

The background is a vibrant blue with abstract, flowing, wavy lines that create a sense of movement and depth. The lines are more pronounced on the left and right sides, framing the central text.

2025 TECH TRENDS REPORT • 18TH EDITION

# SUPPLY CHAIN, LOGISTICS, & MANUFACTURING

FTSG

# Future Today Strategy Group's 2025 Tech Trend Report

Our 2025 edition includes 1000 pages, with hundreds of trends published individually in 15 volumes and as one comprehensive report. Download all sections of Future Today Strategy Group's 2025 Tech Trends report at [www.ftsg.com/trends](http://www.ftsg.com/trends).







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**Mark Bryan**  
Supply Chain Lead

## We need a decisive vision for a fluid supply chain future.

Today's supply chain, logistics, and manufacturing industries sit at a critical juncture, yet each industry is too focused on the near term, mostly because of geopolitical and economic crises. While these challenges are pressing and monumental, this moment—and the future—calls for more expansive thinking and adoption of new practices instead of incremental changes. In an era defined by rapid technological advancements and market evolution, our industries must transcend traditional models, by embracing a holistic and forward-thinking approach. We will have to reimagine what the supply chain looks like, and prepare for a future where self-optimizing, adaptive supply chain networks not only exist but are the norm. We won't just see an enhancement of existing processes; we'll experience a fundamental change in how we manage and optimize supply chains, setting a new standard for operational excellence.

However, it won't be easy, and this approach presents risks. Increased digitization and flexibility bring heightened cybersecurity threats. The complexities of environmental, social, and governance (ESG) compliance and the potential biases in AI-driven procurement processes pose significant challenges. Environmental implications from increased automation, alongside the high costs of implementing advanced tracking systems, further underscore the need for strategic and inclusive approaches.

In light of these opportunities and threats, our actions must be both decisive and visionary. As we move beyond traditional limitations, we have the opportunity to transform supply chains, logistics, and manufacturing into dynamic ecosystems of innovation and resilience. By harnessing advanced technologies and fostering a culture of continuous improvement, we can lead our industries into a future that is efficient, robust, and adaptable to our rapidly changing world. This journey is about building a future that is not only sustainable but also vibrant, resilient, and full of possibility.



## Global industries face challenges as infrastructure setbacks, economic pressures, labor disputes, and rising automation reshape markets worldwide.

1

### Baltimore bridge collapse closes port

The economy takes a \$15 million hit every day that ships cannot make it through the Port of Baltimore.

2

### Beijing lacks new demand

China's manufacturers struggle at home despite being feared in the West for their cheap goods.

3

### JD.com plans \$5 billion stock buyback

JD.com wants to stabilize its share price and reassure investors after the unexpected exit of its major shareholder, Walmart, in a bid to compete in the Chinese e-commerce market against rivals like Alibaba.

4

### Railway union disputes back-to-work orders

In Canada, the orders to end worker strikes at two major railways get hit by lawsuits.

5

### 1 in 10 South Korea workers are robots

Due to its rapid adoption of automation, South Korea reaches a robot density of 1,012 units per 10,000 employees in the manufacturing sector.



## Tackling global instability with innovation and resilience

In 2025, the supply chain, logistics, and manufacturing industries are grappling with a mix of economic challenges, geopolitical shifts, and rapid technological transformation. The predicted slowdown of global growth has pushed companies to diversify their operations away from traditional regions like China, with southeast Asian countries such as Vietnam, Malaysia, and India becoming central manufacturing hubs. Much of this movement is an attempt to keep up with ever-increasing customer fulfillment expectations—and prevent customer loyalties from wavering.

Several regions are dealing with the combination of inflation, raw material shortages, and extreme weather disruptions. Fold in geopolitical tensions, and global supply chains have become incredibly complex to navigate. Conflicts in the Red Sea and Ukraine are disrupting shipping routes and upping transportation costs, pushing companies to seek alternative routes and more agile logistics solutions. Latin America faces its own set of issues—including political instability and insufficient reforms—that are hindering growth and adding to economic inefficiencies. China's and Russia's growing influence in the region, particularly through investments in energy and infrastructure, brings another layer of intricacy to supply chain networks.

At the same time, sustainability movements and preparation for climate change impacts are keeping the industries investing for the future. In the EU, new ESG standards are spurring investments in electrification, resource management, and carbon footprint reduction, with more than 40% of companies making strides toward more sustainable operations.

Despite technological advances, supply chain professionals are still spending considerable time on manual processes, including how they track data, and most don't have a predictive view of supply and demand. The lack of visibility and real-time information hinders the balance between preparing for disruptions and properly managing inventories. To make up for it, the vast majority of supply chain executives plan to increase their investments in preparedness strategies, which will have to include better data integration.

Indeed, this is a year for focusing on building resilience. Companies in the supply chain, logistics, and manufacturing sectors will be looking to diversify sourcing and invest in technology and sustainable practices, while they navigate a complex global landscape of economic volatility and geopolitical risk.





# Innovations abounded in the industry that enhanced productivity and processes.

## FEBRUARY 2024

### C.H. Robinson's AI Load Scheduling

The transportation company's touchless appointment technology saves 7.4 hours per load by optimizing carrier schedules.

## APRIL 2024

### Tracking for Textile Supply Chains

RFID technology tracks cotton and fiber origins, improving traceability in textile manufacturing processes.

## AUGUST 2024

### Ryder Completes AI Yard Pilot

So far, the Ryder AI program designed to automate yard operations has processed 10,000 truck detections with 99% accuracy.

## MARCH 2024

### Cargo Thefts Near \$700 Million

Organized efforts to steal goods sharply rise compared to the start of the COVID-19 pandemic.

## JULY 2024

### Japan's Underground Conveyor Belt

Plans have begun for a 310-mile automated underground package transportation system between Tokyo and Osaka.

← PAST



# Augmented operations will enable new forms of fulfillment and local production.

**MID 2027**

## Nearshoring Regulations Expand

Governments will implement expanded regional trade agreements and incentives to localize supply chains, fostering more secure and resilient trade ecosystems.

**LATE 2029**

## Magnetically Responsive Inks Transform Production

Real-time control over particle alignment using magnetically responsive inks will accelerate manufacturing speeds while improving the structural integrity of printed materials.

**MID 2033**

## Underground Nano-Fulfillment Centers Streamline Logistics

Automated underground transport systems will revolutionize urban logistics, moving goods seamlessly between hubs and delivery points while alleviating surface congestion.

FUTURE >>

**MID 2028**

## Path Optimization Algorithms Enable New Fulfillment Options

AI-powered path optimization algorithms will allow companies to offer flexible delivery options, improving customer satisfaction and reducing fulfillment costs.

**LATE 2030**

## Immersive Digital Twins Transform Supply Chain Monitoring

24/7 immersive digital twin technology will give the majority of large companies real-time insights into their supply chains, enabling predictive troubleshooting and optimized planning.





## Emerging trends offer leaders a way to prioritize and focus.

### Prioritize Technological Debt Hurdles

Companies with technological debt face the cyclical effect of constantly losing out on operational efficiency. As reliance on real-time data and automation increases, laggards will experience bottlenecks, leading to higher costs, lower productivity, and delayed decision-making.

### The Labor of the Future Is Here

Labor shortages are rapidly being circumvented through strategic automation and cobot integration. This is now the norm for what was once considered the future. Before implementation, determine how production practices and management will change as humans and cobots work alongside one another.

### Shipping and Manufacturing Practices Will Change

In response to rising transportation costs and geopolitical challenges, businesses will shift toward more sustainable and flexible manufacturing and shipping practices. Go beyond nearshoring to rethink the local supply chain and production process.

### Networks Will Become Autonomous

Automation is becoming a requirement for all back-of-house and manual processes. Include sourcing and procurement on that list, with secondary and tertiary backup plans (that are also automated) for potential disruptions.

