MIT Technology Review
Insights

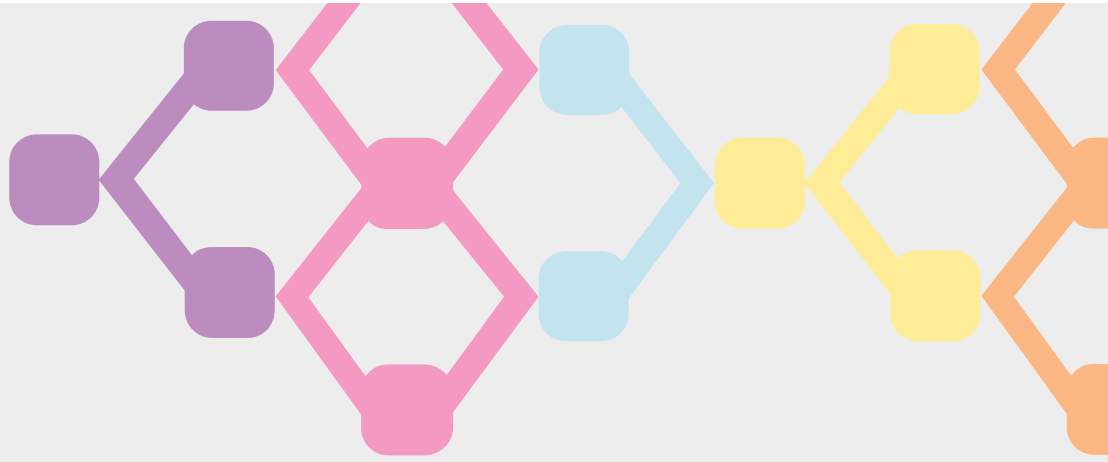How digital infrastructure drives insight and agility

Building resilient supply chains

Foreword

BEFORE COVID-19, only a few companies were on the forefront of building a resilient supply chain. Most were focused on constructing a cost-effective supply chain to deliver products on time with the lowest cost. The pandemic, however, has exposed weaknesses and difficulties in handling disruption—underscoring the imperative to build a supply chain that is resilient.

A resilient supply chain makes more accessible this goal of delivering on-time performance. But more important, when fortified by the latest digital technology, it also helps a company avoid disruptions before they occur by sensing unanticipated crises and rapidly pivoting in response to the changing environment.

To discover how resilient its supply chain is, a company needs to conduct a comprehensive stress test that shows its strengths and vulnerabilities. This stress test examines supply chain resilience along several dimensions: planning, geography, suppliers, distribution, manufacturing, product portfolio/platforms, and financial/working capital. The results help the company to set a new course for long-term supply chain resilience.

Since digitalization is a key driver of resilience, a central aspect of the stress test is a deep dive into the company's digital infrastructure and processes at each link of the supply chain. The stress test shows not only where digitalization is sufficient but reveals where it needs to be enhanced.

Digitalization throughout the supply chain can provide granular and timely information to empower better decision-making. It also unites historically disconnected parts of the business around the world and increases visibility across the entire supply chain. With the large quantities of data it gathers, digitalization allows for more accurate predictions of potential crises and greater agility in responding to disruptions that could occur anywhere.

Understanding the growing need for digitalization, companies are making the challenging shift to Industry 4.0 tools (including automation, IoT networks, AI, and robots) and smart manufacturing solutions. With these digital tools, companies are:

- Achieving better inventory management, smaller warehouses, and less energy consumption
- Designing standardized product containers that can be produced, filled, and shipped in a seamless factory-to-consumer supply chain
- Participating in the same-day or next-day delivery of goods
- Building fulfillment centers within producers' and suppliers' warehouses to optimize assets while distributing inventory risk

Overall, supply chain resiliency helps companies simplify their operations so they can work efficiently with minimal components, production stages, and partners, and helps them better manage the remaining complexity that cannot be eliminated. Balancing the quest for simplicity while reducing risk (through managing complexity) is key to building and sustaining a resilient supply chain.

Suketu Gandhi and **Steve Mehltretter**
Partners at Kearney

Turbulent times can expose weaknesses in distribution chains, putting stress on chokepoints and reducing access to critical components, suppliers, and capital. The ability to respond to changes rapidly and effectively depends on a variety of assets and business capabilities: replacing or augmenting supply sources in response to partner inventory issues or trade war-induced tariffs or restrictions, and having agile manufacturing processes that reduce redundancies and streamline product inputs.

