Deloitte.

The 2015 MHI Annual Industry Report
Supply chain innovation—
Making the impossible possible

Supply chains face conflicting demands to be better, faster and cheaper. Innovation is the key to achieving all three.
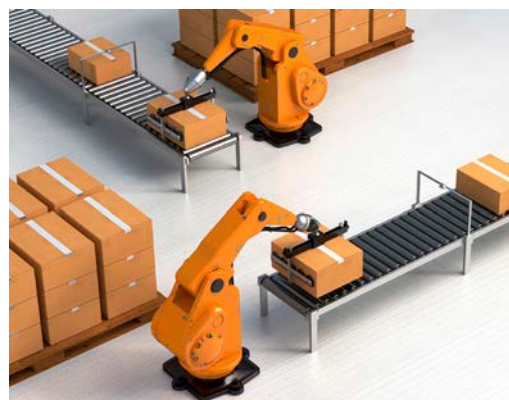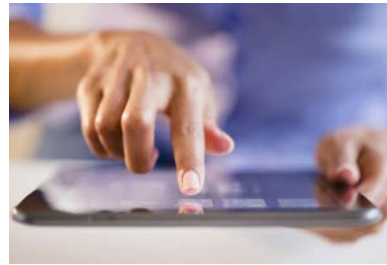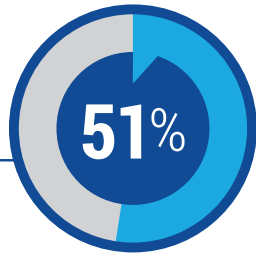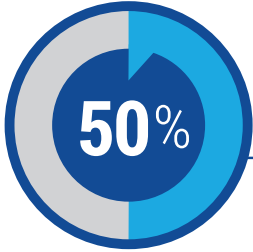
Table of contents

Eight emerging technologies that will transform traditional supply chain models over the next decade.

Challenges

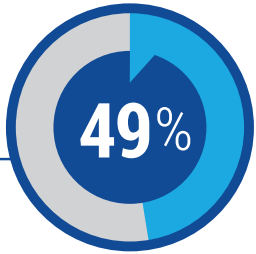**Customer Demand for Lower Delivered Costs**
51%

Customer Demand for Faster Response Times
50%

Rising Customer Service Expectations
49%

LEARN MORE p5

Emerging Technologies

75% of respondents believed that at least one of the technologies could either be a source of competitive advantage or disruption in their industry in the next 10 years.

Top Four of Eight

45% Inventory & Network Optimization Tools

42% Sensors & Automatic Identification

39% Robotics & Automation

38% Predictive Analytics*

LEARN MORE p33

* Predictive analytics, is only used today with 24% of respondents, but expected to climb to 70% in the next 3-5 year

Adoption Rate

Adoption rate chart showing 2014 Adoption and 5-year Compound Annual Growth Rate across technologies:

- Inventory & Network Optimization Tools
- Sensors & Automatic Identification
- Cloud Computing & Storage
- Robotics & Automation — *Maturing*
- Predictive Analytics
- Wearable & Mobile Technology — *Growth*
- 3D Printing
- Driverless Vehicles & Drones — *Emerging*

Legend: ■ 2014 Adoption ■ 5-year Compound Annual Growth Rate

LEARN MORE p8

Barriers

LEARN MORE p6–7

36% Lack of a clear business case to justify the investment.

31% Lack of adequate talent to utilize the technology effectively.

Spending

Companies spending on emerging technologies over the next two years.

$100 MILLION + — **4%**
$10 MILLION + — **17%**
$1 MILLION + — **49%**
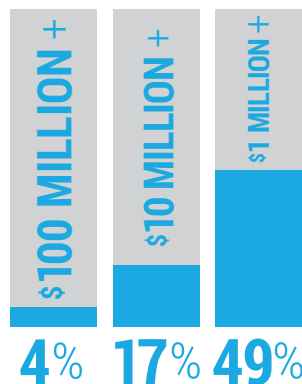
LEARN MORE p10

Preparation

52% Training workforce to use new technologies

46% Partnering with vendors to understand benefits

42% Began piloting new technologies

41% Increased budget

LEARN MORE p41

Supply chain innovation— Making the impossible possible

Supply chains face constant pressure to do more with less. After years of cost-cutting and efficiency improvements, the pressure to reduce costs while simultaneously boosting performance continues unabated—with no end in sight. These conflicting challenges are putting pressure on margins and creating headaches for supply chain executives who are often stuck between the rock and hard place of slashing expenses and building new capabilities.

As many supply chain organizations have spent years cutting costs and eliminating waste, incremental improvements are leading to diminishing returns. This is driving the need for supply chain executives to seek more innovative solutions.

"The speed at which supply chain innovation is being adopted coupled with rising consumer expectations for anytime, anywhere service is stressing traditional supply chains to near-breaking points," says George Prest, CEO of MHI. "Companies that continue to rely on traditional supply chain models will struggle to remain competitive and deliver orders that are complete, accurate and on-time."
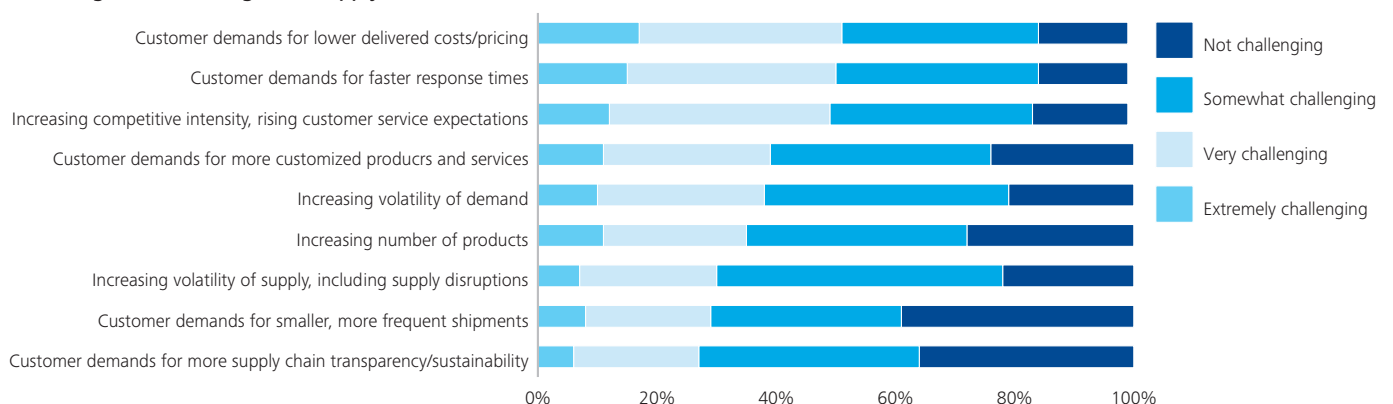
In this year's annual MHI Industry Report, developed in collaboration with Deloitte, we delve more deeply into these supply chain challenges with a specific lens on how technology innovation can help illuminate the path to the supply chain of the future.

In 2014, the 100-plus thought leaders and partners behind *The U.S. Roadmap for Material Handling & Logistics* predicted that traditional supply chain models will undergo dramatic transformational change due to technological innovation and changes in customer demand between now and 2025.[1]

Survey participants for this Annual Industry report included more than 400 supply chain professionals from a wide range of industries, with the majority (57%) holding executive positions such as CEO, Vice President, or General Manager. Participating companies ranged in size from small to large, with half reporting annual sales in excess of $100 million, and 11% reporting $10 billion or more.[2]

"Companies that continue to utilize traditional supply chain models will struggle to remain competitive and deliver orders that are complete, accurate and on-time."

Figure 1: Challenges for supply chains

Legend: Not challenging; Somewhat challenging; Very challenging; Extremely challenging

Categories (top to bottom):
- Customer demands for lower delivered costs/pricing
- Customer demands for faster response times
- Increasing competitive intensity, rising customer service expectations
- Customer demands for more customized producrs and services
- Increasing volatility of demand
- Increasing number of products
- Increasing volatility of supply, including supply disruptions
- Customer demands for smaller, more frequent shipments
- Customer demands for more supply chain transparency/sustainability

Source: survey results

1 MHI: *U.S. Roadmap for Material Handling & Logistics*, January 2014
2 See "About the report", page 43

The survey focused on eight technologies identified by *The U.S. Roadmap for Material Handling & Logistics* that are driving next generation supply chains:

- Inventory and network optimization tools
- Sensors and automatic identification
- Cloud computing and storage
- Robotics and automation
- Predictive analytics
- Wearable and mobile technology
- 3D printing
- Driverless vehicles and drones

Across the board there is an expected increase in spending on these supply chain technologies over the next two years. At the high end of the spectrum, 4% of companies plan to invest more than $100 million over the same period.

The survey also identified the following five critical supply chain realities where these technologies can help drive step-change improvements.

It's all about the customer experience
According to the survey, customer pricing pressure (51%), demands for faster response times (50%), and rising customer service expectations (49%) are the top three issues that supply chain leaders and professionals find very or extremely challenging (see Figure 1).
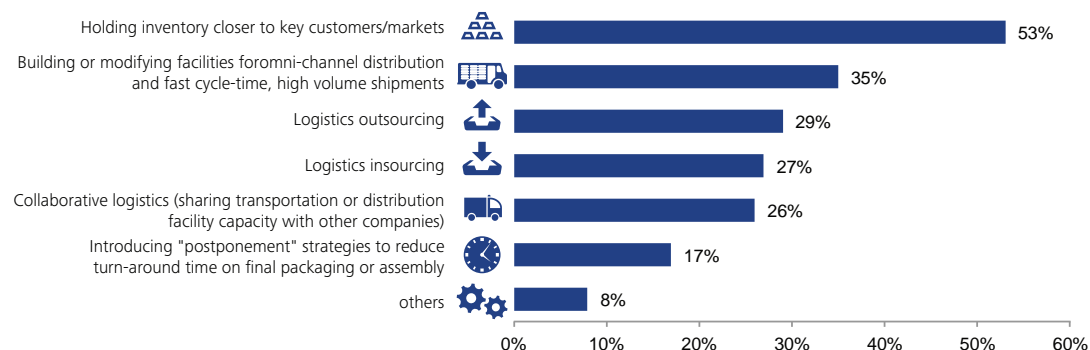
To address these challenges, many organizations are changing their fulfilment strategies and holding inventory closer to key customers or markets and building specialized, high-velocity facilities (see Figure 2). These strategies are a step in the right direction; however, fulfillment strategies alone will not be sufficient to address the current and future challenges that supply chains face.

For example, although holding inventory can be an effective way to buffer against uncertainty, it can also be expensive. Emerging technologies such as advanced inventory optimization tools can help supply chain leaders make smarter decisions about where inventory buffers can be deployed most effectively.

Similarly, building specialized, high-velocity distribution facilities for high-volume products can streamline omni-channel shipments and reduce total delivered costs. However, in order for that fulfillment strategy to be both efficient and effective, companies should invest in enabling technologies such as tightly integrated planning and execution systems coupled with automation and automatic identification.

"The best decision-making is driven by feedback on events as or before – not after – they occur," said John Hill, a director at The St. Onge Company. "Automatic identification, wearable and mobile technology, and cloud-based systems provide the real-time visibility into the dynamics of actual operations that companies must have for world-class supply chain decision-making and management."

Figure 2: Fulfillment strategies to meet customer expectations

Strategy	%
Holding inventory closer to key customers/markets	53%
Building or modifying facilities for omni-channel distribution and fast cycle-time, high volume shipments	35%
Logistics outsourcing	29%
Logistics insourcing	27%
Collaborative logistics (sharing transportation or distribution facility capacity with other companies)	26%
Introducing "postponement" strategies to reduce turn-around time on final packaging or assembly	17%
others	8%

Source: survey results

Alignment between supply chains and customer needs is paramount

As we pointed out above, 50% of this year's survey respondents cite "customer demands for faster response times" as extremely or very challenging. As companies expand their global footprints, adjust their trade flows, and try to meet their customers' ever-rising expectations for faster response times, they should invest in forward-looking technologies and capabilities that can help them rapidly assess and redesign their complex supply chain networks to satisfy the demands of a constantly changing marketplace.

Network optimization tools help companies develop forward-looking scenarios that identify dollar-value impact and associated risks. These tools can be very powerful in determining where to produce which products, what to make versus buy, where to hold inventory, which transportation modes to use, and how to differentiate service response times by product and customer.

"The best decision-making is driven by feedback on events as or before – not after –they occur."