### Operational Skills Are Shifting

Gesture control and voice control operations are scaling, upending traditional operator activities. Companies will need to identify what skill void that leaves in their current human labor force.

### Last Mile Could Become Instantaneous

With companies increasingly focused on local production and new developments in hyperlogistics, products might be offered instantaneously. Most manufacturers and e-commerce platforms are not prepared for this type of delivery model and should consider pricing and operational restructuring.



## These individuals are at the forefront of development and transformation in the supply chain, logistics, and manufacturing industries.

- ◆ **Mark Albrecht**, vice president for artificial intelligence at **C.H. Robinson**, for progress on using AI to automate logistics management tasks.
- ◆ **Arun Rajan**, chief operating officer at **C.H. Robinson**, for working toward automating management tasks in the supply chain and logistics industries.
- ◆ **Dr. Alexandra Brintrup**, professor at the **University of Cambridge**, for leading efforts in using AI in supply chain networks.
- ◆ **Rupert Cruise and Phill Davies**, co-founders of **Magway**, for their work on underground delivery systems.
- ◆ **Aaron Zhang**, co-founder and CEO of **A2Z Drone Delivery**, for a drone-network-as-a-service model.
- ◆ **Juyoung Lee**, research assistant at **Korea Advanced Institute of Science and Technology**, for insights on gesture control in XR technology.
- ◆ **Dipali Goenka**, CEO and managing director of **Welspun Living Ltd.**, for work on automating data capture throughout the supply chain.
- ◆ **Jiaguo Yu**, professor at **China University of Geosciences**, for advancements on intelligent labels that can self-heal.
- ◆ **Patrick B.M. Fahim**, for research with **Delft University of Technology** on transforming ports into a physical internet.
- ◆ **Devin Bhushan**, founder of **Squint**, for work on automating data entry and augmented reality.
- ◆ **Shameek Ghosh**, CEO of **TrusTrace**, for its Forced Labor Prevention Solution.
- ◆ **Stephanie Gabriela Gomez Prieto**, recent MIT graduate student, for work on enabling demand forecasting for family-owned nanostores.

## Supply chain could soon see opportunities for advanced tracking and procurement...

### OPPORTUNITIES

#### Advanced RFID and DNA tracking

The development of these systems in the agriculture and textile industries creates opportunities to enhance transparency and traceability across supply chains, which in turn ensures product authenticity and reduces contamination risks.

#### Automated data relationships in manufacturing

With automatic data connections in the textile industry, manufacturers can improve production quality, track fiber authenticity, and meet customer expectations for premium products.

#### Dual-sourcing procurement models

New systems that integrate dual-sourcing and penalty constraints can help manufacturers mitigate their supply chain risks. Spreading dependencies across multiple suppliers ensures a reliable flow of goods even during disruptions.

#### Rapid production of advanced materials

The innovation of magnetically responsive inks in continuous 3D printing allows for greater control over material properties, giving industries like aerospace and robotics the ability to rapidly produce stronger and more specialized components.



## ...but with increased automation comes new threats and challenges to address.

### THREATS

#### Cybersecurity vulnerabilities in smart ports

Increased digitization and automation of operations expose ports to cybersecurity risks. Vulnerabilities in connected systems could lead to service disruptions, data theft, or compromised infrastructure that affect global supply chains.

#### AI bias in procurement decisions

AI algorithms used in procurement processes could introduce biases that unfairly exclude suppliers, leading to a lack of diversity in the supply chain and potential reputational harm for companies relying on these systems.

#### Environmental risks from increased automation

The growing use of automated machinery, robotics, and AI systems in supply chains could result in higher energy consumption and increased carbon emissions, potentially clashing with global sustainability goals and regulations.

#### High costs of advanced tracking systems

The implementation of advanced tracking systems could lead to increased costs for smaller businesses, potentially limiting the widespread adoption of these technologies.



# Companies must be purposeful in how they explore and ultimately integrate emerging technologies into their value chain.



Implement flexible omnichannel management systems that integrate across the entire supply chain. This will improve efficiency and adaptability in diverse operational needs, and help companies maintain a competitive edge in evolving markets.



Prepare for adaptive, self-healing supply chains that anticipate disruptions, reroute shipments, and resolve issues in real time without human intervention.



Make real-time route optimization and localized production capabilities a priority to improve operational efficiency and meet customer demands.



Facilitate DNA testing in the supply chain on site and at customer locations, using technology solutions to automate data collection and analysis, while improving efficiency and accuracy.



Leverage sector-agnostic data for omnichannel platforms where possible. Larger companies may find this easier, while smaller ones should seek partnerships to stay competitive.



Standardize gesture control across the supply chain, to make transitions between workers seamless and raise efficiencies during periods of high demand.







## Important terms to know before reading.

### **ADDITIVE MANUFACTURING (AM)**

A process of creating objects by adding material layer by layer, synonymous with 3D printing. It includes 4D printing, where objects evolve in response to external stimuli such as heat or moisture.

### **CUSTOMER RELATIONSHIP MANAGEMENT (CRM)**

A system for managing a company's interactions with current and potential customers, often integrating data to deliver personalized customer experiences and improve sales processes.

### **DIGITAL TWIN**

A digital representation of a physical object or system used to simulate, monitor, and optimize real-world operations. In logistics and manufacturing, digital twins allow for real-time monitoring and decision-making, improving accuracy and reducing downtime.

### **ENTERPRISE RESOURCE PLANNING (ERP)**

A system that integrates various functions of an organization—such as development, manufacturing, sales, and marketing—into a single unified solution for better coordination and efficiency.

### **ENVIRONMENTAL, SOCIAL, AND GOVERNANCE (ESG)**

A set of criteria used to evaluate a company's operations based on sustainability, ethical impact, and governance practices.

### **FULLFILLMENT CENTERS**

Warehouse facilities used for storing, packaging, and shipping consumer goods, often supporting e-commerce and retail logistics operations.

### **GENERATIVE ADVERSARIAL NETWORKS (GANS)**

A class of machine learning models consisting of two neural networks—one generating data and the other evaluating it—used to create realistic synthetic data.

### **IMMERSIVE REALITY (XR)**

A collective term for immersive technologies such as virtual reality, augmented reality, and mixed reality, used in applications ranging from entertainment to workforce training.

### **INTERNET OF THINGS (IOT)**

A network of interconnected devices that collect, share, and analyze data to automate and improve operations. IoT spans sectors such as manufacturing, transportation, health care, and smart cities.

### **LAST-MILE DELIVERY**

The final stage of the delivery process, where a product is transported from a distribution center or hub to its final destination, typically a residence or business.

### **LOGISTICS**

The detailed coordination and management of the movement of goods, services, and information from the point of origin to the point of consumption.

### **MULTIMODAL LOGISTICS**

The coordination and movement of goods using multiple modes of transportation—such as trucks, ships, trains, and airplanes—within a single shipment. Multimodal logistics integrates different transportation methods to optimize the efficiency, cost, and speed of moving goods across various distances and regions, often involving seamless transitions between carriers and transportation modes.

### **NANO-FULLFILLMENT CENTERS**

Small, hyperlocal fulfillment centers that leverage automation and 3D printing to produce and deliver goods quickly and efficiently. These centers are often integrated into urban environments to reduce shipping times and costs.

### **ORDER MANAGEMENT SYSTEM (OMS)**

A system that manages the order fulfillment process, including inventory tracking, order processing, and delivery scheduling.



**PRODUCT LIFECYCLE MANAGEMENT (PLM)**

A software system that manages a product’s lifecycle from its initial concept through design, manufacturing, service, and disposal, helping companies optimize product development and operations.

**PROCUREMENT**

The process of sourcing and acquiring the goods and services a company needs to meet its business objectives. It includes negotiations, contract management, and supplier relations.

**QUANTUM COMPUTING**

A computing technology based on quantum mechanics that enables complex calculations to be processed much faster than with traditional computers.

