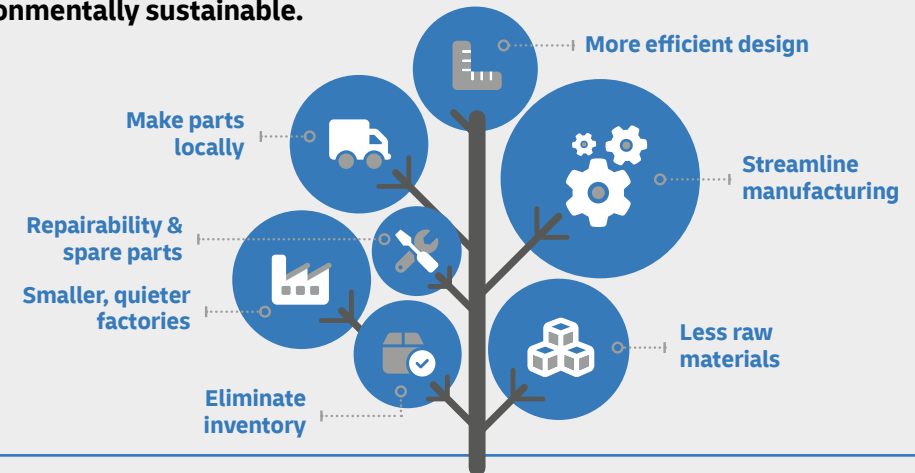
Source: All3DP

Challenges

- Small-batch production size compared to conventional manufacturing makes 3D printing more costly and slower than mass production; this restricts widespread adoption across industries.

- Another barrier to adoption is the limited range of materials that can be used in their raw state for 3D printing; in some cases it continues to be difficult to achieve the same material properties as in conventional manufacturing.

- Concerns that digital design templates stored on cloud could be targeted by hackers, risking copyright infringement, remains a major barrier for many companies in adopting 3D printing.
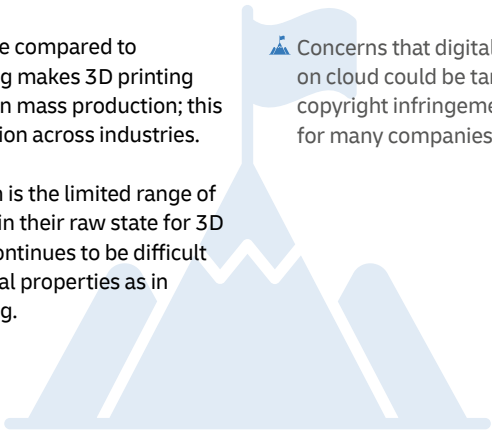
Resources

DHL - How 3D printing is disrupting the logistics industry →

Outlook

This trend should be **MODERATELY monitored,** with some use cases applicable today.

3D printing will remain a good fit for low- to medium-volume production. With the right level of planning, engineering, and material development, it can be seamlessly integrated into production. As this technology moves towards integration into all stages of new product development from conceptualization to production, in future we can even expect being able to print objects embedded with electronic chips and sensors at reasonable cost. This will help reduce reliance on third-party suppliers, meaning companies gain more control of their production processes, mitigating risk in the supply chain. The global 3D printing market size was valued at 15.10 billion USD in 2021 and is projected to grow from 18.33 billion USD in 2022 to 83.90 billion USD by 2029 with a CAGR of 24.3%.

Related Trends

Decarbonization →

Mass Personalization →

Bio-Based Materials →

Smart Labels →

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ScienceDirect (2021): Conventional or additive manufacturing for spare parts management: An extensive comparison for Poisson demand.

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SupplyChain (2022): 3D printing technology 'is future of sustainable supply'.
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HDI (2021): How 3D printing is shaping the supply chain of the future.
ALL3DP (2022): 3D printed food: all you need to know in 2022.

ALTERNATIVE ENERGY SOLUTIONS

The trend of Alternative Energy Solutions encompasses the variety of technologies and related infrastructure which harness, store, and use energy from renewable, inexhaustible sources. In this trend, conventional fossil energy systems are abandoned and replaced by those relying on sunlight, wind, water, geothermal, biomass, and other sources.

Global warming affects people and businesses, across industries and countries, and is exacerbated by the burning of fossil fuels. The electricity generated from coal-fired power plants, as well as total global emissions, reached an alarming peak in 2021 so CO_2-heavy industries such as logistics must develop, invest in, and use alternative energy sources. Progress is being made – in the same year, wind and solar energy accounted for 10% of total global electricity, and all power from sustainable sources reached 38%. However, there is still great potential for industry in particular to advance and implement alternative energy solutions to lead the way towards a future of clean energy.

There is common understanding across the logistics industry that alternative energy solutions are needed to ultimately reduce CO_2 emissions to zero. However, existing solutions are not yet available in the quantities required and are significantly more expensive than conventional, non-renewable solutions. Therefore, in order to implement the UN roadmap for clean energy and reduce the share of fossil fuels in the global energy mix to 30% by 2030, high investments in the development and application of alternative energy solutions are required.

Trend Overview

Impact:

HIGH

Realization:

5-10 Years

Focus Areas:

Environmental Sustainability

Trend Clusters:

None

Sectors:

Auto-Mobility	Energy	Engineering & Manufacturing	Life Sciences & Healthcare	Technology

DHL

Relevance to the Future of Logistics

Energy Supply for Buildings & Facilities

As of November 2021, mandatory energy codes for residential and non-residential buildings are part of 43 countries' agenda for more energy-efficient buildings, so the trend towards alternative energy solutions is important for all facilities including those in logistics.

One popular solution is solar panels for offices, warehouses, distribution centers, and parking lots. Current models offer 16-20% efficiency but the US National Renewable Energy Laboratory has been able to produce solar cells with efficiencies close to 40%.

On-site energy storage is a challenge for companies using solar panels or wind power solutions for their facilities and buildings, but so-called gravity batteries like those from the British company Gravitricity offer an innovative solution. When there is a surplus of green energy, gravity serves as a storage device by pulling a weight upwards via electric motors and, as soon as demand increases, for example at night, this weight can be lowered to release the stored energy.

Geothermal energy provides another way to power logistics facilities and office buildings. While the principle is not new, companies like Fervo Energy, a start-up funded by Bill Gates' Breakthrough Energy Ventures, use new technological solutions such as horizontal drilling, fiber-optic sensing, computer modelling, and analytics to make geothermal energy more cost effective. Large office buildings such as Boston University's new Center for Computing and Data Sciences and the Google Bay View Campus use geothermal energy to reduce the CO_2 footprint; these examples prove feasibility for large logistics buildings such as warehouses.

Clearly, various available solutions can be applied to logistics facilities but these typically require initial investment with a positive economic impact only after a few years.

Ground Transportation

The Alternative Energy Solutions trend has been a high priority for ground transportation in the last few years and clean last-mile transportation solutions are already being used at scale. DHL in Germany, for example, has already electrified around 20,000 vehicles, a third of its delivery fleet, and uses 19,000 e-bikes and e-trikes for end customer delivery.

Car makers are now developing electrified last-mile delivery solutions; for example, Fiat's e-Ducato has a range of 280 km (174 miles) in mixed traffic.

However, it is a different situation for middle-mile and long-haul transportation. Although there are some electrification developments, these are still restricted by range limitations and insufficient charging infrastructure. Truck electrification is being driven by established companies such as Volvo, the e-mobility frontrunner Tesla, with its Semi model, and start-ups such as Nikola.

Another alternative energy solution is hydrogen for middle-mile and long-haul trucks. Next to start-ups such as UK-based Tevva and US-based Hyzon, DHL is testing VDL's hydrogen-powered trucks in real logistics applications in the Benelux countries as part of the H2-Share initiative in collaboration with Apple. The overarching long-term goal is to scale up these low-carbon heavy-duty commercial vehicles.

Although many start-ups and established companies are active in this field, middle-mile and long-haul solution development is typically in pilot phase or will take a few more years before production sites can meet market demand at scale.

Air Transportation

In 2021, global carbon emissions from aviation accounted for 2.5 % of total CO_2 emissions, which is roughly equivalent to Germany's total CO_2 emissions.

For air cargo, the use of sustainable aviation fuel (SAF) is currently the most promising solution for emissions reduction but availability and high cost are barriers to widespread adoption. SAF is fuel from renewable sources such as biomass, animal fats, oils, and, alcohol which can be blended with conventional kerosene. Initiatives like the Clean Skies for Tomorrow Coalition, led by the World Economic Forum, bring together stakeholders across the aviation industry to drive carbon-neutral flying in future, leveraging the availability and use of SAF.

DHL Express announced two of the largest deals related to SAF in 2022. Its cooperation with bp and Neste will secure 800 million liters (211 million gallons) of SAF for DHL Express by 2026 and further advance DHL's sustainability strategy.

In addition to SAF, electric engines will also be an attractive propulsion method for air freight transportation of the future. The Alice electric aircraft from the Israeli start-up Eviation, scheduled for market launch in 2024, can be used for short-haul domestic flights and is likely to become a viable sustainable solution for national and even regional air transportation. Therefore, DHL Express has ordered twelve airplanes with a range of 815 km (506 mi) to kick-off the electrification of its fleet.

Another area of sustainable aviation research is the use of hydrogen fuel. Start-ups like H2FLY and ZeroAvia are working on promising concepts but experts do not expect commercial application of sub-regional and regional hydrogen fuel cell aircraft before 2030.

Many developments are underway to enable sustainable aviation but they are associated with high research and development (R&D) investments and infrastructure costs. While progress is being made, especially with SAF, fully sustainable aviation remains a long way off.

Relevance to the Future of Logistics

Water Transportation

Research into alternative energy solutions for ocean freight is driven by new regulations such as those of the International Maritime Organization (IMO), which has pledged to reduce carbon emissions by at least 40% by 2030 compared with 2008 levels.

One transitional option is the use of biofuel which, according to studies by the US Department of Energy and the Department of Transportation, could reduce greenhouse gas emissions by up to 93% depending on the biofuel composition. However, the production of biofuel for maritime transport currently faces economic and infrastructural obstacles.

In addition to biofuels, conceptual solutions could become game-changers in the long term, such as the Oceanbird concept from the Swedish company Wallenius Marine. This uses air as the main source of energy; the vessel has aerodynamic masts, which are conceptually based on aircraft wings, that almost eliminate the need to use conventional fossil fuels.

Another long-term solution that can play a major role in decarbonizing maritime transportation is liquid hydrogen. Currently, there are no scalable solutions for hydrogen-powered cargo ships but the example of Norway's MF Hydra, the world's first hydrogen-powered ferry, provides evidence and insights for future cargo ship applications.

Government and other regulations such as those from the IMO are driving the development of alternative energy solutions for ocean freight, with biofuel most likely to be used as a transitionary technology before both wind and hydrogen solutions become viable in the long term.

Energy Harvesting for Sensors

Alternative energy solutions are also needed for sensors in logistics, particularly for tracking and monitoring environmental influences on packaging and containers.

A major sensor problem, especially for microsensors, is battery life. One potential solution is to harvest energy from each sensor's direct environment (from light, movement, and radio waves). The start-up Wiliot specializes in harvesting radio frequency waves from Bluetooth, Wi-Fi, and other 2.4-GHz connectivity technologies via its stamp-sized Internet of Things (IoT) device.

Another sensor solution has been developed by researchers at the University of Massachusetts. Called the Air-gen, it uses a natural protein that produces electricity from ambient humidity and is expected to find future application in wearable electronic devices such as health monitors, smartwatches, and cell phones.

Further developments in the field of energy harvesting sensor technology are likely to bring additional and above all scalable solutions to solve problems in the field of energy supply for small electronic devices and sensors.

The number of battery-powered electric vehicles globally increased almost tenfold from 1.2 to 11.3 million between 2016 and 2021.

1.2m — 2016

11.3m — 2021
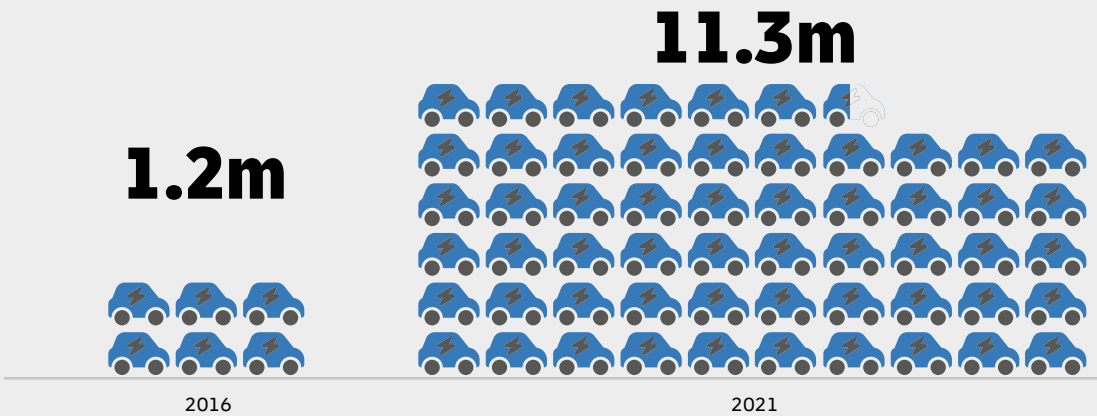
Source: Statista

Challenges

- Due to the variability of solar and wind energy, expensive energy storage systems are required allowing companies to bridge outages with previously generated renewable energy.

- The construction of alternative energy production facilities is very time- and cost-consuming and dependent on government and other regulations.

- Developing alternative energy solutions often requires a high initial investment, which is a major hurdle to the implementation and scaling of these solutions.

- Due to the increased risk of explosion, the scaling of hydrogen cell solutions is highly dependent on validated safety concepts.

DHL

Outlook

This trend should be **PASSIVELY monitored,** with applications still mostly being developed or explored.

Some alternative energy solutions are already available but many industry-revolutionary technologies are still in pilot phase and not yet scalable. However, with sufficient market demand, rapid development is achievable as the example of e-mobility in ground transportation shows. Investment in R&D and infrastructure, as well as corporate commitment to new solutions, will be crucial to achieving timely sustainability solutions.

Resources

DHL - Plugging into an electric vehicle future →

DHL - Partnering up with Fiat for electrification of last mile delivery fleet →

DHL - 800 million liter sustainable aviation fuel deal →

DHL - Launch of parcel transport by solar ship in Berlin →

Related Trends

Circularity →

Decarbonization →

Environmental Stewardship →

Bio-Based Materials →

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McKinsey (2022): DHL on sustainable, customer-centric delivery in the last mile.
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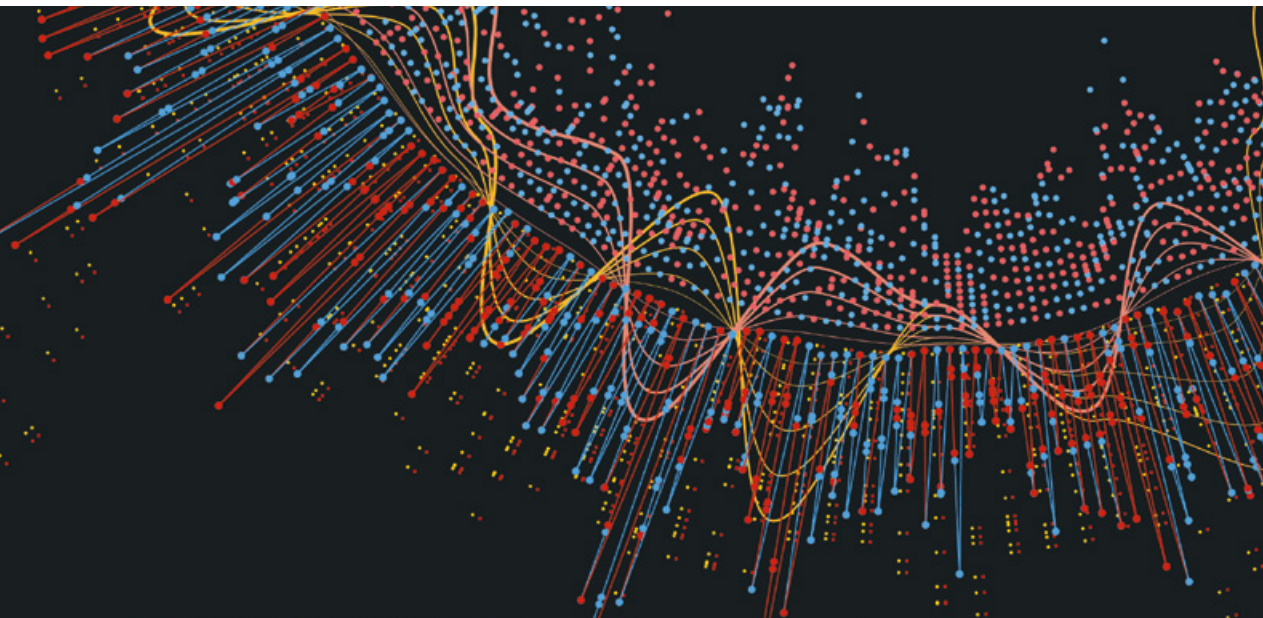
BIG DATA ANALYTICS

The trend of Big Data Analytics refers to the analysis of large quantities of data to reveal patterns of the past, highlight real-time changes in the status quo, and create predictions and forecasts for the future. This trend involves various processing techniques of structured data, which consists of specific numbers and values that are searchable and stored in a predefined format, as well as unstructured data, which may come in various native formats like video and audio files from sensors and social media posts.

The importance of data has generally been well understood for decades by those in the logistics industry. Without data and analytics, one cannot optimize or even have foresight to prepare for things to come. It is for these and other visibility reasons that logistics leaders have embraced sensors, dashboards, and other technologies to collect and display streams of information. As the use of data collecting devices increases, compounded with exponentially growing raw data found on social media and the internet overall, the rate of data coming in is far outstripping the rate of processing, with 463 quintillion (1018) bytes (or 463 billion GB) of data to be produced daily in 2025. To differentiate these massive accumulations of both structured and unstructured data from more traditional data that can be easily manipulated on a spreadsheet, experts have labelled the former as 'big data.'

The processing and analysis of big data in real time using artificial intelligence (AI) algorithms and other technologies is itself an entire field of study, but we here at DHL see 4 main types of big data analytics that could be applied in use cases along and across entire supply chains: descriptive, diagnostic, predictive, and prescriptive analytics.

Descriptive analytics seeks to understand the existing situation and answer the question of what happened, while diagnostic analytics tries to investigate why something happened. Meanwhile, predictive analytics, as the name suggests, generates predictions and forecasts of what might happen in the future, and prescriptive analytics utilizes historical and situational data to recommend changes in what should be done.

The trend of Big Data Analytics has moderately high impact on logistics. While not directly transforming the look and feel of the supply chain physically, the greater visibility and optimized decision making that result from this trend can lead to strategic optimization along supply chain segments, substantially improving levels of service, from more efficient pallet storage in a facility to better customer case handling. In terms of realization, big data analytics is very much closer in the logistics industry than in other industries. Many, if not all, logistics leaders have harnessed big data in recent years to drive strategic decisions, and soon this trend will simply become the standard way of doing business and incorporated into logistics services.

Trend Overview

Impact:

MODERATE	

Realization:

< 5 YEARS

Focus Areas:

Automation & Efficiency · Customer Experience · Environmental Sustainability · Visibility & Resilience

Trend Clusters:

Artificial Intelligence · Digital Backbone · Internet of Things

Sectors:

Auto-Mobility · Energy · Engineering & Manufacturing · E-Retail & Fashion · Life Sciences & Healthcare · Technology

Relevance to the Future of Logistics

Inventory & Asset Optimization

One of the main opportunities of analyzing big data is providing logistics players with organized, filtered, and digestible real-time visibility of the current situation on the ground in facilities like warehouses and hubs.

On the descriptive end, the processing of big data from sensors can reveal where assets such as roller cages are located and what their current status is – for example, if they are currently being used or they are broken. Analysis of inventory data from sensors can help determine if stocks are running low or if any vacancies exist on pallet shelves. For diagnostic purposes, analyses may reveal how certain shipments cause a particular conveyor to frequently break down or can identify world or local events that have a dramatic effect on the inventory level of specific products.

Meanwhile, when it comes to prediction, the analysis of sensor data on assets like machinery and vehicles can support predictive maintenance procedures, flagging damaged assets that should be inspected and repaired before they break down. For inventory, forecasts can be made to project an expected pattern of incoming orders and deliveries during upcoming peak and low seasons. Finally, prescriptive analyses can compare inventory plans with actual adoption to better allocate inventory space to various stock keeping units (SKUs). DHL's Applied Analytics team, for instance, performs studies for customers that can recommend changes based on identified patterns in the data, where inventory may have exceeded original demand forecasts, for example, or in which safety stock may have depleted below critical thresholds. For assets, historical data can be processed to suggest the best place to store tools and other equipment to limit the distance workers must travel to retrieve them.

In general, big data analytics can give logistics organizations the necessary visibility to optimize shipment storage and movement through facilities, as well as to improve the utility and lifetime of assets.

Supplier Risk & Due Diligence Assessment

Auditing existing and potential partners, whether a robotics provider or a packaging supplier, as part of a risk-and-resilience due diligence evaluation can be tedious work. Leveraging big data analytics to drive decisions and even automate some evaluation processes can help logistics organizations save time, money, and risk.

On the descriptive end, data from sensors and other sources can be used to evaluate the timely delivery and quality of offerings by suppliers in real time. This, paired with diagnostic analysis, can help logistics leaders find patterns and understand the factors that make certain suppliers superior to others, informing organizations of variables and attributes to look for when evaluating partners in the future. For example, if the results of a diagnostic study finds suppliers from certain regions are chronically late with their shipments due to customs checks, this signals to inventory planners where the problem may lie.

Predictive information can help with vendor selection. Processing the various attributes and the supply chains of potential vendors can achieve automated forecasting of each vendor's likelihood of meeting the logistics organization's needs in certain emergency scenarios like natural disasters in a particular region. Finally, with prescriptive analysis of vendor past performance, the logistics company can receive a recommendation on contract renewal. Results from this type of analysis also help the organization to grade and classify existing and potential partners, facilitating strategic business decisions like pursuing a contract or purchase order.

In general, big data analytics can be a useful tool for logistics organizations when evaluating existing or potential partnerships with suppliers and vendors.

Transport & Delivery Optimizations

The trend of Big Data Analytics offers various solutions to overcome challenges that logistics organizations often face in the transportation and delivery segments of the supply chain.

For descriptive analysis, big data processing can help monitor service levels on a particular route or lane, identifying disruptions like truck breakdowns in real time when they occur. Additionally, data from dozens to thousands of sensors gives visibility to supply chain organizations on whether products are being delivered in a high-quality state or are damaged along the way. With diagnostic analysis, companies can see why certain shipments are chronically late – this may be because the route schedule coincides with rush hour traffic or the shipment passes through understaffed ports of entry, for example.

For predictive purposes, various sources of data can help calculate the risk of lane disruption along segments of the supply chain. For instance, Everstream Analytics utilizes global news feeds and other propriety data to make predictions for its supply chain customers across 30 risk categories, including natural disasters and political violence. In doing so, it claims to reduce disruption-caused revenue losses by 30%, achieving 100 million USD in savings from transport-mode optimization. For prescriptive information, logistics leaders can look at past data and adjust scheduling and fleet sizes accordingly, ensuring vehicles are maximally utilized and products are delivered on time. Such analyses may show supply chain managers the wisdom of modifying routes and lanes where historical theft has occurred in a particular segment of the supply chain.

Overall, big data analytics can improve the performance of delivery, ensuring shipments are delivered in good condition and on time, in a cost-efficient manner.

# Relevance to the Future of Logistics
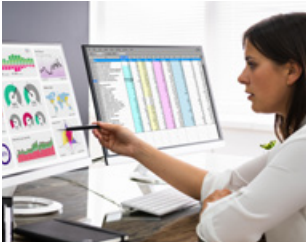
Customer Management

While big data analytics is often used to optimize core operations within a supply chain, it can also be used to improve the customer-facing functions of a logistics organization to improve the customer experience.

With descriptive analyses, B2B and B2C customers can be grouped by various categories with their associated attributes like industry, age, geographic region, order sizes, and needs. These categories can then be displayed in a visual manner like in a dashboard so logistics organizations can better understand the customer base and who may be affected by supply chain changes. Meanwhile, diagnostic analyses can help demystify the loss of customers or the preference for a particular offering, whether it is because price modifications, convenience factors, or other variables.

Prediction is also valuable for customer-facing use cases. Demand forecasting helps logistics organizations that frequently experience bottlenecks in the supply chain or underutilization of facilities and vehicle fleets. For instance, DHL's Applied Analytics team uses machine learning models to help customers optimize capacity and transport planning based on historical data, reducing costs associated with booking resources at the last minute. Lastly, prescriptive analyses can take on several forms. Processing historical data can help logistics leaders calculate and determine price elasticity for their offerings, ensuring a better price point that lies within customer expectations. Supply chain organizations can also study past orders and throughput patterns through peak and low seasons to optimize current workforce size while guaranteeing high-quality service levels. Furthermore, processing consumer data from websites can enable more personalized customer journeys, increasing the chance of purchases and customer retention.

Overall, big data analytics can help logistics organizations improve the customer experience and the customer journey, strengthening brand loyalty.
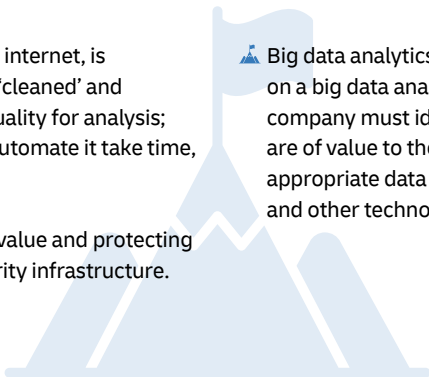
Business leaders who work with big data say that 'analysis,' 'processing,' and 'implementation of findings' are the 3 most intimidating aspects of working with big data.

13% Cleaning

32% Analysis

13% Collection

What is the most intimidating aspect of working with big data?