Collaboration is crucial as supply chain boundaries blur

"Material handling can no longer stand alone as an efficiency play inside the four walls of a warehouse," says Mike Nayden, the leader of Deloitte Consulting LLP's Logistics and Distribution practice. Data proliferation and the emergence of powerful data-driven technologies are laying the foundation for sharing information across the entire value chain.

A smattering of companies are starting to leverage some of these new technologies and pursuing collaboration in a variety of ways, including: using customer data (23%) or supplier data (16%) to drive predictive analytics; using cloud computing to collaborate with trading partners (20%); and using information from sensors and auto-identification to share and collaborate with customers and suppliers (22%).

"The best companies in the world use collaboration to create high-performing, customer-oriented supply chains," says Prest. "They are finding new ways to compete by leveraging innovation that is driven by technology and the digitally-connected consumer. This collaboration not only provides visibility into customer experience, but drives innovation by producing a more complete view of a company's products and supply chain."

Traditional cost-cutting strategies will miss financial targets

Many companies have already slashed substantial costs from their supply chains. Continuing to rely on cost-cutting measures is likely to provide diminishing returns and cause supply chain organizations to fall short of financial and competitive expectations.

As a result, deciding where and when to invest is critical to success, especially for technologies that are still in their infancy. Our survey found that the number one barrier to investing in new technologies and innovations is the lack of a clear business case (36%). Lack of access to capital ranks as the lowest barrier to investment (25%), indicating that companies are able to invest, they just aren't sure how to quantify the benefits in a way that justifies spending the money.

The workforce crisis is real and innovation only adds to the challenge

An estimated 600,000 manufacturing positions in the U.S. are unfilled for a lack of qualified workers.[1] In addition, *U.S. Roadmap for Material Handling & Logistics* predicted that, between now and 2018, there will be 1.4 million new jobs in the logistics and supply chain field.[2]

"Multiple factors are contributing to the talent shortage including an aging workforce," says Prest. "But, the changing skill sets needed for jobs in the supply chain is the biggest factor. The sophistication of the skillsets required to operate leading-edge equipment and systems requires an equally sophisticated and well-trained workforce."

According to the survey data, 31% of respondents cited the lack of adequate talent to implement and deploy the technologies was a significant barrier to their implementation. "The next supply chain evolution needs to consider every aspect of its DNA, including the most valuable asset--people," says Jonathon Rader, manager of design engineering at FedEx SmartPost. "The industry needs to work with the academic community to develop curricula that prepares today's innovators and leaders and creates career paths that the best and brightest will aspire to."

The most critical supply chain skillset for the next five years is strategic problem solving (53%), which is nearly twice as important as functional supply chain knowledge (28%). This suggests that traditional training programs might not be preparing workers effectively for the supply chain of the future.

Business leaders need to keep a close eye on new technologies and have a strategy to incorporate them into their operations. Technology innovation efforts should not only focus on new products, but should also address business model innovations focused on the people, networks, processes, services or channels which can have a major impact on supply chain performance. To make the technology choices efficiently and effectively, supply chain leaders need to address these questions:

- Which technologies will have the most profound impact on supply chains over the next decade?
- When are most companies planning to deploy these technologies?
- How are companies using the technologies today?
- Which technologies are right for my company?
- What should I do to get started?

In this report, we help supply chain and corporate leaders find answers to the above questions in the context of their specific challenges.

---

1   World Economic Forum: The Future of Manufacturing, April 2012
2   MHI: U.S. Roadmap for Material Handling & Logistics, January 2014

Eight technologies redefining the future of supply chains

Exponential advances in technology are creating a fertile ground for innovations that are reshaping traditional supply chains. These advances enable early adopters to achieve dramatic improvements in efficiency and performance. In some cases, the innovations are even disrupting the basis of competition.

What's more, as the pace of innovation continues to accelerate, the capability gap between early adopters and their slower competitors is growing, giving leaders and innovators a sustainable competitive advantage that makes it difficult for companies with traditional supply chains to compete or catch-up.

"Nothing can energize an organization and its people more than a highly visible, developed, and supported innovation program," says Art Roman, director of design and construction at U.S. Foods. "Because it touches so many people and processes, the supply chain function is uniquely positioned within most organizations to provide a broad and lasting injection of this energy."

In this year's report, we will examine eight technologies identified in the *The U.S. Roadmap for Material Handling & Logistics* that are revamping the supply chain landscape. We grouped them into three categories—maturing, growth and emerging—based on current adoption levels and anticipated adoption over the next five years (see Figure 3).

Supply chain technologies are high on corporate radar

Although adoption of these technologies is not yet pervasive, survey respondents have them in their sights. The vast majority—75%—believe that in the decade ahead at least one of the highlighted technologies will either be a source of competitive advantage or a disrupter in their industry.

The four technologies expected to have the greatest competitive or disruptive impact are: optimization tools, sensors and automatic identification, robotics and automation, and predictive analytics (see Figure 4). As Figure 3 shows, three of these four technologies are already among the most widely used in supply chains today.

Figure 3: Adoption levels for supply chain technologies
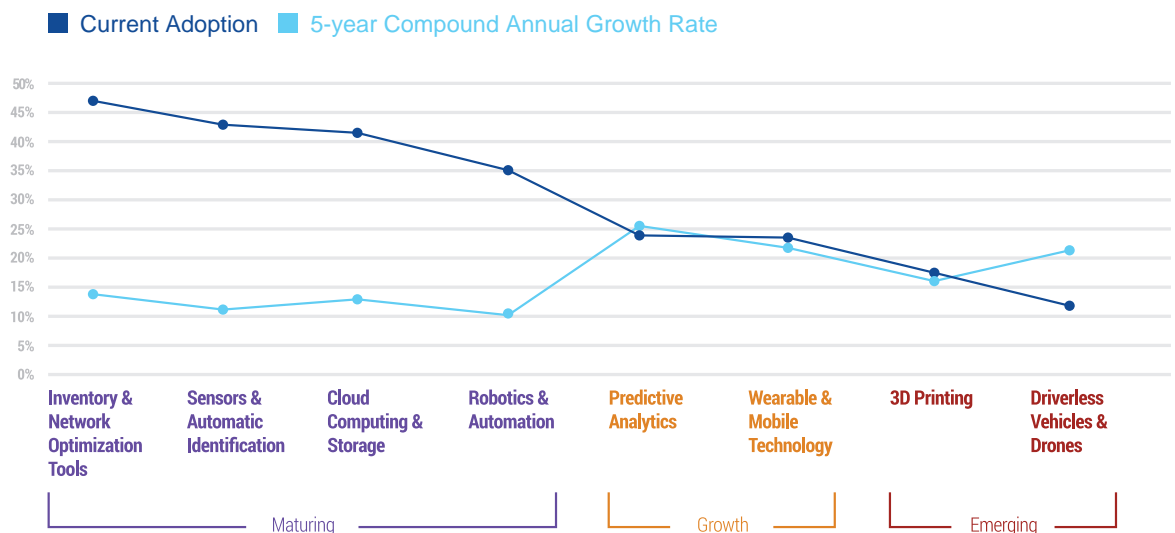
The exception is predictive analytics, which only 24% of surveyed companies use currently. However, as Figure 3 shows, adoption of predictive analytics is expected to climb to 70% over the next three to five years. Given the significant expected growth (24% five-year CAGR) and 38% of respondents citing it as a source of competitive advantage, early adopters are likely to pursue predictive analytics solutions aggressively in the next one to two years.

"The pace of advancement in supply chain innovation is forcing organizations to change the way they evaluate, select, pilot, and deploy new technologies," comments Kelly Marchese, the leader of Deloitte's Supply Chain Strategy practice. "The ability to adapt and innovate will likely be a key differentiator in the decade ahead."

Supply Chain Innovations by Lifecycle Phase:

Phase	Technologies	What you need to know
Maturing	• Inventory and network optimization tools • Sensors and automatic identification • Cloud computing and storage • Robotics and automation	• Significant levels of adoption today (35%+) with moderate growth in adoption (~10-15% CAGR) over next 3-5 years • These technologies have reached the tipping point of adoption with a wide variety of proven use cases and demonstrated business value • Maturing technologies can offer significant improvements in both efficiency and service which may quickly become the industry standard as adoption levels approach 80-90% by 2019 • Bottom Line: Companies deferring investment will struggle to keep up with customer expectations for lower costs and improved service levels
Growth	• Predictive analytics • Wearable and mobile technology	• Moderate levels of adoption today (20%+) with significant growth in adoption (20-25% CAGR) over next 3-5 years • Approximately 1-2 years behind maturing technologies in expected adoption • Applications and use cases are less common, creating more ambiguity around value and requiring different investment criteria and risk tolerance • Bottom Line: Early adopters have an opportunity to get ahead of the competition through early piloting and deployment
Emerging	• 3D printing • Driverless vehicles and drones	• Lower levels of adoption today (~10%) with accelerating growth • 6+ years behind maturing technologies in expected adoption levels • Current applications are more limited and tend to be more relevant to specific industries • Bottom Line: Companies should understand current and near-term applications in their industry and the potential for disruption

Figure 4: Expectations for competitive advantage or disruption

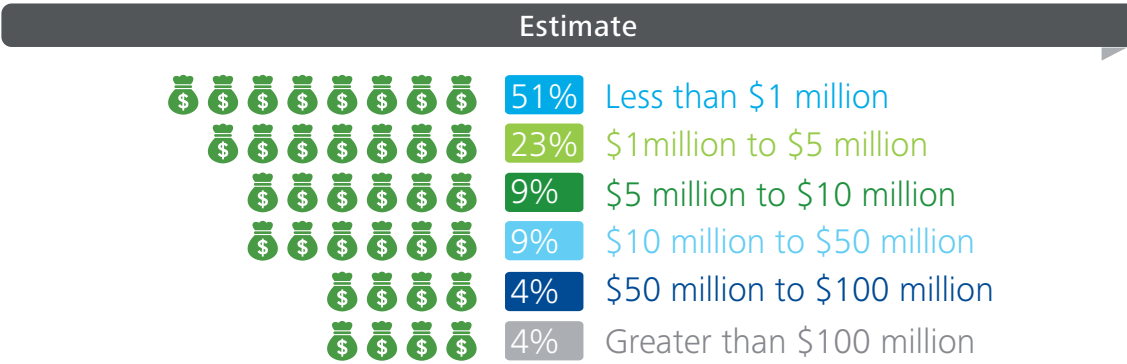|	% Having some impact	% Competitive advantage/disrutption
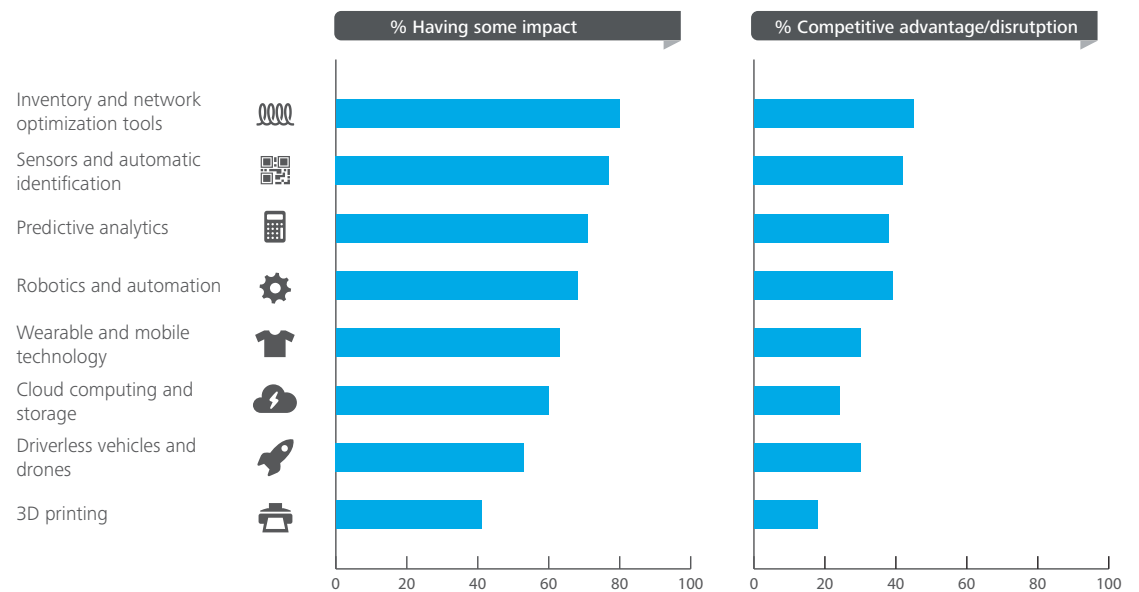
Source: survey results

Large and small companies are investing

Reflecting the urgent importance of new technologies, respondents report that their organizations are making substantial investments. On average, companies expect to spend more than seven million dollars on new supply chain technologies over the next two years, with the top 17% spending over $10 million (see Figure 5). With an average of 16 manufacturing facilities (averaging 250,000 square feet), that's nearly a half million dollars per facility ($450,000) in just two years.