**SMART CONTRACT**

A self-executing contract with the terms of the agreement directly written into code. In logistics, smart contracts enable automated enforcement of agreements, such as making a payment based on predefined conditions.

**SMART WAREHOUSES**

Warehouses that use advanced technologies like AI, real-time data monitoring, and robotics to optimize storage, inventory management, and product picking. These warehouses improve operational efficiency and reduce human intervention.

**SUPPLY CHAIN**

The network of organizations, people, activities, information, and resources involved in the production and delivery of a product or service, from the sourcing of raw materials to delivery to the end consumer.

**TRANSPORTATION MANAGEMENT SYSTEM (TMS)**

A system used to plan, execute, and optimize the physical movement of goods, ensuring efficient transportation, cost control, and timely delivery.

**WAREHOUSE MANAGEMENT SYSTEM (WMS)**

A software system that manages and optimizes the operations of warehouses and distribution centers, including inventory tracking, order picking, and shipping.



# SUPPLY CHAIN, LOGISTICS, & MANUFACTURING TRENDS



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# SUPPLY CHAIN & LOGISTICS MANAGEMENT





3RD YEAR ON THE LIST

# AUGMENTED & AUTOMATED PROCESSES

WHAT IT IS

AI-powered automation is revolutionizing supply chains as it enhances precision, efficiency, and decision-making across logistics, procurement, and operational workflows.

HOW IT WORKS

Ryder Systems' integration of AI-powered computer vision in yard management is a prime example of how augmented and autonomous processes are transforming supply chain efficiency. Using Terminal Industries' technology, the company automated truck tracking and boasts a 99% accuracy rate in identifying more than 10,000 vehicles. This automation replaces manual tasks like recording license plates and DOT numbers, as well as integrates with third-party databases to provide complete vehicle profiles. The result of instant action to such information: streamlined, real-time decision-making.

Logistics firm Qued employs AI to automate email-based scheduling through natural language processing. The tool reads and responds to email requests, simplifying appointment bookings. This autonomous process reduces workloads for small to midsize logistics firms, saving brokers and carriers time and improving customer satisfaction.

AI further enhances procurement processes. A South Korean system uses machine learning models to match companies with international bidding opportunities. By parsing vast amounts of procurement data, it precisely evaluates company profiles against bid requirements, offering real-time recommendations that also improve bid success rates.

Even in supply chain resilience, the Two-Stage Deep Decision Rules method uses deep learning to manage uncertainties like fluctuating demand and supplier disruptions. This optimizes resource allocation and aids in adapting to market shifts.

WHY IT MATTERS

These processes have the potential to enhance accuracy, speed, and resilience of supply chains. Traditional logistics often rely on manual data entry, but that's asking for errors and delays. AI can process large volumes of data in real time, reducing errors, cutting costs, and accelerating logistics operations for quicker deliveries and improved customer experiences. Automating workflows like truck tracking or appointment scheduling transitions tasks toward autonomous processes, enhancing precision and service quality. This shift reduces the need for human intervention in routine tasks, giving workers more time to pay attention to more complex activities.

Geopolitical uncertainties and persistent market fluctuations are forcing supply chains to become more robust and adaptive. AI tools that make decision-making more informed and efficient — even under uncertain conditions — empower businesses to stay competitive and meet demand despite disruptions. Automation also plays a crucial role in sustainability by reducing operational waste and optimizing resource allocation. All of these factors position AI as a vital element in building resilient, sustainable supply chains, not just for efficiency but also for future-proofing the industry against unforeseen challenges.



3RD YEAR ON THE LIST

# REAL-TIME OPTIMIZATION

WHAT IT IS

The ability to optimize logistics in the moment positions companies to make the most of their container space, better allocate resources to reduce costs, and scale their supply chains.

HOW IT WORKS

Real-time optimization uses advanced algorithms to tackle complex logistics issues, such as fleet management and container utilization. A key example is research to use algorithms like the Hybrid Genetic Algorithm and solutions like the Solomon Insertion Heuristic to optimize fleet delivery routes while considering constraints like vehicle capacity and customer time windows. The algorithm mimics natural selection to evolve route solutions while using a hybrid approach to enable faster convergence to high-quality solutions, enhancing fleet efficiency. AI is also used to predict container utilization rates with long short-term memory networks and model-agnostic meta-learning, accounting for long-term dependencies in time-series data. Machine-learning algorithms like K-Means clustering segments shipping routes, to optimize container allocation and adjust resources dynamically.

The multimodal transport logistics system is another beneficial innovation for small and medium-size businesses. It combines subjective inputs (user preferences) with objective data (location, traffic) for precise, real-time logistics quotations. It optimizes both delivery and return processes by integrating multiple transportation methods and reducing manual intervention. AI-powered demand forecasting helps small businesses manage inventory in real time, minimizing stock issues. Companies like C.H. Robinson use real-time AI for scheduling, which reduces inefficiencies, while Oracle's plans for a real-time worker oversight system ensures accuracy in manufacturing and supply chains.

WHY IT MATTERS

By optimizing routes, container usage, and workforce management in real time, companies can reduce operational costs, including those related to fuel consumption, labor, and vehicle wear. This leads to more sustainable logistics practices, such as lowered carbon emissions and improved resource allocation. With predictive models and real-time data, logistics providers can adjust dynamically to changing conditions, such as traffic patterns, fluctuating demand, or supply chain disruptions, all musts for establishing faster, more reliable deliveries. AI-driven logistics solutions are set up to scale efficiently, to manage large fleets and complex shipping routes as e-commerce and global trade expand.

Real-time optimization also improves the decision-making by providing actionable insights into future demand and resource needs. Companies can anticipate peak shipping seasons and allocate containers more effectively, reducing underutilization or congestion. This results in better customer experiences, with more on-time and complete deliveries, and keeps complaints down. The long-term effect will be a more streamlined, resilient, and environmentally friendly supply chain. Integrating these innovations is quickly becoming a necessity rather than a luxury.



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**Global supply chains are broken—too many are still being run on Excel... Operators spend countless, frustrating hours battling endless spreadsheets... It's inefficient, chaotic, costly, suboptimal and completely unfit for the modern world.**

Dave Clark, former Amazon Consumer CEO & Co-founder of Auger





3RD YEAR ON THE LIST

# VISIBILITY TRACK AND TRACE

WHAT IT IS

True traceability is happening throughout supply chains, for up-to-date tracking of movements and an understanding of where materials originated. This enhanced transparency is addressing long-held sustainability and security concerns.

HOW IT WORKS

Tracing the origins of goods has become a must, not only for compliance reasons but to build customer trust. In agriculture, innovations in DNA tracking allow for rapid, on-site identification of crop traits. NanoBio Designs has developed portable DNA tests so that grain handlers can instantly verify genetic traits, while also reducing contamination risks and meeting export compliance requirements. In textiles, RFID tags are used in the production process to track fibers, bales, and equipment. This digital traceability verifies claims about origins of materials, such as premium cotton types. Blockchain technology enhances this data integrity even further by creating an immutable ledger.

Besides tracking goods, these technologies also automate the relationship between different production stages by linking inputs, processes, and outcomes in a seamless digital system. Real-time monitoring offers unmatched visibility plus improved quality control and operational efficiency. Additionally, innovations like the CICAPT-IIoT dataset, which addresses risks in Industrial Internet of Things (IIoT) environments, enhance cybersecurity. By integrating provenance data, this system improves the detection of advanced persistent threats, to maintain the integrity of interconnected supply chains and help companies develop stronger defenses against cyberthreats.

WHY IT MATTERS

Across industries, enhanced traceability and real-time data in supply chains are becoming the norm and are increasing the return on investment. Rapid genetic testing could help prevent billions in losses from rejected agricultural, textile, and other shipments by reducing contamination. This granular level of visibility also helps streamline operations by reducing manual errors, increasing efficiency, and enabling quicker responses to disruptions. Consumers can feel more confident about companies' product origin claims, ethical sourcing, and sustainability. These advances also help both governments and businesses manage their compliance with international regulations, for improved global trade operations.

