Creating better visibility using standards, technology, and physical and digital tools.

Unlocking supply chain resiliency

Key takeaways

1 "Phygital" technology blends data from the physical and digital worlds. This fusion can increase the efficiency of existing systems and unlock new ways to create supply chain resiliency.

2 Increasing supply-chain transparency requires robust digital standards that provide a common language to identify, capture, and share information, including support for rich data carriers like RFID technology and 2D barcodes like QR codes.

3 Unique identifiers and strong standards can help bridge supply chain gaps with new levels of visibility, allowing organizations to monitor every process and touchpoint along a product's life cycle.

Tracking a Big Mac hamburger's journey from ranch to fast-food restaurant isn't easy. Today's highly segmented beef supply chain consists of a wide array of ranches, feedlots, packers, processors, distribution centers, and restaurants, each with its own set of carefully collected data. Yet in today's complex digital world, organizations need more visibility than ever to manage inventory, know where products are coming from, and maintain consumer trust, says Bob Carpenter, president and CEO of GS1 US, a not-for-profit, international supply-chain standards organization.

To manage this wealth of data, industries use one of the simplest and most reliable data standards: the barcode. This ubiquitous machine-readable set of parallel lines encodes unique identification numbers for most items at points of sale around the globe. Although a Big Mac is never scanned, the journey of its ingredients is understood and communicated using these standards.

To gain greater visibility into its supply chain, fast-food restaurant giant McDonald's teamed up with supplier, Golden State Foods, in a pilot project that uses radio-frequency identification (RFID) technology to automatically track fresh beef's movement from manufacturer to restaurant in near real-time. This strategy promises to "create a golden digital thread of traceability, giving partners across our ecosystem the information they need to build trust, improve transparency, and drive value," says Sue Fangmann, U.S. supply chain services director for McDonald's.

"The more organizations can agree on common data standards to uniquely identify products with information such as weight, dimension, nutritional content, and location, the more they can enable a heightened level of transparency and efficiency in their supply chains."

Bob Carpenter, President and CEO, GS1 US

Welcome to the "phygital" universe where assets from the physical and digital worlds are blended to unlock vast volumes of information. In recent years, labor shortages, transportation failures, and political volatility have contributed to severe supply chain disruptions. Organizations like McDonald's are discovering phygital tools can address these difficulties by merging the efficiency and agility of technology, including artificial intelligence (AI) – with help from physical object identifiers – to create faster, more accurate, more transparent, and more resilient supply chains.

Creating transparency across the supply chain requires robust digital standards that provide a common language to identify, capture, and share information, including standards that support rich data carriers like RFID technology and 2D barcodes, such as quick response (QR) codes.

"Standards are important to driving interoperability," says Carpenter. "Interoperability allows systems to work with each other using a standardized data syntax. The more organizations can agree on common data standards to uniquely identify products with information such as weight, dimension, nutritional content, and location, the more they can enable a heightened level of transparency and efficiency in their supply chains."

The benefits of embracing the phygital

The best-known global standards for classifying products are Global Trade Item Numbers (GTINs), used for identifying products, and Global Location Numbers (GLNs) to identify locations. A new generation of data carriers has emerged capable of carrying these standards, and much more, to enable more robust use cases and significant benefits.

Chief among them is greater supply chain visibility. From a global pandemic to a Suez Canal blockage, "the supply chain disruptions the world has recently experienced have driven companies to want to invest in greater visibility," says Leslie Hand, group vice president at IDC Retail Insights.

In fact, according to research firm IDC, 20% of retailers see a lack of visibility into the supply chain as the biggest gap most likely to hinder supply chain success.

Unique identifiers and robust standards can help to bridge this gap by providing a level of visibility that allows

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Real-time data sharing enables richer experiences for customers, suppliers, distributors, retailers, and warehouses

Disruptions can be resolved and value unlocked by sharing data across the supply chain, says Leslie Hand, group vice president for IDC Retail Insights. Consider these possibilities:

Inventory management
Better supply chain visibility end-to-end for improved order accuracy, discovery of new revenue opportunities, and more efficient transportation.

Warehouse and fulfillment centers
Automation and robotics for more efficiency, and near real-time insights on supply capabilities and supplier network positions.

Personalized customer experience
Anticipate customer needs with proactive servicing, increased engagement, and better inventory visibility.

Organizational resiliency
More flexibility and transparency for stability during market changes, and broader data sets available for innovation.

Employee experience
Faster and more accurate data, more productive collaboration, and modern tools for the workplace mean faster decisions.

organizations to monitor every process and touchpoint along a product's life cycle, from the moment a product is planned to its arrival in a customer's hands. Armed with this real-time information on the production, location, and status of products, Hand says organizations can "fine-tune their operations to become more nimble and better able to adapt when something in the supply chain shifts," such as the unanticipated closing of a shipping port or a customer's decision to switch products.