Businesses that place large strategic bets on new supply chain technologies and innovations are likely striving to achieve a sustainable competitive advantage in the marketplace. Larger firms clearly have an advantage in that they can invest more dollars. However, they should invest in the right areas, because any one of these disruptors could open a vulnerability for competitors to exploit.

Smaller companies may lack the spending power of larger enterprises, but can look for ways to pool resources and collaborate in order to leverage communities and access resources that are similar to those available to large firms. Smaller companies need to look at these disruptors to identify both vulnerabilities and opportunities.

Figure 5: Spending on new supply chain technologies

Estimate	
51%	Less than $1 million
23%	$1million to $5 million
9%	$5 million to $10 million
9%	$10 million to $50 million
4%	$50 million to $100 million
4%	Greater than $100 million

**Businesses are waiting for markets to move—at their own peril**

As the pace of innovation continues to accelerate, the capability gap between early adopters and their slower competitors is widening, creating a sustainable advantage that disrupts the basis of competition. The gap can also make it difficult for companies with traditional supply chains to compete or catch-up.

According to the survey results, only 35% of companies are early adopters that expect to deploy supply chain innovations before their competitors do. A larger number (46%) will likely wait until forced to do so—either by mandate, regulation, or competitive necessity. Nineteen percent take an opportunistic approach by planning to use new technologies when the market advantage is clear (see Figure 6).

A de facto strategy of delaying until forced to take action might have worked in the past, but is unlikely to be sufficient in the decade ahead as the accelerating pace of technological advancement starts to create insurmountable capability gaps.

Taking action now can help companies address many of the market's competing demands, and may provide a sustainable competitive advantage. It can also help a business mitigate future risks such as labor shortages and wage inflation triggered by economic growth, while capitalizing on historically low interest rates that make it relatively cheap to invest in the future (before those rates start to rise).

Figure 6: Supply chain innovations strategies

46%	35%	19%
Forced Adopters	Early Adopter	Opportunistic Adopter
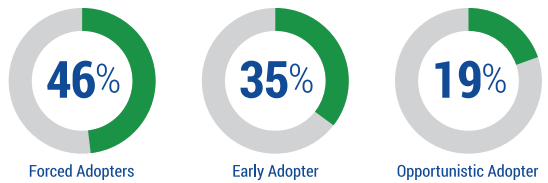
Source: survey results

Maturing technologies

Maturing technologies can create dramatic improvements in efficiency and service. Current adoption levels are significant, with 35% or more of companies using them. These technologies have reached their tipping point as evidenced by adoption levels expected to reach 80% to 90% by 2019. Companies holding off on deploying maturing technologies may find themselves struggling to keep pace with competitors as these technologies become industry standards.

In this section, we offer a deep dive into these maturing technologies:

- Inventory and network optimization
- Sensors and automatic identification
- Cloud computing and storage
- Robotics and automation

Inventory and network optimization

According to the survey, inventory and network optimization tools rank as the most widely used and most likely to deliver a competitive advantage. This is not surprising given their potential to significantly reduce costs without requiring a major capital investment.

The ability to deploy assets and position inventory well is crucial to delivering the right service at the right cost. These are powerful decision-support tools to model end-to-end supply chain costs and trade-offs.
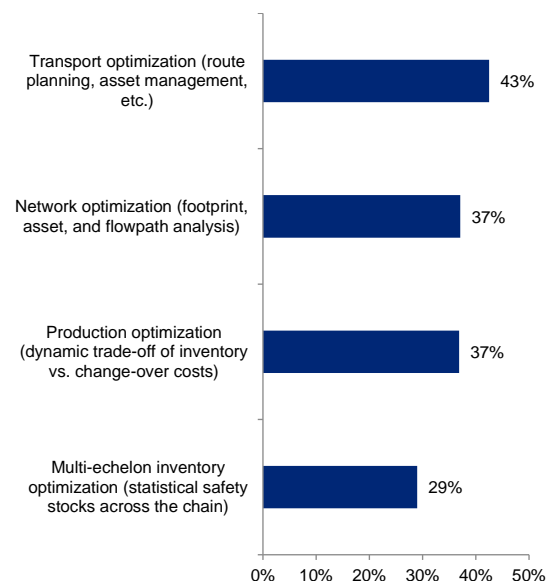
By layering in costs and constraints, a company can design networks that deliver orders at the lowest landed cost while addressing defined constraints such as service levels and capacities. This is especially powerful when creating scenarios that address both hard constraints (which cannot be changed) and soft constraints (which cost money to change).

Applications

Figure 7 shows the top supply chain uses for inventory and network optimization tools today and over the next one to two years. Inventory and network optimization tools can also be applied effectively to manufacturing strategy, cost-to-serve optimization, M&A strategy and execution, production capacity planning, and risk management.

Figure 7: How are companies using inventory and network optimization tools today (or planning to use it over the next 1-2 years)?

Transport optimization (route planning, asset management, etc.)	43%
Network optimization (footprint, asset, and flowpath analysis)	37%
Production optimization (dynamic trade-off of inventory vs. change-over costs)	37%
Multi-echelon inventory optimization (statistical safety stocks across the chain)	29%

Source: survey results

Value drivers

Inventory and network optimization tools can reduce total supply chain costs by 10% or more, with even larger potential reductions in total inventory costs.[1] Key benefits include:

- **Optimized inventory levels.** This can include inventory reductions, but in many cases companies could actually be running too lean (a lesson learned from the aftermath of the 2011 tsunami in Japan). A strategic approach to inventory would include holding the right amount of inventory in the right locations based on desired service levels and risk tolerance. Understanding risk vulnerabilities (e.g., suppliers in high risk geographical areas) supports scenario modeling and decision-making.

---

1 The European Business Review - Efficient Frontier: A Moving Target, December 2014

- **Lower transportation costs.** Incorporating transportation costs into inventory models balances shipping expense with holding costs to meet demand at the lowest landed cost. Optimization tools might also identify alternate production or warehouse locations to minimize overall transportation costs.
- **Streamlined and aligned distribution network.** As companies grow, both organically and through acquisitions, geographic concentrations of customer demand can change. Using routine, forward-looking scenarios to plan capacity and network configurations are key to staying lean and aligning the distribution network with future growth plans.

- **Lower taxes.** Tax implications can be a major benefit of a network optimization. Producing, shipping, or storing products in tax-advantaged jurisdictions often offsets the incremental transportation costs, which can be significant.

What leaders should be doing today

The value companies get from these tools is proportional to the complexity of their supply chains (including factors such as the number of production facilities, products, warehouses, ship-to locations, and modes of transport). The more complex your supply chain, the greater the potential value—and thus the more you will want to invest. Regardless of your investment strategy, here are some guidelines to help you think through your approach:

- **Align your network with your customers' strategies.** Before building your network of the future, engage with your customers to understand their needs and growth plans, and how your business contributes to their success. Segment customers based not only on their value to you, but also on how they value your products and services. Do they prefer low prices over lead time responsiveness, or vice versa? The answers to such questions will impact how you set up your network.
- **Understand your costs.** Some companies spend considerable time and money painstakingly modeling their supply chain network only to base decisions on fundamentally flawed cost data. Making significant network decisions (e.g., production locations, make versus buy, source-switching, warehouse strategies) should use activity-based costing for major cost drivers. Most companies accurately calculate variable costs, but struggle to apply fixed costs. Accuracy with fixed costs is important since these are not fixed over the long term. Look at the impact of demand volatility and the costs associated with change-overs, as well as inventory holding, returns, and transportation costs (e.g., partial shipments, expedites, demurrage/detention).
- **Start small, learn, and expand.** Instead of trying to model the entire supply chain for all products and regions— which can be overwhelming—select a single product line, business unit, or region that is big enough to matter, but small enough to generate a quick win. Good data is crucial to effective decision-making, but lack of perfect data is no excuse for inaction. As you gain experience, you can start adding more complexity to the model by, for example, removing hard constraints or adding tax data.
- **Embed repeatable capabilities.** It can be useful to engage an experienced, unbiased third party to assist with tool selection, initial data gathering, modeling, and evaluation. However, it's important to embed training and knowledge transfer into third-party agreements to help build the in-house capabilities required for sustained effectiveness. These capabilities should include an explicit role for an optimizer who can maintain the data and run routine scenarios on an ongoing basis.

Real-world uses of inventory and network optimization tools

Escaping the diminishing returns of cost-cutting[1]
A Fortune 500 food and beverage manufacturer was growing rapidly and needed to develop a scalable supply chain network that could efficiently and effectively meet the changing needs of its expanding customer base. Like many organizations, the company had been pursuing cost-cutting measures for some time and the efforts were yielding diminishing returns.

Each of the company's two major business units had their own one-size-fits-all supply chain network. Company leaders wanted to know if it would be feasible to merge the two networks and how best to serve customers in different channels through a consolidated network.

The company tackled the problem in three stages:

- **Voice of the customer.** The first step was to understand the unique needs of the various customer segments that the company served. Using cross-functional, customer-facing teams to conduct value-focused customer interviews for large accounts, the company discovered distinct segments with differing delivery timeframes, price sensitivity and value to the company. The resulting insights about service level requirements and service distances were valuable inputs for the optimization model.
- **Network modeling.** The next step was to model the current network, apply constraints, and then model a variety of scenarios (including the option of a consolidated network versus separate networks).
- **Scenario modeling.** The company then compared the results for different scenarios, weighing the pros and cons of everything from customer to financial impact.

The result was approximately a 20% reduction in logistics costs, a reduced warehouse footprint, and a leaner, more responsive supply chain network that was tailored to customer needs.

1   Source: Deloitte client experience

Sensors and automatic identification

Automatic identification (Auto ID) technologies—including barcode, RFID and voice, point-of-sale systems, imagers, and beacons—generate vast amounts of valuable data. Auto ID feeds corporate information systems with the precise identity and location of each physical item in a supply chain in an automated and timely manner.

Adopting such technologies provides a major opportunity to improve tracking and tracing systems, process control, and inventory management. Longer term, Auto ID systems can give a company full visibility into its supply chain by removing a number of traditional limitations. Many transportation and logistics companies are using RFID today to achieve: near 100% accuracy in shipping, receiving, orders, and inventory accuracy; 30% faster order processing; and 30% reduction in labor costs.[1]

By 2018, the total market for RFID is expected to more than double in size to $20 billion.[2] The retail industry is the primary user, and is expected to account for 27% of the total global RFID market in 2024, up from 5% in 2014.[3]
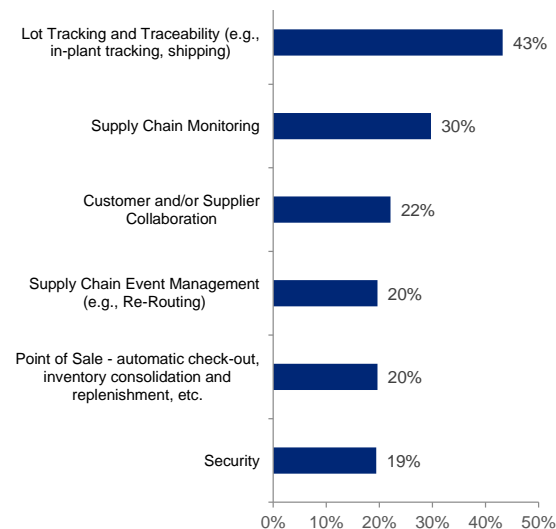
Newer technologies, such as two-dimensional imagers, are gaining momentum because of their ability to read two-dimensional bar codes for coupons and other smart-phone applications. In January 2013, Motorola announced the first imaging scanner for retail point-of-sale applications, the MP (multi-plane) 6000. Shortly thereafter, Datalogic announced a line of image-based POS scanners. At the 2013 ProMat show, Cognex said the costs for imaging technology for in-line, high speeds scanning applications (such as bar codes on a conveyor line) are now on par with laser scanners that have dominated the market for decades. In addition, imagers will likely deliver higher read rates, reducing misreads and costly carton rejects.[4]

Applications

Figure 8 shows the top supply chain applications for sensors and automatic identification. Lot tracking and traceability stand out as the top application. Auto ID is helpful for tracking customer or supplier shipments, or more easily tracking down inventory. Supply chain monitoring ranks second and can help companies manage supply chains more proactively with real-time data. A growing number of companies are adopting supply chain control towers to manage operations and supply chain risk.