The increased use of blockchain takes sustainability and visibility to an even higher level. By incorporating blockchain technology, companies can address growing concerns about data integrity in supply chains, particularly in high-value or sensitive industries such as pharmaceuticals, electronics, and food safety. The immutable ledger component of blockchain should become a priority for companies as government regulations could soon require data to be provided through such platforms. By acting on this now, companies can also shore up concerns about future cybersecurity risks.





3RD YEAR ON THE LIST

# ESG TRACKING AND DECLARATIONS

WHAT IT IS

Environmental, social, and corporate governance (ESG) reporting has become a critical requirement for companies across the globe due to new regulations, particularly the EU's push for heightened transparency and accountability in supply chains.

HOW IT WORKS

Innovative platforms are helping companies meet the heightened ESG requirements for tracking and reporting across their supply chains. Shipzero, a green logistics startup, recently secured funding to assist logistics providers in monitoring and reducing transport emissions. The new funding supports the development of a “Book & Claim” solution that companies can use to get credit for supporting sustainability attributes of transportation fuels that they do not directly use.

Heavy-duty trucking is responsible for more than 3% of global emissions, and some in the industry are working to reduce trucking's impact while saving money. Like Shipzero, the climate-focused nonprofit Center for Green Market Activation also uses a Book & Claim system, but it's focusing on helping carriers fill low-emission trucks with guaranteed shipments. Carriers can use it to justify their investment in new technology by gaining stable business for their low-emission fleets. Blockchain-enabled platforms are also becoming crucial in ESG compliance by enhancing transparency and traceability, with real-time monitoring of contracts and supply chain operations to detect anomalies, predict risks, and secure sensitive data. Additionally, AI integration in supply chain solutions, like Alibaba's AI-powered sourcing engine, is making B2B procurement processes more intuitive and efficient.

WHY IT MATTERS

The shift toward more transparent, ethical, and sustainable supply chains is being driven by both regulatory requirements and market demand for environmental and social responsibility. While many companies are concerned about additional costs due to new procedures, platforms like Shipzero and blockchain-based logistics solutions are not only helping companies meet ESG targets but improving their overall operational efficiency. These innovations offer critical tools for tracking carbon emissions, ensuring regulatory compliance and improving supply chain security—and companies implementing them are better positioned to meet the growing calls for sustainable business practices.

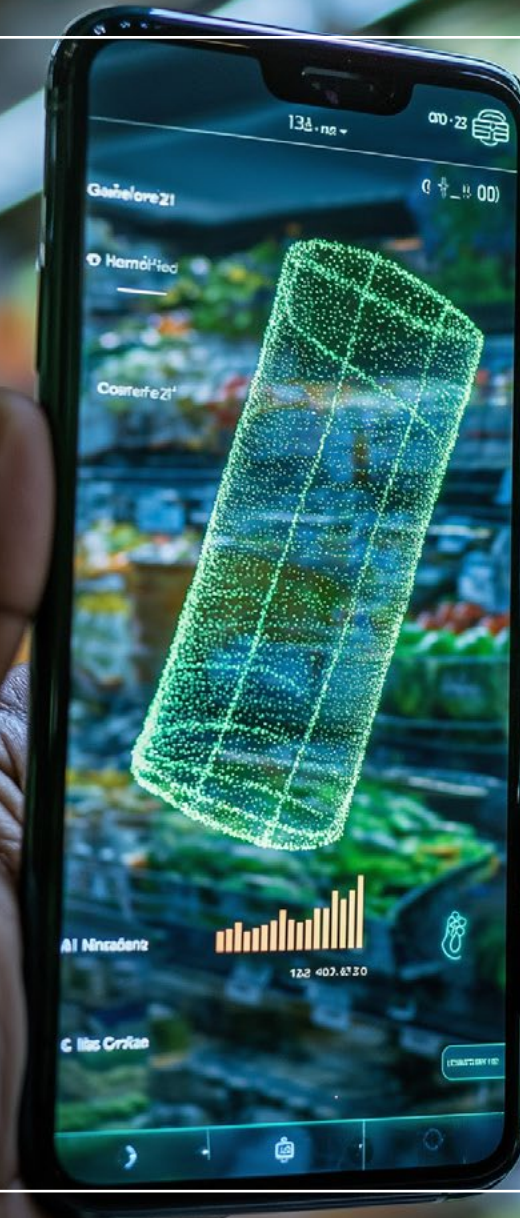
However, the adoption of these technologies requires significant investment and operational shifts, which will be a challenge for smaller companies and those without advanced reporting systems. Companies facing high technological debt may need to find partners to address their current and future needs. One simple step companies could take would be to investigate current fuel usage by their transportation and logistics partners and services. Switching to new fuel sources or local production would require little to no technological change. Even with its challenges, this trend marks a pivotal moment in the transition to a more sustainable global economy.



## SCENARIO YEAR 2027

# DNA SHOPPING

It's 2027, and in Sweden, grocery shopping has leaped into the future with the integration of DNA tracking and cutting-edge technology. Klara, a resident of Gothenburg, steps into her local eco-friendly grocery store, one of many local options that now offer a fully immersive shopping experience. She pulls out her smartphone, equipped with a custom XR app, to explore the products more closely as she walks down each aisle. This has become a key part of Klara's routine; she now expects to know the full lifecycle of her groceries, from farm to table. She holds her phone over a bag of flour, and instantly, the app scans the product, revealing its digital twin. Klara can see the exact origins of the wheat, harvested from an organic farm in the Skåne region. As Klara continues her shopping, scanning items like pasta and oats, she receives personalized recommendations for products with DNA scores that align with her physiological wellness directives. For Klara, and many like her, this level of transparency and technological sophistication is more than a convenience—it's an expectation in a country that consistently leads the world in health and innovation.







3RD YEAR ON THE LIST

# OMNICHANNEL MANAGEMENT PLATFORMS

WHAT IT IS

While management platforms have traditionally been siloed, omnichannel management platforms combine various tools to serve as an end-to-end solution across industries.

HOW IT WORKS

Startups like Didero are advancing omnichannel platforms for midsize companies, to ease supply chain tasks like finding suppliers, negotiating contracts, and analyzing costs. In cross-border logistics, omnichannel platforms such as Cargado simplify US-Mexico freight movement by addressing regulatory complexities. These platforms are increasingly focusing on cybersecurity: one example is SPatch's patch management services. These services secure omnichannel systems by using differential symbolic execution to ensure software updates fix vulnerabilities without disrupting functionality.

Blockchain is another key component because it's improving supply chain traceability. Advanced systems now allow for multi-condition queries across blockchain data, filtering by transaction details or timestamps. Adaptive Bloom filters and Trie trees facilitate faster searches, offering real-time validation and feedback. This significantly enhances logistics managers' ability to quickly identify and resolve issues like shipment delays or tampering. AI-powered features, like those in C.H. Robinson's Digital Dispatch, use real-time data to optimize load matching for carriers, accelerating freight booking and reducing manual tasks.

WHY IT MATTERS

Whether it's in logistics, retail, or manufacturing, omnichannel management platforms offer customizable, scalable solutions that cater to diverse industry needs. In situations where flexibility to address specific tasks becomes increasingly vital, comprehensive platforms that integrate procurement, logistics, and real-time analytics provide major advantages. They reduce the need for multiple systems, lowering costs and increasing agility. They also empower companies to develop cohesive long-term strategies, optimize resource allocation, and enhance decision-making.