20% Implementation of findings

21% Processing
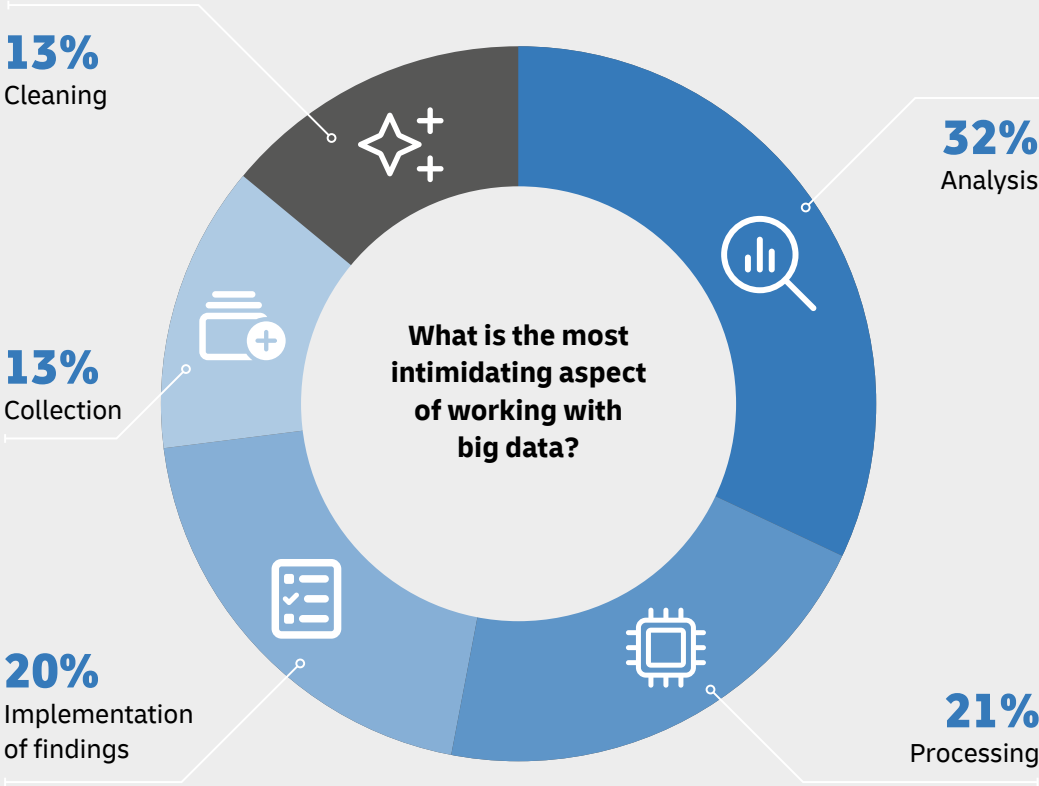
Source: Unsupervised

Challenges

⛰ Most data, especially from the internet, is unstructured and needs to be 'cleaned' and filtered to achieve sufficient quality for analysis; this process and attempts to automate it take time, money, and talent.

⛰ Data can have high monetary value and protecting it requires a robust cybersecurity infrastructure.

⛰ Big data analytics needs data; before embarking on a big data analytics journey, a logistics company must identify which types of data are of value to the organization and then build appropriate data collecting networks of sensors and other technologies.

Resources

📄 **DHL - Big energy meets big data** →

🔗 **How data and analytics are fueling a finance transformation at DHL** →

Outlook

This trend should be **CLOSELY monitored,** with implementations available for many use cases today.

The trend of Big Data Analytics has great potential to increase supply chain and business performance using the existing infrastructure with almost no change. While challenges include processing unstructured data into something meaningful, many logistics companies have decided to tackle this and have achieved very valuable benefits. Continual advances in analytical AI are increasing the ability to process even more data in less time and to detect deeper patterns to further improve and optimize logistics.

Related Trends

Digital Marketplaces →

Mass Personalization →

Smartification →

Next-Generation Wireless →

Sources
World Economic Forum (WEF) (2019): How much data is generated each day?

DHL

BIO-BASED MATERIALS

The trend of Bio-Based Materials encompasses all materials produced exclusively from substances derived from traditional sustainable biomass, as well as modern bio-synthetic processes. This trend focuses on the beginning rather than the end of the product life cycle and so it includes both biodegradable and non-biodegradable materials.

With consumers and corporations paying increased attention to sustainability in recent years, and as expectations rise and demands increase, logistics organizations are seeking to eliminate from daily operations materials seen as unsustainable and to reduce waste. Bio-based materials are identified as carbon- and waste-reducing solutions that can be integrated into sustainability strategies. A wide range of potential applications for the use of bio-based materials exists in various supply chain segments, from building construction to packaging.

Some bio-based materials have been used in logistics for many years already, especially those derived from conventional biomass, the best example of such a valuable and long-standing bio-based solution is the wooden pallet. In addition, other bio-based materials have been introduced and tested recently, eg, bamboo and coconut. Meanwhile, next-generation solutions targeting certain qualities like strength, flexibility, and biodegradability using forefront bio-synthetic processes are being explored and can greatly expand use cases in supply chains. While potentially impacting the sustainability of a supply chain through an environmental lens, bio-based materials are not anticipated to have a profound effect on day-to-day operations and so are expected to have a low impact in the logistics industry.

Trend Overview

Impact:

LOW

Realization:

5-10 Years

Focus Areas:

Environmental Sustainability

Trend Clusters:

Packaging & Containers

Sectors:

Auto-Mobility   E-Retail & Fashion

DHL

Relevance to the Future of Logistics

Building & Construction Material

According to the United Nations Environment Programme, approximately 40% of global energy use and about 30% of energy-related greenhouse gas emissions are linked to the building and construction sector. With logistics organizations utilizing hundreds of thousands of facilities, warehouses, and offices, there is a great opportunity to reduce the environmental footprint of supply chains beyond just transport emissions.

Bio-based building materials have significant potential in achieving sustainability goals, with many tech providers already recognizing their capabilities. For example, Prometheus Materials, an American startup, has developed a bio-cement alternative to conventional cement (a large emitter of CO_2) through a photosynthetic process using microalgae. By utilizing bio-based materials, logistics organizations are empowered in tackling not just emissions from transportation but also from building construction.
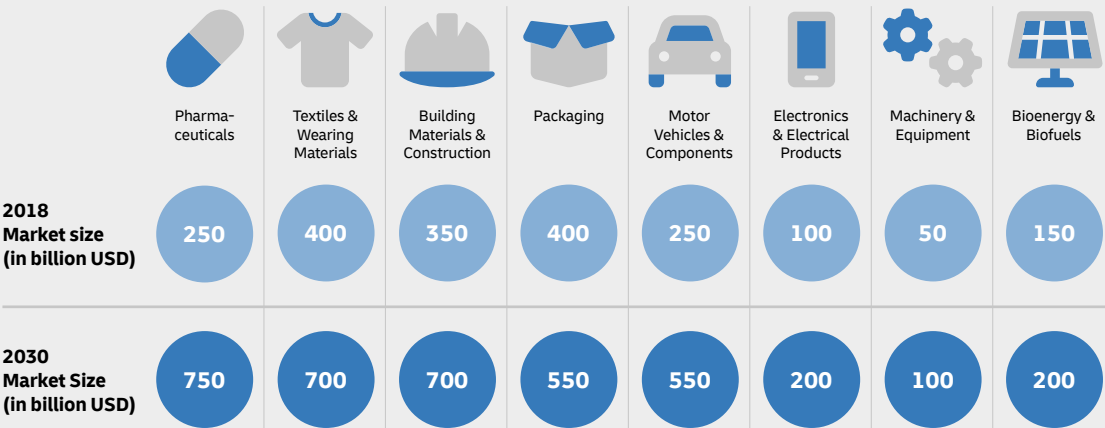
Warehouse Assets

As e-commerce expands, the number of warehouses will grow exponentially along with associated warehousing assets such as pallets, racks, and picking bins. For instance, the global pallet market is expected to increase by more than 33% from 82 billion USD in 2020 to 110.5 billion USD in 2027. However, more assets generally mean more anticipated replacements, usually due to normal wear and tear.

Today, 90% of pallets are wooden and are already mostly bio-based but they break relatively easily compared with their fully metal or plastic counterparts. Instead of replacing them with these less sustainable alternatives or with increasingly expensive wood and nails, logistics organizations are progressively searching for bio-based materials that are more durable and reusable. One attractive solution, provided by Dutch company CocoPallet, is made from coconut husks that are not only biodegradable but also more durable and space efficient when stacked for storage.

By using bio-based materials like coconut pallets for assets in facilities, organizations can further enable warehouses and supply chains to be more sustainable while reducing replacement costs.

Packaging & Packing Materials

The most visible waste outputs from supply chains are packaging and packing materials, with less than 10% of plastic products recycled globally. Bags, wraps, bottles, and styrofoam are contaminating natural environments around the world. Pressure to address the status quo has grown, compelling the logistics industry to seek biodegradable alternatives.

However, not all biodegradable products come from renewable sources, and several companies especially in the eRetail and fashion sector, around the world are seeking to bridge this gap. Mushroom Packaging in New York, for example, designs and manufactures fungus-derived packaging for various products that can decompose in soils within 45 days. Meanwhile Notpla, based in the UK, utilizes seaweed to mass-produce food containers, paper, and liquid sachets that are both edible and compostable.

By adopting packaging and packing material that are both biodegradable and bio-based, supply chain organizations can better ensure they are tackling the sustainability challenge for the entire product life span, not just downstream.

Bio-based products have a multitrillion growth opportunity.

	Pharma-ceuticals	Textiles & Wearing Materials	Building Materials & Construction	Packaging	Motor Vehicles & Components	Electronics & Electrical Products	Machinery & Equipment	Bioenergy & Biofuels
2018 Market size (in billion USD)	250	400	350	400	250	100	50	150
2030 Market Size (in billion USD)	750	700	700	550	550	200	100	200

Source: World Business Council for Sustainable Development (WBCSD)

DHL

Challenges

⛰ Bio-based material production is still relatively small and there may be supply challenges if such materials are adopted on a large scale.

⛰ Most bio-based solutions are pricier than less sustainable alternatives, limiting adoption.

⛰ While still a worthy step towards achieving sustainability goals, bio-based materials are not all biodegradable and may still contribute to waste.

Resources

🔗 **The third wave of biomaterials: When innovation meets demand** →
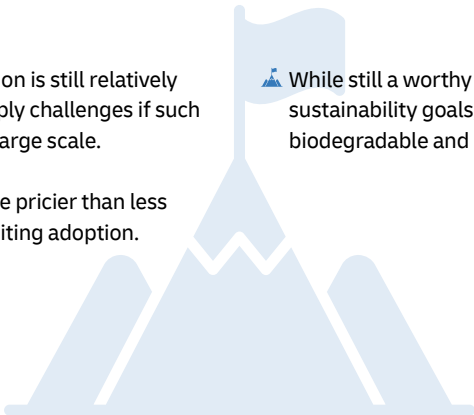
This trend should be **MODERATELY monitored,** with some use cases applicable today.

Outlook

Due to increasing demand for more sustainable solutions, bio-based materials – despite not being new – have developed recent momentum across supply chains. However, adoption is limited by costs and current production scale. Still, as more bio-based alternatives are developed and reach market, we anticipate a surge in use to address sustainability challenges.

Related Trends

Circularity →

Decarbonization →

Environmental Stewardship →

Next-Generation Packaging →

Sources
United Nations Environment Programme (UNEP) (2020): Sustainable buildings.
Statista (2021): Pallet market size worldwide 2019-2027 (2022).
Fédération Européenne des Fabricants de Palettes et Emballages en Bois (FEFPEB) (accessed 2022): Facts & Figures.
National Wooden Pallet and Container Association (NWPCA) (2021): Pallet Facts.
United Nations Environment Programme (UNEP) (2022): Our planet is choking on plastic.

DHL

BLOCKCHAINS

The trend of Blockchains includes the development, implementation, use, and management of decentralized, digitally recorded ledgers that are distributed across networks. By incorporating immutable and serialized recording, blockchain technology acts as a single source of truth for its users.

Blockchain technology came to public attention with news headlines capturing the meteoric rises and crashes of cryptocurrencies. In the background, however, particularly during the COVID-19 pandemic, logistics leaders in several industries sought applicable use cases for this technology in their supply chains; some organizations, including DHL, pre-emptively launched their own digital ledgers. Looking back, the blockchain technology market grew from 2015 to 2022 with a 65% global CAGR to a value of 7.3 billion USD. From 2022, the market is anticipated to boom with an 86% global CAGR to a value of 1.4 trillion USD in 2030 as more businesses accept blockchains in their operations. This increase in participant numbers will have an amplified network effect, boosting the supply chain value and benefits of this Blockchains trend.

Blockchain technology exists today and is applicable to many segments along a supply chain, although not necessarily at the same degree. To maximize the benefit and utility of blockchain, however, companies need various methods of detection, including many sensors, at almost every segment. This requires coordination and collaboration among many players in the typically disjointed logistics ecosystem. Therefore, the small blockchain implementations of today are likely to need several more years before they mature to meaningful, comprehensive integration within the end-to-end supply chain.

Trend Overview

Impact:

MODERATE	

Realization:

5-10 Years

Focus Areas:

Automation & Efficiency   Customer Experience   Physical & Digital Security   Visibility & Resilience

Trend Clusters:

Digital Backbone

Sectors:

Auto-Mobility   Energy   E-Retail & Fashion   Life Sciences & Healthcare   Technology

DHL

Relevance to the Future of Logistics
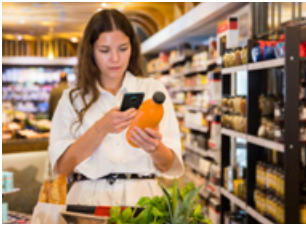
Traceability & Transparency

Today, companies have limited visibility of products as they move through production processes and supply chains. Manufacturers, retailers, and end customers are all demanding better and more reliable track-and-trace capabilities for products, raw materials, and waste. Blockchains, paired with logged records from sensors, can provide this visibility as a trusted, immutable ledger.

Supply chain professionals and customers can access a blockchain ledger with an interface from which they can see each product's shipment status and accurately confirm product attributes, such as whether it was locally produced, organically grown, or received certifications. Additionally, using blockchain technology, companies can quickly identify points of unauthorized removal or the insertion of products, helping to investigate theft, fraud, and counterfeiting. Finally, with hundreds of international trade laws and regulations, a blockchain-supported level of transparency enables supply chain organizations to ensure supplier and distributor compliance.

By acting as a single source of truth, blockchains can bring a sense of fidelity to all partners along the supply chain.
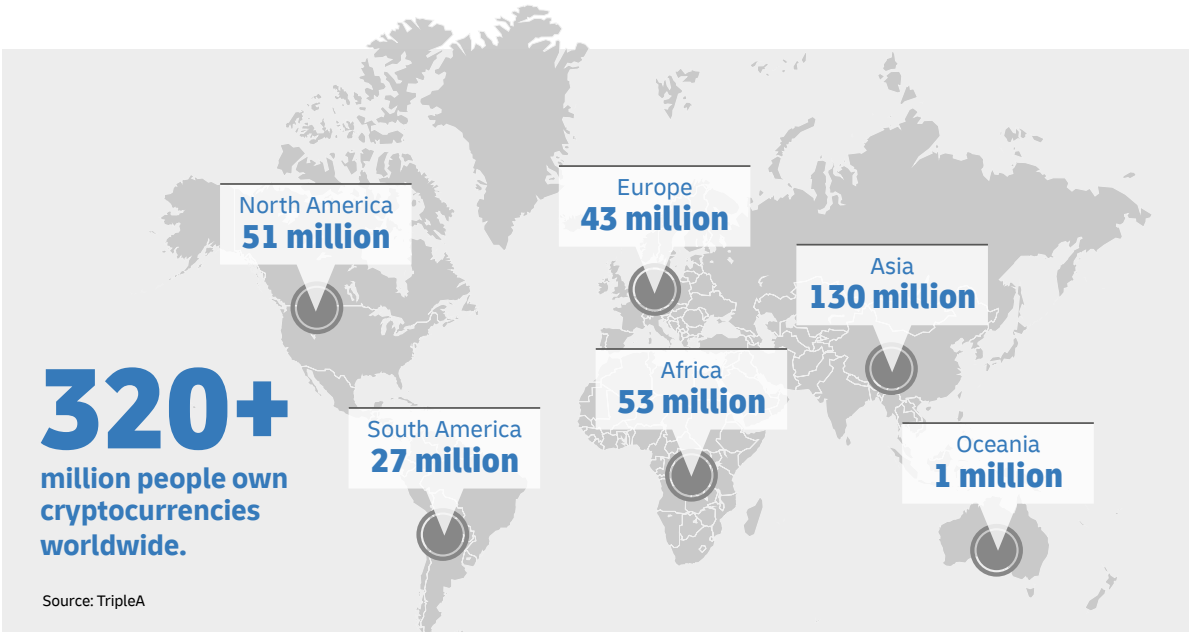

Smart Contracts

During its supply chain journey, each product can be subject to multiple back-office processes, from manufacturing invoices and customs forms to retail agreements and delivery payments. These processes can take weeks or even months of human activity, involving many different parties. Instead, blockchain-based smart contracts effectively eliminate delays and shorten the critical-path timeline.

The smart contract is essentially an elaborate digital 'if-then' statement which self-executes procedures once pre-determined and agreed criteria are met. For example, if a product and all its components have been properly recorded, tracked, and traced in a customs agency's smart contract, the product meeting all requirements may automatically clear customs without any forms. Smart contracts can also perform more advanced functions like splitting payments among parties based on the distance each has travelled or subtracting varying degrees of penalties from payments depending on how late or damaged a package is when it arrives at its destination.

By implementing blockchain-based smart contracts, logistics organizations can streamline processes, reduce clerical errors, and bring transparency to an automated system.

Cryptocurrency Payments

It has been estimated that in 2022, about 320 million people around the world own some form of cryptocurrency or 'crypto'. In Vietnam, almost 1 in 5 people are crypto users while, in Nigeria, this number reaches almost 1 in 3.

Like the normalization of credit cards and PayPal as payment methods before it, bolstering the rise of e-commerce, crypto can help companies extend their reach into markets as an alternative form of payment. While the value of cryptocurrencies like Bitcoin and Ethereum has proved volatile, there are other cryptos – known as 'stablecoins' – which have a more reliable, predictable value as they are pegged to a fiat currency like the USD or Euro. Some countries have begun to recognize and provide more legal space for crypto, including protections and regulations. To date, 2 countries, El Salvador and the Central African Republic, have gone so far as to recognize Bitcoin as legal tender.

As the personal use of cryptocurrency appears to be increasing and with regulations to follow, supply chain companies should consider accepting this alternative form of payment to better accommodate their customers.

North America
51 million

Europe
43 million

Asia
130 million

Africa
53 million

South America
27 million

Oceania
1 million

320+
million people own cryptocurrencies worldwide.

Source: TripleA

DHL

Challenges

- Technical limitations such as scalability and power consumption must be overcome to enable sustainable, large-scale deployment.

- Governance, standards bodies, and industry consortia will be required to ensure conformity to regulations and interoperability between carriers, operators, customers, and customs authorities.

- Industry-wide adoption along and across supply chains will be difficult given industry fragmentation and competition.

- Cryptocurrencies are mostly unregulated, increasing the risk of scams and lowering levels of trust; this is a barrier to the acceptance of crypto as payment and assets.
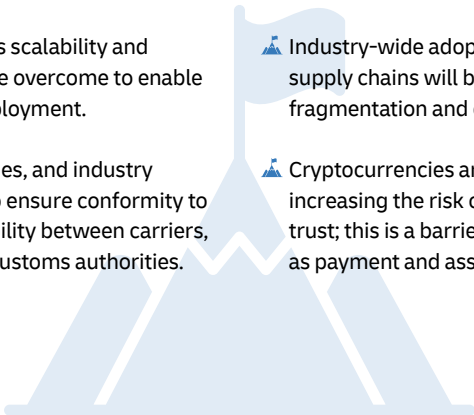
Resources

Dubai Customs introduces blockchain-based platform to facilitate cross-border e-commerce →

DHL - Tap the benefits of blockchain, but mind the pitfalls →
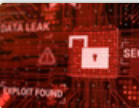
This trend should be **MODERATELY monitored,** with some use cases applicable today.

Outlook

Many pertinent and impactful use cases have been identified in the supply chain for existing blockchain technology. It is only a matter of time before multiple players along and across supply chains coordinate and collaborate to create comprehensive blockchain ecosystems, accelerating the full capabilities of this technology.

Related Trends

Cybersecurity 2.0 →

Metaverses →

Smartification →

Smart Labels →

Sources
Fact.MR (2022): Blockchain technology market outlook (2022-2032).
Grand View Research (2022): Blockchain technology market report.
TripleA (2022): Cryptocurrency across the world.
Yahoo Finance (2021): Which countries are using cryptocurrency the most?

CLOUD & APIS

The trend of Cloud & APIs refers to the expanding operational integration of cloud computing, using web-based software services to store and exchange data online instead of using on-premise hard drive solutions. Further it includes application programming interfaces (APIs) which are software protocols that allow software services and applications to communicate with each other and exchange data and functionalities in real time.

Because APIs allow companies to open up access to their resources while maintaining security and control, they have become a valuable aspect of modern business. Some popular examples of application programming interfaces include Open Authorization (using Facebook, Twitter or Google to quickly authenticate the user), third-party payment processing (eg. PayPal), and location services (eg., routing option to nearest retail location via Google Maps).

Popular API examples include third-party payment processing such as Paypal, providing location services such as directing people to the nearest retail store via Google Maps, or using an open authorization framework (OAuth) to authenticate users via their Facebook, Twitter, or Google account through third-party providers.

In 2021 alone, companies delivering their main value proposition via an API (or by using an API) raised 5 billion USD in funding. As an example, the financial services company Stripe began as an API with just seven lines of code and went on to partner with many of the biggest enterprises in the world; it has diversified to offer loans and corporate cards, and was recently valued at 36 billion USD.

In the logistics industry, as well, the need for connecting to partners along the value chain and exchanging real-time data is increasing as well. Applications range from generating shipping labels to tracking shipments and returns.

With the increasing need and value of exchanging data between functions, operations, companies, and end users, it is expected that cloud computing and APIs will grow in the next 1 to 3 years. Especially in the area of e-commerce, there are good prospects for APIs in the implementation of an integrated omnichannel strategy and the assimilation of detailed track-and-trace information from logistics service providers into e-retailer websites.

This trend is likely to have only a low impact on logistics; while it will support day-to-day operations and improve the customer experience, it is more likely to be classified as an enabling technology.

Trend Overview

Impact:

LOW

Realization:

< 5 YEARS

Focus Areas:

Automation & Efficiency	Customer Experience	Physical & Digital Security	Visibility & Resilience

Trend Clusters:

Digital Backbone

Sectors:

Auto-Mobility	Energy	Engineering & Manufacturing	E-Retail & Fashion	Life Sciences & Healthcare	Technology

Relevance to the Future of Logistics

Robotic Fleet Management

Robotics is booming during times of labor shortage, especially in the logistics industry. In North America alone in 2021, companies across industries ordered and incorporated more than 40,000 robots into operations.

Implementing more robotic systems increases the complexity of onboarding each additional solution, as well as monitoring interactive processes. Effective scaling and efficient implementation of new robots can only be achieved if all involved systems are interoperable. In this use case, APIs can successfully connect different robots from various vendors to a single warehouse management system (WMS).

Companies like Blue Yonder, one of DHL's partners, identified this challenge and developed a solution for the increasing complexity of warehouse automation. Blue Yonder's software-as-a-service cloud solution Robotics Hub, built on Microsoft Azure, integrates any type of robot into an existing WMS while reducing integration time for new robots and enabling monitoring of entire robotic fleets via one dashboard. This means the Robotics Hub acts as a communicator between the WMS and the cloud systems of all the robots so that orders are processed as efficiently as possible – all connected via APIs.

It is clear that the ongoing automation of supply chain operations, which goes hand in hand with the integration of robotic solutions, demands logistics companies focus on cloud and API solutions.

Integrative Cloud Logistics Platforms

The integration of cloud logistics platforms into existing IT data infrastructure and systems such as enterprise resource planning (ERP) systems via APIs enables companies to incorporate all relevant logistics data into operational planning and execution. This allows companies to streamline logistics processes through fleet management, optimized inventory management, and accurate shipment tracking and monitoring. In addition, cloud logistics platforms create a high level of data transparency across a company's value chain, enabling a smoother end-customer experience by integrating updated and relevant information (eg, order options, billing and tracking details) across all customer touchpoints. Companies like Cleo, with its Cleo Integration Cloud, are developing cloud logistics platform solutions to digitize complete end-to-end business processes by integrating third-party services into platforms using APIs.

Through the integration of cloud logistics systems, decision makers receive real-time data that improves performance management and enables new insights into business data through analytics. For example, by connecting to the main ERP system, a cloud logistics system can directly map price fluctuations in global freight forwarding in order to reschedule transport routes at short notice, if necessary, and to inform customers and internal stakeholders about possible delays.
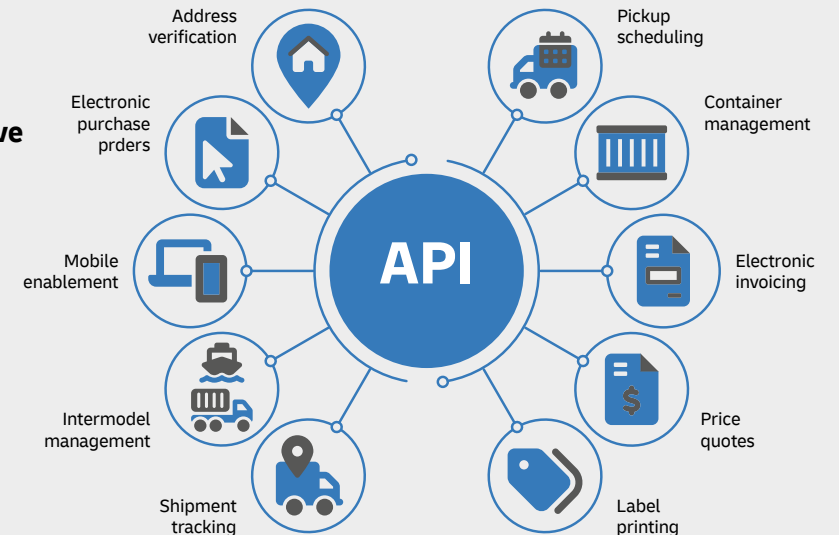
E-Commerce Integration

The scaling of cloud and API solutions is enabling new opportunities for many companies to extend their reach by integrating with different platforms, as well as offering new capabilities to customers. Already in 2020, 36% of retailers considered APIs a strategic resource for creating business value. This indicates the relevance of APIs, particularly in the e-commerce sector, to enable presenting updates digitally to the end customer, from the ordering process on the company's own platform to last-mile delivery.