Figure 8: How are companies using sensors and automatic identification today (or planning to use it over the next 1 - 2 years)?

Application	%
Lot Tracking and Traceability (e.g., in-plant tracking, shipping)	43%
Supply Chain Monitoring	30%
Customer and/or Supplier Collaboration	22%
Supply Chain Event Management (e.g., Re-Routing)	20%
Point of Sale - automatic check-out, inventory consolidation and replenishment, etc.	20%
Security	19%

Source: survey results

1   Motorola: Advantages of RFID in Transportation and Logistics, December 2011
2   Technavio: Global Sourcing of RFID Tags Market 2014-2018, December 2014
3   IDTechEx: RFID Forecasts, Players and Opportunities 2014-2024, July 2014
4   Supply Chain Digest: RFID and Auto ID News, March 2013

Beyond common applications, different industries have specialized uses for sensors and automatic identification technologies:

- **Automotive.** Tracking spare parts availability, identifying assembly line problems or bottlenecks, improving critical parts availability, and managing containers and shipping yards.
- **Healthcare.** Bedside point-of-care, prescription administration, patient identification, and improving accuracy when manufacturing, inspecting, labeling, tracking, and dispensing products.
- **Retail.** Inventory tracking, put-away, inventory look-up, restocking, receiving, picking, kitting, and shipping.
- **Transportation.** Parcel and shipment tracking; shipping, delivery, receiving confirmation; and improving loading and unloading accuracy.
- **Warehousing.** Inventory tracking, receiving, put-away, cycle counting, picking, restocking, and data entry.

Value drivers

In supply chain and logistics, Auto ID in combination with GPS and other sensors and data loggers will be used increasingly to track and monitor products and conditions such as temperature. Specific benefits include:

- **Fewer problems.** Sensors and automatic identification technology can help control and reduce product contamination, counterfeiting, and piracy—problems that are all too common in today's complex supply chains which increasingly rely on offshore manufacturing, multi-site storage, and third-party shipping.
- **Greater visibility and flexibility.** Sensors and automatic identification systems provide real-time information and improved visibility, which enables increased flexibility and responsiveness.
- **Lower costs.** RFID visibility provides earlier views into potential inventory problems, allowing companies to take pre-emptive action and reduce the need for costly expedited freight.
- **Reduction in waste, inventory and shrinkage.** Improved visibility allows for more effective inventory control and deployment.

What leaders should be doing today

- **Don't just think of these as an isolated investment**. Consider the impact that sensors and automatic identification technology can have on other technology investments. For example, supply chain visualization and control tower visibility are becoming more popular and valuable. However, they are only as good as the data that feeds them. RFID and sensors can enable real-time visibility into where shipments are—and where delays are likely to occur—which can help decision-makers address issues before they turn into problems.
- **Revisit the business case**. Supply chain executives should identify current supply chain challenges that could be solved or mitigated by real-time data visibility or traceability. They should then determine if the potential benefits justify the investment. Costs associated with these technologies have been steadily declining, so companies that have considered these technologies in the past might want to take another look.
- **Consider the costs and risks of not investing**. These technologies can have a positive impact on customer service and loyalty by improving supply chain visibility. Visibility leads to improved fill rates and greater transparency. Companies that fall behind their competitors could find their customer accounts at risk.

Real-world uses of sensors and automatic identification

Surmounting relentless cost pressures[1]

A leading manufacturer was struggling to keep pace with cost pressures as commodity prices were rising and the company was unable to pass those increases through to customers. The business had very manual and laborious paper-based logistics systems that had become very expensive and challenging to manage. The lack of data and automation was not only inefficient, it was leading to errors, missed deliveries, and customer service challenges. The company was experiencing increased cycle times, low stock accuracy, and lost time due to counting and searching for materials. The organization couldn't increase production volume without hiring more personnel and incurring additional costs.

To address these challenges, the manufacturer launched a global project using Radio Frequency Identification. The goal was to automate the tracking and tracing of products within their plants and create real-time visibility into the entire supply chain. The company tested and developed the technology extensively before eventually making it live in all facilities.

Today, the manufacturer can view inventory levels at any given moment, locate specific stock, and automate processes that were previously handled manually. The result is more concise workflows and consistent business processes across all facilities.

Cutting two man-years off labor costs[2]

One of Asia's largest logistics organizations needed greater efficiency in tracking goods and shipments at its Singapore facility so the company and customers could have greater visibility into supply chain operations.

To create that visibility, the company deployed an RFID system that tagged each of the location's 150,000 pallets with UHF passive tags. When shipments arrive, staff members scan barcodes on boxes and use a portal to read RFID tags on pallets. The pallet identification data is then sent via Wi-Fi to internal users and consumers.

This system saved six minutes of staff time per pallet, resulting in approximately two man-years of labor savings. In addition, RFID reduced the potential for error and improved fulfillment.

1   Source: Deloitte client experience
2   Motorola: Advantages of RFID in Transportation and Logistics, December 2011

Cloud computing and storage

Enterprise businesses are steadily moving their information technology services, applications and infrastructure to cloud-based architectures. The trend has increased cloud-based spends by 300% since 2011.[1] Looking ahead, spending on cloud services, applications, security and data analytics is expected to grow by nearly 13% year-on-year from $145 billion in 2013 to $235 billion in 2017.[2] Industries likely to see the most added value from cloud are manufacturing, healthcare, insurance, banking and securities.

Cloud computing has also played a vital role in improving supply chain management by helping enterprises share data with multiple partners across many different locations worldwide.

Cloud offerings fall into four major categories, each based on an IT-related solution offered as a service rather than physical products.

- **Infrastructure-as-a-Service.** Hardware resources and computing power provided as cloud-based services. Companies use these cloud resources instead of buying dedicated servers and networking equipment.
- **Database-as-a-Service**. Storage and database capabilities. Many of these offerings use a multi-tenant architecture in which data for different clients is stored in identical physical tables.
- **Software-as-a-Service**. Software applications provided as a service, eliminating the need to buy, install, update and maintain software packages. Application data is stored in cloud databases. Major service providers include Salesforce.com and SharePoint.
- **Platform-as-a-Service**. Complete cloud-based application development platforms that support all phases of the development lifecycle, from design and debugging to deployment, implementation, and testing. Companies are able to develop standalone web applications and add-ons.

Applications

The top supply chain uses for cloud computing today, and over the next one to two years, include operational software, sales and operational planning systems and transportation management (see Figure 9).

Figure 9: How are companies using cloud computing and storage today (or planning to use it over the next 1-2 years)?

Category	Percentage
Supports operational software (e.g., supply chain execution systems, WMS, Labor Management, other)	31%
Supports Sales & Operations Planning process (e.g., scenario modeling)	29%
Transportation Management systems (e.g., On-demand TMS, route optimization)	27%
Spare parts management (e.g., inventory, order management)	22%
Supply chain collaboration with trading partners (e.g., customers, suppliers)	20%
Supports strategic decisions (e.g., profitability, cost-to-serve, and segmentation analysis)	19%
Control tower analytics and visualization for performance management	18%

Source: survey results

1 HIS: Cloud Related Spending by Businesses, February 2014
2 IDC: Worldwide SaaS and Cloud Software 2012–2016 Forecast and 2011 Vendor Shares, August 2012

Value drivers

Cloud-based solutions offer a number of key benefits over traditional IT. In particular, cloud computing and storage enables:

- **Lower cost of entry for smaller firms.** In the past, small- and medium-sized businesses often did not have access to world-class IT systems and solutions because of high upfront sourcing and deployment costs. Cloud reduces the initial cost barrier, because cloud services typically feature a usage-based pricing model. Other key cloud benefits for small- and medium-sized businesses include scalability, flexibility, and on-demand service.

- **Faster time to market.** Cloud providers can offer their clients almost immediate access to computing resources—with no upfront investment of time or capital—which accelerates time to market for many businesses.

- **Easy scalability.** By managing computing resources through software, they can be deployed very quickly as new requirements arise. A key goal for many cloud providers is the ability to dynamically scale resources up or down through software APIs in response to a client's changing workload, with minimal service provider interaction.

What leaders should be doing today

- **Collaborate across functions**. As companies generate increasing amounts of data, there is a greater need to store and analyze data to provide business insights. Sales and marketing are generally large users of structured and unstructured data and need to define their own big data strategy. It is important to coordinate multiple functions to develop a company-wide data strategy. Investments in cloud computing may have a higher ROI when viewed holistically.

- **Rethink the role of IT**. To capitalize on cloud technology, companies should adapt their people, infrastructure, and processes. CIOs could play a new role as strategic executives who add value by driving business transformation through innovative uses of technology, rather than by overseeing a large IT staff. On-premise and co-located data centers could be replaced by cloud-based infrastructure which also frees up IT staff so they can focus on more strategic projects Similarly, software applications could be developed and hosted using Platform-as-a-Service, or even replaced by Software-as-a-Service. Such shifts could help companies streamline their IT capital investments and staff, while giving them the flexibility and scalability required to compete effectively in today's fast-moving marketplace.

Real-world uses of cloud computing and storage

Learning the limits of manual processes the hard way[1]

A large, global electronics manufacturer serving customers in more than 160 countries was scrambling to meet regional demand in the aftermath of the 2010 volcanic events in Iceland. Relying on spreadsheets, faxes and email, the company's shipment tracking and visibility processes were mainly manual and labor intensive.

In response, the organization deployed a new cloud visibility system that incorporates internal data as well as web and EDI inputs from trading partners and carriers. The system coordinates logistics operations from the point of shipment through transportation and freight selection. It also receives event milestone updates from carriers while balancing logistics constraints and customer requirements. Using track and trace milestones across the globe, the new system provides visibility into order status from factory to delivery. This new cloud visibility system allows shipping, shipping companys and 3PLs to collaborate on an independent cloud platform.

In addition to supporting day-to-day operational efficiency, the cloud visibility systems improve transportation management by producing milestone reports and performance data for each 3PL partner. To avoid potential schedule slips, the EDI and web portal provide more timely information on a daily basis on carrier performance, in-flight visibility, and custom clearance delays. In addition, the company can look at overall optimized container utilization, transit times, end-to-end lead times, and trend analysis to drive innovation and efficiencies across the supply chain.

Getting relief from squeezed margins[2]

Competition was relentlessly squeezing margins at a major pharmaceutical company. To get breathing room, the company tackled fixed IT costs by embracing cloud computing to replace its existing product delivery model. The first step was to migrate a large portion of the workload to Infrastructure-as-a-Service. After that, once cloud technologies and standards had matured, the company sourced a wide range of services from different cloud vendors, carefully brokering and coordinating its cloud ecosystem. The objective was to reduce costs and increase IT responsiveness.

Cloud enabled the company to switch IT resources on or off in response to the changing needs of the business. It also provided the flexibility to easily shift workloads between cloud providers as their capabilities evolved. In addition, cloud reduced IT costs, allowing the company to focus its investment capital on revenue-generating activities. Today, cloud computing is providing the company with reliable IT service that is faster, leaner, and more flexible than its traditional IT model.

1   Aberdeen Group: Globalization and Global Trade Drive Renewed Focus on Supply Chain Visibility, September 2011
2   Source: Deloitte client experience

Robotics and automation

Robots have revolutionized manufacturing. As they become smarter, cheaper, and faster, they are able to do much more than the repetitive and onerous tasks to which they have been traditionally relegated. Today's robots can produce goods with higher quality, less down time, and fewer errors than can humans.

In today's manufacturing world, which relies heavily on outsourcing to countries with lower labor costs, robots can have a significant impact on reducing supply chain costs and risks. Modern-day robots are easily integrated into existing manufacturing and distribution operations, and they are versatile enough to pack boxes one day and repair machines the next. Many of these robots are surprisingly affordable and thus accessible to both large and small businesses. Tasks that in the past might not have been considered for automation can now be automated inexpensively, flexibly, and in close proximity to humans. This enables companies to co-locate design and manufacturing in a cost effective manner. It also reduces lead time.[1]
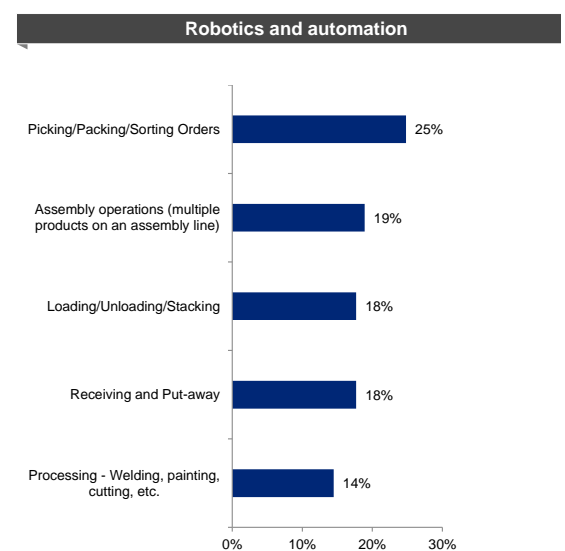
Robotic automation in the manufacturing and industrial sectors has experienced strong growth over the past decade, with nearly 180,000 units sold in 2013—a 12% increase over 2012.[2] The automotive industry still dominates the use of robots and automation. However, other industries are expected to gain ground.