Platforms capable of managing global trade complexities are critical for seamless cross-border operations. So is the need for robust cybersecurity, especially with the rise in digital platform complexity. Tools like SPatch demonstrate how omnichannel systems must balance efficiency and security to protect supply chains from cyberattacks. Omnichannel platforms are now key enablers for growth and resilience in a dynamic market. They must be adaptable across sectors and tasks, to help companies meet immediate goals and plan strategically for future challenges. Investing in flexible, sector-agnostic platforms positions businesses to manage market shifts, regulatory changes, and technological advances.



3RD YEAR ON THE LIST

# DIVERSIFYING THE PROCUREMENT PROCESS

WHAT IT IS

Procurement processes are increasingly affected by global disruptions. To mitigate these risks, companies are turning to advanced technologies that offer diversity, flexibility, and resilience in their supply chains.

HOW IT WORKS

When it comes to diversifying the procurement processes, new AI-powered systems are driving the trend, by creating what's known as flexible, liquid networks that can adapt in real time to shifting demands and challenges. One major innovation is dual-sourcing combined with penalty constraints. The first aspect mandates using multiple suppliers for the same product, reducing reliance on a single supplier and mitigating the risk of supply chain breakdowns. With penalty constraints, companies ensure that suppliers meet their performance standards. Modern procurement systems are also tracking suppliers across multiple tiers and integrating direct and indirect suppliers in the decision-making process.

With liquid networks, procurement processes continuously adapt to changes in material flow and supplier capabilities. AI-driven systems monitor procurement timelines and optimize purchases based on current demand. AI systems can further diversify procurement by continuously analyzing data and adjusting workflows; they track every step in the process, identifying inefficiencies and making automatic adjustments to improve speed and accuracy. Additionally, through community benchmarking, companies compare their performance against industry peers so they can make data-driven decisions based on cost-efficiency and improve how they collaborate with their suppliers.

WHY IT MATTERS

The pandemic, geopolitical tensions, and environmental crises have revealed the limitations of traditional procurement strategies that rely on single suppliers or rigid systems. The shift toward liquid procurement networks will make companies more adaptable to sudden changes. Real-time AI systems provide unprecedented transparency, giving companies the ability to swiftly respond to changes in supplier availability, pricing, and material needs. This also creates a more fluid relationship between companies and suppliers, as businesses can dynamically adjust their procurement strategies to achieve optimal prices without compromising supply chain stability. This flexibility is crucial for industries, like manufacturing and consumer goods, that have frequently changing material needs.

AI-driven procurement also reduces reliance on manual interventions. Automated decision-making systems can adjust purchase orders, reallocate tasks, and suggest improvements as needed, streamlining operations and reducing administrative overhead. Companies adopting these technologies will build resilient, scalable supply chains that can withstand future disruptions and provide greater worker autonomy and time. As more autonomous systems are implemented, the refinement process of worker routines could become a challenge if daily tweaks to operations become an annoyance to workers.





SCENARIO YEAR 2032

## SELF-HEALING NETWORKS

By 2032, the Liquid Logistics Network (LLN) has evolved into a fully self-healing, autonomous system capable of resolving disruptions without human intervention. These networks are now equipped with advanced predictive analytics and AI that monitor countless data streams—weather patterns, geopolitical shifts, market conditions, and even cyberthreats—enabling them to plan for disruptions before they occur. For instance, if a hurricane is forecasted to hit a major port, the system will reroute shipments days in advance, redirecting goods to alternate hubs and rebalancing inventory across warehouses to avoid delays. Autonomous drones and electric trucks are dispatched from nearby cities to handle overflow, ensuring that the entire supply chain continues to function seamlessly, even in the face of major logistical bottlenecks.

When unexpected disruptions do occur, such as a cyberattack aimed at bringing down a key supplier's infrastructure, the LLN's blockchain-backed security protocols spring into action. Blockchain ensures that no critical data is lost or compromised, while smart contracts instantly trigger backup processes, like switching to secondary suppliers or rerouting shipments through safer channels. These networks have grown so advanced that they not only resolve issues in real time but also “learn” from each incident, adjusting algorithms to prevent future occurrences of the same nature. In a world where supply chains are increasingly complex and globalized, these self-healing capabilities provide companies with constant continuity, even during crises, while minimizing human intervention and optimizing for cost and sustainability. The era of reactive logistics management is over, replaced by a proactive, intelligent system that keeps the global economy flowing smoothly no matter the challenges it faces.





3RD YEAR ON THE LIST

# LAST-MILE SOLUTIONS

WHAT IT IS

Last-mile solutions optimize the final stretch of the delivery process to get products to customers quickly and efficiently.

HOW IT WORKS

New platforms use real-time data to dynamically adjust routes and delivery windows. For example, drivers and supervisors at Solar Coca-Cola in Brazil rely on Descartes' route execution and fleet performance management solution to manage delivery routes as they're happening. Accounting for traffic, weather, and delivery windows, the mobile-based platform also captures customer information at delivery points along with driver progress, so routes can be continuously re-sequenced as needed.

AI research, especially in reinforcement learning for large language models (LLMs), is contributing to progress in last-mile optimization. New systems can fine-tune LLMs to produce relevant outputs without human input, for better delivery communications and operations. Companies like Best Buy use AI for customer support and delivery tracking to reduce customer frustration and enhance the delivery experience. Wiliot, an IoT company, leverages generative AI for natural-language interactions with IoT-connected products so that customers can communicate directly with packages during transit. Innovations in smart storage solutions are also advancing last-mile delivery. Companies like Arrive AI provide a "mailbox-as-a-service" platform, offering secure, smart storage for deliveries when recipients aren't available. The solution includes self-powered IoT Pixels and AI for real-time data analysis.

WHY IT MATTERS

The transformation of last-mile delivery is crucial for meeting consumer expectations of rapid and convenient delivery, especially in e-commerce. The upsides of AI, IoT, and real-time data optimization are enhanced delivery efficiency, reduced costs, and improved customer experiences. But there's also the potential for increases in urban traffic congestion. More delivery vehicles on the road could exacerbate existing traffic issues. While AI-enabled routing can choose the best paths to avoid congestion, the cumulative effect of increased deliveries may still be slowed traffic and increased road wear.

Sustainability and carbon emissions are also significant concerns. The frequency of last-mile deliveries raises questions about carbon emissions and energy use. Companies that adopt sustainable practices like investing in electric fleets, drones, and cargo bikes could reduce environmental impact.

Infrastructure will have to evolve to support these solutions. Urban areas may need to redesign spaces for delivery vehicles, drones, and smart mailboxes, such as dedicated lanes or parking zones, to minimize disruption to communities. Investing in new technologies and smart city solutions is essential to balance efficiency, customer satisfaction, environmental impact, and infrastructure demands.





3RD YEAR ON THE LIST

## SMART PORTS

WHAT IT IS

Smart ports leverage advanced technologies to enhance operational efficiency, supply chain integration, and environmental sustainability.

HOW IT WORKS

Around the world, ports are modernizing through digitization, real-time data analytics, AI integration, and electrification. The Port of Halifax is creating a digital data hub that integrates information from trucking, marine, and rail operations. Its real-time dashboards monitor vessel turn-around times, container movements, and truck scheduling. The Port of Bellingham in Washington is installing electrical plugs so that docked ships can connect to the electrical grid, reducing their reliance on diesel engines and cutting emissions. Another advancement in port management is the use of automatic information system data for predictive modeling. This data helps estimate port congestion while providing accurate ETAs for ships and better forecasting of where goods will be at any point in time.

Ports are also using innovative machine learning models like DBSCAN and XGBoost to identify and manage congestion points. Advanced predictive models combining linear regression with machine-learning algorithms such as random forest can more accurately forecast incoming commodity volumes. The emerging Physical Internet paradigm could create a hyperconnected logistics system by standardizing protocols and treating goods movement similar to how data transfers on the internet. Additionally, extended reality and digital twins are enhancing precision and safety in remote operations by allowing operators to control machinery from a realistic representation of the physical environment.