Customer experience is key

Phygital systems fed with rich and accurate data can also unlock unique, personalized, and ultimately more reliable customer experiences. That's good news for today's customer-centric organizations. Research from global management consulting company McKinsey reveals that **improving customer experience** can increase sales revenue by 2% to 7% and profitability by 1% to 2%.

Fortunately, there are plenty of ways to leverage data — and the mechanisms that store this information — for customer satisfaction. For example, a QR code accessed via a mobile phone camera can provide consumers with information about a product's attributes, from nutritional value to expiration date, with a simple smartphone scan. Assigning a GTIN to an item lets brands uniquely identify products with authentic product information that can be shared with distributors, retailers, regulators, and consumers. By using RFID technology, retailers can offer consumers real-time visibility into

Barcode run-down

The first grocery item ever scanned using a barcode was a 10-pack of Wrigley's Juicy Fruit gum in 1974. The pack of gum and receipt is held by the **Smithsonian National Museum of American History**. Since then, the technology has advanced from the familiar machine-scannable UPC to barcodes that contain increasingly more data and flexibility.

Standard barcode

The ubiquitous one-dimensional barcode can contain about 12 to 20 characters of data.

QR codes

The increasingly used QR (quick response) code can contain vastly more data, and has error-correction features that enable it to be read even if it is damaged.

QR codes have the capacity for:
- 1,817 Chinese characters
- 4,296 Latin letters
- 7,089 Arabic numbers

Source: Compiled by MIT Technology Review with data from GS1 US and TechTarget, 2023

"The possibilities really are endless in terms of how companies can use the combination of an identified product or identified store shelf with better customer service in terms of satisfying the customer."

Leslie Hand, Group Vice President, IDC Retail Insights

stock levels and other indications of product availability. "The possibilities really are endless in terms of how companies can use the combination of an identified product or identified store shelf with better customer service in terms of satisfying the customer," says Hand.

Data sharing can also lead to better customer experiences by enabling servicing and more efficient supply chain execution. Restaurant chain **Chipotle Mexican Grill**, for example, tested RFID technology to enhance its traceability and inventory systems at its Chicago distribution center and approximately 200 restaurants in the greater Chicago area. Ingredients arrive at Chipotle restaurants affixed with RFID-enabled case labels, which are scanned by RFID readers. By tracking ingredients from suppliers using RFID technology and gaining access to real-time inventory data, Chipotle hopes to improve inventory management while enhancing food safety and ensuring freshness for a better customer experience.

Gaining next-level safety and efficiency

In most industries, mislabeled packages, incorrect product selection, and inventory overload can lead to costly supply chain inefficiencies. But in the health-care sector, failure to properly share data about a product's journey using global identifiers and standards can be downright dangerous.

Phygital is increasingly finding its way into the medical arena, from hospitals to pharmacies, to deliver significant benefits. For example, unique identifiers can help drug manufacturers monitor products along the supply chain to improve patient safety and boost health-system efficiency. Manufacturers can combat fraud by providing a way for supply chain partners to easily identify counterfeit drugs and devices. Some hospitals rely on **bedside barcode scanning** to reduce the risk of potentially life-threatening medication errors.

Beyond health care, increasing transparency across the supply chain ecosystem can also help organizations identify and eliminate inefficiencies. Sharing data using global identification standards can "enable the use of automation and robotics in warehouses and fulfillment centers, leading to increased operational efficiency and real-time operational insights," says Hand. For instance, a barcode or RFID tag can provide accurate information about goods that are shipped by suppliers before

Sustainability hinges on global standards and visibility

Many organizations are recognizing the role unique identifiers and standards can play in helping them meet ESG goals and satisfy the demands of environmentally conscious consumers.

Sue Fangmann, U.S. supply chain services director for McDonald's Corporation, points to the food industry as a perfect example of how global standards can improve sustainability. "The food industry has a ton of waste," she says. In fact, according to a 2014 U.S. Environmental Protection Agency **guide to reducing food waste and packaging**, more than 45% of waste sent to landfills each year is from food and packaging/containers, with **39.6 million tons coming from food waste**. She adds, "the moment you achieve granular visibility, you can identify the actionable insights that you need to address this waste." One strategy, for instance, might be to monitor expiration dates and inventory levels to better match demand, thereby reducing waste, she says.

Large corporations turning an eye to these standards can make an impact: McDonald's operates or franchises more than 40,000 quick-service fast food restaurants in more than 100 countries. According to a recent **sustainability progress report** by MacDonald's, 81% of its global consumer packaging was sourced from renewable, recycled, or certified sources in 2022, while 97% of its fiber-based (primarily plant-based) packaging globally came from recycled or certified sources in 2022.

Greater visibility into the supply chain is also a powerful means for measuring sustainability data. "If you create a golden thread of visibility, you can start to objectively measure your carbon footprint over time," says Fangmann.

they arrive at a warehouse. This notification allows companies to plan their receiving actions in advance and streamline the process for greater speed and accuracy.