Each thread of this complex web of factors that affects supply chain resilience must be examined and assessed separately to identify potential vulnerabilities and mitigate them. At the same time, most of this web simplifies down to two primary strands, common capabilities that run through every resilient business: increasing visibility and maintaining sufficient diversity in the supply chain.

Capability 1—Insight
Developing data capabilities and analysis tools that reach from suppliers and partners all across the value chain through to end customers, allowing companies to anticipate and prevent supply disruptions.

Capability 2—Agility
Being able to quickly mobilize an effective response to disruptions means managing a wide ecosystem of suppliers across all dimensions of the the supply chain.

The digital imperative
Digitalization is central to achieving resilience because it leads to better insight in decision-making. "Digital transformation provides firms with a certain purpose: increased visibility across their entire supply chain. Business leaders use visibility to increase responsiveness—and with that, they can achieve resilience," says Maria Jesus Saenz, director of research for digital supply chain transformation at the MIT Center for Transportation and Logistics.

A number of digital technologies are helping companies bolster supply chain performance. AI-driven predictive analytics allow businesses to interpret shipment and demand data to make leaner, faster purchasing and

Key takeaways

1 There are two interdependent strategic priorities at the core of corporate efforts to enhance supply chain resilience: using data to increase visibility and insight at each stage in the value chain, and developing alternatives and options for responding to disruptions with agility.

2 Reducing complexity—removing redundancy in sourcing or minimizing the number of components—is often a goal of supply chain optimization initiatives. But complexity has its upsides as well: having alternative supply sources and distribution routes offers companies a broader set of options in times of uncertainty. This means complexity must be managed—not expunged.

3 Initiatives to drive digitalization and supply chain resilience must include components of people and process change management. This is a critical step for ensuring that data and insight drive real decisions at every stage of the value chain.

production decisions. Increasingly, those data are derived from intelligent sensors, internet of things (IoT) devices, and even blockchain-enabled stock-keeping units (SKUs), that are monitored along every link in the supply chain. Cloud resources and edge computing enable automated manufacturing plants to quickly change production schedules and configurations.

These technologies are becoming of strategic importance, says Ibrahim Gokcen, chief technology officer at Schneider Electric. "With all these things getting more important—managing remote and automated operations to increase the resilience of our supply chains and business models—there is a clear need for us to invest more into AI and machine learning-type initiatives and capabilities. It was a clear strategic area of investment for us even before the crisis. We have lots of initiatives around demand forecasting and optimizing processes to create resilient capabilities which allow us to manage our options, or recover from disruptions."

Can there be good complexity?

Digital tools can help supply chain managers minimize the number of required components, production stages, or partners—effectively simplifying operations. Yet they also enable firms to manage necessary complexity, for example by allowing them to identify and activate alternative suppliers when bottlenecks arise. Supply chain managers' increasing need to navigate around the complexity impairs supply chain visibility, while maintaining an ecosystem that provides sourcing and supply alternatives. Balancing the quest for simplicity with the simultaneous reduction of risk is the key to building and sustaining a resilient supply chain.

Fast fashion retailers, says Saenz, where garment design takes place within a 15-day window, require a highly responsive business model. "They need to monitor what is happening both up and downstream, even into a customer's experience," she says. "This includes taking signals gleaned from sensors, from marketing, from websites or social media, from competitors, or even trends in the subway. All these signals, all this visibility, needs to be put back into their upstream supply chains to increase responsiveness."

Along came covid

Covid-19 continues to hold the world in the grip of a public health emergency that has eroded global economic activity and will reshape its contours for years to come. The International Monetary Fund's October 2020 World Economy Outlook projects that despite some signs of recovery in the third quarter, global GDP will shrink 4.4% this year, wiping $3.9 trillion off the value of the world's economies in a single year[1]. While companies in most industries experienced some kind of knock to productivity, manufacturers and their supply chain ecosystem partners have taken an unprecedented blow. Recent research

published in Nature estimates that the collective impact of sweeping lockdowns to mitigate the spread of covid-19 could reduce the economic value-add of the world's supply chains by between $20 trillion and $30 trillion this year[2].