Applications

Current uses for robotics and automation span a range of supply chain activities (see Figure 10).

Figure 10: How are companies using robotics and automation today (or planning to use it over the next 1-2 years)?

Robotics and automation	
Picking/Packing/Sorting Orders	25%
Assembly operations (multiple products on an assembly line)	19%
Loading/Unloading/Stacking	18%
Receiving and Put-away	18%
Processing - Welding, painting, cutting, etc.	14%

Source: survey results

---

1   Aberdeen Group: Globalization and Global Trade Drive Renewed Focus on Supply Chain Visibility, September 2011
2   International Federation of Robotics: 2014 Industrial Robot Statistics

Value drivers

Robotics and automation are gaining new ground in companies of many shapes and sizes. Key benefits include:

- **Productivity increases.** Robotics and automation reduce manual effort, including searching for goods in the picking process, which increases overall workforce productivity by focusing humans on higher-value tasks. It also reduces the training cycle time in a high-churn operating environment.
- **Faster response times.** In high-demand, high-velocity omni-channel environments, automation can drastically reduce the pick, pack, and ship times to better meet customer demand.
- **Improved warehouse efficiency.** Automation helps reduce operating costs, space utilization, and energy efficiency (reduces the need for lighting and temperature control in robotic-only areas).

- **Lower production costs.** Declining wage arbitrage opportunities in Asia are forcing companies to adopt robotics and automation in order to reduce costs.
- **Improved security and control.** Maintaining robotic-only areas reduces safety incidents and pilferage risks. Furthermore, inventory accuracy can improve as human error is removed from the process.
- **Improved safety.** Robotics can help take people out of hazardous environments. It also can help to eliminate strenuous jobs where the risk of injury, whether immediate or over time due to repetition, is very high. Innovations in robotics—and the laws that govern its use—are now allowing machines to work side-by-side with humans.

What leaders should be doing today

- **Understand where and when investments make sense for your business**. Robots are a good solution for high-volume, high-utilization environments, particularly where labor is expensive. However, robots might not make sense for a business with a variable labor pool and extended periods of downtime. The business would lose some of its ability to flex its workforce in response to changing demand. However, robotics and automation should not be viewed as an all-or-nothing-proposition. For example, you might be able to capitalize on robotics by segmenting your products into (1) high-volume, predictable products and (2) lower-volume or more erratic products, and then establishing an automated production facility for the high-volume segment.
- **Start with a single line or facility**. In addition, there are a number of business events that might create an opportunity for robotics, including building new facilities, expanding capacity, redesigning the network, or re-evaluating make-buy decisions. Often companies start with a single production line as a pilot test, which can help provide the data required to build a business case for broader expansion.
- **Talk to companies using the technology**. When working with vendors, ask to speak with their existing customers and tour facilities where the technology has already been implemented. Many companies are very open about sharing their experiences and lessons learned.
- **Develop your talent strategy.** Begin thinking about which roles may be automated in the next 5-10 years and develop a transition strategy. Think about how roles will evolve and what skillsets will be needed. Think about when you should let natural attrition play into reduced headcount needs or how you will redeploy workers to higher-value activities. Robotic technicians and engineers are roles that may be in high demand even though they are not prevalent today.

Real-world uses of robotics and automation

Proving the value: robots versus traditional warehouse operations[1]
An online clothing retailer dedicated half of its central distribution center to pilot an automated picking solution. Dividing the center allowed the company to directly compare productivity, costs, and risks in the two environments and determine the value of additional warehouse automation.

The online retailer receives everything from a single product order to complex multi-orders with varying types of products. In their traditional picking environment, it can take up to 48 minutes to fulfill a a single order and up to three hours for a more complex one.

After automating a portion of the warehouse and tracking results over time, the company achieved the following:

* **Doubled warehouse efficiency**
* **Drastically reduced picking time**—down to 12 minutes from 48 to 180 (order dependent)
* **Improved storage capacity**—80% better than on the traditional side of the house
* **Perfect inventory accuracy**—100% (zero defects in cycle counts)
* **Zero safety incidents**—versus two or three per week in traditional warehousing operations
* **Reduced training cycle time**—critical in high-churn operational environments
* **Lower energy costs**—reduced need for lighting and climate control
* **Improved security**—personnel are not allowed in robotics areas which reduced pilferage risk

The powerful results have led the company to explore additional automation innovations.

Cutting warehouse space in half[2]
A dietary supplement manufacturer and distributor streamlined its distribution operations by automating its material handling system. The initiative was driven by an acquisition that required the company to significantly reduce inventory to generate more cash. Large inventories were also masking inherent flaws in its supply chain operations. The company realized that optimal inventory levels would need a much smaller facility than the company currently had. Ultimately the manufacturer relocated from a 280,000 square foot location to a much smaller facility with only 100,000 square feet. To make the move, the new distribution center needed to support annual throughput of 33 million bottles, with 2,000 SKUs requiring a mix of refrigerated and ambient temperature handling.

To achieve its aims, the company designed and implemented a multi-level pick module system to fit its operation into the smaller space. It used automation to reduce touches, travel, and headcount by more than 50% while doubling productivity from 110 to 222 lines per hour.

1   Kiva Systems: YouTube https://www.youtube.com/watch?v=Fdd6sQ8Cbe0
2   Source: Deloitte client experience

Growth technologies

Although current adoption levels of these technologies are moderate—approximately 20%—they are expected to mount significantly over the next three to five years. In fact, their adoption lags that of maturing technologies by only one or two years. Applications and use cases are not yet widespread which can create ambiguity around the value of these technologies and require different investment criteria and risk tolerance. However, early adopters may gain an advantage over their competitors.

In this section, we delve into these growth technologies:

- **Predictive analytics**
- **Wearable and mobile technology**

Predictive analytics

Predictive analytics is the application of advanced statistical analysis of structured and unstructured data sources to identify patterns and predict future events or outcomes. For example, predictive analytics can provide companies with a look into the future and give them opportunities to identify emerging patterns in the marketplace that can lead to highly effective and personalized customer engagement strategies.

Companies are no longer limited to looking in the rearview mirror to see what happened after the fact. Instead, they can take their data, and in some cases pair it with third-party data, to do predictive modeling and scenario analysis.

For decades, companies have been employing a basic form of predictive analytics through forecasting techniques that use sales history as the primary indicator of future market demand. However, with the proliferation of data, the sources and volume of both leading and lagging indicators allow for much richer analysis and broader applications.

The market for advanced and predictive analytics software is projected to grow from $2.2B in 2013 to $3.4B in 2018 (a 9.9% CAGR).[1] Global spending on hardware, software and services for big data is expected to grow at a CAGR of 30% through 2018, reaching a total market size of $114 billion.[2] In 2013, the market experienced a noticeable shift toward cloud-based solutions. In addition, the distinction between business analytics and big data is increasingly blurring now that the hype over big data is subsiding.

Predictive analytics lets supply chain managers manage inventory better, plan more reliable transportation networks and reduce variability in lead times. This can enhance service levels, lower costs and improve the bottom line.

Applications

Figure 11 shows the top supply chain uses for predictive analytics today, and over the next one to two years. However, other valuable applications for predictive analytics include:

- Evaluating machine use, performance, and failure rates to predict potential breakdowns for preventive maintenance
- Predicting product failure rates for returns or warranty planning
- Using external data—such as population growth, demographics, and economic growth—to design a supply chain footprint that aligns with future demand
- Leveraging external supplier data for risk modelling to identify, measure and understand potential vulnerabilities to production or service levels.
- Monitoring retail point of sale to adjust production and replenishment plans base on consumer activity

Figure 11: How are companies using predictive analytics today (or planning to use it over the next 1-2 years)?

Predictive analytics	
Using internal data	38%
Using external customer data (e.g., Point-of-Sale)	24%
Using big data (e.g., customer behavior, social media, etc.)	23%
Using external leading indicators (e.g., commodity prices)	17%
Using external supplier data (e.g., supplier locations, credit ratings) to assess supply risk	16%
Predicting machine breakdowns for preventive maintenance	16%
Predicting product failure rates for returns or warranty planning	16%
Using external data (e.g., population growth, demographics, economic…	15%

Source: survey results

1   IDC: Worldwide Business Analytics Software 2014–2018 Forecast, July 2014
2   ABI Research: Big Data Spending to Reach $114 Billion in 2018; Look for Machine Learning to Drive Analytics, September 2013
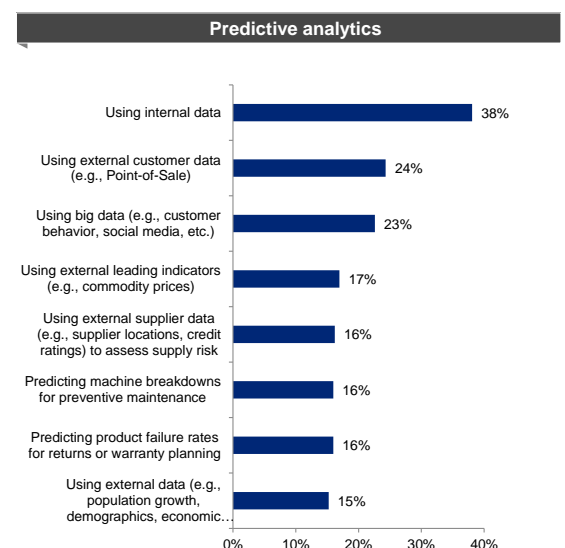
Value drivers

As supply chains become more global and interconnected, supply and demand volatility is increasing and driving the need for better predictive models. Specific benefits of predictive analytics include:

- **Ability to sense demand.** Companies are able to move beyond sales history and use forward-looking indicators—such as commodity prices, point-of-sale data, social media information, and macro-trend data—to better predict near-term demand. Such uses have positive ripple effects, including reduced inventory and better customer service levels.

- **Improved responsiveness.** Incorporating big data and social media into analytics can quickly identify important market changes such as shifts in demand patterns or potential supply shortages. For example, overlaying supply chain maps with social media data can reveal the need to transfer inventory to areas with higher use of certain keywords. Similarly, a price reduction in retail stores might indicate potential shortages.

- **Reduced failure rates.** By using data such as historical machine breakdowns and utilization levels, manufacturers can better predict breakdowns before they happen. This capability can enable preventative maintenance at the right time and reduce costly failures.

What leaders should be doing today

- **Start with the business problem you are trying to solve.** Knowing where to start is the biggest barrier to embracing the power of predictive analytics. Data sources and potential applications can seem endless, which often leads to analysis paralysis. A great way to begin is to think about the business problems you are trying to solve. What are the greatest unmet customer needs or pain points within the supply chain? What information and insights could help address those issues? Where might the required data be found?

- **Start small and iterate.** The next step is to know how to mine and analyze the data. This requires careful consideration of your system architecture and potential solutions. Work with your IT organization to better understand the available options and associated costs. In many cases, your options might range from simple spreadsheets to complex visualization layers. A key is to start with something small enough to be achievable, yet big enough to matter—and then iterate and improve from there.

- **Listen to the customer.** Practice 'social listening' to predict consumer behavior in the near future. The ability to leverage unstructured data from social media or internet content, analyze that information and quickly respond can be a huge advantage especially for retailers and consumer product companies. Understanding and aggregating customer sentiment in real time is another means to forecast short-term demand more accurately and then respond with the right item for your customers.

Real-world uses of predictive analytics

Predicting failures before customers experience them[1]
A small appliance manufacturer was plagued by high failure rates that were impacting sales and significantly increasing warranty expenses. Even worse was the risk to the company's brand and reputation. The organization had limited knowledge of the drivers of these product failures or what to do about it. The challenge was exacerbated by the fact that all manufacturing was done in Asia using contract manufacturers

To better understand and isolate the underlying drivers of these failures, the manufacturer employed predictive analytics using a series of internal and third-party data. First the business gathered internal data to segment appliance families based on quality issues. Drilling down further, the company overlaid third party data to determine appliance reliability as a function of manufacturing variability, product usage, consumer demographics and water hardness ratings by U.S. city.