An example of leveraging APIs is the so-called super-app which can connect countless mini-apps via one main app platform, so the end user does not have to leave the app platform to use a variety of different services. The most prominent example of a super-app comes from the Chinese company WeChat, which has used API technology to integrate over 3 million mini programs in its super-app, covering everything from retail online shopping to online dating.

APIs are a great enabler of new commercial opportunities for logistics by integrating real-time information on delivery options, shipment tracking, freight rates, and availability of transportation solutions and other services into apps, websites, and customer platforms. Through the DHL API Developer Portal, interested third parties can access a range of APIs to integrate DHL solutions such as tracking, shipping, and location services on their own e-commerce platforms in order to provide frictionless transparency to their end customers.

In the logistics industry, the various opportunities presented by cloud and API services lead to an enhanced customer experience, deeper customer relationships, business growth, and ultimately competitive advantage.
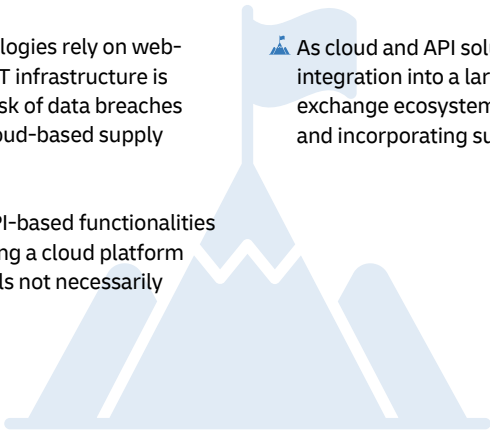
Processes up and down supply chains can benefit from APIs, reducing administrative costs and improving customer service.

Address verification · Pickup scheduling · Container management · Electronic invoicing · Price quotes · Label printing · Shipment tracking · Intermodel management · Mobile enablement · Electronic purchase prders · API

Source: Eradani

Challenges

- Since cloud and API technologies rely on web-based programs, a secure IT infrastructure is essential to minimize the risk of data breaches and ensure trouble-free cloud-based supply chain operations.

- Successfully integrating API-based functionalities and building and maintaining a cloud platform requires resources and skills not necessarily available in logistics.

- As cloud and API solutions are the cornerstone of integration into a larger, connected digital data exchange ecosystem, the initial costs of building and incorporating such solutions can be high.

Resources

DHL, Microsoft and Blue Yonder robotic hub implementation →

DHL - API developer platform →

DPDHL processes record API transaction volume using Google Cloud →

This trend should be **CLOSELY monitored,** with implementations available for many use cases today.

Outlook

Cloud and API solutions will continue to be an integral part of day-to-day operations for many companies, so that an increase in number of these solutions can be expected. Even if the overall impact on the core logistics business is rather small, we expect cloud and API technologies to mature in the next one to three years, so that API integration will be standard for any additional IT solution in the future.
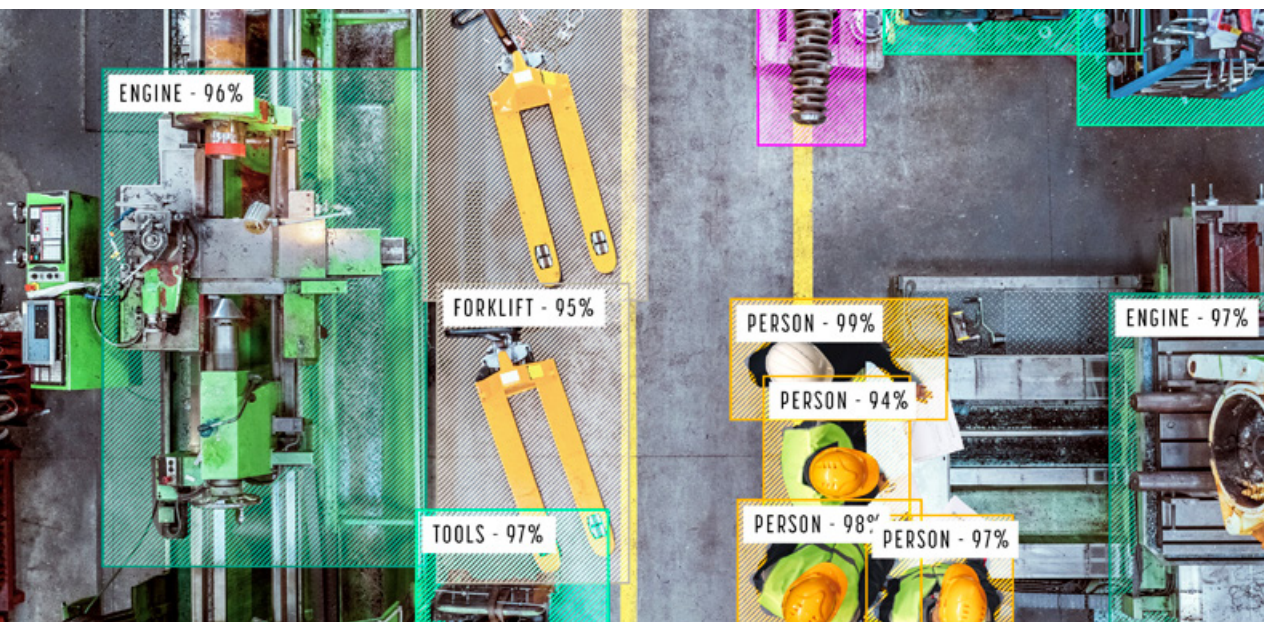
Related Trends

Omnichannel →

Smartification →

Big Data Analytics →

Next-Generation Wireless →

Sources
GGV Capital (2022): The GGV Capital API-First Index.
Reuters (2022): Robots marched on in 2021, with record orders by North American firms.
Google Cloud (2020): State of API Economy 2021.

COMPUTER VISION

The trend of Computer Vision utilizes cameras to capture photos or videos and applies artificial intelligence (AI) algorithms to analyze data extracted from this digital imagery. Rudimentary visual AI systems are trained to simply differentiate objects from each other, while more advanced versions can track objects across viewpoints and learn on their own.

Emerging from AI as a trend in its own right, Computer Vision has developed in conjunction with the advancement of deep machine learning, leveraging the rising quality and decreasing cost of camera devices. In 2020, the computer vision market globally was worth 9.4 billion USD and – as AI, vision systems, and computer processing continually improve – it is anticipated this market will more than quadruple to 41.4 billion USD in 2030. Today, advanced computer vision technology is perfecting depth perception, 3D reconstruction, and dark and blurred image interpretation, all of which will unlock more opportunities in supply chains.

The Computer Vision trend is set to highly impact logistics in the coming years. Its technology will underpin and drive future logistics, enabling more efficient processes as well as sustainable and safe operations. However, more investment is needed for this trend to be fully realized. As experienced in the early days of sensor adoption, computer vision applications must be scalable for logistics organizations to maximize benefits.

Trend Overview

Impact:

MODERATE

Realization:

< 5 YEARS

Focus Areas:

Automation & Efficiency   Health, Safety & Future of Work   Physical & Digital Security   Visibility & Resilience

Trend Clusters:

Artificial Intelligence   Robotics

Sectors:

E-Retail & Fashion   Life Sciences & Healthcare   Technology

DHL

Relevance to the Future of Logistics

Order & Shipment Processing

Many tasks in the warehouse involve humans to visually assess or confirm elements of a product, parcel, or pallet as it passes through the facility. As computer vision technology advances, we here at DHL recognize such tasks can be gradually delegated to computer vision-enabled AI systems.

One practical use case is dimensioning a shipment, or measuring its area or volume. This can be difficult when shipments are large or oddly shaped, or they are on fast-moving conveyor belts. Companies like German-based Metrilus have recently developed low-cost solutions that automate this dimensioning process, capturing measurements in milliseconds and sending this data to the warehouse management system. Accurate measurement and volume detection enables best fitting packaging selection to avoid shipping air, thereby reducing waste and keeping sustainability at the forefront of logistics.

Another use case is object identification for picking and packing. Currently, most orders are picked by hand, and those that utilize computer vision in robotics solutions tend to identify a product by its barcode or QR code. But developments in computer vision have enabled robots to identify tens of thousands of products with high accuracy, regardless of the presence of identifier codes.

With this level of visual AI, logistics providers can optimize processes, reducing cost while increasing throughput.
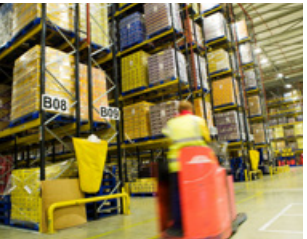

Asset Tracking

Millions of dollars are lost every year across sectors due to tools, equipment, and other assets going missing, and many hours are spent by workers searching for them. Computer vision technology can provide useful solutions to help track such assets and save time and money.

When a worker picks up a wrench and walks around a facility with it, a computer that processes connected visual feeds can locate where the wrench was last put down, while also tracking dozens of other tools at the same time. Vehicles like forklifts in a warehouse or trucks in a yard can also be tracked; this data can be used to determine if vehicle movements are performed in an optimal way. Furthermore, visual AI software can follow pallets of goods in inventory sections and keep accurate records of shelf vacancies and how long a pallet has remained on a shelf, in addition to tracking any falling or shifting parcels in the back of courier vans.

In implementing computer vision solutions in their facilities, logistics providers can avoid wasting time searching for misplaced assets and manually confirming asset locations. They can also use the analyses from visual AI to further optimize operations and accurately determine inventory stock levels.

Safety in the Workplace

Maintaining and improving safe working conditions is a top priority for the logistics industry. The COVID-19 pandemic increased attention to this and visual AI technology will be relevant and helpful to workplace safety in the years ahead.

During the peak of the pandemic, computer vision was used to ensure workers adhered to personal protective equipment (PPE) regulations. At DHL, we now see this technology expanding into other workplace safety use cases. Cameras and the AI behind them may one day detect if employees are utilizing ergonomic best practices to minimize injury risk, identify lone-worker emergency situations in less-trafficked areas, ensure vehicles are complying with local speed limits, and even determine if predefined walking pathways are being respected in a facility.

To ensure personal and data privacy, advanced computer vision solutions can blur out faces or separate personal identifying factors from analyses. This is helpful as it demonstrates to all parties that the goal of computer vision is not finding fault with individual workers but ensuring their safety and optimizing the workplace experience by assessing workflows, mapping out areas of high incidences, and triggering process change.
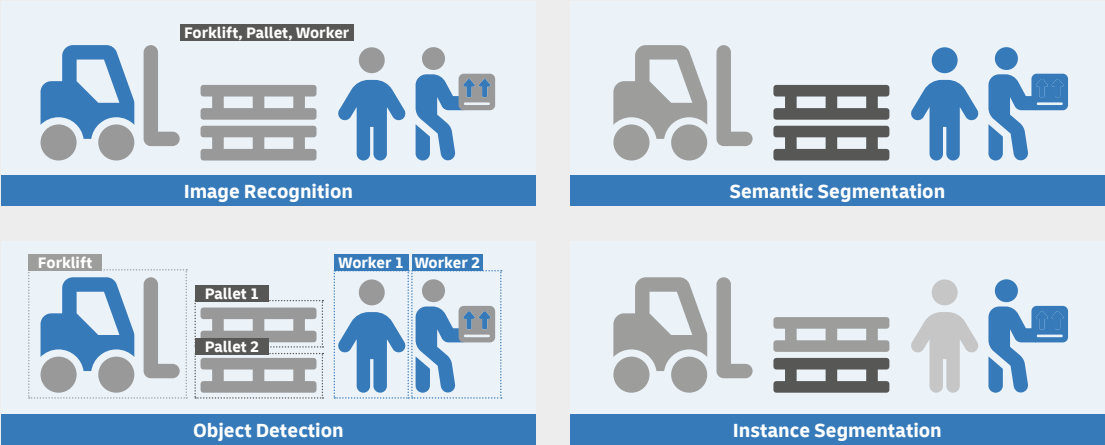

Trouble-Free Operations

With today's global supply chain networks strained and under immense pressure, logistics operations must remain functional and unhampered by incidents and broken-down equipment. Computer vision can help with this.

Digital side mirrors like those designed by Israeli startup Brodmann17 can highlight nearby vehicles, especially those in blind spots, to truck drivers, enabling safer lane changes and turns while also reducing incident risk. Meanwhile, visual AI via cameras, whether on gates or drones, can detect irregularities in various objects like airplane wings, shipping containers, and warehouse rooftops, initiating predictive maintenance procedures to assess any potential damage or need for repair. Computer vision can also be applied to repair or emergency stocks, keeping inventory count, flagging items like lubricants and spare wheels that are running low, and triggering timely replenishment.

With computer vision as a preventative tool, logistics organizations can better protect supply chains from avoidable delays.

Computer Vision can process single or multiple object detection and classify a number of elements from a single image

Forklift, Pallet, Worker

Image Recognition

Semantic Segmentation

Forklift
Pallet 1
Pallet 2
Worker 1 **Worker 2**

Object Detection

Instance Segmentation

Source: Allied Market Research

Outlook

This trend should be **ACTIVELY monitored,** with imminent developments and applications.

The trend of Computer Vision has use cases in practically every segment along a supply chain. The technology can be a helpful to logistics organizations in optimizing operations, improving worker health and safety, and reducing cost.

Highly valuing data privacy and security from the beginning of visual AI implementations may relieve initial employee resistance to the technology. As today's pilot projects pass their trials, rapid implementation is anticipated in the next few years.

Resources

	DHL - Measurement in a flash →

Related Trends

	Big Data Analytics →

	Drones →

	Interactive AI →

	Stationary Robotics →
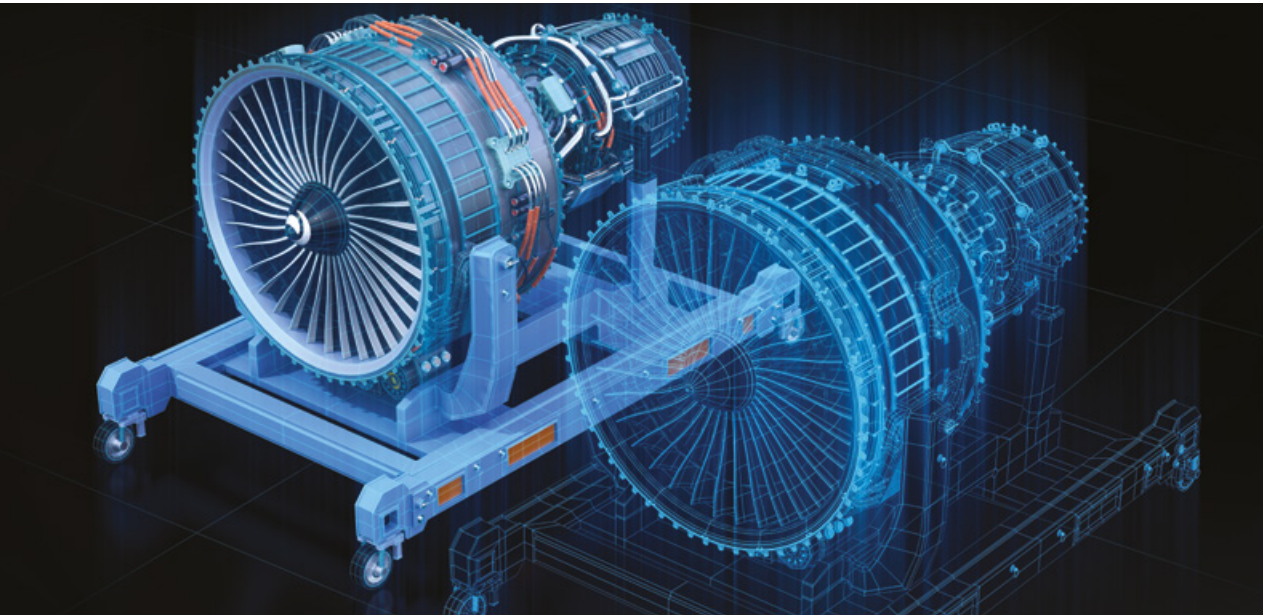
Challenges

- Employees may be highly suspicious and resistant to computer vision solutions, believing they are being constantly watched and their personal data is at risk.

- While approximately 90% of internet protocol (IP) cameras can be easily integrated and configured into new software platforms, older camera technology must be upgraded to scale computer vision solutions.

- Unless cybersecurity measures are considered and strengthened, there is a risk of hacking and malicious manipulation of data, resulting in skewed analyses and altered AI performance.

- Compliance with GDPR and other data privacy and protection laws must be considered and may limit the scaling of a computer vision solution across regions.

DIGITAL TWINS

The trend of Digital Twins encompasses virtual models that accurately mirror the real-time conditions and behaviors of the physical objects or processes they represent. A digital twin provides value through visualization, diagnosis, analysis, prediction, simulation, and/or optimization without the need for someone to interact with its physical twin.

The growing diversification and application of sensor technology and the development of cloud computing and artificial intelligence (AI) over the last few years have enabled the creation of more accurate digital twins for a wide range of objects and systems, from nanomaterials and machines to large production lines and entire cities. This progress has captured the attention of many players across sectors, including those in the logistics industry. As more digital twins are implemented, the market, which was valued at more than 5 billion USD in 2020, is consequently projected to grow beyond 35% CAGR between 2021 and 2027.

Despite the maturity of enabling technologies and the uptick in digital twin implementations in supply chains, we here at DHL see this trend as still having a realization beyond 5 years. As logistics organizations begin adopting the solution, it will take some time before digital twins move from individual applications to whole ecosystems, integrating everything from assets in operations to entire supply chains end to end. The trend of Digital Twins has maintained a moderately low impact in the Logistics Trend Radar, helping logistics organizations address efficiency, resilience, and environmental and visibility needs without significantly changing the overall characteristics of the supply chain.

Trend Overview

Impact:

MILD	

Realization:

5-10 Years

Focus Areas:

Health, Safety & Future of Work   Visibility & Resilience

Trend Clusters:

Artificial Intelligence   Digital Backbone   Internet of Things

Sectors:

Auto-Mobility   Energy   Engineering & Manufacturing   Life Sciences & Healthcare   Technology

DHL

Relevance to the Future of Logistics

Stress-Testing Resilience

Global supply chains are performing under extreme pressure, navigating disruptions to meet increasing demand and handle ongoing volatility. Taking the Covid-19 pandemic and other recent events as lessons, logistics organizations have renewed efforts to achieve more resilient supply chains together with customers.

Stress testing the digital twin of an entire supply chain can help build resilience. In such simulations, the user's complete network of inbound and outbound flows between manufacturing sites, distribution centers, ports, markets, and other entities are first reflected as accurately as possible in a digital twin. Then, applying scenarios like natural disasters and cyberattacks, the user can see – without impacting real operations – how these disruptions would affect service levels and the supply chain. The user can additionally modify the digital twin of the supply chain and rerun scenarios to see if certain rearrangements lead to more resilient results. These stress-test simulations are already being offered by logistics consultants and digital twin providers with whole digital supply chains being built in the span of just a few weeks, depending on the level of detail.

As it would be unrealistic and damaging to simulate crises on actual, physical supply chains, digital twins provide an opportunity for logistics planners and crisis managers to pinpoint and take more resilient strategic decisions.

Predictive Maintenance

Unplanned downtime is disruptive and expensive, costing industrial manufacturers lost time of over 15 hours a week and over 50 billion USD a year, even before the pandemic. With equipment failure cited as the cause of almost half of all downtime, predictive maintenance (anticipating and repairing assets before they break or fail) is seen as a worthy strategy to effectively cut costs and increase productivity for manufacturers and logistics providers alike.

Able to provide real-time visibility of the condition of physical objects, digital twins are often seen as the ideal solution for predictive maintenance. In 2022, Kraft Heinz partnered with Microsoft to create digital twins of all its 34 manufacturing sites in North America, with one of the goals being to reduce mechanical downtime at each facility.

Digital twins can additionally be applied to smaller, individual assets, not just whole warehouses. The most advanced logistics players and equipment service providers are creating digital twins of assets like individual robots, trucks, and tools, tracking their conditions and detecting any wear and tear that should be addressed to avoid breakdowns.

By using digital twins to facilitate predictive maintenance, logistics providers can save about 40% of reactive maintenance in a given year, boosting operational throughput and reducing costs.

Optimizing Logistics Processes

Practically all processes within supply chains can benefit from the trend of Digital Twins. From appropriately allocating workloads to efficiently managing inbound and outbound flows, a digital twin can facilitate logistics optimization through visibility.

German drugstore retailer dm-drogerie markt, for instance, recently utilized digital twins to optimize inventory operations, including replenishing products on shelves. The retailer created digital twins of each of its 2,000+ stores, including the shelf layout and all product SKU locations in every branch. By having real-time visibility of product availability across all its locations, dm-drogerie markt has been able to optimally combine goods on incoming mixed pallets from distribution centers to ensure shelves are properly stocked with the fewest pallets needed. Furthermore, as the retailer knows where exactly in each branch every product belongs, it can help to minimize employee in-store walking distances. On a smartphone display, personnel can see the optimal restocking path for each item.

In implementing digital twins for specific supply chain processes, logistics organizations can potentially reduce the cost, time, resources, and waste previously incurred when completing tasks.


In logistics, the ultimate digital twin would be a real-time replica of an entire supplychain network.

Source: DHL

Challenges

- Real-time, high-quality data is the basis for any digital twin solution but demanding or prohibitive field conditions can limit data access and degrade the accuracy of a digital twin.

- Some qualities of a complex asset like its chemical, electrical, and thermal state can be extremely costly and challenging to accurately replicate, often forcing users to make generalized, less accurate assumptions and simplifications in digital twin models.

- Digital twins require considerable investment in sensor technology, platforms, model development, and high-touch maintenance.

- With direct connection to physical objects, digital twins potentially pose a security risks, giving cybercriminals a possible new point of entry to disrupt an organization's operations.
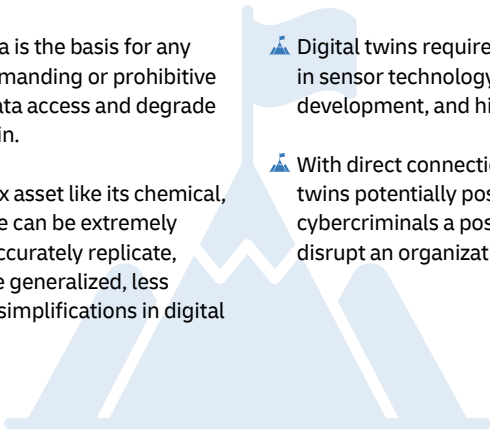
Resources

DHL - Trend Report: Digital Twins in Logistics

DHL - 5 ways digital twinning will revolutionize logistics

Outlook

This trend should be **MODERATELY monitored,** with some use cases applicable today.

While digital twin technology has existed since the start of the 21st century, the trend is now approaching a tipping point where widespread adoption is likely in the next 5-10 years. For now, the main application areas will primarily be singular assets and contained systems. However, for supply chain management, the next level of adoption will be digital twins of entire supply chains, involving thousands of assets spanning various players.

Related Trends

Smartification →

Extended Reality →

Next-Generation Wireless →

Wearable Sensors →

Sources
Capgemini Research Institute (2022): Reflecting reality; Digital twins: adding intelligence to the real world.
Forbes (2022): Unplanned downtime costs more than you think.
Wall Street Journal Custom Studios (2022): Unlocking performance.
General Electric (2022): Digital twin.

DRONES

The trend of Drones, otherwise known as 'unmanned aerial vehicles' (UAVs), refers to the development and utilization of variously shaped aircraft without a human pilot or crew on board. Enabled by embedded sensors and transceivers to navigate, drones are often controlled remotely by a human pilot, but advanced versions can fly autonomously beyond visual line of sight (BVLOS) using software-controlled flight plans.

For almost a decade, drones have been seen as a potential new mode of delivery for logistics organizations. While holding great promise to provide quick, point-to-point shipping, this trend remains far from realization – regulations and technology, as well as economics, have limited drone delivery to only a few isolated operations around the world. However, as this primary use case progressively develops, other applicable areas along the supply chain have been identified, from security to dimensioning. Drone providers are continuously shaping and improving their products and services to meet these needs.

The trend of Drones has moderately high impact on logistics. As a new transport mode, UAVs can enable transportation lanes previously deemed too costly. Beyond transportation, they can help save time for logistics workers undertaking operational tasks. Still, there are only some use cases applicable today which is why the most impactful applications of this trend are beyond 5 years. Both technological advancement and regulatory development are required to bring drones to a standard fit for service at scale.

Trend Overview

Impact:

MODERATE

Realization:

5-10 Years

Focus Areas:

Automation & Efficiency   Customer Experience   Physical & Digital Security   Visibility & Resilience

Trend Clusters:

Robotics

Sectors:

Energy   E-Retail & Fashion   Life Sciences & Healthcare

Relevance to the Future of Logistics

Mid- & Last-Mile Delivery

Delivery by drone is perhaps the most visible use case of this trend in the supply chain. So far, drones typically deliver high-value and time-sensitive products like medication and blood and even still, only in limited situations. However, progressive technology developments have expanded their potential use in delivery logistics, helping alleviate pressure in the supply chain caused by more e-commerce orders, worsening traffic congestion in cities, and the growing truck driver shortage.

In both mid- and last-mile delivery, regulatory bodies around the world have cautiously permitted limited commercial drone operations. For instance, Bulgarian start-up Dronamics has developed a fixed-wing cargo drone capable of carrying a 350 kg (772 lb) payload, enabling same-day delivery over a distance up to 2,500 km (1,553 mi). In time for its first planned commercial operations, the company recently received an EU license to self-authorize flights, including BVLOS operations. In the US, American-based drone delivery service company Zipline received federal certification in 2022 to operate as a small air carrier, allowing it to expand existing e-commerce and pharmaceutical delivery operations. In addition, South African startup Cloudline was recently granted permission by the Kenyan government to test its autonomous blimp-like airships to deliver 100 kg (220 lb) payloads carbon-free to less accessible regions.

Overall, as land-based supply chains strain further and as governments recognize the potential benefits of drone technology in the face of macroforces, we here at DHL anticipate UAV use to grow as a delivery mode within the next decade for select use cases and limited mainstream application.