In addition, Hand says poor communication among various parts of a business can result in waste of resources like fuel, water, packaging, and inventory. "Modern digital technologies can address these gaps, providing visibility into energy and emissions, which is a key strategy for successful organizations," she says.

Ensuring sustainability helps the bottom line

The sources of raw materials, product packaging, and energy use are more than simply environmental, social, and governance (ESG) concerns. Rather, they're factors that can significantly impact a company's profitability.

According to a survey of U.S. consumer attitudes on sustainable shopping by First Insight and the Baker Retailing Center at the Wharton School of the University of Pennsylvania, three-quarters of Generation Z respondents prefer to buy sustainably rather than to go for brand names.

"People care about sustainability and where their food comes from, whether it be cage-free eggs, sow housing, or sustainable packaging," says Fangmann.

In response, many organizations are recognizing the role unique identifiers and standards can play in helping them meet ESG goals and satisfy the demands of environmentally conscious consumers.

Gauging one's sustainability strengths is a critical capability as countries around the world introduce new environmental legislation. As it stands, the EU's Corporate Sustainability Reporting Directive (CSRD) calls on nearly 50,000 companies to regularly report

Visibility is the biggest supply chain threat

A 2023 IDC global survey of 811 executives from manufacturing, life sciences, and retail rated what supply chain problems loom the largest going forward.

Lack of supply chain visibility and resiliency to see necessary changes in time to react effectively	**46**%
Lack of robust data analytics and insight intelligence	**37**%
Lack of digital competencies limits the ability to transition the supply chain to new business models	**32**%
Lack of deep insight into our customers and consumers	**31**%
Lack of sufficient collaboration with external suppliers and/or customers	**30**%

Source: Compiled by MIT Technology Review with data from **IDC**, 2023

on sustainability, while U.S. regulators are finalizing their emission disclosure requirements. At the same time, the International Sustainability Standards Board (ISSB) is developing standards that will guide companies on the sustainability disclosures they need to report for global investors.

Global standards are playing an increasing role in the circular economy, as organizations rethink approaches to production, distribution, consumption, and reuse. Data is a crucial asset to obtain the level of efficiency and transparency needed by the circular economy model.

"People care about sustainability and where their food comes from, whether it be cage-free eggs, sow housing, or sustainable packaging."

Sue Fangmann, U.S. Supply Chain Services Director, McDonald's Corporation

"This generation is much more focused on the pedigree of a product, how it's manufactured, and how it can be properly recycled for a circular dynamic rather than a linear dynamic," says Carpenter. "But you can't have a circular economy if you don't have greater transparency."

The future of phygital

As the UPC barcode turns 50 years old, next-generation barcodes such as two-dimensional QR codes promise to once again unlock new phygital possibilities. At the same time, technologies like blockchain, the internet of things, and generative AI will increasingly collect, consume, and disseminate data-driven insights in real time within the supply chain. Use of data standards allow these new technologies to scale for the benefit of all stakeholders.

A perfect example of future use cases for unique identifiers is material traceability. Environmental non-profit Delterra recently teamed up with global supply chain standard setter GS1 and Empower, a blockchain-based material traceability tool provider, to create a product passport for recycled materials using 2D barcodes. Powered by blockchain technology, the solution records data at each stage in the value chain to create a secure registry that accurately identifies how a product was recycled with the help of common data standards. This mark of authenticity allows supply chain partners to claim with confidence that they're using recycled materials – a prerequisite for both consumer trust and carbon credits.

"It's one of many examples of pilots that we're testing to showcase how sustainability information is not only important to consumers but to brand owners that are purchasing recycled materials," says Carpenter.

The benefits of enhanced ESG reporting

In a Deloitte survey of 300 senior executives, respondents chose their top three expected outcomes of enhanced ESG reporting. These were the top six choices.

Talent attraction and retention	**52%**
Increased efficiencies and ROI	**52%**
Enhanced trust with stakeholders	**51%**
Brand reputation/enhancement	**49%**
Premium pricing of products	**49%**
Reduced risk	**48%**

Source: Compiled by MIT Technology Review with data from **Deloitte**, 2023

Maximizing the advantages of emerging technologies requires an ecosystem of supply chain partners equally committed to a global set of unique identifiers and standards. The visibility enabled by the seamless flow of data can provide the solid foundation organizations need to reach for their revenue, sustainability, and customer satisfaction ambitions. "Organizations need to operate as an ecosystem to take advantage of advanced technology," says Fangmann. "Success really does require sharing and data transparency."

"Unlock resilient supply chains with physical and digital tools" is an executive briefing paper by MIT Technology Review Insights. We would like to thank all participants as well as the sponsors, GS1 US. MIT Technology Review Insights has collected and reported on all findings contained in this paper independently, regardless of participation or sponsorship. Michelle Brosnahan was the editor of this report, and Nicola Crepaldi was the publisher.

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