WHY IT MATTERS

Turning ports into smart, interconnected hubs will enhance global supply chain resilience and efficiency. By adopting real-time data analytics, AI, and automation, ports can reduce bottlenecks and improve cargo flow. AI and machine learning enable predictive analysis for better congestion management and resource allocation, leading to more accurate ETA predictions and streamlined goods movement. Electrification and a focus on environmental sustainability are necessary for reducing the maritime industry's carbon footprint. New advancements support the development of hyperconnected logistics networks, to further improve the performance of individual ports and the overall global supply network, and ultimately revolutionize how goods are managed and delivered.

XR technologies and digital twins will make it so operators can precisely control heavy machinery from afar, reducing the risks in challenging environments they face today. This not only improves safety but also allows for better resource allocation and predictive maintenance, minimizing downtime. Ports play a crucial role in the future of global trade and are poised to set new standards for efficiency, sustainability, and operational excellence in the supply chain.



SCENARIO YEAR 2040

## GESTURE PORTS

It's 2040 at Mumbai's Smart Port, and Arjun, an immersive port operator, begins his day by activating a small wearable pin on his shirt. With a simple flick of his hand, the entire port springs to life in front of him, displaying real-time data on every ship, container, and vehicle in the port's bustling ecosystem. The digital twin projected by Arjun's wearable gives him full control of the port operations without the need for cumbersome equipment or physical terminals. When he swipes to the right, an autonomous crane begins lifting a container from a recently docked ship, and with a pinch-and-zoom motion, he zooms into the container details.

As one of the AI-powered ships connects to the port's electrification grid, Arjun gestures to check the status of the energy draw and cargo synchronization. The XR interface seamlessly overlays critical information, allowing him to use simple motions to make adjustments, such as rerouting cargo pickups or shifting the order of containers being unloaded to avoid congestion. Drones assist in monitoring, and smart containers adjust themselves in real-time, ensuring smooth transitions and deliveries. His wearable pin keeps the digital twin active wherever he goes, allowing him to stay connected to the port's operations even while on the move. At the end of his shift, Arjun taps his wearable to sign off, and it automatically logs his work time.







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# MANUFACTURING & DISTRIBUTION ENHANCEMENTS



3RD YEAR ON THE LIST

# CONTINUOUS ADDITIVE MANUFACTURING

WHAT IT IS

Increasingly refined and reliable, continuous additive manufacturing is living up to its name with seamless, nonstop production of items even as errors are monitored in real time.

HOW IT WORKS

The production process known as continuous additive manufacturing enables nonstop 3D printing, eliminating traditional pauses between layers. Innovations like real-time error detection systems, such as the AlexNet-SVM model, monitor common defects like “spaghetti” and “stringing” with high accuracy, reducing material waste and downtime. This technology ensures stability and quality during the continuous operations. Additionally, magnetically responsive inks offer precise control over material alignment during extrusion, and they don’t require pauses for curing or drying. They enable the rapid production of complex microstructured composites.

Recent advancements include a vertical conveyor system with build plates that unfold during printing and fold back to release the finished product, allowing for the immediate start of the next item. This eliminates downtime and facilitates the production of taller, larger objects in high-volume settings. Another breakthrough is the development of flexible multifunctional energetic fibers. These can be precisely laid on complex surfaces and ignited using low-voltage input, offering improved fire suppression capabilities by allowing rapid, controlled ignition in critical environments.

In metalworking, using chitinous biomolecules allows for producing metallic composites at ambient temperatures, which require less energy consumption, and enables making custom parts on site. Finally, all-in-one printers like Markforged’s FX10 offer seamless switching between metal and composite printing, enhancing productivity and reducing downtime.

WHY IT MATTERS

Continuous additive manufacturing is allowing for nonstop, efficient manufacturing processes that significantly reduce waste and enhance the quality of products. For businesses, the ability to produce high-quality, customized items more quickly and at a lower cost will provide a competitive edge in industries like aerospace, electronics, and advanced manufacturing. The adoption of this technology is particularly crucial for sectors requiring precision and durability, as it offers enhanced control over a final product’s properties and performance. Advancements in this field have the potential to improve safety measures in various applications, and could directly impact companies’ operational security and risk management.

By reducing energy consumption and environmental impact, continuous additive manufacturing also aligns with sustainable business practices, which is increasingly important for regulatory compliance and corporate responsibility. As this capability becomes more widespread, it will transform supply chains by enabling on-demand production and reducing dependency on traditional manufacturing methods. Companies may need to rethink the value of production time and cycles if 24/7 production becomes more of the norm, which should be incorporated into systems that leverage AI-driven demand forecasting.



3RD YEAR ON THE LIST

# SMART WAREHOUSES

WHAT IT IS

Smart warehouses are optimizing efficiency in supply chains, reducing human intervention, and introducing innovations like quantum computing and gesture-based control.

HOW IT WORKS

In China, companies like Shein and Xiaomi are leading this transformation with advanced logistics hubs and fully autonomous factories. Shein is working on a smart supply chain hub in Guangzhou that will combine its stocking, picking, and distribution activities into one seamlessly run logistics park. Xiaomi's autonomous factory in Beijing showcases the future of manufacturing by producing smart-phones with minimal human intervention by using AI-driven production software and advanced robotics.

Intelligent warehouse management systems put goods where they need to be for fast access and cost savings based on real-time factors like product demand and environmental conditions. Advanced analytics provide insights into frequently purchased product combinations, enabling strategic bundling and promotions while ensuring efficient operations throughout the storage lifecycle.

Quantum-enhanced generative adversarial networks are also being explored to further enhance warehouse automation, with more precise supply chain optimization models. Autonomous forklifts and gesture-based control using digital twins keep these smart environments running and keep them well maintained. Advanced predictive maintenance models using technologies like dynamic time warping and variational autoencoders, will improve the detection and prognosis of faults in industrial components.

WHY IT MATTERS

By integrating AI, robotics, and advanced analytics, companies can automate tasks like stocking, picking, and distribution, significantly reducing operational costs and improving response times. This is vital in today's market, where customer expectations for rapid, on-time deliveries are higher than ever. It is also an important shift due to decreasing labor.

The application of quantum computing in logistics amplifies these benefits, by helping businesses more quickly solve complex optimization problems, ultimately leading to more efficient routing and inventory management. With gesture-based controls and digital twins providing real-time monitoring and remote management capabilities, companies can adapt to market fluctuations and maintain smooth operations under the most challenging conditions.

Additionally, smart warehouses help mitigate workforce shortages by automating repetitive tasks to free up employees to focus on higher-value activities. Predictive maintenance models enhance equipment reliability, minimizing downtime and extending the lifespan of assets. This means businesses can achieve consistent productivity, lower maintenance costs, and ultimately enhance customer satisfaction by ensuring reliable, efficient delivery of goods.





“

**Automated robots never get tired, can work 24/7, and have no aversion to taking on the laborious, hazardous, and heavy-lifting work that can tire humans... Robots can, and have, literally stepped in and saved the day.**

Richard Gilliard, CEO of Renovotec





SCENARIO YEAR 2028

## PRINTED FIRE SUPPRESSION

In 2028, on the outskirts of Stockholm, a drone swarm hovers over a river gorge to construct a lightweight, carbon-fiber bridge. The cluster of drones is part of a cutting-edge infrastructure project that is utilizing continuous additive manufacturing technology to 3D print the bridge. Each drone carries both a spool of carbon fiber and flexible energetic fibers, weaving together the intricate structure mid-air. As the drones work in synchrony, assembling the bridge section by section, an unexpected short circuit in a drone's battery pack causes a fire to erupt in the newly laid bridge fibers. Smoke begins to rise, and the potential for catastrophic damage becomes apparent. The swarm's energetic fibers detect the fire through embedded temperature sensors. Within seconds, they release a fire-retardant chemical embedded within their structure, snuffing out the flames before they can spread further.