Dimensioning & Inspecting Large Assets

Whether for an oddly shaped, oversized piece of industrial equipment or the roof of a large warehouse, logistics organizations usually utilize a human crew to measure asset dimensions and identify inconsistencies and points of damage. Often, these routine processes can take many hours, as mismeasuring or missing a fracture can lead to costly consequences. Additionally, these tasks sometimes involve safety risks as workers may need to climb heights and walk on an uneven surface to properly measure or inspect an asset.

Drones with cameras, light detection and ranging (LiDAR) capabilities, or other sensing technology have demonstrated the ability to accurately perform these tasks, saving workers' time and exposure to risky environments. Dutch start-up Mainblades provides an inspection service for airplanes, using drones to identify paint quality, lightning damage, and other blemishes and discrepancies and creating inspection reports faster than the 2-3 aircraft engineers that would usually be required to perform the same task. Meanwhile, FairFleet utilizes drones to measure large assets and shipments in facility yards, with accuracy to within a few centimeters.

Security & Surveillance

Logistics facilities from ports to warehouse yards often cover large areas, making it difficult for security personnel to assess on-site damage and detect perimeter intrusion. A subset of drone providers focuses on this use case to help logistics organizations maintain the security and integrity of their property.

Nightingale Security, for example, offers a drone security service with multiple autonomous functions. Scheduled patrols of facility areas at different altitudes with varying hover durations, and camera directions can be pre-programmed at suitable times and on different days. If human or vehicle intruders are detected in any of the areas, the drone sends alerts to security personnel for further analysis. Furthermore, if an alarm is triggered by, say, a warehouse perimeter breach, the system automatically dispatches a drone to the local area and begins a live-stream video. If an emergency such as a fire starts, security teams can manually take control of the drone to pilot and properly monitor events.

As different types of cameras, from night vision to thermal imaging and artificial intelligence (AI)-enabled devices, are put to use in security drones, these can help the security personnel of logistics organizations cover more ground in less time. Using its own in-house solution in South America, DHL has succeeded in reducing the time needed for patrolling from several hours to a mere 20 minutes.


Inventory Management

Currently, many logistics organizations rely on human personnel to check inventory in facilities, particularly shelves for pallets. As shipments enter, rotate, and leave the warehouse, workers have to assess and confirm stock counts and vacancy rates on shelves. While several technologies aim to automate this process, drones are seen as a viable solution for what can be an expensive and time-consuming activity.

Instead of having dozens of workers scanning codes and recording placements, drones can quickly perform the same tasks without needing large warehouse vehicles like aerial work platforms to examine the higher shelves. Whole fleets of drones can operate autonomously, with only one worker needed to manage and assess flagged circumstances. Furthermore, as completing an inventory no longer requires a large workforce, companies can check stock more frequently, increasing warehouse management system (WMS) accuracy and further optimizing facility operations.

Companies across industries have ranked 'saving time' and 'improving work safety' as the 2 most important reasons for adopting drones.

57%	56%	53%	37%
Improving work safety	Saving time	Improving quality	Saving costs
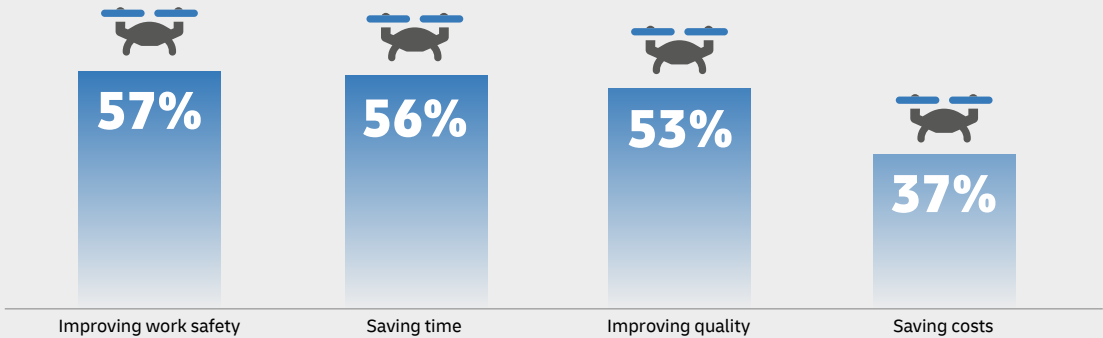
Source: Drone Industry Insights

Challenges

- Different regulations and requirements across countries and regions delay the mass adoption and deployment of drones in logistics.

- High-profile drone incidents have reduced confidence in UAV technology and hindered progress with regulators.

- Privacy, noise, and safety remain top concerns in residential areas, and this can necessitate operational compromises to be made in drone route planning.

- While less of an issue than before, adverse weather conditions still pose a safety risk for drone operations; back-up plans are always needed to fulfill tasks and deliveries in case bad weather prevents drone flights.

- Costs to deliver by drone are generally quite high, limiting the business case to specific products and circumstances.

Sources

Outlook

This trend should be **MODERATELY monitored,** with some use cases applicable today.

While the trend of Drones has taken longer to materialize than many initially anticipated, technology development has enabled some logistics use cases. Regulations have shifted the landscape to favor drone operations on private property; for example, security and inventory management use cases. More permissive legislation has recently enabled limited public-facing drone operations, particularly in mid- and last-mile deliveries. Overall, we here at DHL see drones as one part of the future of logistics and anticipate greater adoption in selected operational areas once the drone business case becomes more favorable.

Resources

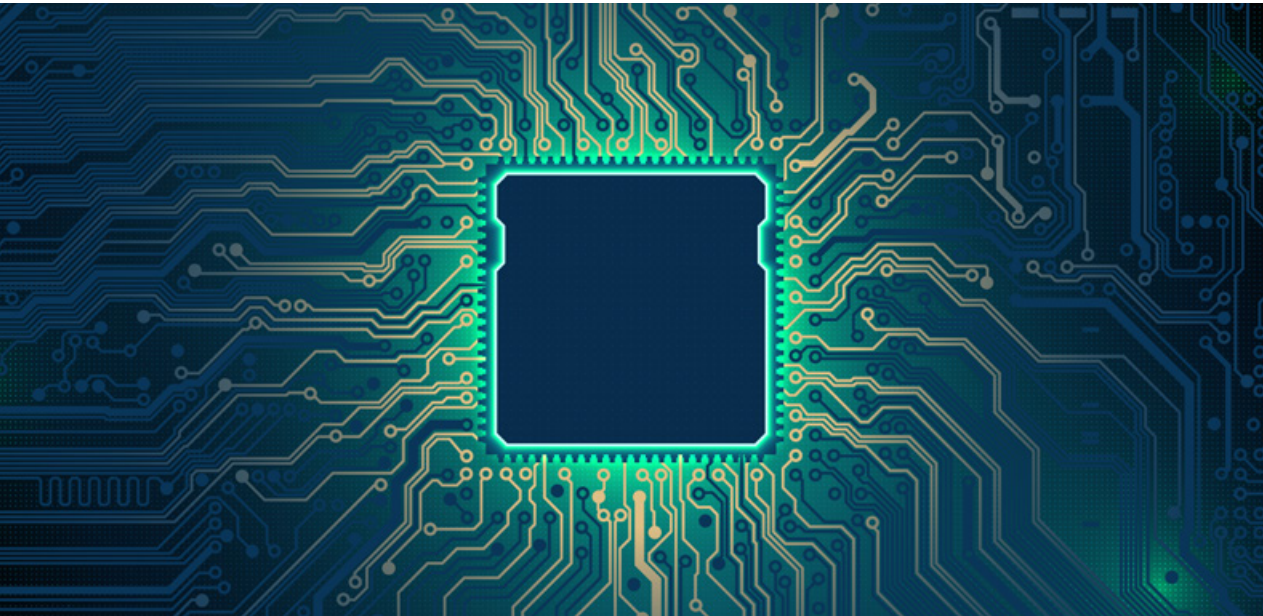Partnership of dronamics and DHL →

Related Trends

Omnichannel →

Quick Commerce →

Computer Vision →

Outdoor Autonomous Vehicles →

EDGE COMPUTING

The trend of Edge Computing refers to the decentralization of IT architecture, bringing computer processing closer to sensors and other data sources – at the edge of a network – and away from remote cloud servers and data centers. Deploying computing and storage resources at the location where data is produced, edge computing minimizes the need for continuous, long-distance communication between clients and servers, improving processing time and the speed of response to surrounding changes.

The volume of data generated by internet-connected devices is growing far too quickly for traditional data center infrastructures to cope. Gartner predicts that by 2025 75% of enterprise-generated data will be created outside centralized data centers. Moving such vast amounts of data via the internet is often time- and disruption-sensitive.

With edge computing and the ability to decentralize IT architecture with the growing capabilities of mobile computing and the Internet of Things (IoT), organizations gain near real-time insights with a lower demand for cloud server bandwidth. This also adds an extra layer of security for sensitive data, as decentralization means data can be more safely stored near to its source.

With global market value predicted to hit 116.5 billion USD by 2030, and expanding at a CAGR of 12.4% between 2022 and 2030, this trend and its wide application across many different sectors also triggers other innovative technologies, accelerating development and new capabilities.

It is said that the rise of 5G networks across the globe actually positions edge computing as the next evolution of cloud computing. More than ever seen in the past, organizations can now harness comprehensive data analysis without the IT infrastructure that was necessary in previous years. Considering that edge computing is in relative infancy, its maximum potential is still far from full realization, although it is already accelerating digital transformation across organizations, including logistics and supply chain facilities. As edge computing streamlines how much detailed data the organization can process at any given time, it enables companies to learn more and it delivers insights at a faster rate than before. This helps businesses to predict, manage, prepare, and adapt, meaning they remain resilient in the face of future demands.

In the logistics industry, the ongoing development of self-driving vehicles is a prime example of an edge computing application. Driverless cars must react and adapt to surroundings in real time rather than wait for commands from data centers in far-away locations.

Trend Overview

Impact:

MODERATE	

Realization:

< 5 YEARS

Focus Areas:

Automation & Efficiency   Physical & Digital Security

Trend Clusters:

Digital Backbone   Internet of Things

Sectors:

Auto-Mobility   Technology

Relevance to the Future of Logistics

Enabled Connectivity in Dark Zones

In remote locations and in regions lacking legacy infrastructure (dark zones), edge computing can overcome IoT device connectivity limitations. By processing data at the edge of the network, rather than running data through remote data centers or network infrastructures, edge computing allows captured data to be analyzed at source. Once data is processed at the edge, it can then still be transmitted to cloud applications. Highly relevant to tracking and visibility use cases, this gives logistics providers and customers alike uninterrupted access to real-time shipment locations.

For high-value shipments, this is essential if another party attempts to hack shipment location data. Edge computing increases the level of IT ownership and security, and therefore reduces the risks both of data theft and product theft. Similarly, this is important for shipment of sensitive goods; for example, when temperatures must be maintained to ensure product quality and any deviation may be harmful to human consumption. Here, edge computing ensures manufacturers and consumers know about the product's environment and condition at all times, regardless of whether at any stage of the supply chain it entered a dark zone with no connectivity.

Supply Chain Resilience

At the granularity of individual product level, logistics companies need to know their stock at all stages of the supply chain and at all times so they can meet the growing demand for visibility and enable increasing e-commerce. To address this, logistics providers as well as retailers use IoT devices to monitor temperature, track real-time location, and watch stock levels in order to make data-driven business decisions.

There are numerous opportunities to increase resilience by leveraging edge computing in various supply chain processes. During transportation (trucking and last-mile delivery), an autonomous vehicle is vulnerable to increasing cyberattacks; if vehicle control is compromised, this endangers other road users and the shipment itself. When a self-driving vehicle is connected to the edge, however, it is able to react to situations in real time, rectifying any malfunction and correctly responding to cyberattack without requiring human intervention.

Within a warehouse, edge-enabled devices share and process data in real time. This improves the speed and accuracy of warehouse operations. For example, edge-enabled cameras can scan barcodes on individual pallets to monitor all stock per micro-location in the facility. The cameras can read barcode metadata and indicate if a box has been placed in the correct location. Crunching metadata in real time, the analytics platform can trigger an alert of fraudulent barcodes and incorrect placements. This data can then be streamed, connecting the edge-enable devices to the warehouse management system and enterprise resource planning system via the cloud, so that employees are actioned to rectify the situation.

Another good example is how edge computing supports the efficient management of volume fluctuation during high seasons, helping warehouses to cope with a surge in demand for consumer goods.
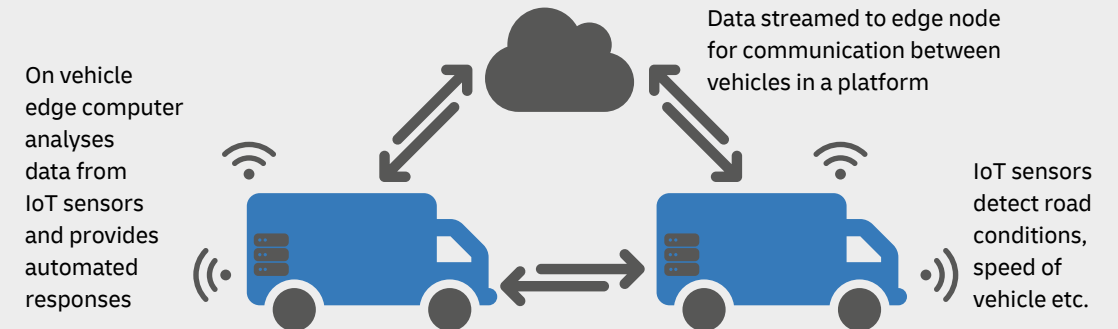
Operational Efficiency & Security

Manufacturing and warehouse operations benefit from the way edge computing enables close monitoring. For example, watching the efficiency of equipment and production lines helps to detect failures before they occur, avoiding costly delays caused by downtime. In the energy sector, companies can keep a close eye on assets in order to avoid disruption in meeting consumer demand and overcoming global shortages.

Within a traditional operational setup, closed-circuit television (CCTV) cameras in a warehouse continuously output raw video signals which stream constantly to a cloud server. From there, a motion-detection application identifies any footage containing activity, ensuring this is saved to the cloud server – this represents a constant strain on the warehouse's internet infrastructure as large bandwidth is needed to transfer all this footage; it also imposes a heavy load on the cloud server which must process all camera footage simultaneously. Edge computing offers an excellent alternative. If each camera's motion sensor computation is moved to the network edge, using its own internal computer to run the motion-detection application, the camera need only send this footage to the cloud server, resulting in a significant reduction in bandwidth use. Now the cloud server would only be responsible for storing footage of significance and it would be able to communicate with a larger number of cameras without being overloaded.

Thanks to edge computing, high-speed and dense autonomous truck platooning is possible as driverless trucks can quickly communicate with each other without having to connect to a distant cloud server for instructions on how to react to their everchanging surroundings.

On vehicle edge computer analyses data from IoT sensors and provides automated responses

Data streamed to edge node for communication between vehicles in a platform

IoT sensors detect road conditions, speed of vehicle etc.

Source: STL Partners

Challenges

- Managing disparate networks and storage systems to edge compute is complex and requires specialized IT expertise and talent at multiple geographical locations simultaneously.

- As the trend is still at a relatively early stage, expect developments in data security when computing moves to the edge; the IT infrastructure will go beyond the multiple layers of physical and virtual network security offered by centralized computing and will, therefore, introduce more potential targets for cybercrime.

- The physical isolation of devices powered by edge computing, and therefore the data being exchanged by multiple devices, makes it difficult to monitor, authenticate, and authorize data access.

- Edge computing requires time and investment which can be challenging while running hundreds of container clusters simultaneously with different microservices provided at different edge locations at different times.

Resources

| DHL - Innovation at the edge of the network | → |

Outlook

This trend should be **ACTIVELY monitored,** with imminent developments and applications.

Experts predict that one quarter of supply chain decisions will be made using edge ecosystems by 2025, as organizations shift away from centralized systems towards more distributed networks enabled by developments in Wi-Fi, Bluetooth, and 5G data communication. With edge processing of real-time data, we here at DHL anticipate supply chains becoming more dynamic while covering larger networks, with data and decisions originating from the edge. This impacts operators, machines, and sensors, as well as devices.

Related Trends

| Cybersecurity 2.0 → | Smartification → |
| Big Data Analytics → | Quantum Computing → |

Sources
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GlobeNewswire (2022): Edge computing market size to hit at USD 116.5 billion by 2030.
Hewlett Packard Enterprise (2022): What is edge computing?
Atos (2022): Why edge computing is about to solve major IoT issues.
STL Partners (2022): Edge use cases for retail, warehousing and logistics.
Cloudflare (2022): What is edge computing?
DC Velocity (2022): Edge computing holds rising value for logistics and manufacturing firms, Gartner says.
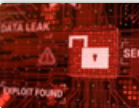STL Partners (2022): Edge computing market trends.

EXOSKELETONS

The trend of Exoskeletons involves wearable devices built to support or enhance human physical capabilities. While passive exoskeletons absorb energy from movements and relinquish power when support is needed, active devices are externally powered and can sense and react to specific movements of the human body.

With over 1.7 billion people affected worldwide, musculoskeletal disorders (MSDs) are one of the most common work-related health issues. Exoskeletons, originating from the healthcare and military industries, appeared on the market for industrial use in logistics more than a decade ago to reduce the development and effects of MSDs in the workplace. Typically classified by the regions of the body they support, both active and passive devices have been improved over the last 2 years in terms of usability, form factor, and performance. In 2021, the exoskeleton market was valued at 257.9 million USD and is predicted to grow with a CAGR of 18% from 2022 to 2030, highlighting anticipation of further breakthroughs and wider adoption in workplaces.

While the Exoskeletons trend is expected to have only minor impact on efficiency gains within supply chain operations, the technology is understood to positively impact employee health and safety. As logistics operations face an aging workforce and growing labor shortages, exoskeletons capable of reducing physical strain on the human body have become a topic of interest for logistics organizations seeking to limit the particularly high sick leave rates per full-time equivalent (FTE) affecting the industry. In addition, the implementation of exoskeletons in operations could provide differentiation to attract labor. However, large-scale deployments have yet to be seen, mostly because currently available devices offer support only for specific sets of movement, limiting their application to niche use cases.
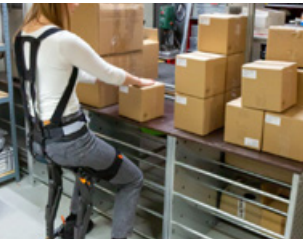
Trend Overview

Impact:

LOW	

Realization:

< 5 YEARS

Focus Areas:

Health, Safety & Future of Work

Trend Clusters:

Bionic Enhancements

Sectors:

Auto-Mobility   Energy   Engineering & Manufacturing

DHL

Relevance to the Future of Logistics

Tasks with Heavy Bending & Lifting

Lower back pain is the main contributor to musculoskeletal burdens and among the most common workplace injuries and illnesses resulting in days away from work. Meanwhile, handling and frequently lifting heavy loads are some of the main risk factors for lower back pain.

Exoskeletons specifically designed for lower back support can be beneficial for workers bending, lifting, and carrying heavy objects like boxes or tires in facilities. Active exoskeletons like the Cray X from German Bionic and the passive devices of Ottobock, Laevo, and HeroWear can all be implemented for specific use cases and help supply chain organizations improve employee health and safety in the workplace and reduce costs arising from preventable injuries.

Overhead Work

Neck and shoulders have both been identified as body areas widely affected by MSDs and associated symptoms. Activities involving either static overhead work, such as inspecting and repairing the underside of delivery vehicles, or continually handling weight above shoulder height, like when loading the top spaces of containers, are considered major risk factors for injury.

Exoskeleton providers like Levitate Technologies, Ekso Bionics, and Skelex offer passive devices specifically built for these activities, acting as support structures for the upper arms to reduce strain in the neck and shoulders. While very task-specific in supply chains, these devices can help reduce injury and soreness for logistics workers participating in these activities and maintain their quality of work.

Workspaces Without Seating

Many facilities in supply chains do not accommodate seating in workspaces because of space constraints or for operational safety reasons. As a result, workers must be always on their feet when working – a requirement that can further restrict the industry's talent pool.

Tech companies such as Noonee and Archelis have developed space-saving solutions often referred to as 'chairless-chairs.' Nimbly attached to the legs of the worker, these devices fold out when the worker squats, providing them with chair-like support for resting, only to retract when the worker again stands. Although the cumulative impact of these chairless-chairs in supply chains has yet to be fully understood, like other types of exoskeleton, they have potential in attracting prospective workers who otherwise would not qualify or not want such physically taxing jobs.

Preventing workplace injuries increases worker health and happiness, but it also saves organizations money in many ways.

5-30x

How much greater indirect costs of an MSD case can be over the direct costs.

■ **Indirect Costs:** includes training replacement employees, accident investigation, lost productivity, repairs of damaged equipment and property, and costs associated with lower employee morale and absenteeism

■ **Direct Costs:** includes worker's compensation payments, medical payments, and legal expenses

Source: IntechOpen. Work-related Musculoskeletal Disorders

DHL

Challenges

- The perception of exoskeletons as depicted in science fiction and superhero films, paired with the lack of understanding of the technology's limitations, has cultivated widespread, unrealistic expectations that can work against exoskeleton trials and implementations.

- Today's exoskeletons require well-organized onboarding and personalization; initial implementation can be more similar to a change management project than a simple installation of new hardware.

- Most available exoskeletons are not entirely effortless to wear and still add a significant amount of weight; this creates a trade-off between benefit in certain movements and perhaps a burden in others.

- In order to move from pilots to actual deployments, user acceptance is not the only hurdle to overcome – quantifiable data, such as productivity impacts and cost savings from reduced sick leave, somehow needs to be recorded to prove a business case.

Resources

The rise of exoskeletons in logistics →

This trend should be **ACTIVELY monitored,** with imminent developments and applications.

Outlook

Industrial exoskeletons have reached a critical tipping point, finally achieving satisfactory levels of user acceptance in workplace trials. While it is expected that devices will become cheaper and even more comfortable and flexible to wear in the near future, we here at DHL question if a universal augmenting device for diverse use cases will be developed soon. Instead, we assume that multiple devices will still be required in the foreseeable future, with each supporting a different, singular task.

Still, these tools can help logistics organizations today by not only bolstering the health and safety of workers but also expanding the pool of candidates who qualify for physically arduous responsibilities.

Related Trends

Diversity, Equity, Inclusion, Belonging →

Silver Economy →

Edge Computing →

Wearable Sensors →

Sources
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Grand View Research (2022): Exoskeleton Market Size & Share Report, 2022-2030.
National Academy of Social Insurance (NASI) (2021): Workers' Compensation: Benefits, Coverage, and Costs.
World Health Organization (WHO) (2022): Musculoskeletal health.

EXTENDED REALITY

The trend of Extended Reality, otherwise known as XR, encompasses the different experiential technology genres of augmented reality (AR), virtual reality (VR), and mixed reality (MR). AR enriches the physical world with purely visual digital screens or overlays in the right place at the right time; VR is a fully immersive digital experience requiring special headsets; and MR is at the intersection of both, infusing interactive virtual content within the physical world.

Early XR applications made their appearance to the wider public when Google Glass was released in 2014, allowing users to view virtual elements inserted into their surroundings via an AR lens. While mass market popularity of AR reached its peak in 2016 with the launch of interactive smartphone and tablet apps like Pokémon GO and Snapchat, enterprise adoption of AR began its slow but steady climb during these years, with smart glasses first introduced to the supply chain for workflow guidance and seamless, hands-free remote support. In 2018, Oculus released the first VR stand-alone, head-up displays for consumers. With VR's ability to create a fully immersive virtual experience through headsets, the gaming market was an early adopter but, over time, many enterprises, including those in logistics, recognized the potential of 360° virtual content for engagement and worker training, and VR now continues to gain traction.

With ongoing AR and VR developments, MR – a new form of XR – began to emerge in recent years. Unlike AR, MR not only displays additional virtual content onto reality but also utilizes elements of the physical world to contextualize the virtual content, allowing virtual content to blend in or interact with physical objects through a lens, like having virtual goods appear to move along a real conveyor belt in an actual warehouse. MR technology allows users to not only view virtual objects, but also collaboratively interact with them, opening up an array of possible use cases yet to be explored. Like VR, MR requires dedicated hardware, but it differs in that the virtual experience is not fully immersive; users generally remain cognizant of the physical world surrounding them but can also see embedded interactive virtual elements.

Overall, XR headset sales massively increased during the Covid-19 pandemic, reaching a global total of 11.2 million units shipped in 2021. On the software side, we have seen major developments with more and more providers like TeamViewer offering no-code editors as part of their applications. This enables logistics companies and other organizations to easily generate and manage their own content for XR applications.

Today, multiple industries including logistics are using AR smart glasses for workflow guidance and remote support, and there is a lot of potential for even wider application. Similarly, companies are also using VR, particularly for training and simulation. First examples of use cases can be seen in logistics and there is also much potential to scale these applications. Still in a nascent stage, MR can be expected to develop quickly within the near future and it is interesting to imagine the use cases where MR is likely to offer real differentiation, going beyond AR to achieve more than just enhancing the user experience.

Trend Overview

Impact: MILD

Realization: < 5 YEARS

Focus Areas:
Automation & Efficiency | Customer Experience | Environmental Sustainability | Health, Safety & Future of Work

Trend Clusters:
Bionic Enhancements

Sectors:
Auto-Mobility | Energy | E-Retail & Fashion | Life Sciences & Healthcare | Technology

Relevance to the Future of Logistics

Workflow Guidance

Making operational processes more efficient and less prone to human error as well as quickly onboarding new employees are crucial to success in the logistics industry. The use of AR or MR headsets with dedicated software enables companies to provide hands-free step-by-step instructions to employees while they are performing operational tasks. Here at DHL, we were a first mover in using smart glasses for workflow guidance in the picking process, with pilot projects already completed in 2014. These smart-glass picking process solutions offer hands-free operation and have increased productivity while reducing error rates; these represent substantial benefits for DHL customers.

Today, so-called vision picking is an inherent part of DHL's service portfolio. What has worked for the picking process is easily replicated in other processes – for example, upskilling labor so workers can provide more complex value-added services to customers and accelerating new employee onboarding time. With the increasingly availability of quick-to-build no-code applications, it is now very easy to digitalize workflows and run them on smartphones, tablets, and smart glasses.