The company developed predictive models to estimate the probability of product failure and key drivers of failure based on manufacturing line, shift, batch size, day and month, number of engineering changes, consumer usage patterns, demographics, and water hardness ratings by city.

The analysis identified $16-$28 million in cost of quality reductions.

Beating competitors to the punch[2]
A manufacturing company was plagued by the increasing severity and frequency of worldwide supply disruptions. Many such disruptions were driven by natural disasters such as severe storms, hurricanes, and tsunamis. However, some geographic markets were more prone to disruptions spurred by political unrest, labor stoppages, or changing regulatory restrictions. Moreover, the company realized that if it could respond to supply disruptions better than its competitors did, it would have a new competitive advantage.

By harnessing the power of big data and predictive analytics, the manufacturer was able to assess a wide range of risk factors, including historical weather statistics, to identify high-risk geographies. Overlaying supply chain data such as key suppliers, material flows, and production facilities, predictive analytics were then used to calculate probabilities of delays, identify back-up suppliers, and develop contingency plans to ensure continued production even during a natural disaster.

This new capability not only reduced supply chain risk in an increasingly volatile world, it increased responsiveness and customer service during normal times when its competitors struggled to satisfy customer demand.

1   Source: Deloitte client experience
2   Source: Deloitte client experience

Wearable and mobile technology

Wearable and mobile technologies give people convenient and immediate access to information wherever they happen to be working. Mobile technology includes smart phones, tablets and other wireless devices that have become ubiquitous in recent years. Wearable technology is a new product category that includes smart glasses and watches as well as voice-directed, hands-free wearable scanners. These devices give the people who wear them ready access to a world of information and can also collect and display data about the wearer and surrounding environment.

Transportation devices, such as on-board or in-cab computers, are another arena where mobile devices are gaining traction. Near-real-time data such as routing information, signature captures for proof of delivery, and driver hours of service can bolster efficient operations and improve customer service. The ability to track where vehicles are located provides more accurate and timely information about where assets are at any given time.

These devices can also capture real-time traffic information and suggest alternate routes to avoid delays. They provide geo-fencing to confirm an appointment automatically once a truck moves within a certain distance of a DC. This capability can improve delivery times and help set customer expectations with more accurate ETAs.

Applications for wearable devices such as smart glasses are still emerging but have significant potential for desk-less workforce applications. They enable real-time information to be overlaid onto actual work environments through a hands-free, intuitive interface.

Manufacturers, distributors and their partners are experimenting with these technologies to expedite processes, improve worker safety and increase transparency within the supply chain to proactively free up potential bottlenecks.

Today, there are approximately 17 million workers in the fields of manufacturing, logistics, technical services, emergency response, and medical care.[1] Many need to work hands-free and require real-time data and intelligence.

Enterprise adoption is now economically viable, with clear use cases and a compelling returns on investment. Device costs are coming down, and enabling technologies such as software applications and cloud computing are increasingly available.

Although wearable technology is still in the early stages of adoption, the market is exploding—with projected growth of 38% year-on-year from $2.5 billion in 2013 to $12.6 billion by 2018.[2] As of 2014, over 19 million wearable devices have shipped worldwide, tripling 2013 figures— with businesses driving much of the growth.[3]

Applications

According to our survey, the top supply chain applications for wearable and mobile technology today, and over the next one to two years show a clear focus on manufacturing and warehousing activities (see Figure 12) such as order picking and value-added processing.

 "Companies are beginning to experiment and prove the value of smart glass hardware and software," says Joe Fitzgerald, a senior manager at Deloitte leading the firm's Wearables Innovation practice. "In supply chains, this is often combined with IoT device experimentation. Companies are piloting smart glasses in supply chain and manufacturing operations to understand how the technology can augment the existing systems and workforce. This might include improvements to existing processes for monitoring operations, routing workers around factories, warehouses or installation sites, and providing remote expert support to workers in the field."
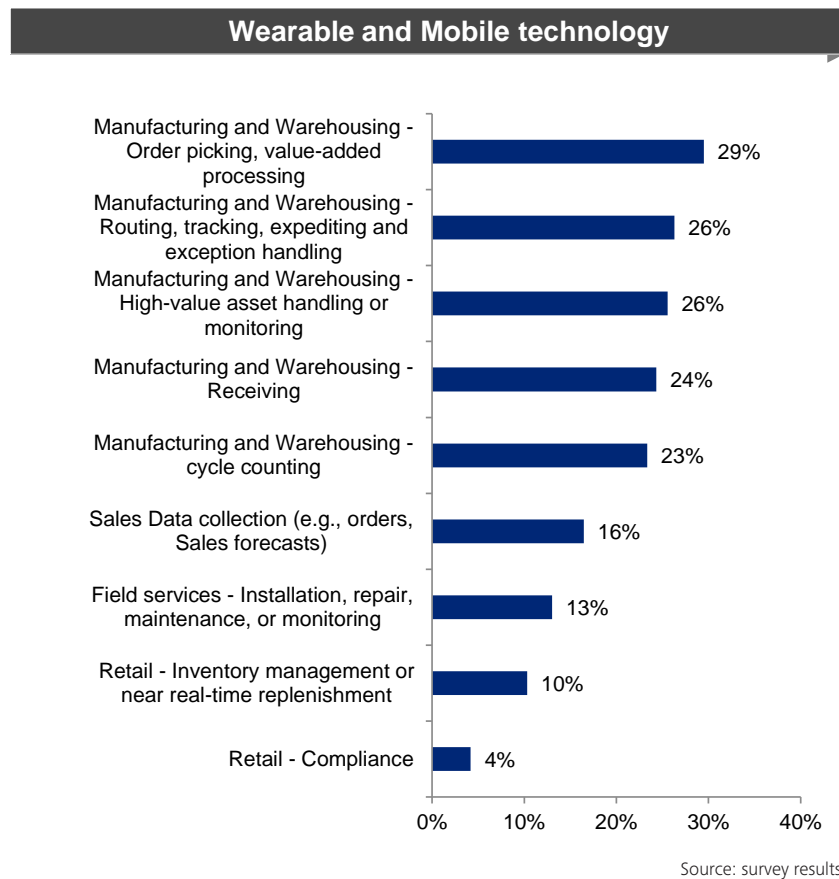
Other relevant near-term applications include:

• Field installation and repair of complex equipment
• Receiving inventory for validation and storing
• Routing, tracking, expediting, and exception handling
• Visual inventory cycle counts
• Visual picking of eCommerce goods in fulfillment centers and in the store
• Equipment maintenance and calibration

---

1   Deloitte University Press: Wearables Tech Trends 2014, February 2014

2   Statistica: Wearable Device Market Value from 2010 to 2018
3   Deloitte University Press: Wearables Tech Trends 2014, February 2014

Figure 12: How are companies using wearable and mobile technology today (or planning to use it over the next 1-2 years)?

Wearable and Mobile technology

Category	Percentage
Manufacturing and Warehousing - Order picking, value-added processing	29%
Manufacturing and Warehousing - Routing, tracking, expediting and exception handling	26%
Manufacturing and Warehousing - High-value asset handling or monitoring	26%
Manufacturing and Warehousing - Receiving	24%
Manufacturing and Warehousing - cycle counting	23%
Sales Data collection (e.g., orders, Sales forecasts)	16%
Field services - Installation, repair, maintenance, or monitoring	13%
Retail - Inventory management or near real-time replenishment	10%
Retail - Compliance	4%

Source: survey results

Value drivers

The return on investment for wearable and mobile technology is becoming clearer. "Many of the smart glasses that could be used in supply chains today are priced on par with hand-held scanners, which cost several thousand dollars each," says Fitzgerald of Deloitte. "It's important to note that the components used in these systems are based on those used in cutting edge smart phones. Therefore improvements in smart glasses can build on innovations in miniaturization within the smart phone market."

Key sources of impact and benefit include:

- **Improved capabilities and efficiency for remote workers**. Wearable and mobile devices can boost the productivity of remote workers by providing critical information wherever and whenever they happen to be working. Workers can promptly connect to experienced supervisors who can see what employees are doing and guide them through the task rather than waiting for a manager to arrive on-site.

- **Improved order fulfillment.** In addition, mobile technologies enabled by GPS can support optimal routing, dynamic re-routing based on traffic and weather, reduced fuel costs, and more accurate ETAs for customers.
- **Accuracy and productivity.** Voice-directed software for hands-free wearable devices enables automation throughout the supply chain. The potential benefits include significant improvements in productivity and fulfillment accuracy when compared to manual operations.
- **Improved training**. Visually laying out work tasks and requiring completion of a task before moving on to the next improves training efficiency and effectiveness. In high-turnover manufacturing industries, this efficiency can be a tremendous advantage.
- **Improved safety.** Wearable solutions can be embedded into protective glasses and clothing such as jackets and boots. They can also provide hands-free convenience so workers can use their hands for other tasks.

What leaders should be doing today

- **Identify the most applicable use cases for your company**. Take time to evaluate the potential use cases and applications, and then assess your own supply chain environment to identify efficiency opportunities. Start within the manufacturing environment and field services as these both require hands-free, remote work and access to data. High-value assets with costly downtimes are particularly worth evaluating. Large distribution centers are another good area, especially the handling of custom orders, which take extra time and are prone to errors.
- **Understand the risk and impact of not adopting**. Explore and assess opportunities and risks created by the broader ecosystem associated with wearable and mobile technologies, focusing not only on replacing existing technologies but on discovering new value-added applications.
- **Start paving the road for future adoption**. Since the wearables industry is maturing quickly, companies should take steps to evaluate, adopt, and deploy trials of wearable technologies within the next two to three years. These technologies will likely face some initial resistance from the organization, but the more you familiarize employees with the technology, the easier it will be to drive more widespread adoption.

Real-world uses of wearable and mobile technology

Tracking trucks in real time[1]
Improving the accuracy of the estimated arrival times for its nearly 400 trucks was critical to the success of a large food and beverage distributor. To improve that accuracy, the company turned to a mobile PC solution that offered:

- Navigation and messaging capabilities to transmit data in near-real-time for analysis, re-routing, and more accurate ETAs so customers can plan shipment arrivals, unloading, and take pre-emptive actions to manage delays
- The ability to log route data and customer interactions, eliminating the need for drivers to enter data manually at each stop and at distribution centers
- Embedded GPS to optimize its delivery network, significantly reducing fuel costs and the company's carbon footprint

The roll-out increased customer satisfaction, improved driver efficiency, and reduced transportation costs. In addition, the company experienced a marked improvement in driver-to-dispatch and transportation-to-sales communication.

Augmenting pickers' reality[2]
A multinational electronics company had been using hand-held scanners and paper pack lists which was time consuming and prone to error. To address the issue, the organization partnered with DHL to create a more efficient and scalable process for order picking in its warehouses. The company equipped pickers with smart glasses supported by Ubimax software to create a leaner, hands-free order picking process. It works as follows:

- A picker logs in through smart glasses
- He or she then scans the next available picking trolley which brings up the pick list
- The smart glass software puts task information in front of the picker's eyes (e.g., isle number, location ID, quantity, percent complete)
- The glasses provide a visualization of the trolley so pickers can see what goes where and the percent complete

The technology drives a much faster, more accurate, and user friendly approach to order picking over traditional methods. A pilot project has already shown significant improvements in time efficiency and error reduction. The technology has also received high scores from pickers. "This is just our first step in our innovation journey," says Dr. Markus Kuckelhaus, director of DHL Trend Research. "In the future, we see augmented reality playing a role in other parts of the supply chain."

Slashing costs by almost a fifth[3]
At a grocery store distribution center in Ireland, workers move among 87 aisles of three-story shelves. Many wear armbands that track the goods they're gathering, freeing up time they would otherwise spend marking clipboards. The armbands also assign tasks to the wearers, forecast completion times, and quantify their precise movements within the facility's 9.6 miles of shelving and 111 loading bays. A 2.8-inch display provides analytical feedback, verifying the correct fulfilment of an order, for example, or nudging a worker whose order is short.

The grocer has been tapping such tools since 2004, when it signed a $9 million deal for an earlier generation of wearables to put into service in 300 locations across the UK. The efficiency gains it hoped to achieve have been fully realized, with the number of full-time employees needed to run a 40,000-square-foot store dropping by 18% from 2007 to 2012.