The drones pause their work momentarily as the fire suppression completes, ensuring no further threats remain. The flexible energetic fibers, initially developed for military purposes, now prevent the destruction of critical infrastructure, showcasing their versatility. Once the fire is extinguished, the drone swarm resumes its task, picking up where it left off. The continuous 3D printing process remains uninterrupted, thanks to the real-time adjustments and automated safety systems in place.

By the end of the day, the bridge's skeleton is complete, with only minor delays, demonstrating the powerful combination of continuous additive manufacturing and advanced safety technologies that have transformed modern construction. The project continues, now more resilient than ever, with the confidence that any future threats can be swiftly neutralized by this innovative system.





3RD YEAR ON THE LIST

# NANO- FULFILLMENT CENTERS

WHAT IT IS

Nano-fulfillment centers are redefining local manufacturing and logistics by combining 3D printing and underground automated networks to enable quick, on-demand production and efficient delivery.

HOW IT WORKS

Nano-fulfillment centers represent a new approach to manufacturing and logistics, with a focus on hyperlocal production and delivery. The “Made in Old Town” project in Portland, Oregon, serves as a pioneering example. Transforming a historic neighborhood into a hub for sustainable footwear and apparel manufacturing, the 30,000-square-foot green manufacturing facility will be equipped with advanced additive manufacturing technologies for brands to produce small batches and prototypes locally.

Looking in the opposite direction of drones, companies are also exploring underground automated networks for efficient product delivery. Leading the way are projects like Magway in the UK and Japan’s 310-mile automated underground transportation system: They’re designed to mitigate issues such as traffic congestion and greenhouse gas emissions by shifting deliveries to underground channels. The Japanese system aims to handle the cargo equivalent of 25,000 trucks daily, significantly reducing the strain on surface transportation.

In addition, the integration of digital twins, like inVia Robotics’ Twin IQ, is enhancing the efficiency and performance of fulfillment centers. By simulating warehouse environments and workflows, businesses can optimize their layouts and processes, to ensure real-life operations run smoothly and meet tight deadlines. The combination of advanced manufacturing, underground logistics, and digital twin technology creates a robust framework for nano-fulfillment centers.

WHY IT MATTERS

Nano-fulfillment centers should be a high priority for companies looking to protect themselves from disruption. By localizing production and using advanced manufacturing techniques, nano-fulfillment centers reduce the carbon footprint associated with long-distance shipping and mitigate the risks of disruptions in the global supply chain. The use of underground automated networks for delivery will help address urban challenges like traffic congestion and pollution. This trend has the potential to revitalize local economies by bringing manufacturing jobs back to communities, promoting sustainability, and fostering innovation in product design and delivery methods. This could also lead to better product distribution to rural areas.

Additionally, these centers enhance the consumer experience by enabling rapid production and delivery of customized products, meeting the growing demand for personalization and speed. The use of digital twin technology keeps operations efficient and adaptable, giving businesses agility to respond to shifting market demands. As the logistics and manufacturing industries continue to embrace these innovations, expect to see a significant transformation in how goods are produced, distributed, and consumed.





3RD YEAR ON THE LIST

# ACTIVE & INTELLIGENT PACKAGING

WHAT IT IS

Active and intelligent packaging integrates advanced materials and technologies to preserve products, monitor their conditions, and reduce waste.

HOW IT WORKS

Among the significant advancements in packaging is nanoclay-based bio-packaging, which utilizes various types of clay to enhance mechanical strength and barrier properties. These nanocomposites are embedded into bio-based polymers, improving thermal stability and reducing permeability to gases and moisture, thus extending a product's shelf life. Some composites even incorporate antimicrobial agents like copper oxide to inhibit microbial growth, further ensuring food safety. Another breakthrough is UV-blocking films, which use UV-absorbing agents to protect food from the photochemical reactions that can degrade quality. By absorbing, reflecting, or scattering UV radiation, these films significantly extend how long a food product can last. Additionally, oxygen-scavenging films with coatings like pyrogalllic acid help reduce oxygen levels in packaging, to slow down microbial growth and maintain freshness, particularly in sensitive products.

Reusable packaging solutions aim to reduce waste by using replaceable components. Innovations like self-heating blister packaging incorporate mechanisms that activate heating zones upon contact with water, allowing for customizable heating without external sources. These reusable systems reduce waste by enabling multiple uses with replaceable components. Scientists are also developing self-healing electronics for labels and sensors, so they can repair minor damages and continue functioning without intervention.

WHY IT MATTERS

The evolution of active and intelligent packaging is significant for the manufacturers, consumers, and the environment. Nanoclay-enhanced bio-based materials reduce reliance on plastics, supporting companies' sustainability goals through biodegradability and reduced waste. Improved packaging performance directly translates to an extended shelf life, reducing food waste—a critical global challenge. The enhanced strength and barrier properties keep food products fresher for longer while reducing the need for preservatives. Other advancements can enhance user experience, by making packaging more than just a container but an active participant in food safety and quality control.

However, these innovations come with potential cost implications. As packaging becomes more intelligent and active, the cost of production and investment in these technologies may drive up shipping and product costs. A solution could be having consumers opt in to pay an additional fee for enhanced packaging features, especially for products where safety and quality are paramount. So, while active and intelligent packaging presents a step forward in sustainability, efficiency, and user engagement, it also opens discussions on cost distribution and consumer choice.