For more complex tasks, it sometimes makes sense to use MR as this allows contextualized 3D digital content to be projected onto real objects for more detailed guidance. The user in this case would need to wear a headset such as the Microsoft HoloLens or the Magic Leap for visualization. While some first examples of MR exist in logistics – for example, maintenance of complex machinery – other suitable use cases are yet to be explored.

Training & Simulation

While AR and MR are adding virtual content to reality, VR can be used to create immersive training experiences, simulating realistic scenarios in a fully virtual environment. Among industry experts, VR is often referred to as the future of training. Participants in VR training sessions learn 4x faster than in classroom training. This could be explained by the fact that participants show significantly higher emotional connection to virtual content and are far less distracted during fully immersive VR training.

Considering the training time that can be saved and the fact that content creation is now easier (and more no-code editors are available), it is becoming increasingly attractive to invest in VR for training. DHL Express is already using VR as a training and engagement tool for employees and external audiences. In a gamified approach, people can learn how to load pallets and containers with shipments. They are awarded more points if they use space optimally and pay attention to special-handling labels.

Using VR for training is ideal to simulate a real-world situation, allowing people to learn and take decisions in a safe environment, and it can also ensure a fun experience.

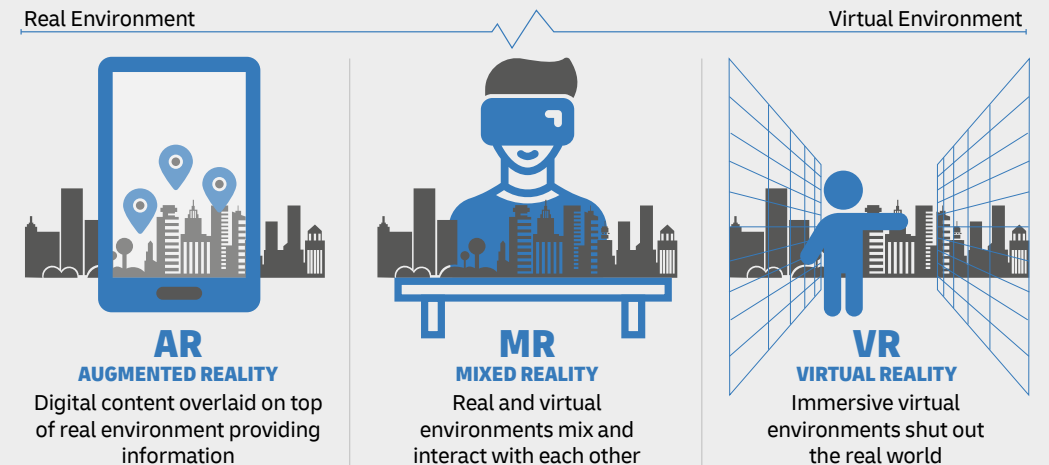## Remote Support & Collaboration

AR technology enables a remotely located expert to be connected to an on-site operator wearing smart glasses via a live video call; this allows both people see the same things at the same time, and it keeps the operator's hands free. With dedicated software, the expert can provide instructions, sketches, and annotations to guide the operator.

During the Covid-19 pandemic, when travel restrictions and social distancing meant experts could not physically visit and stand alongside operators, this application area gained a lot of traction for audits, project go-lives, and site inspections. Beyond the pandemic, remote support is a great alternative to in-person support, eliminating the time and cost of travel with the added benefit of sustainability.

The combination of workflow guidance and remote support promises significant gains for maintenance, service, and any other process requiring expert knowledge which is not always available locally. In addition to providing immediate access to expert knowledge, these solutions typically allow for automated report generation for documentation purposes.

If higher levels of collaboration are required, it is interesting to consider using VR and MR headsets. With an MR solution, people in multiple locations can meet in a single virtual collaboration space and use 3D holograms to design products, solutions, and processes, for example. There are also examples of conferences and events being held in a fully virtual way, using VR headsets to meet as avatars in a virtual space.
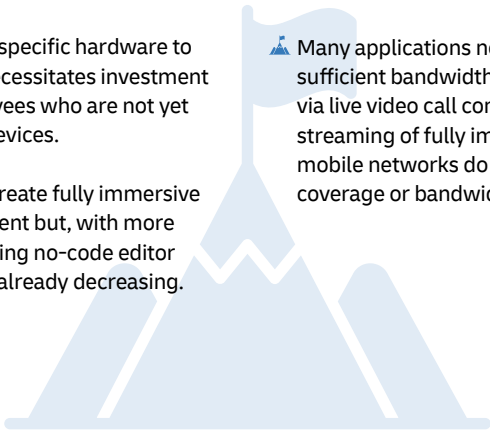
The Reality-Virtuality Continuum offers users a wide range of experiences.

Real Environment — Virtual Environment

AR AUGMENTED REALITY — Digital content overlaid on top of real environment providing information

MR MIXED REALITY — Real and virtual environments mix and interact with each other

VR VIRTUAL REALITY — Immersive virtual environments shut out the real world

Source: ResearchGate

Challenges

⛰ Most XR use cases require specific hardware to display information; this necessitates investment and onboarding for employees who are not yet familiar with using these devices.

⛰ It takes time and effort to create fully immersive content and workflow content but, with more and more platforms providing no-code editor applications, this barrier is already decreasing.

⛰ Many applications need live connectivity – with sufficient bandwidth to pull data from a system via live video call connectivity and with actual streaming of fully immersive 3D content – but mobile networks do not yet offer the required coverage or bandwidth.

Resources

| Building a virtual reality experience for DHL | → | Logistics VR Training with DHL | → |

Outlook

This trend should be **CLOSELY monitored,** with implementations available for many use cases today.

Early headsets traded off computing power and battery life with size and weight but technology advances are now changing this. A start-up called Mojo Vision has even developed a first prototype of a smart contact lens. Responding to metaverse developments, AR glasses are likely to conquer the consumer market soon; Apple may launch an Apple Glass, and Google – although cautious about privacy concerns – may publicly test new smart glass prototypes. Seeing these hardware developments and the growth of 5G coverage, we here at DHL consider it the right time to prepare for mass adoption of data-heavy VR and MR applications.

Related Trends

| Metaverses | → | Remote Work & Teleoperation | → |
| Digital Twins | → | Wearable Sensors | → |

Sources
IDC (2022): AR/VR headset shipments grew dramatically in 2021.
PWC (2021): How virtual reality is redefining soft skills training.

DHL

INDOOR MOBILE ROBOTS

The trend of Indoor Mobile Robots encompasses the various types of portable robot that fulfill tasks primarily inside facilities without direct input from human operators. Automated guided vehicles (AGVs) follow predetermined visible or invisible paths, while their next-generation successors, autonomous mobile robots (AMRs), use real-time path planning and can more freely move around obstacles.

Mobile automation has developed through 2D lidar autonomy to 3D visual autonomy, which is currently maturing, significantly advancing AMRs in various applications and boosting uptake. AMR sales in the logistics industry are expected to grow by 31% per year between 2020 and 2023.

Today, we are seeing more and more applications for indoor mobile robots in logistics. Especially in markets with higher labor costs, indoor mobile robots are being used extensively in order fulfillment. In other areas such as automated mobile manipulation however, the technology is not yet widely marketable and will take a few more years to achieve commercialization on an industry-wide level. As soon as indoor mobile robots can be deployed at scale, they have enormous potential to reduce cost and increase efficiency within operations. Therefore this trend is considered highly impactful for the logistics industry.

Trend Overview

Impact: HIGH

Realization: < 5 YEARS

Focus Areas:
Automation & Efficiency | Health, Safety & Future of Work | Physical & Digital Security | Visibility & Resilience

Trend Clusters:
Robotics

Sectors:
Auto-Mobility | Energy | Engineering & Manufacturing | E-Retail & Fashion | Life Sciences & Healthcare | Technology

DHL

Relevance to the Future of Logistics

Point-to-Point Transportation

Moving goods between predefined locations within a warehouse is an essential yet highly repetitive process that takes up a lot of warehouse staff time. Using indoor mobile robots is an effective way to save resources, with just one employee overseeing a fleet of transport indoor mobile robots while the rest of the workforce is free to perform more value-adding tasks.

When selecting the appropriate autonomous solution for point-to-point transportation, there is a distinction between three-dimensional (such as an autonomous forklift) and two-dimensional (such as autonomous pallet jacks and bin-pulling robots) devices. Furthermore, with deployments in 3 different regions, DHL has already deployed several of these autonomous forklift fleets. Fleets of autonomous high reach robots that take over the full pallet picking and put away tasks, lifting up to 11m high while also performing double-deep activities.

In addition, there are solutions such as the EffiBOT, a fully autonomous handling robot from the French company Effidence, which also has follow-me mode to follow humans and carry loads of up to 300 kg. This allows the system to be utilized in environments that may still be too complex or dynamic for most AMR technology today.

These examples show there are already many solutions on the market for point-to-point transportation, each capable of significantly reducing the repetitive workload, walking distances, and time of logistics staff.

Order Fulfillment & Assisted Picking

In the unautomated warehouse environment, workers can sometimes be required to walk up to 9 miles each day. This puts an enormous physical burden on workers and at the same time presents an opportunity and a strong argument for the introduction of indoor mobile robots. Assisted picking robots can drive efficiency in the overall order fulfillment process by shortening the distance walked by humans and reducing the time between picks.

There are two main types of order fulfillment solution: goods-to-person AMRs and solutions that fall into a zone picking category. A classic goods-to-person AMR solution comes from Geek+ with robots able to pick up and transport inventory shelves to the required picking or pack station where an employee prepares the order for fulfillment without having to walk anywhere.

In zone picking, on the other hand, workers are assigned to a specific predefined warehouse area in which they operate. A prime example of a direct zone picking solution is from Locus Robotics, and DHL recently celebrated its 100 millionth pick using Locus robots. In this Locus solution, totes are placed on robots that travel to pickers in various work zones and then visually indicate the closest pick option for each tote via a screen.

Using AMRs to support order fulfillment allows workers to focus on the accuracy of their picking and significantly diminishes the distance they must cover each day and the required travel time.

Loading & Unloading

Loading and unloading containers and trucks with loose load is one of the most physically demanding activities in logistics. Workers are exposed to extreme weather conditions and must repeatedly move heavy goods in confined spaces as quickly as possible to ensure downstream operations can continue uninterrupted.

More and more companies are exploring ways to automate these tasks. To unload pallets from a trailer, Fox Robotics has developed the Automated Trailer Unloading solution. It offers simple implementation, with no need for warehouse management system integration, and simple user interfaces – just one operator can control several robots simultaneously via a tablet.

Boston Dynamics is developing the Stretch robot for a range of different warehouse tasks but initially this indoor mobile robot will enable autonomous unloading of floor-loaded containers and trucks. Stretch consists of three components: a lightweight robotic arm that can lift cartons of up to 50 lb (22.7 kg), a relatively small mobile base designed to easily fit inside trailers and containers, and the perception arm that includes depth sensors and 2D cameras to help the robot identify cartons of different shapes and sizes and provide insights into helping Stretch perceive the environment in which it operates. Future models may be capable of loading, building up pallets, and depalletization.

Today's deployed solutions are typically for unloading cartons or pallets. However, with advances in robotic software and computer vision capabilities, indoor mobile robots will eventually achieve additional autonomous capabilities such as mobile case picking. Nevertheless, loading and unloading of mixed cases are complex tasks and it will take further research and development before scalable autonomous solutions comes to market.

Facility Support

According to a study by the European Parliament, more than 8.34 billion USD (8.2 billion EUR) is lost annually in Europe due to cargo crime alone. Globally, 25% of all cargo crimes take place within warehouses.

With increasing sprawl and the resulting higher requirements for security infrastructure, today's warehouses are at risk. Companies can integrate autonomous security robots (ASRs) to better monitor and control these facilities. Use cases range from automatic license plate recognition to the detection of blacklisted mobile devices or suspicious devices and video surveillance.

The four-legged mobile robot Spot, from Boston Dynamics, can be used as an ASR, equipped with additional cameras and night-vision technology. Designed to walk stairs and uneven terrain, this robot can live monitor different levels in a warehouse or operations facility, and can be operated remotely via a tablet or follow pre-mapped routes.

The use of ASRs in warehouse security and surveillance remains limited but, in future, it is likely that security robots will be used as a deterrent, forming a minor part of a comprehensive security concept.

In addition to security robots, autonomous cleaning robots are increasingly used to support facilities. One example is the Liberty SC60 from the Danish company Nilfisk, a robot specifically designed for cleaning large areas which features a 5 hour maximum run time and utilizes BrainOS, one of the leading AI platforms for autonomous mobile indoor robots, for its navigation.
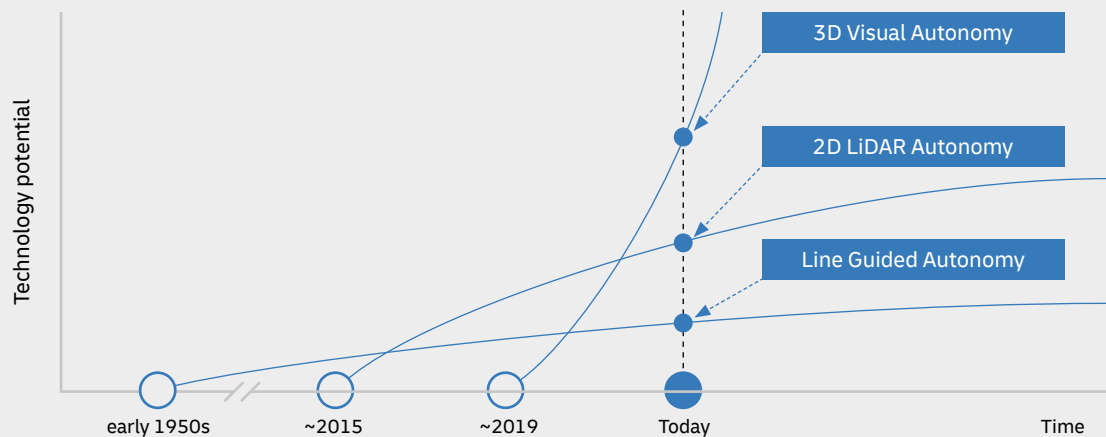
Relevance to the Future of Logistics

Inventory Management Automation

According to a study by the global real estate company CBRE, rental costs for industrial properties including warehouses have increased by 25% on average compared to the prices paid at the end of five-year leases expiring in 2021. This means space utilization within the warehouse is becoming increasingly important.

One way to boost storage density is by introducing an automated storage and retrieval system (ASRS). These computer-controlled robotic storage systems can be used for autonomous handling, storage, and retrieval of totes or shelves in a warehouse. ASRS solutions, such as the cube-based system from Norwegian company AutoStore, have many advantages over traditional picking solutions. AutoStore's solution offers a high-density system reducing the required space by a factor of up to 4 and can speed up manual picking by up to 5 times compared to conventional picking.

Although the initial investment for such solutions is relatively high, this can be economically viable, especially when handling large volumes of stock keeping units (SKUs) of slow- and medium-velocity goods, optimizing the throughput and operational efficiencies of the system.

Autonomous navigation technology of indoor mobile robots has developed considerably, especially in the last decade.

- 3D Visual Autonomy
- 2D LiDAR Autonomy
- Line Guided Autonomy

Technology potential

early 1950s — ~2015 — ~2019 — Today — Time

Source: DHL

Challenges

- There needs to be adequate Wi-Fi or cellular network coverage throughout the facility to guarantee frictionless integration of an AMR solution over a large area, all while meeting the necessary IT security requirements.

- Deploying a fleet of numerous automated robot solutions from different manufacturers requires very robust software platform enabling efficient route planning and mission dispatching.

- In crowded facilities where many people are working and numerous obstacles block the way, an indoor mobile robot may detect too many obstacles that interfere with its ability to integrate seamlessly into operations.

- Indoor mobile robot system integration can be challenging given the wide variety of warehouse management platforms in use.

- In an environment where indoor mobile robots operate alongside personnel, a comprehensive safety and risk analysis must be performed due to the added complexity of navigating in close proximity to humans.

Outlook

This trend should be **ACTIVELY monitored,** with imminent developments and applications.

There are already many different indoor mobile robot use cases and applications currently being scaled in logistics, as can be seen in the example of Locus. However, if you look at the entire indoor mobile robot technology suite, it cannot yet be implemented in every warehouse. Before further solutions can be scaled and used in a variety of applications, the technology must further mature and decision makers must gain confidence in this technology to willingly deploy these solutions in mission-critical tasks. More steps are being taken towards full warehouse orchestration so, in the not-so-distant future, indoor mobile robot solutions together with stationary robotics will start to automate and support a large part of warehouse work.

Resources

| | DHL - Assisted Picking Robots: Picking up the pace | → |

| | DHL - Deployment of autonomous fork lifts in Belgium | → |

| | DHL - DHL Supply Chain invests to furher automate warehousing via Boston Dynamics collaboration | → |

| | DHL - Implementation of DHL Supply Chain's first European fully automated small parts warehouse | → |

Related Trends

Computer Vision →

Drones →

Outdoor Autonomous Vehicles →

Stationary Robotics →

Sources
International Federation of Robotics (2021): Mobile Robots Revolutionize Industry.
Forbes (2021): Warehouse Labor Woes Are Worse Than Ever.
DHL (2022): DHL Supply Chain surpasses 100 million units picked by Locusbots in North America.
TT CLUB, TAPA EMEA and BSI Connect SCREEN Intelligence (2021): 2021 Cargo Theft Report.
DHL (2021): DHL Supply Chain further accelerates commercial deployment of its fleet of autonomous forklifts and pallet movers.
DHL (2021): DHL Supply Chain deploys its first autonomous forklifts in North America.
DHL (2021): See DHL Robots at Work: EffiBot.

INTERACTIVE AI

The trend of Interactive AI involves artificial intelligence (AI) algorithms that can process human user input, like text and speech, and provide a reasonable response. Advanced forms of this technology can interpret various writing styles and accents, hold complex conversations, perform complex tasks beyond simple commands, and mimic a sense of empathy with human users.

Emerging from the overarching trend of AI, there are multiple types of interactive AI with varying applications ranging from geolocation and navigation, facial detection and recognition, chatbots, digital assistants, speech-to-text dictation, and e-payment, to name a few. Within logistics and the supply chain, this brings greater efficiency to operations, making the day-to-day activities of employees less manual while also delivering a more automated customer experience.

Considering the impact so far of AI on the logistics industry, we here at DHL expect further developments in the next 5 years for the subset Interactive AI trend. This will have a powerful impact on customer-centric business approaches for logistics companies, as use cases are being identified across a multitude of workflow processes at all transactional levels in the supply chain powerfully. Continuous adoption and scaling of interactive AI technology within warehouses and other operational environments as well as in back-office workflows demonstrates the opportunities for human-machine collaboration.

Trend Overview

Impact:

MILD	

Realization:

< 5 YEARS

Focus Areas:

Automation & Efficiency   Customer Experience   Health, Safety & Future of Work

Trend Clusters:

Artificial Intelligence

Sectors:

Auto-Mobility   Engineering & Manufacturing   E-Retail & Fashion   Life Sciences & Healthcare   Technology

DHL

Relevance to the Future of Logistics

Customer Experience Automation

With customer experience at the core of business success in logistics, customer service departments are very important to logistics companies. These departments are the first touchpoint when issues arise. Chatbots can help logistics companies handle low to medium-volume call center queries about, for example, requesting deliveries, editing orders, shipment tracking, and responding to FAQs.

Chatbots can also facilitate valuable analytics metrics, enabling the company to better understand customer needs and enhance the customer experience. As a result, chatbots represent today's fastest-growing brand communication channel with a handling rate of chat completion from start to finish at 68.9% in 2020 (an increase of 260% in end-to-end resolution over 2017), with the contribution to e-commerce transactions predicted to reach 112 billion USD by 2023. With Interactive AI, customer service automation also extends to user input processing through other commonly used communication channels such as immediate email responses, automated phone services, and integration with most widespread used text messaging platforms. This extends the realms within which customers can obtain immediate and satisfactory responses to enquiries.

Chatbots In The Workplace

In the context of digital workplaces, chatbots are commonly used in just about all sectors, most significantly in the healthcare industry when Covid-19 hit, to handle the massive influx of questions from the public. In all sectors, AI chatbots can enable workers to access the information needed to complete their work.

According to Gartner, 70% of white-collar workers will interact with chatbot platforms daily by the end of 2022. Similar to customer service applications, these platforms can provide immediate information and answers to office workers, helping the organization disseminate details about change management, human resources, helpdesk support, general services, anomaly reporting, and organizing meetings.

For logistics operations, chatbots can streamline inventory handling and management, cargo tracking, and delivery schedules, as well as customer relationship management (CRM) and warehouse management system (WMS) updates. The adoption of interactive AI technology within the supply chain automates workflows and order management, freeing up operations employees to focus on more complex and value-adding tasks. In the event of a chatbot being unable to complete an enquiry, it assigns the task to a human for further action while notifying the requestor about this status.

AI-Assisted Sales & Marketing Employee Experience Automation

Analytics of data captured on an interactive AI platform can provide valuable insights to the business. For example, companies may better understand customer pain points and consumer behavior patterns, enabling more effective marketing campaigns to attract potential leads. Data analytics can help with price optimization and – for retailers – better in-store and web-based layout mapping based on behavioral data. It can also help retailers and e-commerce businesses efficiently manage the supply chain while ensuring supply and demand are met at operational level.

Start-up vendors delivering sales and marketing intelligence as well as acceleration software tools like Groove and UpLead enable companies to reach their full potential through interactive AI. In recent years, we've all become familiar with AI assistants – for example, Amazon's Alexa which provides consumers with an AI-powered cloud-based voice service accessing hundreds of millions of devices including third-party device manufacturers.

Data captured through Alexa and similar devices enables more individually targeted marketing, with algorithms to analyze consumer behavior. Meta's chatbot BlenderBot accumulates user data to tailor its responses in accordance with the user's history, tapping into the vast library of human thought on the internet. The device is trained on large language datasets, allowing it to generate with factual accuracy passably human responses to questions. In the long term, the purpose and goal of this chatbot is a virtual assistant capable of responding to a wide variety of topics with factual intelligence.

Chatbots are becoming useful tools for businesses when engaging with customers.
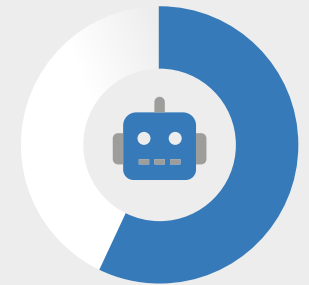

Response rate from customers

90% Best chatbots
40% Average chatbot

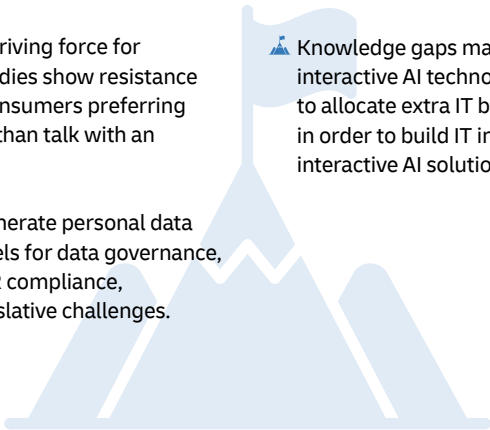67% average increase in sales after chatbot implementation

57% of businesses say that chatbots deliver massive ROI on minimal investment

Source: Thrive My Way

Challenges

- Customer experience is a driving force for logistics companies yet studies show resistance to chatbots, with 60% of consumers preferring to wait for an agent rather than talk with an interactive AI device.

- Interactive AI platforms generate personal data from users, raising risk levels for data governance, privacy, security, and GDPR compliance, potentially resulting in legislative challenges.

- Knowledge gaps may prevent smooth adoption of interactive AI technology; organizations will need to allocate extra IT budget to this niche skillset in order to build IT infrastructure and deploy interactive AI solutions.

Resources

DHL - How digitalization has transformed DHL Express' operations →

Outlook

This trend should be **ACTIVELY monitored,** with imminent developments and applications.

While we have seen developmental leaps in AI in recent years, it continues to generate interest and investment is predicted to grow in the long term in expanding interactive AI applications capable of driving significant economic value. The 3 key building blocks of more data, better algorithms, and stronger computing power indicate these use cases are likely to materialize and scale.

Logistics and the supply chain are integral to soaring AI adoption levels every year. The industry's AI adoption rate is predicted at 42.9% CAGR, reaching a value of 6.5 billion USD by 2023. By adopting interactive AI technology, the logistics industry can respond effectively to the operational challenges of growing B2B and B2C demand for immediate goods delivery.

Related Trends

Digital Marketplaces →

Big Data Analytics →

Computer Vision →

Extended Reality →

Sources
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Beezy (2021): AI chatbots: The good, the bad, and the employee experience.
Locobuzz (2021): Importance Of Chatbots For Logistics And Supply-Chain.

Groove (2020): Groove sales productivity platform.
UpLead (2020): UpLead.
Multiple (2022): Future of AI according to top AI experts: In-Depth Guide for 2022.
Data Root Labs (2021): Artificial Intelligence in Logistics: Emerging Startups, Challenges and Use Cases.

NEXT-GENERATION PACKAGING

The trend of Next-Generation Packaging refers to the evolving changes in materials used for primary, secondary, and tertiary packaging as well as the technology added to this packaging. These materials and new technology enable packaging to sense and react to environmental changes and to changes in the packaged contents. This trend also incorporates elements of sustainability, incorporating new packaging materials that are more bio-based, recyclable, reusable, and biodegradable.

From the continued boom and rise of e-commerce to the global drive for sustainability, the need is growing for creative and cost-efficient packaging solutions with a heavy focus on the reduction of CO_2 footprints. In order to meet customer demand, there is keen focus on recyclability, reusability, compostability, and biodegradability and a rising demand for antimicrobial packaging, package traceability, and condition-monitored packaging. It is increasingly important for logistics providers to meet these needs. Propelled by population growth, technological developments, and changing consumer expectations about product packaging, the global packaging market has seen rapid growth in recent years. With a current market size of 27.4 billion USD, the global next-generation packaging market is forecast at a 10-year CAGR of 6.1% to reach a market size of 49.3 billion USD by 2032.

This growth is mainly driven by consumer awareness around topics of sustainability and the development of new technologies to ensure product-handling safety and care in the end-to-end supply chain right up to final delivery. Recent advances in packaging technology include the incorporation of radio-frequency identification (RFID) tags, sensors, and indicators in packaging materials, as well as redefining the way packaging materials are sourced.