1   Inbound Logistics—Mobile Communications: Managing Supply Chains on the Go, October 2011
2   Vision Picking at DHL—Augmented Reality in Logistics, YouTube https://www.youtube.com/watch?v=I8vYrAUb0BQ
3   Source: Deloitte client experience

Emerging technologies

According to our survey, the use of emerging technologies is on the upswing even though current adoption hovers around 10%. Although current applications are rather limited to specific industries, company leaders should understand the current and near-term uses of these technologies and prepare for the possibility that they may significantly disrupt their industries over the next six or more years.

In this section, we examine these emerging technologies:

- **3D printing**
- **Driverless vehicles and drones**

3D printing

Additive Manufacturing (AM), also known as 3D printing, refers to a group of technologies that manufacture products through addition of layers from a digital 3D blue print. With additive manufacturing, companies can create complex designs, increase speed to market, and reduce waste compared to traditional manufacturing methods.

Use of AM for production of parts and final products has grown from near zero to 28.3% over the past decade and is continuing to improve its functionality and applications.[1] In essence, instead of injection molding or fabricating products, 3D printing builds them layer-by-layer.

3D printing can be a potentially disruptive force because the barriers to manufacturing (requiring investment in infrastructure) are effectively removed. For example, a small firm can now create a 3D computerized model of a toy and then send it to a 3D printer locally or even around the world to China for production. 3D printing changes the concept of economies of scale by providing the ability to customize at no incremental cost and produce fewer items at lower cost than with assembly-line production.

Perhaps the real news in 3D printing is the capability to print quickly with high-performance metals. That capability will be of great benefit to companies that need to decrease the time between when they complete the initial phases of product design to the prototyping and refinement phases.

Applications

Industries including aerospace and defense, automotive, healthcare, consumer products, and retail have seen the most significant applications.

The survey results in figure 14 show the top uses for AM currently. Very soon, we expect to see a rise in the use of AM for:

- Service parts
- High-volume/complex products (e.g., chocolate: Hershey has announced partnership with 3D Systems to create a 3D chocolate printer)[2]
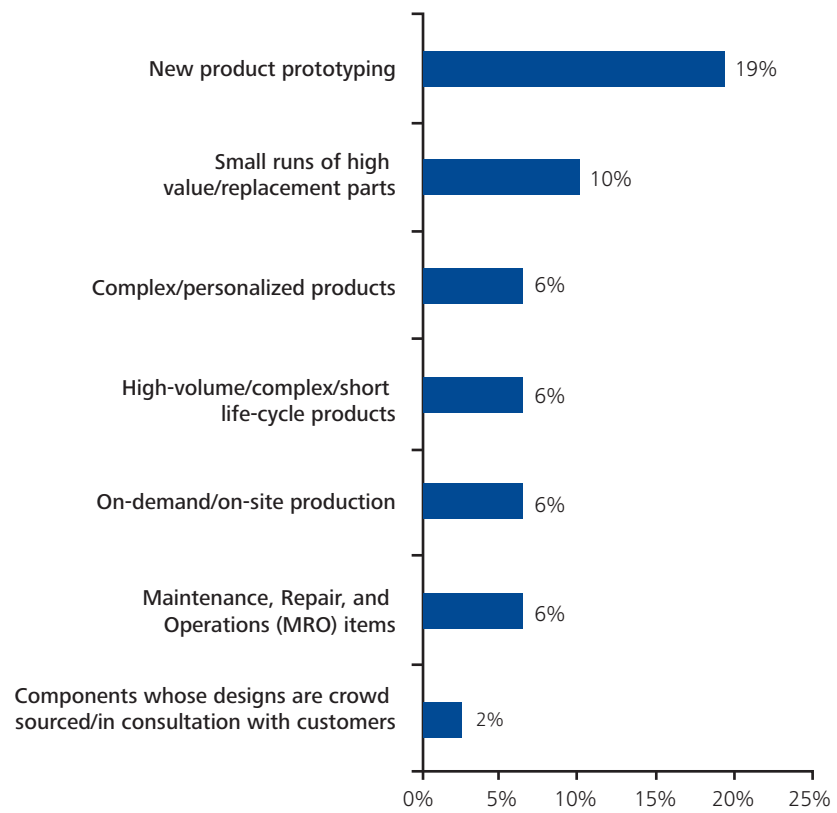- Fashion/trend products with high-volume/short lifecycles

Over the long term (as the technology improves), we see a broader applicability for mass production / customization of fast-moving consumer goods.

The survey results in Figure 14 shows the top uses for AM.

1   Wohler Associates: The Use of 3D Printing for Final Part Production Continues Impressive 10-Year Growth Trend, November 2013
2   3D Systems: 3D Systems Previews New Chocolate 3D Printer CocoJetTM at 2015 International CES, January 2015

Figure 14: How are companies using 3D printing today (or planning to use it over the next 1-2 years)?

New product prototyping	19%
Small runs of high value/replacement parts	10%
Complex/personalized products	6%
High-volume/complex/short life-cycle products	6%
On-demand/on-site production	6%
Maintenance, Repair, and Operations (MRO) items	6%
Components whose designs are crowd sourced/in consultation with customers	2%

Source: survey results

Value drivers

Additive manufacturing could eventually transform how many products are manufactured and distributed. In particular, it enables:

- **Low volume production**. AM redefines economies of scale by providing the ability to customize products at no incremental cost and to produce fewer items at a lower cost than with assembly-line production.
- **Mass customization**. Since there is no change over cost, AM allows consumers to customize or create unique products, such as personalized toys or products with images of themselves. This might prompt traditional business-to-business companies to build ecommerce channels to interact directly with consumers, which may require new processes, infrastructure, and capabilities.
- **Shortened supply chain with localized production**.

AM enables the ability to print products and parts on demand—whenever and wherever they are needed—instead of mass producing them at a centralized manufacturing facility and then fulfilling orders from a distribution center. This could be particularly useful for maintenance, repair, and operations (MRO), where parts and tooling are complex and expensive, and storage space is limited.

- **Optimized design**: By building layer upon layer, AM allows infinitely complex designs without additional cost or specialized tooling.
- **Low cost production**: AM reduces or eliminates scrap and changeover costs. Currently, AM material costs are higher than those of traditional raw materials, but the costs have been steadily decreasing.

What leaders should be doing today

Start familiarizing yourself with the technology now. Pilot programs can help you build valuable internal capabilities and external alliances, positioning your business to capitalize as technology advances support broader applications. For many manufacturers, prototyping is a practical application that can provide value in the short term while evaluating longer-term opportunities. This can be especially true for businesses where speed to market is important and products go through many iterations during development.

To capitalize on AM's long-term potential, supply chain leaders should ask these questions:

- How can products and components be redesigned using AM to reduce material and assembly costs?
- Can AM improve product performance and/or reduce production quality issues?
- What supply chain challenges, such as speed to market, can AM help surmount?

Real-world uses of 3D printing

Going from twenty separate parts to one[1]
The automotive and aerospace industries are two of the main beneficiaries of 3D printing. In 2012, an aircraft manufacturer purchased one of the biggest metal additive manufacturers in the world to begin ramping up 3D printing of aero engine fuel nozzles. The conventional method of building fuel nozzles required making 20 separate parts and welding them together, which is extremely labor-intensive and has a high scrap rate.

3D printing allows the creation of preassembled nozzles which reduces the need for purchasing, inventorying, and assembling those different components. The manufacturer predicts that, by late 2015, it will make 10–20 fuel nozzles for each engine using 3D printing, or 25,000 a year. The company also predicts that 50% of a jet engine will be additive manufactured within current lifetimes.

Accelerating speed to market[2]
An industrial manufacturer purchased a Fused Deposition Modeling 3D Printer to in-source building form, fit, and function prototypes for items such as mounting brackets for motors, conduit boxes, fans, and breakers.
Models that once cost $500 to prototype are now produced for $15 in-house through 3D Printing. Prototype creations that once took four to six weeks now only take an hour. As a result of faster turnarounds, the company has been able to deliver more innovative products, cheaper, and faster to market.

1   Source: 3D Systems
2   Source: 3D Systems

Driverless vehicles and drones

Self-driving vehicles and drones use a variety of technologies including cameras and advanced driver assistance systems to handle some or all functions of operating a vehicle. By 2017, 20% of logistics organizations will exploit drones as part of their monitoring, searching and event management activities.[1] What's more, by 2030, vehicles capable of driving autonomously are expected to represent approximately 25% of the passenger vehicle population in mature markets.[2]

In reality, this idea is not new to the supply chain. Autonomous vehicles have been used in material handling applications for years and many autonomous commercial vehicle (ACV)-related systems are already in use today within the trucking industry. Examples include electronic stability control (ESC), collision avoidance technology, rear- and forward-view camera systems, plus related electronic sensor arrays needed for transmitting data between such systems and a truck's engine, transmission, and brakes.

Applications

The survey results in Figure 13 show that the supply chain applications for these emerging technologies today and over the next one to two years are still fairly limited. A common use is on-site transportation within a corporate campus or building, followed by transportation and inbound transportation.

Although drones and driverless vehicles have yet to enter the mainstream consumer market, some companies are already exploring how these technologies can transform their businesses. Application areas include:

- **Consumer product delivery**. Last mile delivery of orders by retailers, food delivery by restaurants, and parcel delivery by logistics companies.

- **Oil and gas**. Field monitoring and mapping to identify problem areas, detect oil spills, monitor terrain, map landscape, and drive in low visibility conditions and difficult terrain.
- **Search, rescue and firefighting**. Rescuers and firefighters locating accidents, and mapping locations to increase personnel safety.
- **Agriculture and crop management**. Increasing crop yields and reducing damage by mapping locations to help identify irrigation problems, soil variation, pest infestations, and other threats.
- **Media and entertainment**. Using mobile cameras to capture sporting, news, and other media events.

Figure 13: How are companies using driverless vehicles and drones today (or planning to use it over the next 1-2 years)?
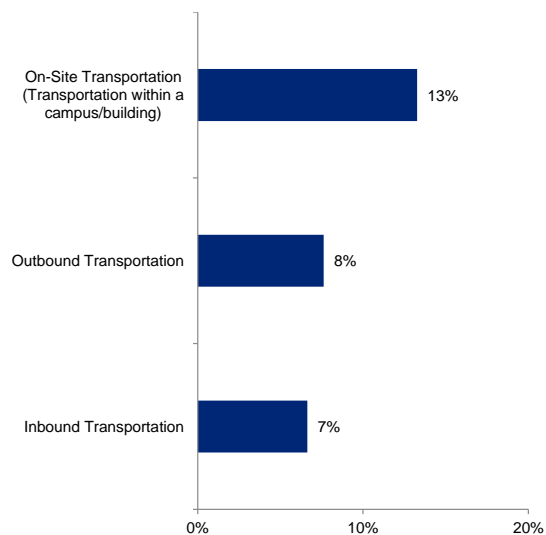
Source: survey results

1   Gartner: Predicts 2014: Global Logistics Differentiating for the Future, November 2013
2   Gartner: Crashing Industries and Our Societal Beliefs — The Real Implications of the Autonomous Vehicle, October 2014

Value drivers

Although driverless vehicles and drones are still in their infancy, they are generating a great deal of interest and press coverage—especially for business applications. In five years, drones are expected to be a standard part of operations in many industries, particularly for remote activities such as agriculture and oil exploration. Over the next five to six years, self-aware vehicles will likely emerge that are increasingly able to sense, interpret, decide, act, and communicate with other automobiles, infrastructures, organizations and people. A recent study by Frost & Sullivan found that some price-sensitive markets may be slow to adopt such technology. Other markets —notably the long-haul trucking sector—may experience at minimum a return on investment (ROI) period of three years. The study also predicts active use of automated vehicles on North American roads by 2025.[1]

Driverless vehicles and drones offer a number of key benefits over traditional manned vehicles, including:

- **Lower costs**. Driverless vehicles and drones are more efficient and cheaper to operate as they can optimize fuel and maintenance costs and may alleviate constrained demand for qualified truck drivers.
- **Improved safety**. Automation reduces the potential for human error, though there are still the legal implications of driverless vehicles involved in potential accidents that have yet to be resolved.
- **Reduced stress**. Driverless vehicles and drones enable people to focus on more important tasks. This is especially true for long haul carriers that allow drivers to take breaks and stay connected with the outside world.