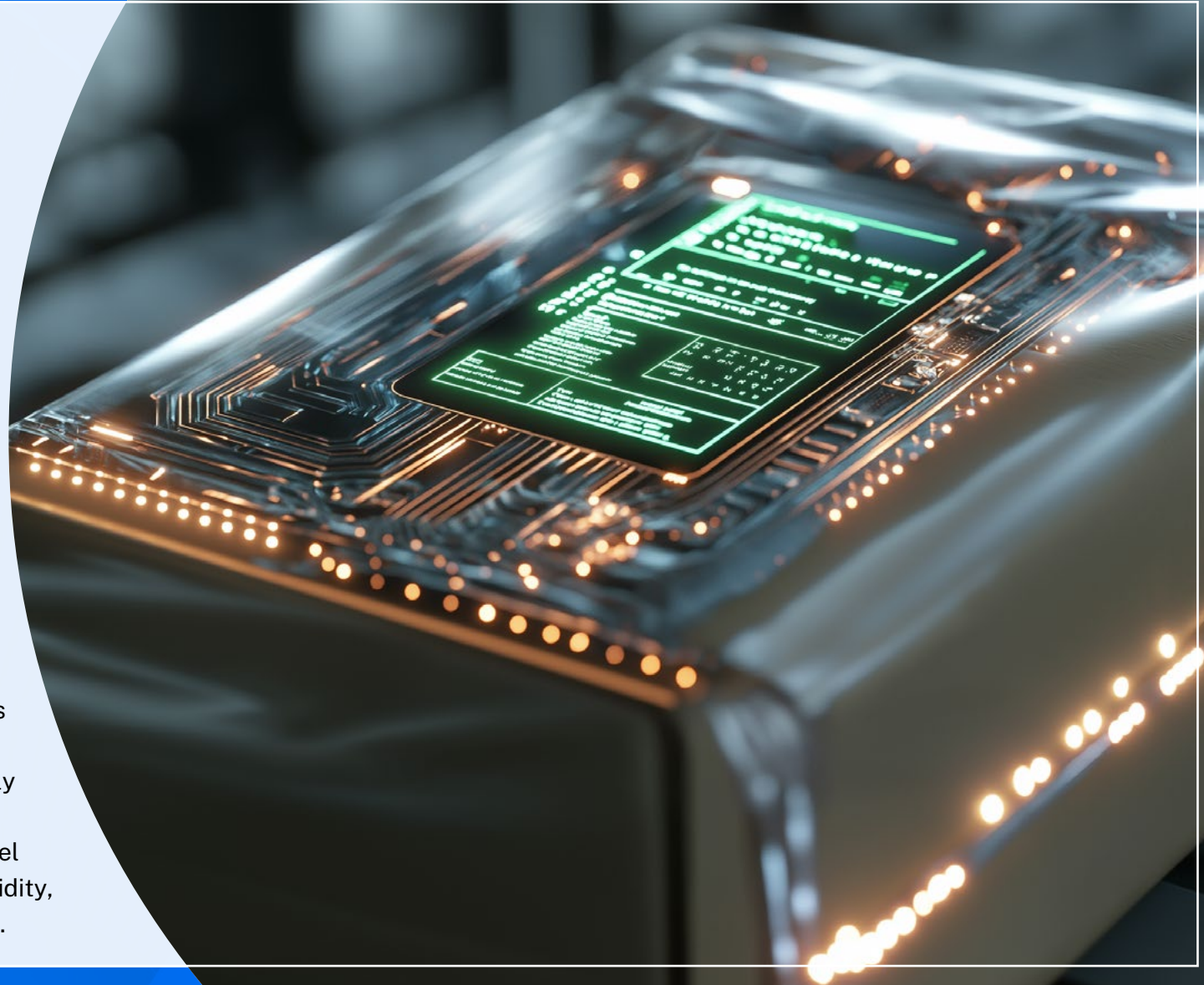


## SCENARIO YEAR 2030

# LABELS SAVE THE DAY

It's 2030 and in the control room of a pharmaceutical smart warehouse, Johan notices an uptick in alerts coming through his screen. The rise in same-day drone deliveries has led to a new wave of criminal activity: hacked drones that drop off packages in unauthorized locations. With the high value of pharmaceutical shipments, the supply chain has become a prime target for these attacks. As Johan scans the incoming data, a notification pops up. One of the drones carrying critical medication was tampered with mid-flight.

The hacker had successfully redirected the drone, causing it to drop the package at a suspicious location. However, the warehouse's real-time monitoring system, powered by smart labels, was already in action. The moment the package's seal was broken, the label sent out a cascade of alerts: first to Johan's screen and then directly to the authorities. The smart label's GPS tracking provided the exact location of the breach, so local law enforcement could swiftly respond. The label's innovation didn't end with the alert. As the hacker tampered with the package, its stretchable self-healing electronics in the label automatically repaired any damage, keeping the internal tracking systems fully operational. Even as the package sits at the wrong drop-off point, the label continues to monitor environmental conditions like temperature and humidity, ensuring that the integrity of the pharmaceuticals won't be compromised.







3RD YEAR ON THE LIST

# AUTONOMOUS COBOTS FOR OPTIMIZATION

WHAT IT IS

Autonomous collaborative robots (cobots) are revolutionizing warehousing and delivery by improving operational efficiency, stock accuracy, and workflow management.

HOW IT WORKS

Warehouses that use cobots are noticing upticks in efficiency and accuracy of inventory. FLX Logistics employs DexoryView, merging autonomous mobile robots with digital twin technology for real-time stock monitoring and workflow optimization. Cobots like BMW's Figure 02 humanoid robots demonstrate high dexterity when they assist in tasks like precise fitting in car chassis assembly.

AI integration enables cobots to perform tasks needing human-like skills. Amazon and Rockwell Automation use AI models like Covariant Brain and Nvidia's Isaac in cobots for improved efficiency. Innovations include wearables like the "Third Thumb," an additional limb that a study found 98% of participants could use successfully within a minute. In collaborative manipulation tasks, cobots handle delicate items alongside humans to avoid damaging torques while increasing safety and reducing worker strain.

Drones are already deployed in environments like Ikea's fulfillment centers for stock management. A2Z Drone Delivery's "drone-network-as-a-service" allows autonomous drone docking for recharging and package handling. Companies like DroneUp provide enhanced drone capacity, with autonomous drones traveling at 60 mph and carrying up to 10 pounds. Autonomous delivery vehicles like the Vayu One, using a transformer-based mobility model, can transport up to 100 pounds at 20 mph without lidar, making them ideal for diverse environments.

WHY IT MATTERS

Cobots enhance safety and productivity by enabling sophisticated logistics solutions. They address the challenge of labor shortages and the demand for higher efficiency in logistics as they work alongside humans, allowing businesses to maintain operations even with reduced workforces. By providing real-time data and predictive insights, cobots help companies optimize their workflows, making the entire supply chain more resilient and adaptable.

The impact extends beyond warehouse operations; AI-driven cobots and drones are also having an impact on stock management to delivery tasks. This transformation benefits various sectors, from retail and manufacturing to health care and food services, where timely and accurate delivery is critical. Drones are particularly instrumental in reshaping last-mile delivery, offering solutions that are faster and more flexible, and that meet the demands of the growing e-commerce sector.

Humanoid cobots and wearables represent a future where human-robot collaboration will be seamless and significantly enhances productivity while reducing physical strain on workers. This not only improves employees' well-being but also reduces the associated costs involved with worker injuries and makes operations more sustainable.

**SCENARIO YEAR 2027**

# PACKAGE COMMUNICATION

It's a typical Wednesday evening in the Dallas-Fort Worth suburbs in 2027, and Sarah is stuck in the evening rush hour. Luckily, her favorite pizza from Donatos Pizza is on its way, delivered by SkySlice, a new drone-as-a-service provider. She's been using this service for the last few weeks, and each delivery has been perfect. Tonight is no different—except she's about to experience a new level of interaction.

Around 6:20 p.m., Sarah gets a notification: “Your pizza has left Donatos Pizza, and SkySlice Drone 542 is on its way to your ThermoBox™ Smart Mailbox.” Curious, Sarah decides to chat with her order through SkySlice's blockchain chatbot.

“Hi, can you tell me how hot my pizza is right now?” Sarah speaks to her wearable pin as she sits in traffic.

The chatbot responds instantly: “Sure! Your pizza is currently at 154°F and maintaining temperature. Would you like me to show the full temperature log?”

“Yeah, show me that,” she replies. The chatbot displays a detailed, blockchain-verified temperature log starting from the moment her pizza was prepared, showing that it hasn't dropped below 150°F. “Nice, no cold pizza for me tonight!” Sarah says with a smile.

Moments later, she gets another message: “Drone 542 has delivered your pizza to your ThermoBox™. It will stay warm for the next 90 minutes at 140°F.”







Sarah decides to try something new. “Hey, ThermoBox™. How’s my pizza doing?” This time, a cheery AI voice responds from the ThermoBox app: “Hi Sarah! Your pizza is safe and warm. It’s currently being kept at a cozy 140°F for you. Shall I keep it warm, or would you like me to adjust the temperature?”

Sarah laughs. “Keep it warm for now. I’ll be home in about 30 minutes.”

“No problem, Sarah! I’ll keep your pizza warm and delicious until you get home. Have a safe drive!”

By the time Sarah gets home, her pizza is waiting patiently in the smart mailbox. She walks up to it, unlocking it with her phone as the ThermoBox greets her again. “Welcome home, Sarah! Your pizza is ready.” She opens the mailbox, retrieving the piping hot box, feeling satisfied that she didn’t have to worry about a thing.

As she sits down to eat, Sarah reflects on how the entire experience felt more personalized and interactive than ever. Not only did SkySlice’s drone ensure that her pizza arrived promptly, but her ThermoBox Smart Mailbox actively kept her food warm and ready to eat—right down to a casual conversation about its temperature.

“This is what the future should be like,” she thinks as she takes her first bite. Perfectly warm, just as promised.





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Mark Bryan is a Senior Foresight Manager at Future Today Strategy Group, leading the Built Environment, Hospitality, Retail, Supply Chain, Restaurants & CPG practices. Mark's portfolio of clients includes national foundations, global CPG companies, international associations, product manufacturers, international retail brands, higher education institutions, nonprofits, multi-family developers, supply chain organizations, health care systems, senior living facilities, restaurants, and large corporate clients.

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