With developments in this trend set to continue in the next 5 years, more and more companies are reconsidering the materials used in their packaging. In May 2022, the global packaging company Amcor launched its latest technology bottles that are up to 30% lighter and made of 100% recycled materials. As more companies change the ways they use materials and sustainable goods, logistics players also need to make adjustments, implementing next-generation packaging practices and reevaluating current operations to ensure new types of packaging can be processed safely through conveyor belts, scanners, and more and the contents of this packaging can be delivered without damage to recipients.

Several big industry players are expanding packaging solution portfolios through partnerships, acquisitions, and mergers. For example, MeadWestvaco merged with Rock-Tenn to become WestRock, currently the second largest American packaging company. Another example is the collaboration between manufacturers Stora Enso and NXP Semiconductors to develop intelligent packaging with integrated RFID technology, a solution designed to enhance consumer engagement and improve supply chain efficiency.

Trend Overview

Impact:

MODERATE	

Realization:

< 5 YEARS

Focus Areas:

Customer Experience   Environmental Sustainability   Visibility & Resilience

Trend Clusters:

Internet of Things   Packaging & Containers

Sectors:

Auto-Mobility   Engineering & Manufacturing   E-Retail & Fashion   Life Sciences & Healthcare   Technology

DHL

Relevance to the Future of Logistics

Active Packaging for Fresh & Cold Chain

Active packaging incorporates additives to maintain or extend product quality and shelf life. Active packaging solutions today account for an over 36% share of the global next-generation packaging market and are predicted to remain dominant for the next 10 years. Examples of active packaging include antimicrobial packaging, heating/cooling packaging, items including gas emitters, absorbers and scavengers, moisture/odor/flavor absorbing and releasing packaging, corrosion control packaging, and spoilage retardant items.

These types of packaging are engineered to respond and react to changes in the external and internal atmosphere of a package and are therefore of utmost importance and significance to the pharmaceutical and nutraceutical industries. Logistics providers in turn, need to have fresh chain and cold chain operational capabilities in place to ensure product delivery meets the standards set by customers and, aligns with varying fresh and cold chain legislation.

## Intelligent Packaging for Asset Monitoring

Intelligent packaging systems monitor the internal condition of packaged goods to give information on quality during transportation and storage. Simply defined as packaging which senses and informs, these systems integrate hardware components such as time temperature indicators (TTI), freshness and ripening sensors, and RFID and other tags. This helps maintain the quality of products , contributing to a reduction in global waste. The healthcare and pharmaceutical industries are considered major growth markets, highlighted by the Covid-19 pandemic, as there is a growing need to improve supply chain visibility in these sectors.

Application opportunities for intelligent packaging are not limited to just these industries, however. Within logistics and supply chain operations, smart packaging solutions are vital to goods in many other industries, better protecting them with real-time tracking as this cuts the risk of theft, last-mile delivery diversion, counterfeiting, and other crimes.

An example of this is the BOX developed by the start-up company LivingPackets – a smart packaging solution equipped with sensors to monitor temperature, humidity, and shock during transportation. As the BOX incorporates a digital screen, there is no need for labels to be printed. The screen uses e-ink technology and therefore does not consume energy which, combined with the reusability of the box itself, makes this a sustainable smart packaging solution that contributes to circularity.

Modified Atmosphere Packaging

The vast expansion of global shipping and transportation capacity has enabled rapid transportation around the world of perishable goods and atmosphere-sensitive products. Within this complex process to ensure products arrive in best condition, the internal atmosphere of the storage container or packaging must be continuously maintained and may need to be changed . As such, the use of modified atmosphere packaging (MAP) becomes central to the effectiveness of transportation and delivery.

The benefits of MAP technology include reducing global food wastage, extending shelf life by days and even weeks, and achieving a more profitable and secure global food supply chain. For nutraceuticals, goods that tend to deteriorate through oxidation can be protected by actively replacing oxygen with nitrogen.

The Covid-19 pandemic highlighted the need for MAP solutions to facilitate global vaccine shipments, particularly controlling and modifying atmospheric temperature during transportation. One example of this is the development of packaging that incorporates internal dry ice.
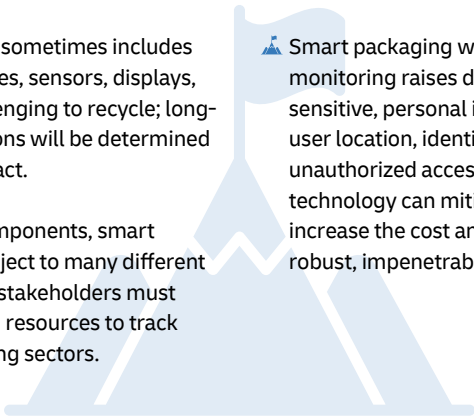
Next-generation packaging solutions can enable consumers and manufacturers to track shipment locations, receive notification of a package being opened, and monitor package condition throughout the journey.

Historic shipment data

Wireless connectivity

Location tracking

Temperature monitoring
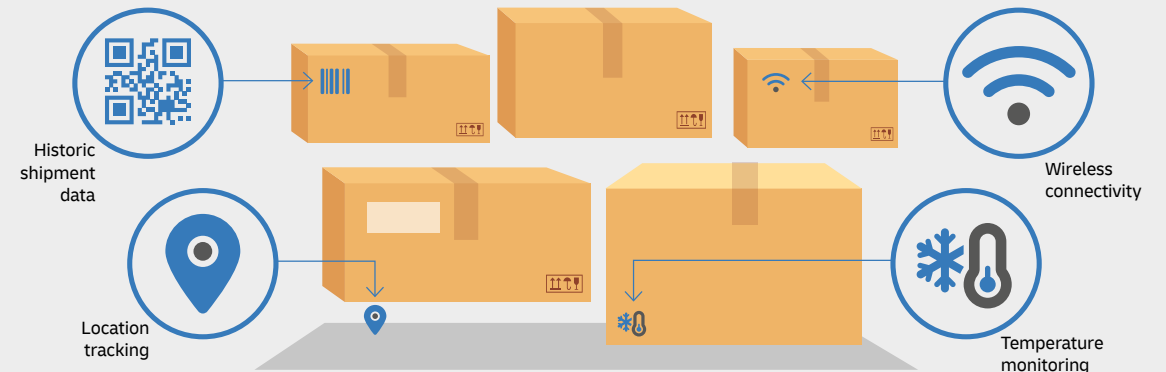
Source: Packmojo

Challenges

- Next-generation packaging sometimes includes components such as batteries, sensors, displays, and circuits which are challenging to recycle; long-term viability of such solutions will be determined by their environmental impact.

- As they include multiple components, smart packaging solutions are subject to many different regulations and legislation; stakeholders must commit significant time and resources to track changing rules in fast-moving sectors.

- Smart packaging with real-time tracking and monitoring raises data privacy concerns as sensitive, personal information (such as the end user location, identity, and preferences) is at risk of unauthorized access; cryptography and blockchain technology can mitigate this but significantly increase the cost and resources required for a robust, impenetrable solution.

Resources

DHL - How digitalization has transformed DHL Express' operations →

DHL - Trend Report: Rethinking Packaging ↓

Outlook

This trend should be **ACTIVELY monitored,** with imminent developments and applications.

From increasing visibility, improving security, and enhancing supply chain reliability, next-generation packaging shows great potential for further growth in increasing the efficiency and dependability of logistics and the supply chain. Outdated packaging systems will be replaced by smart packaging solutions as e-commerce continues to reshape the retail industry and as consumers and regulators demand greater sustainability and a smaller environmental footprint in logistics.

Related Trends

Circularity →

Smartification →

Blockchains →

Smart Labels →

Sources
Future Market Insights (2022): Next generation packaging market outlook (2022-2032).
Amcor (2022): Amcor PowerPost™ is next-generation technology that delivers a more sustainable bottle and better consumer experience.
Supply Chain Quarterly (2019): Smart packaging: challenges and opportunities in the supply chain.
AZO Materials (2021): Modified atmosphere gas mixers from environics.

NEXT-GENERATION WIRELESS

The trend of Next-Generation Wireless is the development and implementation of evolutionary wireless communication technologies and their supporting infrastructure. It includes the utilization of various frequencies and bandwidths across the electromagnetic spectrum to help connect everyone and everything everywhere.

The introduction of wireless internet to the supply chain ushered in the first major wave of digitalization in logistics, from desktop computers and sensors to some of the earliest autonomous mobile robots. However, as digitalization accelerates and more digital devices are incorporated into supply chain operations, the capacity, speed, and stability limitations of typical workplace Wi-Fi have been reached, and logistics leaders have begun testing and implementing alternative and new wireless communication networks. With the ability to effectively monitor, track, and interact with workers, assets, and shipments around the world, logistics providers can attain a new level of speed, accuracy, efficiency, and resilience for the supply chain.

The trend of Next-Generation Wireless has moderately low impact on the logistics industry. Although vast benefits are gained from instant and continuous visibility of workers, assets, inventory, and shipments, the trend's intersection and implementation in the supply chain will not be highly disruptive to operations. However, next-generation wireless technologies are anticipated relatively close to realization as they already exist and adoption is starting to accelerate across supply chain segments around the world.

Trend Overview

Impact:

MILD

Realization:

< 5 YEARS

Focus Areas:

Automation & Efficiency   Physical & Digital Security   Visibility & Resilience

Trend Clusters:

Digital Backbone   Internet of Things

Sectors:

Auto-Mobility   Energy   Engineering & Manufacturing   Life Sciences & Healthcare   Technology

DHL

Relevance to the Future of Logistics

End-to-End Visibility for Customers

Today's customers and supply chain managers highly value visibility of any shipment in the supply chain at any point in time. However, this visibility is still usually limited to just certain time stamps and infrequent updates, even if sensors are attached.

Next-generation wireless technologies are increasingly filling these visibility gaps along the supply chain. For ground transportation, low-power wide-area networks (LPWANs) such as LoRaWAN, LTE-M, NB-IoT, and Sigfox provide low-cost communication over very large areas, with a range usually up to 40 km (25 mi) in rural zones. As sensors using LPWAN transceivers transmit low amounts of data, their battery life using cheap, conventional batteries often extends past 10 years – an additional benefit. One example of LPWANs in use is at Istanbul International Airport where thousands of LPWAN sensors are deployed to monitor vehicles, including those carrying luggage and cargo. As such, a shipment can be tracked and monitored in real time on the tarmac between an airport freight hub and an aircraft.

For air transportation, the Bluetooth network, while not technologically new, has seen increased industrial use, further extending visibility along the supply chain. It is common for shipments to lose tracking as they are being flown due to stringent aviation regulations that govern wireless communication while in the air. In recent years, Swiss unit load device (ULD) management company Unilode developed and applied aviation-compliant Bluetooth beacons on over 118,000 ULDs across 45 airlines, enabling the first-ever transmission of shipment sensor and tracking data in real time during each flight.

For all transportation modes, global area networks (GANs) have become popular tools to enable end-to-end supply chain visibility. Supported by the growing number of low-Earth orbit satellites (LEOs), GAN providers like Starlink are pursuing the idea of pervasive global internet connectivity. For logistics organizations, this means low-power communication with shipment sensors in the remotest outdoor locations on the planet, including oceans, deserts, mountain ranges, and jungles where connectivity dead zones currently exist and disrupt information flow.

Overall, with the steady application and expansion of newer wireless communication technologies, logistics providers can offer customers complete end-to-end, real-time status updates on their shipments.

5G-Powered Robotic Fleets

Logistics organizations are increasingly procuring, integrating, and growing robotic fleets for indoor and outdoor tasks. While many of these robots often process data locally on each device, many still require communication with remote servers and with each other to optimize operations, updates, and troubleshooting. Today's mainstream wireless technology can support small fleets but connectivity issues will eventually result as bandwidth reaches capacity with more robots progressively added to the supply chain.

The worldwide adoption of 5G, the successor to 4G in broadband cellular networks, is considered key to enabling the practical operation and expansion of autonomous fleets in the supply chain. In terms of speed and capacity, this enhanced mobile broadband can deliver 10-20 gigabytes per second (Gbps), which is 100 times faster than 4G, allowing greater data transfer
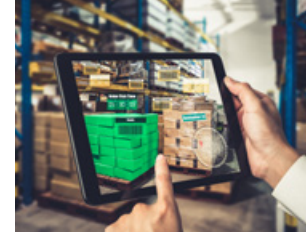
Operational Process Optimization

Optimization in supply chain facilities requires the collection and analysis of data. In turn, data needs to be accurate and travel on reliable communication networks between sensors and servers. Next-generation wireless technologies support both these requirements and are crucial infrastructure in building optimized logistics facilities of the future.

Local area networks (LANs) are viewed as good candidate solutions in this effort. As many facilities already have Wi-Fi to support mobile workstations, printers, hand scanners, and some machines and sensors, next-generation Wi-Fi 6 will be a natural successor, providing 3 times the speed, 4 times the capacity, and 75% lower latency (or delay before processing) than the more common predecessor. This will enable facilities to connect even more digital devices, including possibly small robotic fleets, as logistics organizations begin their digitalization process.

Meanwhile, ultra-wideband (UWB) technology enables precise indoor localization of people, assets, and shipments. While Wi-Fi and other networks including Bluetooth can detect positions within several meters or yards, UWB offers another level of accuracy, pinpointing assets and workers to within 5 cm (2 in), helping identify the correct location of a product on a picking shelf or align a self-driving forklift precisely with a pallet in a storage area.
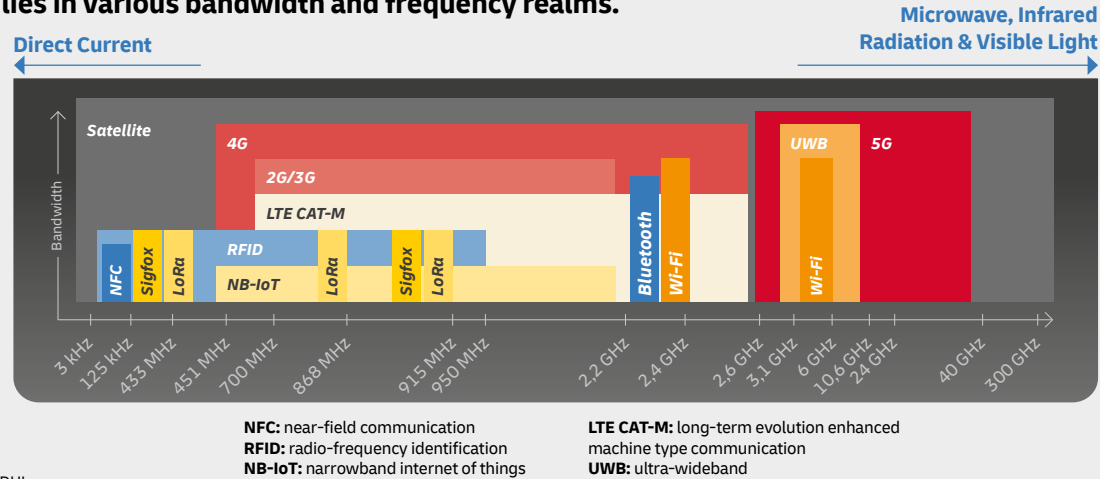
Short-range networks further facilitate optimization of operations in supply chain facilities. Although not new, radio-frequency identification (RFID) technology is again finding traction. Many retailers have moved away from barcodes and towards RFID to track inventory in warehouses without the need for visual line of sight. Meanwhile, Bluetooth Low Energy (BLE) is a rising alternative. As its name suggests, BLE networks use low energy from beacons, thereby elongating battery life to up to 5 years. Eliminating the need to frequently replace batteries of dozens to hundreds of assets, this makes it suitable technology for measuring different variables like the location and temperature of more permanent assets like forklifts and conveyor belts. Added to this, as most smartphones and tablets in facilities have near-field communication (NFC) capabilities, NFC applications can quickly be rolled out. Battery-less dynamic NFC tags embedded in shipments and assets can be powered by the energy field of a reader and provide short-range wireless transmission of data for quality checks.

between robots and servers, and with more robots in the network. Relatedly, in terms of connectivity support, it is estimated that 5G will be able to provide connection to 1 million devices per square kilometer (0.4 square miles), promoting active communication not just among robots and servers but also with hundreds of other sensors in the built environment.

Furthermore, in terms of latency (or delay before transferring data), 5G can reach significantly low levels of under 5 milliseconds – 12 to 20 times faster than 4G – which can unlock the high-speed, mission-critical communication needed for some robots like those driving on public roads. Also, unlike its predecessors, 5G supports network slicing. This means that the entire 5G bandwidth can be divided into several customized slices, in which each slice can be tailored to meet the varying speed, capacity, coverage, and security requirements of different use cases in the supply chain.

Overall, as more logistics organizations look to automate operations in the supply chain, 5G will be a critical piece of wireless infrastructure that must be considered in the digitalization journey.

Next-generation wireless communication technology lies in various bandwidth and frequency realms.

Direct Current

Microwave, Infrared Radiation & Visible Light

Satellite, 4G, 2G/3G, LTE CAT-M, RFID, NB-IoT, NFC, Sigfox, LoRa, Bluetooth, Wi-Fi, UWB, 5G

Bandwidth

3 kHz, 125 kHz, 433 MHz, 451 MHz, 700 MHz, 868 MHz, 915 MHz, 950 MHz, 2.2 GHz, 2.4 GHz, 2.6 GHz, 3.1 GHz, 6 GHz, 10.6 GHz, 24 GHz, 40 GHz, 300 GHz

NFC: near-field communication
RFID: radio-frequency identification
NB-IoT: narrowband internet of things

LTE CAT-M: long-term evolution enhanced machine type communication
UWB: ultra-wideband

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Challenges

🏔 Power, availability, and regulations may limit the viability and geographic reach of applications that can be built.

🏔 The security of wireless networks and infrastructure will be critical, as each connected device can act as a gateway for cybercriminals to access critical logistics infrastructure.

🏔 As multiple technologies can serve similar use cases, architectural investment decisions and priorities may not be immediately clear.

🏔 A fragmented industry and potential lack of collaboration between organizations may result in the need for multiple tags and sensors per shipment along the supply chain to register data through various communications networks.

Sources
Thales (2022): 5G vs 4G: what's the difference?
Qualcomm (2022): Everything you need to know about 5G.
Intel (2022): 5G vs. Wi-Fi 6: A powerful combination for wireless.
ScienceDirect (2019): A comparative study of LPWAN technologies for large-scale IoT deployment.

Outlook

This trend should be **ACTIVELY monitored,** with imminent developments and applications.

The trend of Next-Generation Wireless can bring about an unprecedented level of digital communication and data collection in supply chains around the world. However, logistics organizations have a lot of competing technologies and must weigh the opportunities and costs of each, given the use cases and existing infrastructure. As more players in the logistics industry collaborate and implement these networks, logistics providers and customers will begin to enjoy the greater benefits of total visibility, widespread autonomy, and near-perfect prediction to enhance operational efficiency and service quality.

Resources

⬇ **DHL - Trend Report: Next-Generation Wireless**

⬇ **DHL - Why LPWAN is essential to the future of IoT in logistics**

Related Trends

Smartification →

Space Economy →

Cloud & APIs →

Smart Labels →

OUTDOOR AUTONOMOUS VEHICLES

The trend of Outdoor Autonomous Vehicles encapsulates the variety of self-driving robots operating primarily outside on land or water, both within private property and on public rights of way. This trend focuses on vehicles that are either completely driverless or at least highly automated with occasional control by a human driver.

The dream of self-driving vehicles has been decades in the making. Bolstered by rapid developments in artificial intelligence (AI), edge computing, and sensor technologies, it has come even closer to reality in recent years with all modes of highly automated vehicle making an appearance on the market and fully automated vehicles making test debuts. In late 2021, American startup TuSimple completed the first-ever fully autonomous semi-truck run on public roads, and a few months later, a Japanese consortium of freight companies successfully sailed and docked the world's first fully autonomous container ship without a crew onboard. In the logistics industry, manufacturers, owners, and leasers of all modes of vehicles are starting to look excitedly ahead at what is to come, not just for shipping purposes, but all possible use cases along a supply chain.

The Outdoor Autonomous Vehicles trend will have high impact in logistics as it will significantly change the operational tasks performed by human workers and alter the way that customers interact with logistics providers in the last mile and elsewhere. This trend's realization, however, is quite distant. While implementation has already begun with some use cases on private, gated properties, autonomous driving on public rights of way requires societal confidence. It will take many more years before people trust fully autonomous technology and regulations permit unhindered application on a global scale.

Trend Overview

Impact:

HIGH

Realization:

5-10 Years

Focus Areas:

Automation & Efficiency   Customer Experience   Health, Safety & Future of Work   Physical & Digital Security

Visibility & Resilience

Trend Clusters:

Robotics

Sectors:

Auto-Mobility   Energy   Engineering & Manufacturing

DHL

Relevance to the Future of Logistics

Automated Yard Operations

Warehouse yards, airports, seaports, and other facilities typically allow quicker implementation of self-driving robotic solutions than public rights of way since these private premises are not usually subject to stringent regulations. With an industry-wide labor shortage and focus on safety in operations, logistics organizations are eyeing these closed grounds as entry points for various outdoor autonomous vehicle operations, and there are many tech providers ready to provide suitable products and services.

American startup Outrider, for example, has developed self-driving terminal tractors that transport assets within a warehouse yard, including fully autonomous articulated backing capabilities into the docking stations of trailers and containers up to 16 m (53 ft) in length. ThorDrive, another US-based startup, is perfecting its autonomous cargo and baggage tractors for use at airports. Meanwhile, the French company Stanley Robotics is targeting the automobility market with its valet robot fleet that can lift and maneuver finished vehicles, saving space by parking them with greater density than human drivers can achieve.

In implementing these self-driving solutions, logistics organizations can close any labor gaps in yard operations and simultaneously reap the efficiency benefits that adopting such technologies often brings.
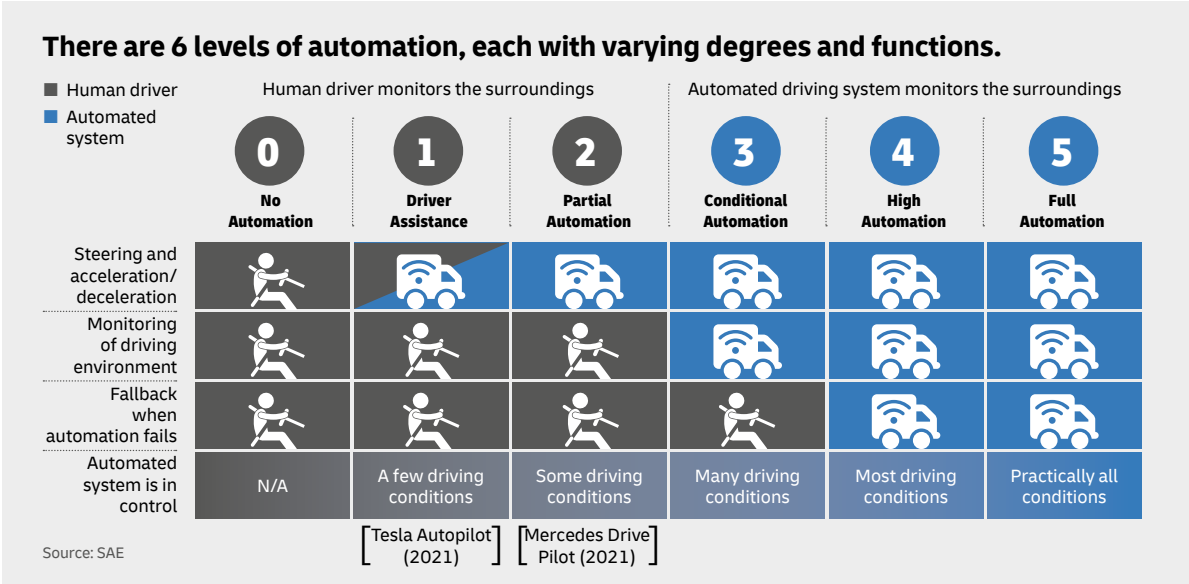
Long-Haul Optimization

Global shortages of human drivers, pilots, conductors, and captains – as well as fewer predictable and set routes – are setting the stage for automation in long-haul, middle-mile logistics operations. Self-driving vehicles in this segment of the supply chain can bring a new level of optimization unachievable with human operators.

With almost instant assessment of the surroundings, autonomous vehicles can minimize crashes that potentially stall the supply chain. Additionally, by driving much closer together at high speeds, two or more communicating self-driving vehicles can form a tight platoon, providing up to 20% in fuel savings and reducing emissions.

Furthermore, without the need for a human crew, more vehicle space can be allocated to cargo. Einride, a Swedish autonomous truck startup, eliminates the entire truck cab, lowering production and operations costs while increasing loading capacity and energy efficiency. Cargo ship designers like Rolls-Royce hope to do the same with future vessels, dedicating more room to cargo instead of canteens and dormitories, to lower transportation costs for each container.

Overall, the adoption of autonomous vehicles in long-haul segments of the supply chain can reduce operations costs and increase efficiency in terms of throughput, capacity, and sustainability.

New Last-Mile Models

The last-mile segment of supply chains is expensive, representing about 53% of today's total shipping costs. With the number of online orders consistently rising and straining delivery services, outdoor autonomous vehicles are seen as a solution that cuts costs while keeping up with demand.

The Covid-19 pandemic saw increased deployment of sidewalk rover fleets, such as the Kiwibot made by a Colombian startup, providing contactless food deliveries en masse to individual customers, with each small rover carrying a single order. Meanwhile, Chinese giant Alibaba went in another direction, developing its own in-house delivery robots that can carry up to 50 packages at once and cover 100 km (62 mi) on a single charge.

Overall, there are many mostly automated solutions for logistics providers to investigate and implement today to help manage costs and service levels for last-mile customers. However, given the complexities of last-mile delivery, from varying paths to customers' doorsteps and complicated road intersections, logistics leaders will mostly likely have to wait closer to a decade for fully automated solutions to come to market that will not require any human piloting intervention.

There are 6 levels of automation, each with varying degrees and functions.