What leaders should be doing today

- **Explore the possibilities.** Self-driving vehicles and drones for business use are closer to reality than many people think—and the implications aren't limited to convenience. These technologies may soon have a major impact on your organization, employees, supply chain, and internal operations, so it's important to start preparing now. Find ways to expand your business by looking for new cross-industry opportunities that combine transportation-related benefits with other activities. Explore innovations that use drones and other automated vehicles to supplement or improve activities that currently require human pilots and drivers.
- **Look for the tipping point.** Sandeep Kar, global director of automotive & transportation research at Frost & Sullivan, identified three key total cost of ownership benefits that should make ACV technology an attractive investment for on-road fleets over time:[2]
  1. Driver satisfaction for both existing and future truck operators: "Drivers won't have to physically operate the truck for long periods as the [ACV] technology will allow them to take breaks and stay connected with the world outside while in the cab," he comments. "That 'connectivity' will be very important for recruiting younger drivers."
  2. Increased fuel efficiency and lower maintenance costs from more "optimized" truck operation due to ACV guidance systems.
  3. Improved safety performance will round out the gains fleets can achieve from so-called "driverless" trucks.

1 FleetOwner: Costs and Benefits of Automated Vehicles Analyzed, January 28, 2015
2 FleetOwner: Costs and Benefits of Automated Vehicles Analyzed, January 28, 2015

Real-world uses of driverless vehicles and drones

Turning the age old mining industry on its head[1]
One of the largest mining companies in the world is now funding the globe's largest non-military robotics programs. As of 2014, the company operates 40 autonomous haul trucks (AHT) working at locations across Australia, with plans to add 150 more. All trucks are controlled remotely from as far as one thousand miles from the mines. To navigate, the vehicles use a combination of senors, radar and GPS.

The company began conducting trials with a robo-truck fleet of five in December 2008. Since then, the trucks have moved more than 130 million metric tons (mmt) of material. The benefits are ponounced: fewer staff and tired drivers as well as fuel savings.

Other mining competitors are following suit which is just the beginning of an evolution of driverless vehicles in mining and beyond.

Autonomous trucking
Last summer, Daimler AG demonstrated its driverless tractor trailer, FutureTruck 2025, which navigates via sensor and camera technology. Daimler plans to have the truck on the road within a decade. A group of Dutch logistics and technology companies has a shorter timetable, however. Within five years it wants to employ driverless trucks to deliver goods from the Port of Rotterdam to other cities in the Netherlands.

Meanwhile, Volvo Trucks has been participating in the SARTRE (Safe Road Trains for the Environment) project to test vehicle platooning. In this system, a driver at the head of a convoy of electronically-linked trucks drives the entire line of vehicles, assisted by automated systems in each vehicle that adjust for following distances and speed. The drivers in the following vehicles serve primarily as emergency backups. The aerodynamics of trucks driving platoon-style would result in better gas mileage, increasing fuel efficiency by 15 percent or more.

Current highway regulations that prohibit or restrict self-driving vehicles are one of the biggest obstacles to their growth. But that is changing gradually.

1   Wall St Daily: New Robo-Trucks Poised to Revolutionize the Mining Industry, May 21, 2014
2   Future Truck: https://www.youtube.com/watch?v=HHpXny86TcY and http://www.daimler.com/dccom/0-5-1714412-1-1714415-1-0-0-1714446-0-0-135-7165-0-0-0-0-0-0-0.html and http://www.cnbc.com/id/102024253
3   http://www.sartre-project.eu/en/Sidor/default.aspx

Making it happen—
Transforming your supply chain

The non-stop spiral of higher service levels at lower prices is pushing supply chain capabilities and infrastructure to the breaking point. Companies that continue to rely on traditional supply chain models will likely find it increasingly difficult to stay competitive and meet customer expectations for orders that are complete, accurate and on-time. "I believe that we are at the dawn of an innovation wave that will soon hit the material handling industry," says Scott Sopher, principal with Deloitte Consulting. "The convergence of big data, faster and cheaper computer power, and the increasing demands of customers will accelerate the growth of innovative products and services in the material handling industry."

The innovations and technologies highlighted in this report have the potential to provide step-change improvements in both cost and service. To advance efforts and surmount the supply chain challenges ripe for innovation, supply chain leaders can take these actions:

Determine where to invest

Deciding where and when to invest is crucial to achieving results, especially for technologies that are still in their infancy. As a starting point, define your innovation strategy (early adopter or opportunistic), which will help to define your investment strategies for mature, growth, and emerging technologies. Regardless of your strategy, it always helps to start with the business problem you are trying to solve and quantify the benefits of a given technology.

"We are at the dawn of an innovation wave that will soon hit the material handling industry."

A key challenge is that problems are not always obvious because their solutions are not yet widely known—or didn't exist before—enabling less than optimal practices to become entrenched as standard ways of doing business. It is important to continually scan the technology landscape and pilot new technologies. Keep lines of communication open with third party vendors, analysts, consultants, and trade groups to understand the evolving technology landscape and applications, and push them to help you develop an effective business case. According to this year's survey results, 46% of respondents are developing these partnerships in order to do just that.

Align with customer needs

Start with a forward looking view of what your supply chain will look like five years from now. Work with sales and marketing to understand growth projections by country and region. How will your product mix change? Consider various scenarios that cover ranges of possibilities and select a tool that will help to model your supply chain and support scenario planning.

Start small, with a single business unit or product line. If you've never used a network modeling tool before, seek third party support. There is no one way to optimize a supply chain and mistakes can be costly. Think of it as an investment in capabilities. These can be powerful tools to support decision-making and to align functions on long-term strategies supported by financial returns.

Collaborate across blurring boundaries

Collaboration can be a powerful way to establish a competitive advantage and emerging technologies are creating new opportunities for such collaboration. The combination of cloud solutions, auto ID, and predictive analytics are creating ripe opportunities for sharing data and offering value-added services.

Of course, it is not practical or even possible to collaborate with all value chain partners. That's why the first step is to segment customers, suppliers, and partners to understand where collaboration can create the most value. Collaboration often involves tangible costs, including the expense of establishing security and privacy protections.

Invest in workforce hiring and training strategies
The supply chain workforce crisis is real and will likely accelerate as new technologies demand a labor pool with increasingly advanced skill sets. MHI has focused on the talent shortage for years and works with the trade to address this critical issue. MHI sponsors the College Industry Council on Material Handling Education (CICMHE), which is a key resource and a supports professors and students in supply chain engineering university programs.
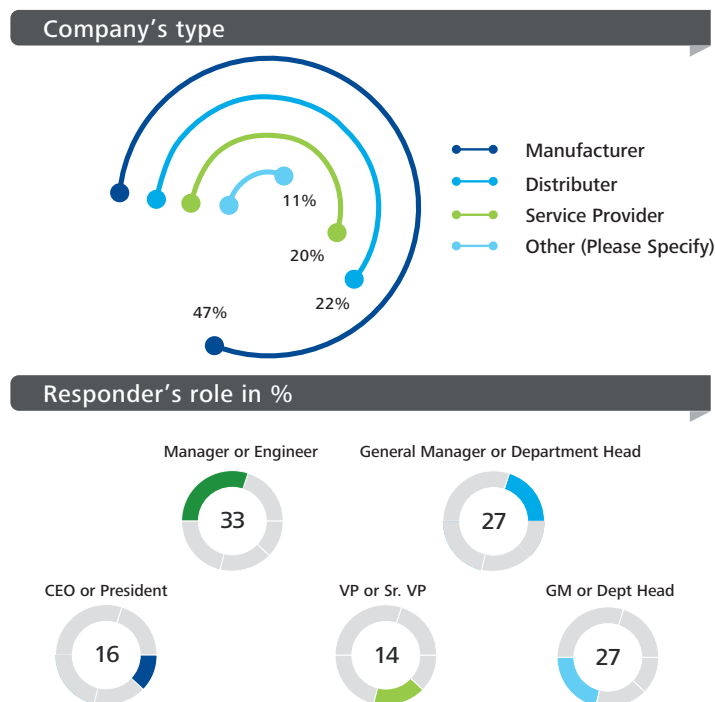
In addition, MHI and the Material Handling Education Foundation, Inc. (MHEFI) have developed the Career Technical Education Program (CTEP), which is helping to build the workforce of tomorrow by supporting curriculum, resources and certification programs at the high-school, vocational-technical- school and community-college levels.

As the Industry That Makes Supply Chains Work, MHI is committed to be at the forefront of these developments. MHI and its members provide industry information and best-in-class equipment and systems that can help deliver on the promise of supply chain efficiency, costs savings and speed to market that customers are demanding. MHI can be a resource to firms pursuing these new technologies.
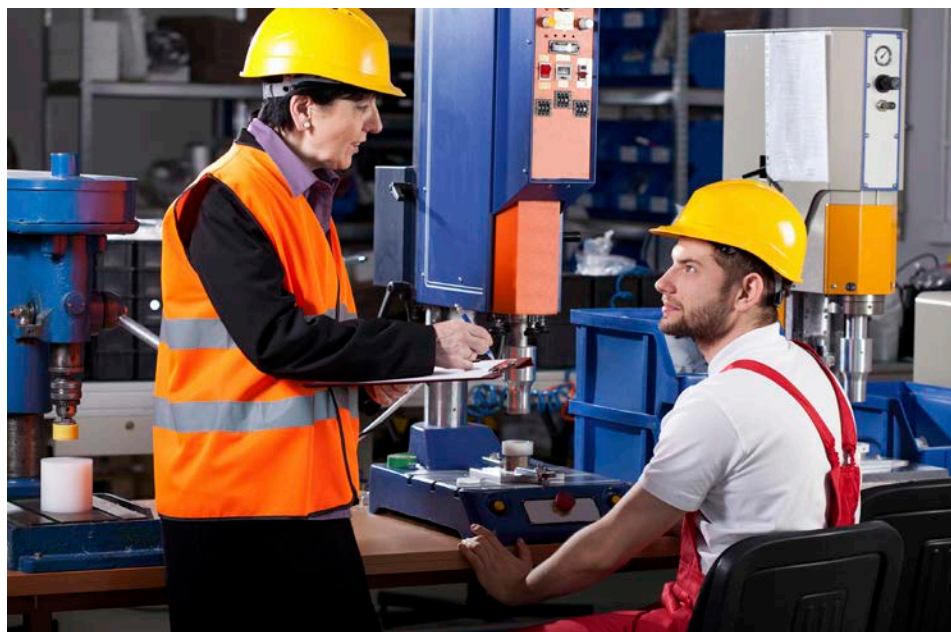
About the report

The 2015 MHI Annual Industry Report is our second annual study of emerging disruptive technologies and innovations that are transforming supply chains around the world. The findings are primarily based on an in-depth global survey conducted in late 2014, which involved more than 400 supply chain professionals from a wide range of company types and industries. The majority of participants (57%) are executives holding the role of CEO, Vice President, or General Manager.

Company's type

11%
20%
22%
47%

- Manufacturer
- Distributer
- Service Provider
- Other (Please Specify)

Responder's role in %

Manager or Engineer
33

General Manager or Department Head
27

CEO or President
16

VP or Sr. VP
14

GM or Dept Head
27

Surveyed companies range in size from small to large, with half reporting annual sales in excess of $100 million, and 11% reporting annual sales of $10 billion or more.

22%	Less than $10 million
20%	$10 million to $50 million
18%	$1 billion to $10 billion
13%	$100 million to $500 million
11%	$Greater than $10 billion
8%	$500 million to $1 billion
8%	$50 million to $100 million

Acknowledgements

About MHI

MHI is an international trade association that has represented the material handling and logistics industry since 1945. MHI members include material handling, logistics and supply chain equipment and systems manufacturers, integrators, consultants, publishers, and third party logistics providers.

MHI offers education, networking and solution sourcing for members, their customers and the industry as a whole through programming and events. The association sponsors trade events, such as ProMat and MODEX to showcase the products and services of its member companies and to educate manufacturing and supply chain professionals on the productivity solutions provided through material handling and logistics.

MHI
8720 Red Oak Blvd.
Suite 201
Charlotte, NC 28217-3992
Tel: 704-676-1190
Fax: 704-676-1199
www.mhi.org

This publication contains general information only and Deloitte and MHI are not, by means of this publication, rendering accounting, business, financial, investment, legal, tax, or other professional advice or services. This publication is not a substitute for such professional advice or services, nor should it be used as a basis for any decision or action that may affect your business. Before making any decision or taking any action that may affect your business, you should consult a qualified professional advisor.

Deloitte and MHI shall not be responsible for any loss sustained by any person who relies on this publication.

About Deloitte

Deloitte refers to one or more of Deloitte Touche Tohmatsu Limited, a UK private company limited by guarantee ("DTTL"), its network of member firms, and their related entities. DTTL and each of its member firms are legally separate and independent entities. DTTL (also referred to as "Deloitte Global") does not provide services to clients. Please see www.deloitte.com/about for a detailed description of DTTL and its member firms. Please see www.deloitte.com/us/about for a detailed description of the legal structure of Deloitte LLP and its subsidiaries. Certain services may not be available to attest clients under the rules and regulations of public accounting.