Legend: ■ Human driver ■ Automated system

Human driver monitors the surroundings | Automated driving system monitors the surroundings

	0 No Automation	1 Driver Assistance	2 Partial Automation	3 Conditional Automation	4 High Automation	5 Full Automation
Steering and acceleration/ deceleration	Human	Automated	Automated	Automated	Automated	Automated
Monitoring of driving environment	Human	Human	Human	Automated	Automated	Automated
Fallback when automation fails	Human	Human	Human	Human	Automated	Automated
Automated system is in control	N/A	A few driving conditions	Some driving conditions	Many driving conditions	Most driving conditions	Practically all conditions

[Tesla Autopilot (2021)] — level 1
[Mercedes Drive Pilot (2021)] — level 2

Source: SAE

Challenges

⛰ Legal restrictions in various regions may prevent or slow adoption.

⛰ The cost advantages of self-driving solutions may be difficult to calculate; there are often high implementation costs and it can be hard to fiscally quantify the benefits of consistency, efficiency, accuracy, and sustainability.

⛰ Potential hacking and the risk of software bugs raises security and safety concerns.

⛰ Upskilling and retraining programs may be needed for employees who are affected by the introduction of driverless vehicles.
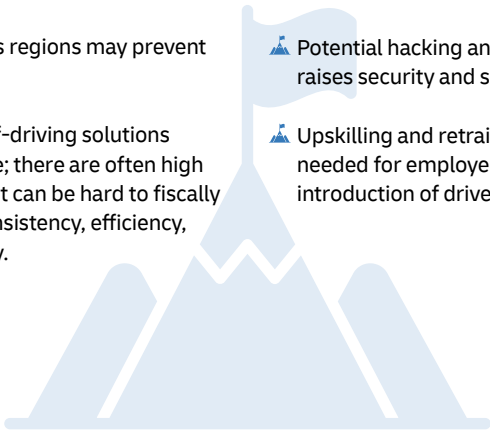
Resources

📄 **DHL - Autonomous Driving in Logistics: At the future's wheel** →

🔗 **DHL orders 100 self-driving U.S. trucks from TuSimple and Navistar** →

Outlook

This trend should be **MODERATELY monitored,** with some use cases applicable today.

The trend of Outdoor Autonomous Vehicles is slowly advancing towards realization in the logistics industry. Despite regulatory barriers, more and more logistics organizations are adopting self-driving vehicle technology in facilities and in supply chain transportation segments. While it may still be many more years before fully autonomous vehicles handle outdoor operations, we here at DHL anticipate highly autonomous vehicles with occasional human guidance will be commonplace in many locations within the decade.

Related Trends

Remote Work & Teleoperation →

Drones →

Edge Computing →

Indoor Mobile Robots →

Sources
Texas A&M Transportation Institute (2022): Next level trucking: Autonomous truck platooning a game changer for fuel efficiency, safety.
Insider Intelligence (2022): The challenges of last mile delivery logistics and the tech solutions cutting costs in the final mile.

DHL

QUANTUM COMPUTING

The trend of Quantum Computing is a computing paradigm that utilizes quantum technology to reach unprecedented levels of processing power millions of times faster than existing supercomputers. The trend of Quantum Computing includes related fields like quantum communication and the quantum internet.

Over the past 2 years, the trend of Quantum Computing has steadily advanced, with processors calculating with more qubits (the quantum equivalent of bits) than ever before, at lower rates of error and at decreasing cost. In almost a race, companies like IBM and Google have publicly announced quantum roadmaps to reach 1 million qubits by 2030, a number many experts say is necessary for most commercial purposes like supply chain-related operations.

The ability to analyze and potentially optimize operations on a large scale instantaneously, as well as provide unhackable information communication, makes the Quantum Computing trend moderately impactful to logistics. The technology is too nascent for practical commercial use in supply chains at scale, but commercial interest is growing and technological milestones are continually being achieved.

Trend Overview

Impact: MILD

Realization: 5-10 Years

Focus Areas:
Automation & Efficiency | Physical & Digital Security

Trend Clusters:
Digital Backbone

Sectors:
Energy | Engineering & Manufacturing | E-Retail & Fashion | Life Sciences & Healthcare | Technology

Relevance to the Future of Logistics

Fleet & Route Optimization

With last-mile delivery costs accounting for 53% of total shipping costs, logistics service providers focus keenly on optimizing this segment of the supply chain – especially by adjusting routes and delivery fleet size. While an optimized route with a handful of delivery stops can be determined relatively quickly by a desktop computer, it would take years for even a supercomputer to calculate an optimized route with dozens of stops and maybe additional parameters to be considered, like fuel usage or traffic patterns.

Quantum computers, however, use special properties from quantum mechanics to optimize an individual route with hundreds of stops within mere minutes. They can also calibrate routes across entire fleets to ensure deliveries are made in the best ways with the least number of vehicles. This means quantum computers can help lower delivery costs for logistics organizations, reduce CO_2 emissions in last-mile travel, and improve the customer experience.

Container Optimization

It is relatively easy to maximize shipment loads in a rectangular container when the parcels and pallets are of uniform size. But this is challenging when the container is oddly shaped like an aircraft unit load device (ULD) and even more complicated when each item varies greatly by shape, volume, weight, and fragility.

Quantum computers will be able to optimize almost instantly the placement of thousands of parcels and pallets in containers headed for various destinations. And when each container is fully utilized, this lowers the cost and emissions per shipment and reduces the overall number of containers required for all shipments.

Rapid Simulation & Digital Twin Support

An advanced simulation of a complex digital twin or model requires an incredible amount of processing power but provides extremely useful information for decision making. Running several simulations to compare outputs can take days or even years using current computers, depending on the complexity. Instead, quantum computers can deliver in minutes, unlocking opportunities that benefit supply chains both directly and indirectly as they become more global, more complex, and overall more complex.

On a microscale, quantum computers will enable the simulation of molecular-level chemical interactions and physical processes, spurring development and the manufacture of new materials and products like better vehicle batteries and biodegradable packaging that can impact and change the logistics industry. On a macroscale, quantum computers can help support digital twins and simulations of complicated supply chain networks with thousands of elements in a single model. Empowered by this technology, logistics planners can evaluate almost in real time various alternative scenarios, such as unexpected closure of a warehouse, and support well-timed, informed decision making.
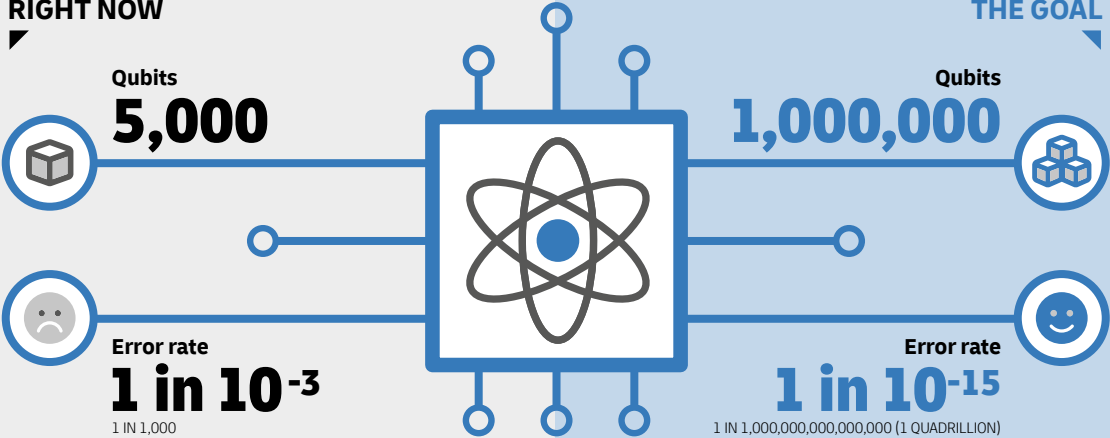
Quantum Internet & Data Protection

As logistics organizations store valuable personal and private information, like names, addresses, signatures, and orders, data protection is a high priority. But with malicious software and tools, hackers can intercept and read emails and other forms of digital communication travelling through fiber optic cables and other channels. Quantum computing can provide an extra layer of digital privacy and security to counteract hacking.

Due to inherent physical properties that differ from those of regular computers, quantum computing messages and keys are theoretically unhackable, with the mere act of interception immediately destroying the information and potentially raising an alarm. Fiber optic cable networks utilizing quantum keys have already been established in China and the US and are growing, establishing the beginnings of a quantum internet. In one step further, China has already launched a quantum satellite that can pass quantum encrypted messages between Beijing and Vienna and plans to launch more in the near future. With these communication developments in quantum computing, logistics providers can better protect customer data.

Quantum computers need more improvements before they can be practically used in everyday commercial operations in supply chains.

RIGHT NOW

THE GOAL

Qubits
5,000

Qubits
1,000,000

Error rate
1 in 10^{-3}
1 IN 1,000

Error rate
1 in 10^{-15}
1 IN 1,000,000,000,000,000 (1 QUADRILLION)

Source: Jülich Forschungszentrum

Challenges

⛰ Several technological breakthroughs – including more robust error correction – are still required for quantum computers to become practical and affordable for everyday use.

⛰ While quantum computers can protect data, they can also be used to attack or break today's cybersecurity protocols; for example, brute-force hacking could be done exponentially faster.

⛰ For day-to-day business use, it is more complex and time consuming to set up and access quantum computers than supercomputers.

This trend should be **PASSIVELY monitored,** with applications still mostly being developed or explored.

Outlook

Quantum Computing is advancing in a way that is similar to desktop computers in the second half of the 20th century, moving from laboratories to personal desks and subsequently into the cloud.

Meanwhile, logistics organizations are starting to understand the potential supply chain benefits and use cases of the Quantum Computing trend. When quantum computers are ready for commercial use, supply chains will be able to unlock a new level of optimization, one that was previously unachievable.

Resources

📄 **DHL - Quantum Computing could transform the logistics industry** →

Related Trends
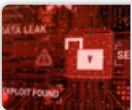
Cybersecurity 2.0 →

Physical Internet →

Big Data Analytics →

Next-Generation Wireless →

Sources
Insider Intelligence (2022): The challenges of last mile delivery logistics and the tech solutions cutting costs in the final mile.
Scientific American (2020): China reaches new milestone in space-based quantum communications.
Science (2020): IBM promises 1000-quibit quantum computer – a milestone – by 2023.
The New Stack (2021): Google's quantum computer can exponentially suppress errors.

SMART LABELS

The trend of Smart Labels refers to the use of printed paper, plastic, or fabric labels upgraded with special intelligent inlay technology that can digitally capture and communicate more information than is printed on the physical label. Technologies generally integrated in these labels include radio frequency identification (RFID), near-field communication (NFC), time-temperature indicators (TTIs), and quick response (QR) codes.

The need to label products spans all stages of a product's life cycle, from supply chain procedures during and after manufacture to the provision of product information to the end user and disposal instructions (specific to products containing hazardous materials such as batteries). The type of information therefore ranges from tracking and condition instructions to date of production and material data – everything that traditionally was printed on a physical label.

Barcodes – the most commonly used form of product identification coding – first facilitated inventory management but, with a maximum storage capacity of only 20 characters, cannot convey detailed information. Compare this with QR codes which store over 7,000 characters. Their introduction gave us a new way of leveraging labels to provide product data. As all smartphones can now read QR codes, it is easy for consumers to scan these codes to reach digital platforms displaying all the product information they are looking for. Today, there are significant advances in labeling digitalization including the use of embedded sensors, printed batteries, and devices that enable person-to-product communication.

With a global market value of 9.5 billion USD in 2022, year-on-year growth of 9.6%, and a projected CAGR of 11.2%, the value of the global smart labels market is expected to reach24.8 billion USD by 2030.

Within logistics and the supply chain, smart label usage has significant impact. Here at DHL we see an increase in the adoption of these technologies to address various aspects of the customer experience and operational efficiency. From the availability of product information through the simple scanning of a QR code to being able to track a parcel or package along its journey to its delivery address, this trend appears on the Logistics Trend Radar with a relatively high impact and realization within 5 years. Although we are seeing current applications and use cases, we believe further development is required before smart labels become truly commonplace.

Trend Overview

Impact:

MODERATE

Realization:

< 5 YEARS

Focus Areas:

Customer Experience   Physical & Digital Security   Visibility & Resilience

Trend Clusters:

Internet of Things   Packaging & Containers

Sectors:

Auto-Mobility   Energy   Engineering & Manufacturing   Life Sciences & Healthcare   Technology

Relevance to the Future of Logistics

End-to-End Visibility

With rising consumer demand for shipment visibility, live location tracking of goods can be achieved with RFID technology embedded in labels. This capability is highly relevant to the customer experience and logistics operations. It also equips manufacturers to track products (particularly high-value goods) from production through delivery to end users. Start-ups like Wiliot enable customers, manufacturers, and logistics players to know shipment location using a low-cost smart label the size of a postage stamp. Powered by harvesting radio frequency energy, these labels capture data of their surrounding environment using Internet of Things (IoT) pixels, which then becomes available via existing Bluetooth devices. In the constant drive towards sustainable logistics, these low-cost solutions can also be reused as their battery power is generated through existing energy.

Combatting Counterfeit

In addition to location tracking, there are also applications for smart labels to address a historically common challenge in the supply chain industry: counterfeit products. Particularly in the pharmaceutical, nutraceutical, and cosmetics sectors, counterfeit products pose a severe threat to corporate reputations and consumer health. This challenge can be addressed with the use of unique RFID or QR codes to verify product authenticity. More covert features to tackle counterfeiting can be found in labels using UV ink, ink taggant, and infrared ink (particular used with pharmaceuticals and nutraceuticals). These inks are only visible to or detected by more sophisticated hand-held readers. Hidden measures such as these allow manufacturers to monitor and ensure genuine goods do not fall out of the authorized supply chain. Tying each product's unique identifier to blockchain technology also achieves a new level of security.

Perishable Goods Quality Control

For groceries and nutraceuticals, there is increasing development of labels which allow the supply chain to enhance product freshness and quality, including color-changing technology to clearly highlight item condition to businesses and consumers. Similar applications include assuring cold chain integrity and providing visibility of package tampering and damage. FreshTag labels developed by Insignia Technologies provide such solutions, with labels that change color if food experienced a temperature excursion, demonstrating that smart labels can more accurately reflect product condition than static use-by dates. A top priority for consumer health is to scale these smart labels for the quality control of perishable goods, ensuring any item shipped to a distant destination through cold chain operations still arrives in a condition that is safe for human consumption.
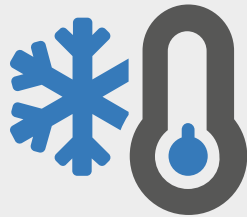
No Labels

With sustainability and cost reduction high on the logistics agenda, companies are opting to print digital product information directly onto packages, eliminating physical labels. This so-called 'no labels' approach still gives consumers the information they need to make informed decisions and enables warehouse operations to easily identify products.

Lending itself to the fight against fraud, start-up PixoAnalytics developed a unique code-generating technology using paper art. Each envelope or package is produced using paper that has a unique and natural paper structure (referred to as its 'fingerprint') which is used for unique identification. Similar to human fingerprints, these paper structures cannot be reproduced. Applicable to any product, and without increasing the environmental footprint of regular envelopes and packages, this technology also equips logistics providers with a tool to ensure customer parcels are not tampered with.
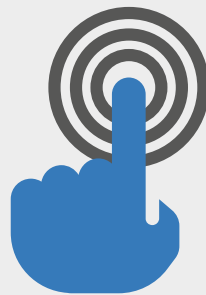
Smart labels respond to:

| MOVEMENT | TEMPERATURE | TOUCH | ENVIRONMENT |

Source: Streetwise Reports

Challenges

⚠ As smart labels enabling data transfer, they also introduce the risk of data tampering which can be mitigated by pairing certain smart label applications with blockchain technology; this may increase the cost and complexity of implementation.

⚠ Single-use labels that are powered by batteries pose a sustainability problem; companies must consider how these devices will be disposed of in a green, safe manner.

⚠ To address security concerns, smart label development and integration with cutting-edge technology is needed and labels must be produced with robust weather- and wear resistant chemicals.

Sources
Future Market Insights (2022): Smart labels market outlook (2022-2030).
Wiliot (2022): Intelligence for every single thing.
Resource Label Group (2021): Anti-counterfeit label solutions to protect consumers and your brand.
Labels & Labeling (2020): Smart and intelligent labels.
PixoAnalytics (2022): We are digitizing logistics with just a blank sheet of paper.

This trend should be **ACTIVELY monitored,** with imminent developments and applications.

Outlook

The ubiquitous use of QR codes allows information access and sharing and – with ever-increasing demand for instant information on parcel tracking, condition monitoring, and product authenticity – we here at DHL do not see developments in the Smart Labels trend slowing down. With imminent moves to eliminate the need for batteries to power certain labels, further adoption of sensor-enabled labels is very likely in the logistics industry. Impacting both suppliers and consumers, the drive to implement smart label technologies on a wider scale is accelerating development. And with sustainability at the top of corporate agendas globally, the interlink between smart labels and sustainability also acts as an undercurrent, propelling further technology development and solution scaling.

Resources

📄 **DHL - Smart return options** →

📄 **DHL - Track & Trace: Why your business needs it more than ever** →

Related Trends

Quick Commerce →

Blockchains →

Interactive AI →

Next-Generation Packaging →

STATIONARY ROBOTICS

The trend of Stationary Robotics consists of all robots that perform value-added tasks from a fixed location. Attached to the floor, ceiling, or other surfaces, these devices often take the form of or resemble robotic arms.

The first stationary robots were introduced in the late 1950s, primarily in manufacturing and automotive production. However, with advances in artificial intelligence (AI) and sensor technologies in recent years, application in the logistics industry has expanded significantly today. Stationary robots can be divided into two types, collaborative robots, which are designed for flexible applications that require interaction with humans, and industrial robots, which are mainly used in applications that require a high payload, long range, and high speed, and usually operate in a segregated area surrounded by security fences. However, even when using collaborative robots, safety measures should be reviewed before use to ensure the health and safety of workers. The increasing prevalence of stationary robots indicates that in future humans will handle fewer monotonous tasks and the focus will shift to collaboration and task sharing between humans and machines.

Especially in light of warehouse labor shortages and demand volatility, many logistics companies are realizing the significant economic potential of implementing stationary robots for repetitive processes. Currently, many companies across all industries are testing stationary robotic solutions and discovering the most promising applications for their logistics operations. Based on this experience and the anticipated further development of stationary robotics hardware and software, we here at DHL expect in 1 to 3 years companies will be able to extensively scale these solutions. This will have a high impact on the logistics industry.

Trend Overview

Impact:

HIGH

Realization:

< 5 YEARS

Focus Areas:

Automation & Efficiency   Health, Safety & Future of Work   Visibility & Resilience

Trend Clusters:

Robotics

Sectors:

Auto-Mobility   E-Retail & Fashion   Life Sciences & Healthcare   Technology

DHL

Relevance to the Future of Logistics

Automated Shipment Sorting

Sorting shipments is a very repetitive, monotonous task that nevertheless requires high-quality output. Operators who have to perform this task for hours on end in the warehouse tend to lose concentration after a certain amount of time, making their work error-prone and leading to additional rework costs. Sorting is therefore an ideal application for automation, particularly the implementation of stationary sorting robots. These devices often use cameras and AI capabilities to differentiate items for shipment and use pre-defined characteristics to classify and sort them.

One example of such a device, used at a DHL Express facility in Miami, Florida, USA is the DoraSorter sorting robot from Dorabot. This uses a tray with a clamp instead of a specialized end-of-arm tool to support the specifics of each operation, ensuring even delicate shipments and irregularly shaped items are not crushed or destroyed.

The use of sorting robots like the DoraSorter can help to further drive human-robot collaboration. It also provides valid business cases especially for greenfield facilities.
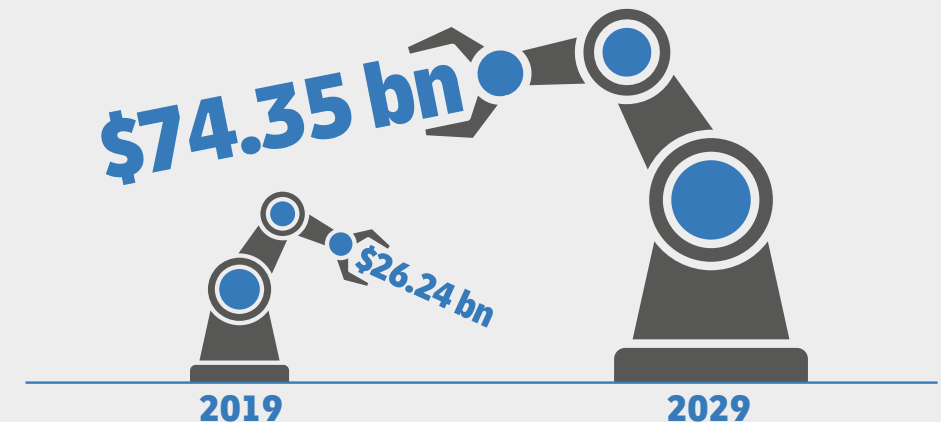

Robotic Picking & Placing

The manual separation and alignment of parcels, letters, cartons, and flyers to prepare them for further processing downstream is very monotonous and labor intensive. The automation of this process via stationary robots has gained a lot of traction in recent years. Robotic induction, the act of picking an item and placing it with a specific orientation on a conveyer belt as well as identifying its characteristics, is a very scalable solution given its widespread applicability.

As an example, the robotic induction solution of Plus One Robotics uses AI to identify objects for pick-and-place applications. When AI is unable to identify objects, a human teleoperator receives an alert message via Yonder supervisor software and can gain access to and control of the robotic arm from a remote service center. The AI system learns from this intervention to further improve its capabilities if similar situations occur in the future.

This AI-human collaboration indicates the potential to create new jobs through widespread implementation of robotic solutions in warehouses and manufacturing environments by upskilling existing labor.

Palletizing & Depalletizing

The automation of palletizing and depalletizing in inbound and outbound warehouse or hub operations holds great potential for stationary robotics. A distinction should be made between uniform and mixed (de)palletizing.

While uniform (de)palletizing is the movement of same-shaped, unvarying goods from and onto a pallet, mixed (de)palletizing describes the handling of pallets with items of various sizes and weights. In general mixed (de)palletizing is more complex than uniform (de)palletizing as it requires much more powerful AI to stack disparate, unwieldy packages as securely and efficiently as possible. However, the company Dexterity provides software that can be used with any robot size or configuration to enable flexible handling and optimal stacking of mixed boxes.

Currently, stationary robots that can palletize and depalletize individual shipments are already widely deployed. Mixed depalletizing solutions are also reaching maturity, but we at DHL expect it to take another 2 to 4 years before widespread use of stationary robots for mixed palletizing is achieved throughout the logistics industry.

In 2021, the market for robotic arms alone was estimated at $26.24 billion and is expected to grow further to $74.35 billion by 2029.

$74.35 bn

$26.24 bn

2019   2029

Source: Data Bridge Market Research

TUBE SYSTEMS

The trend of Tube Systems focuses on next-generation, grade-separated transportation networks that provide unimpeded transit from one place to another via tubes or tube-like systems. These networks rely on existing or new technologies above and below ground to provide a new mode of delivery service.

Tube systems gained widespread public attention when the concept of high-speed 'hyperloop' technology hit the mainstream media in 2012. Since then, many private ventures have explored the idea of low-pressure, magnetic propulsion, cultivating an ecosystem of alternative technologies to transport passengers and cargo. Meanwhile, as urban road traffic now continues to worsen, following a pandemic lull, drivers in many major cities are losing over 100 hours annually due to congestion. Tech companies are looking at new non-hyperloop tube ideas to physically separate freight transportation from passenger journeys, decreasing congestion for both. Meanwhile, in an adjacent tech niche, companies are exploring ways to construct transportation tubes cheaper and faster above and below ground. Tube systems will capture more attention as construction costs reduce and as they move from paper to real-world applications.

This trend of Tube Systems has been reintroduced to the DHL Logistics Trend Radar. It was removed in the previous edition as many years of announcements and proposals did not reflect much progress in terms of testing and actual operations, pushing this trend beyond the publication's 10-year scope. However, in the last couple of years, meaningful advances have occurred, like the first successful trials and government approval of construction plans, so the Tube Systems trend is back, albeit towards the outer edge in terms of realization. As tube technology develops and begins to be integrated in supply chains, these systems will move from a low-impact level to a medium-impact level in logistics.

Trend Overview

Impact:

LOW	

Realization:

5-10 Years

Focus Areas:

Automation & Efficiency

Trend Clusters:

None

Sectors:

E-Retail & Fashion   Life Sciences & Healthcare

Relevance to the Future of Logistics

Middle-Mile Hyperloop

Like many transportation modes before it, hyperloop was first proposed for efficient, fast passenger transportation. However, with growing customer demand for faster deliveries, hyperloop has also become a potential logistics solution to speed middle-mile cargo deliveries.

DP World Cargospeed in the UAE is the world's first initiative to build a hyperloop-powered cargo system; it successfully completed tests back in 2020 on 500 m (0.3 mi) of track. The system focuses on shuttling high-priority, time-sensitive palletized goods at up to 1,000 km/h (621 mph) from ports to regional distribution hubs, eyeing a route between Indian cities Pune and Mumbai as its first line. In another development in Europe, HyperloopTT plans to launch the world's fastest freight system, with tube capsules moving as fast as 1,200 km/h (745 mph), a speed that exceeds a cruising Boeing 777. In 2022, this received further financial backing after passing a risk and safety assessment and meeting new European safety and insurance thresholds, putting HyperloopTT on track to pursue its freight plans further, including a joint project with the Port of Hamburg in Germany.

Overall, while still far into the future, hyperloop technology is passing key milestones that will enable it to one day provide real solutions for logistics and set a new standard for delivery speed.
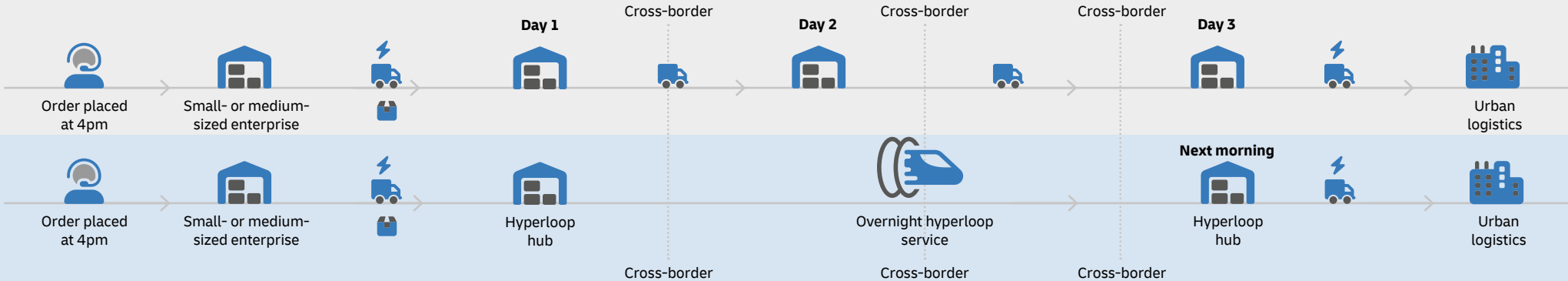
Underground Urban Freight

As urbanization brings more people to cities, transportation activity on urban roads around the world is projected to more than double by 2050. Freight trucks taking goods in and out of cities will contribute to this and impact the environment, and logistics organizations will feel the consequences – longer and less reliable delivery times for customers.

Foreseeing this issue, the Swiss government in 2022 gave the go-ahead to Cargo Sous Terrain to begin constructing its privately financed underground system with phase 1 operations starting in 2031. In this first phase, specially designed cargo pods, including refrigerated units, each loaded at a surface facility with up to 2 pallets of freight will be lowered to an underground freight-only highway that connects 10 destinations along 70 km (43 mi) between Zurich and a regional logistics center. Using electric motors, the pods will travel to the required destination, where they will be lifted to the surface and unloaded. In this way, freight can be delivered directly into urban centers without adding to or being affected by road congestion. If successful, by 2045, phase 2 will expand the system to include other major Swiss cities like Geneva, Bern, and Basel.

With urban roads around the world projected to suffer large increases in congestion in the coming decades, logistics organizations should monitor underground system developments, mindful that in time they may provide a valuable way to protect urban delivery times despite traffic delays.

Hyperloop can open up quick delivery opportunities for supply chains, reducing truck movements and continental delivery times from 3-4 days to overnight.

A customer in northern Spain orders a product from a small online business based in the Netherlands. Today, this would typically take 3-4 days or longer and utilize heavy diesel trucks in the mid-mile.

			Day 1	Cross-border	Day 2	Cross-border	Cross-border	Day 3		
Order placed at 4pm	Small- or medium-sized enterprise									Urban logistics

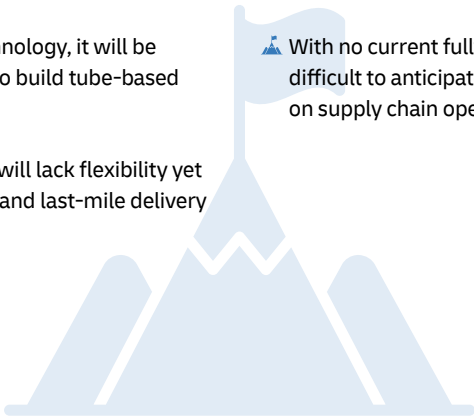|					Overnight hyperloop service			Next morning		
Order placed at 4pm	Small- or medium-sized enterprise		Hyperloop hub	Cross-border		Cross-border	Cross-border	Hyperloop hub		Urban logistics

With a regional hyperloop system, the customer could very well receive their order the following day utilizing a fully electric transport supply chain.

Source: Hyperloop Development Program

DHL

Challenges

⛰ As this is relatively new technology, it will be challenging and expensive to build tube-based transportation.

⛰ Tube system infrastructure will lack flexibility yet still require additional first- and last-mile delivery capabilities.

⛰ With no current fully operational tube system, it is difficult to anticipate the impact of this technology on supply chain operations.

Resources

A vision for the European hyperloop network ⬇

Cargo Sous Terrain →

This trend should be **PASSIVELY monitored,** with applications still mostly being developed or explored.

Outlook

The trend of Tube Systems is slowly advancing towards realization for cargo transport. It will still be many years before logistics organizations can take advantage of this congestion-free mode of transportation. As the first systems open, however, we here at DHL anticipate many more will be announced and constructed as supply chain players and society as a whole realize the benefits.

Related Trends

Quick Commerce →

Supply Chain Diversification →

Drones →

Outdoor Autonomous Vehicles →

Sources
Global Fleet (2021): Alarming traffic congestion data highlights need for mobility solutions.
Organization for Economic Co-operation and Development (OECD) (2021): ITF transport outlook 2021.

WEARABLE SENSORS

The trend of Wearable Sensors encompasses sensors that are worn on or close to the human body with the purpose of tracking body movement or vital functions. Depending on the type of information to be captured, different sensors like gyroscopes and accelerometers are integrated into wearable products, from badges and wristbands to smart glasses and clothing.

For many individuals, it is hard to imagine doing sports without a fitness tracker or smart watch to track performance via built-in sensors. While annual unit shipment of these devices continues to grow and is expected to hit 280 million in 2024, many companies, including those in the logistics industry, have started to recognize the value of such data for industrial applications, particularly in the realm of employee health and safety. As such, many logistics organizations have begun procuring various forms of smart wearable devices and setting up supporting wireless communication infrastructure, like Bluetooth Low Energy (BLE) and Wi-Fi, or even ultra-wideband (UWB) if a real-time locating system (RTLS) is needed, in their facilities.

The trend of Wearable Sensors has moderately low impact on the logistics industry. Although valuable data collected by employees on operational processes make working environments safer and more efficient, the overall organization and operation of supply chains will remain generally similar to today. However, we here at DHL expect wearable sensors to be realized relatively soon – many products and services for various applications are now readily available and are starting to be implemented along the supply chain.

Trend Overview

Impact:

| MILD |

Realization:

| < 5 YEARS |

Focus Areas:

| Automation & Efficiency | Health, Safety & Future of Work | Physical & Digital Security | Visibility & Resilience |

Trend Clusters:

| Bionic Enhancements | Internet of Things |

Sectors:

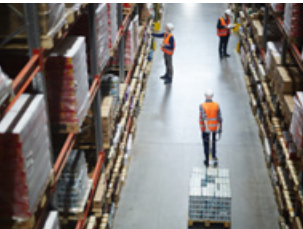| Auto-Mobility | Energy | E-Retail & Fashion | Life Sciences & Healthcare | Technology |

Relevance to the Future of Logistics

Process Intelligence

Optimizing operational processes is essential, especially for manual processes which typically lack visibility. Here the use of wearable sensors enables automatic collection of data and insights replacing current manual processes.

Examples range from heatmaps indicating in real time the occupation of certain areas of an operational facility using solutions from providers such as Kontakt.io and Quuppa to achieve highly detailed analyses of people's motions, taking industrial engineering projects to the next level. For example, MotionMiners, a German startup, has developed a GDPR-compliant solution that leverages data collected from purpose-built wearable devices during a temporary installation to identify process waste and improvement potential. The automation of data collection leads to larger, more detailed data sets which are free from observation biases. Data can be automatically analyzed using algorithms to generate detailed insights and enable data-based decision making.
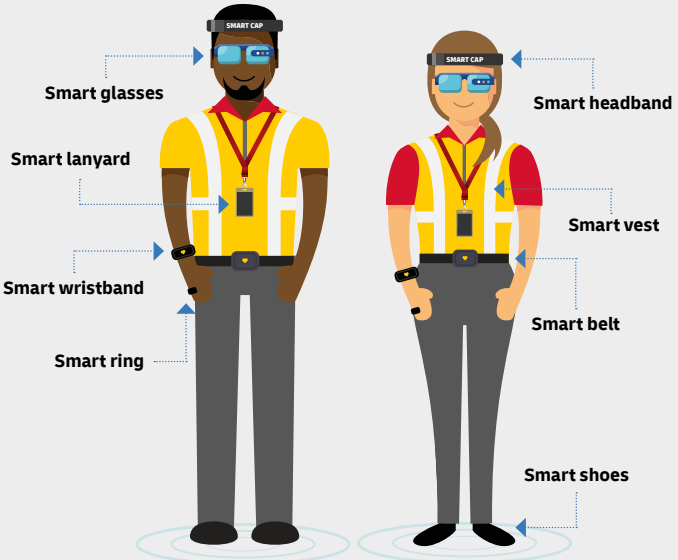
Ergonomic Health

Ergonomic hazards in the workplace are one of the main causes of musculoskeletal disorders (MSDs) which are the most common work-related health issue in the EU, leading to high cost resulting from sick leave and workers having to retire early. Wearable sensors can be used to lower the MSD risk with the main levers being redesign of the workplace and training employees to adjust their actions to more ergonomically friendly movement.

Predimo is an example startup focused on leveraging wearable sensor technology to assess ergonomic risk in the workplace and identify improvement potential. Soter Analytics and Kinetic are two providers out of many that offer wearable sensors for ergonomic training purposes. The idea is to give real-time feedback to a user by vibrating or beeping when a hazardous movement such as bending and twisting is performed. These solutions create awareness and trigger a change of behavior over time, reducing the amount of hazardous movements performed. Also, vital body data captured through wearable sensors has various applications such as fatigue detection and alerting when certain stress levels are reached.

Location Identification

The ability to track employee location in real time opens an array of application fields. One of them mentioned under process intelligence are heatmaps that show the live distribution of employees in a facility. In congested areas, this can enable identification of problem areas flagged for potential layout redesign. Another use case which requires very high accuracy and data transmission in real time is collision warning inside an operational facility to prevent accidents between pedestrians and forklifts. An alert would be given to both the driver and the pedestrian to prevent likely collision.

Another very interesting application is leveraging wearable sensors for automated reporting. The collection of data about an operational employee's time spent in certain physical areas of a facility that serves multiple customers can automate the capturing of work hours attributable to each customer; this also allows for a fully automated billing process. In addition, wearable sensors can automate access control within a facility, restricting access to certain areas or to the use of particular vehicles and tools based on the individual's experience or training level.

Wearable sensors come in all shapes and sizes and are designed to be comfortably worn on different parts of the body depending on their use case.

Smart glasses

Smart lanyard

Smart wristband

Smart ring

Smart headband

Smart vest

Smart belt

Smart shoes

Source: ResearchGate

Challenges

- Wearable sensors raise data protection concerns about sharing personal and performance information with the employer; to succeed, solution providers must ensure GDPR-compliant anonymization of data.

- Infrastructure requirements are highly dependent on the level of precision and the frequency of data sharing required; especially for real-time location system (RLTS) use cases, infrastructure investment is significant and may not provide sufficient return on investment for a single application.

- As more wearable sensor use cases arrive, there is a risk of overloading the employee with wearables and sensors; companies should avoid introducing new hardware for every new application and be mindful of the amount of beeping or vibrating alerts an employee can bear at once.

Resources

	DHL - Advancing workforce capabilities with wearables →

Outlook

This trend should be **CLOSELY monitored,** with implementations available for many use cases today.

Most successful applications for wearable sensors today require little infrastructure and typically rely on purpose-built wearables for each use case. Here at DHL, we already see a trend towards leveraging existing wearable devices such as smart glasses and wearable scanners for data collection. In the future, however, we anticipate a democratization of devices and support infrastructure, bringing down the cost per use case, with generic gateways lowering the entry barrier for applications, especially those requiring accurate localization. We also see technological advancements – like the miniaturization of electronic components, flexible printed circuit boards (PCBs), and increased battery life – accelerating the subtle integration of sensors into clothing. Relatedly, but in another direction, we also see further into the future the development and possible movement of sensors from on the human body to inside the body as multifunctional implants.

Related Trends

Mass Personalization →	Smartification →
Cloud & APIs →	Extended Reality →

Sources
Statista (2022): Number of smartwatches and fitness trackers shipped worldwide from 2021 to 2024.
European Agency for Safety and Health at Work (2019): Work-related musculoskeletal disorders: prevalence, costs and demographics in the EU.
Business Wire (2022): Smart wearables global market report 2022.

JORDAN TOY
EDITOR-IN-CHIEF
THE LOGISTICS TREND RADAR 6.0

INTERVIEW SPECIAL

10 YEAR ANNIVERSARY OF THE LOGISTICS TREND RADAR

A whole decade has nearly come and gone since the publication of DHL's first Trend Radar. As the last pieces of *The Logistics Trend Radar 6.0* come together, we sit down with **Jordan Toy, Trend Radar Editor-in-Chief and DHL Innovation Manager**, to hear more about the legacy of the publication, what's next, and what goes on behind the scenes.

Let's go back to the start. Why did DHL decide to make *The Logistics Trend Radar* all those years ago?

It's interesting to see that the main reasons we published our Trend Radar ten years ago are basically the same reasons we are still doing so today. When making this new one, we decided to take a look back to the very first edition. In the intro, the authors explained that we at DHL had created the Trend Radar to stimulate collaborative discussion, so that collaborative innovation projects could be undertaken throughout our network. I'd say that speaks very much to the heart of why we made Trend Radar 6.0 and why we'll continue to make new Trend Radars in the future.

Would you say that DHL design its radars differently now than in the past?

Graphically, I think DHL has come a long way since the first Trend Radar. Unfortunately, I wasn't around at the time of the first or early editions, but knowing some of the people who did, I believe that

as DHL started learning how popular its radar was with our customers and colleagues, we started being more user-centric in how we design, organize, and portray the information in every succeeding version. There's a lot of information we want to share on our Trend Radar, and we've definitely got better at organizing the information. But we are constantly reminding ourselves to be attuned to the needs of our customers in what they want to know and how to make that information easy to consume and navigate.

But how about in terms of laying out the trends on the Trend Radar? I know you said you weren't there from the beginning, but have any traditions carried through over the years?

Absolutely! In almost a literal sense, every time a new Trend Radar is being made, the innovation teams across all the Innovation Centers huddle in one room and hash it out. We bring markers, pens, whiteboards, and

sticky notes and start sharing ideas of what we've read, heard, or experienced in the last two years, whether from customer representatives or innovation projects.

Wow! Sounds like quite a brainstorming session!

Yeah, and it's not just one session – we have multiple sessions and iterations, harmonizing the views across all four regional Innovation Centers and the views of our many DHL subject matter experts. We really aim to bring a global perspective to the Trend Radar and not only the typical European or American-centric perspective. As you can imagine, what they see and hear in Asia may not be the same as what they see and hear in the Americas. I guess I just want to emphasize that the Trend Radar is not just simply an academic exercise.

Oh, it isn't?

Obviously, the placements of the trends are enriched with our own research. However, overall, each trend and where it lies is the collective result of what we observe and

> "The Logistics Trend Radar is quite literally our guide for DHL's innovation activities."

experience every day, from hearing customer pain points in innovation workshops to talking to hundreds of tech providers to seeing hands-on what DHL colleagues with boots on the ground in our facilities experience in their day-to-day lives. These are things you can't necessarily understand just by being on a computer.

Right. I think making insightful pieces like the Trend Radar definitely requires more than just desktop research. It requires that developed intuition, too. But back to the first edition – what has since changed and what has remained the same? Besides the design, of course!
One thing you'll probably notice straight away is that the Trend Radar has kept the two halves of Social & Business trends and Technology trends throughout the years. This is important as we really want our customers and colleagues to remember that it's not just the technology landscape that is changing supply chains and logistics, but that societal demands and needs like

environmental sustainability or remote working can also shape the logistics industry and disrupt current business models. In terms of changes, I think the most obvious difference is the number of trends!

This really stuck out to me. In this Trend Radar, you have, what – 40 trends this time? The first edition had only 23.
Yep – 40 exactly! And it's not necessarily that 17 new trends appeared out of nowhere. Sure, some are new trends as they developed over the years and became potentially relevant for the logistics industry, like Metaverses or Space Economy. Most, though, are primarily clarified trends – new ones made out of old ones. In doing so, we can be more specific and provide more details below the surface of a trend.

Can you give us an example?
So, if you look at the first Trend Radar, we had Robotics & Automation, as well as

Internet of Things. Probably more than half of the discussions we have with customers and colleagues fall under one of these two things! In order to drive more fruitful conversations for innovation, we've split up trends like these over the following editions to bring them to the right level of depth. So, instead of having Robotics & Automation, we now have more specific trends like Indoor Mobile Robots, Stationary Robotics, and Outdoor Autonomous Vehicles. Or, if we look at the 5th edition, instead of asking all these questions to understand a customer's needs in Sustainable Logistics – which was the hottest topic last year – we can cut to the chase in Trend Radar 6.0 and dive straight into Decarbonization, Alternative Energy Solutions, Circularity, Bio-Based Materials, or other trends.

Makes sense. And speaking of all these trends, are there any that have special backstories?
You mean, are there any that have moved in

a lot of directions over the years?

Yes, or any memorable moments when choosing a particular trend name? Or any that have dropped off the Trend Radar?
Where to begin? There's too many to choose from! Well, one trend, Quantum Computing, appears on the very first Trend Radar back in 2013, and if I remember correctly, remained on our radar until the fourth edition, in which it was finally removed. The reason we removed it was because the trend, in our eyes, wasn't really advancing, and it didn't seem like it would impact the logistics industry within the ten-year scope. However, in 2019 and 2020, as we were producing the fifth edition, we started seeing a lot of headlines and buzz on social media about quantum computing. IBM just released its first commercial quantum computer, and shortly after, we heard news of Google claiming to have reached quantum supremacy. Essentially, in just two or three years, we saw quantum computing jump from science labs into the

commercial market, sparking the quantum 'space race' between all these technology developers.

And that is when you knew to put the trend back on the Trend Radar?
Exactly. There was no doubt in our minds at that point that the trend deserved a return. Ten years out, maybe, but a return, nonetheless. Putting Quantum Computing back onto the Trend Radar in the fifth edition actually led us to trying out the technology with one of the major players in the quantum space race. It was a really cool experiment! The technology is still nascent – it appeared we were right with the ten-year placement, but the experience informed us first-hand what the opportunities and challenges are when it comes to the trend of Quantum Computing. That's all part of the fun in predicting the future!

Wow – what a fascinating story! I imagine that with all this hard work and thought

> # "Each trend and where it lies is the collective result of what we observe and experience every day."

process going into the Trend Radar, and judging by the excitement you have just telling about them, I'm sure it stimulates the collaborative discussion with customers you mentioned earlier.
That's an understatement! First of all, *The Logistics Trend Radar* leads to further deep-dive trend reports that in turn drive even more discussions with our customers.

And what are the trend reports? Are they different to the Trend Radar?
Yes, trend reports are the in-depth publications that we produce alongside the Trend Radar that detail a specific trend on a deeper level than what we present in *The Logistics Trend Radar*. A trend report explores all the opportunities and challenges a trend has in logistics, and it highlights everything that a leader in supply chains should know about these complex topics, from

Future of Work to Next-Generation Wireless.

Ah, I see. So, when someone finishes reading your trend report, they will feel comfortable talking about a trend.
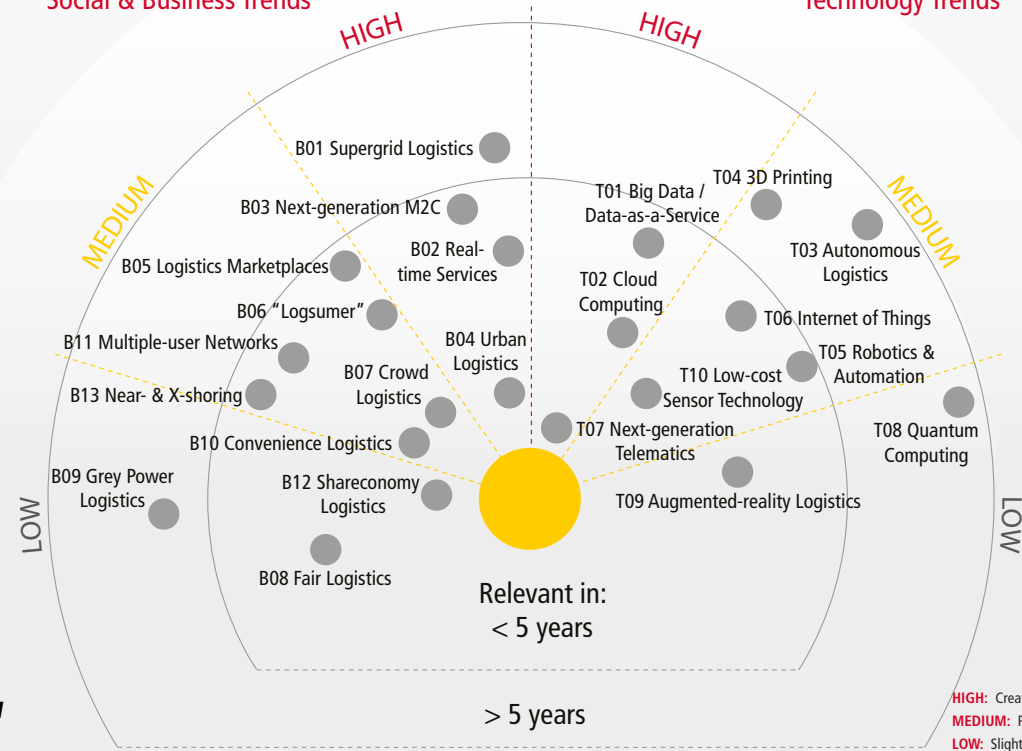Exactly! We don't get super technical as you might in, say, a thesis paper or a science journal, but we introduce the right level of terminology and frame ideas in terms of logistics, so that people in supply chains, who may have never heard of a trend before, can understand why they should care, as well as have some confidence in talking about the subject.

Got it. Seems like DHL has a nice knowledge library for these trends.
Yeah, we do. To help drive innovation in supply chains, we actually provide all these publications for free for anyone to access and read, customers and competitors alike!

Social & Business Trends — Technology Trends

HIGH — HIGH
MEDIUM — MEDIUM
LOW — LOW

B01 Supergrid Logistics
B03 Next-generation M2C
B05 Logistics Marketplaces
B02 Real-time Services
B06 "Logsumer"
B11 Multiple-user Networks
B04 Urban Logistics
B13 Near- & X-shoring
B07 Crowd Logistics
B10 Convenience Logistics
B09 Grey Power Logistics
B12 Shareconomy Logistics
B08 Fair Logistics

T01 Big Data / Data-as-a-Service
T04 3D Printing
T03 Autonomous Logistics
T02 Cloud Computing
T06 Internet of Things
T05 Robotics & Automation
T10 Low-cost Sensor Technology
T07 Next-generation Telematics
T08 Quantum Computing
T09 Augmented-reality Logistics

Relevant in:
< 5 years
> 5 years

The first edition of *The Logistics Trend Radar,* 2013

HIGH: Creates new ways of doing business
MEDIUM: Provides significant improvement
LOW: Slightly improves the process

"There's lots of exciting new tech, but we stay grounded by being close to operations."

That's very generous and perhaps, in ways, reflects DHL's commitment to innovation. But back to what you were saying before I interrupted – how else does *The Logistics Trend Radar* stimulate collaborative discussions with customers?

No worries. As I was saying, the Trend Radar drives discussion through trend reports, which has led to joint strategic or innovation roadmaps. But it also provides context and strategic direction for the hundreds of proof-of-concept projects we do here at DHL. Indoor mobile robots for various tasks and extended reality for piece picking are just a few examples where proof of concept projects have become fully-deployed solutions at DHL.Meanwhile, trends involving sensors, blockchain, and big data have resulted in DHL offering its own IoT platform and blockchain and data analytics services to our customers today. The list really goes on and on. *The Logistics Trend Radar* is quite literally our guide for DHL's innovation activities.

And how about your colleagues? How do people in DHL use the Trend Radar?

Well, it always excites us to hear news that a group in the big DHL family is using our Trend Radar. Not that we don't expect it, but because we are constantly amazed by its reach. Just this year, we learned that Corporate Security and Patent Management use the Radar to drive strategy and have seen the Trend Radar in their slide decks. And it always brings a smile to our faces when we visit a warehouse in another country and see the Trend Radar poster hanging on the wall.

I'm sure it's like an Easter egg hunt sometimes!

That's a fun way to put it! We definitely see it in many places. But yeah, we are very proud to say that all DHL business units, from Express to Supply Chain, are and have been active contributors to the process in every generation of *The Logistics Trend Radar*. It's one of the many reasons why when people in supply chains in and out of DHL look at the Trend Radar, none of the trends seem totally off or very misplaced – there's lots of exciting new tech, but we stay grounded by being close to operations.

Alright, last two questions. What's the coolest customer impact story related to *The Logistics Trend Radar*?

Oh man, it's hard to choose! Just the other day, we were asked by a corporate strategy department of one of DHL's top customers if they could use the tool in their annual strategy development process.

I'm sure you naturally said yes!

For sure – we absolutely encourage innovation as much as possible in logistics, and the Trend Radar is a fantastic tool for that! But I think the coolest impact we've seen on our customers was during the Covid-19 pandemic. In the previous editions, we had included several trends relating to sensor technology and communication of that data, and this drove further research in those areas, including identifying multiple viable tech providers. So, when the pandemic hit and our customers asked us for visibility solutions to see where their vaccine shipments are and how they are being handled, we were able to quickly offer them smart solutions that provide regulation-compliant temperature monitoring and control, mapping, security, and tracking. It's pretty cool to see how the Trend Radar contributes to DHL's purpose: "connecting people, improving lives."

Okay, and finally – I know you're just about to release Trend Radar 6.0, but what can we expect for Trend Radar 7.0 in two years' time?

Well, we can't ruin the surprise! Trend Radar 6.0 is just coming out, but we are already looking ahead to the next edition. The challenge we face when publishing every new version is asking ourselves: how do we make something that is already great, even better? In terms of trends, I think that in two years, we are going to see the maturing of some trends into non-trends, meaning that they're going to be normalized in how we operate or do business as an industry. For the trends that are further out on the Trend Radar, some are probably going to experience increased acceleration, maybe some unexpected acceleration, like in the story about Quantum Computing. Personally, I'm very curious to see how Quantum Computing will play out. Otherwise, for trends beyond the 5-year mark, I have my eyes on Outdoor Autonomous Vehicles, Drones, Decarbonization, and Metaverses, but I know my colleagues are excited about potential upswings in some other trends, too.

Well, we can't wait to see the exciting changes in both the upcoming Trend Radar and the one after that! Thank you for your time, Jordan.

Thank you, and happy innovating!

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Special Thanks

Special thanks go to all our colleagues from the various DHL teams and divisions – Supply Chain, Express, Global Forwarding, Freight, eCommerce Solutions, and Post & Parcel Germany – who supported us with invaluable input and expertise. Furthermore, we would like to express our sincere thanks to all our customers, partners, and colleagues who visit our DHL Innovation Centers every year and support us with their in-depth feedback in the development of our Logistics Trend Radar.

Marketing & Design Agency

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