Except for businesses that were already at the forefront of digitalization, covid-19 has led to a rapid acceleration in technology adoption across business systems and ways of working. In a recent MIT Technology Review survey of business executives, 75% of respondents report having stepped up digital transformation in response to the pandemic. Reliable home broadband, videoconferencing, and workflow or collaboration apps have facilitated the shift to home-working. The bigger and more challenging shifts toward "Industry 4.0" tools—automated production systems, widespread IoT networks, and ubiquitous AI and robotics—are now also a greater priority for producers. These tools have been understood and trialled by manufacturers for some years, although not widely adopted. A 2020 survey by IoT Analytics found that only 30% of producers are using Industry 4.0 and smart manufacturing solutions extensively. A post-covid growth burst is likely—research firm Absolute Reports estimates that smart factory solutions will grow at a compound annual growth rate of 10% to reach a $391 billion market by 2024, as technologies such as robotic process automation become more affordable and accessible.

Covid-19 lockdowns could reduce the economic value-add of the world's supply chains by up to

$30 trillion in 2020.

Measuring supply chain resilience

With digitalization being a key driver of supply chain resilience, companies are seeking approaches to measure and benchmark their digital infrastructure and processes. Kearney's Resilience Stress Test assesses supply chain resilience across eight dimensions that span a company's own processes as well as those of suppliers and partners—measuring the degree of critical digitalization in each. These include using IoT sensors in logistics or fulfilment operations, robotic process automation in production or distribution, and analytics and machine learning in production centers, inventory management, and financial capital management.

In using its stress test to analyze and evaluate the supply chain resilience of dozens of global organizations across several verticals, Kearney found that leading practices in each dimension center on an organization's ability to leverage insight from its tools and management processes and respond with agility, enabled by flexible processes, communication with ecosystem partners, and lean decision-making (see Figure 1).

Best practices are found across the entire range of verticals, although there are some capabilities that occur more organically within some organizations than others. Technology and consumer goods companies, for instance, typically have better capabilities in managing supplier complexity. Technology businesses typically develop products and solutions with large arrays of components or supplier inputs, and consumer goods also manage large portfolios of suppliers. Similarly, companies in sectors with traditionally complex and long production processes, such as pharmaceuticals and chemicals, generally earn higher scores in the manufacturing dimension of the framework.

Automation, remote management, and virtualization

Automated and remotely managed production facilities were essential for Mars Petcare to continue operating smoothly during the coronavirus outbreak. Miao Song, the company's global chief information officer, says "Our manufacturing capabilities with automated systems were separated from office-based work, and all factories were continuously secured. At the beginning of the covid-19 outbreak, our Chinese factories were entirely shut down initially, but a week later we restarted with 10% of our staff, and then 20%, and soon came back to normal factory

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Miao Song, Global Chief information Officer, Mars Petcare

production in China, without waiting until the rest of the world had recovered."

In addition to automation, Song believes that local sourcing across its 100 manufacturing locations globally is another element of its resilience during the pandemic. "All of our ingredients or materials are sourced from the immediate respective local market—even in the case of a crisis, we can still go ahead with our manufacturing."

Many supply chain investments in technology are geared toward increasing production reliability and the visibility of assets and processes to make more precise decisions. Inventory management requires keeping working capital costs low while maintaining readily accessible supplies, meaning "one of our biggest challenges has been the cost-effective management of our warehouse footprints," explains a senior supply chain leader at a European producer of pharmaceuticals and consumer products. "With more technology in our decision-making processes, we achieve better inventory management, smaller warehouses, and less energy consumption." Technology is also helping the manufacturer optimize production

Figure 1: Supply chain Resilience Stress Test score by industry

A higher score in each category correlates to greater supply chain resilience

PHARMACEUTICALS

RETAIL

CHEMICALS

TECHNOLOGY

CONSUMER GOODS

LESS RESILIENT   MORE RESILIENT

SUPPLY CHAIN DIMENSIONS

SUPPLIERS
Reduce dependency on single-sources categories; engage strategic geographic selection

GEOGRAPHY
Broad dispersion of fulfilment centers; access alternative sources on demand

OUTBOUND TRANSPORTATION
Optomized warehouse capacity levels; frictionless transfer between facilities aided by real-time inventory data

MANUFACTURING
Increased use of automated tools in production and component management; ability to dynamically adjust production volume on real-time supply and demand data

INBOUND TRANSPORTATION
Quickly shift alternative routes based on real-time visibility of distribution partners

PRODUCT PLATFORM
Simplicity of product range and components; flexible, highly accessible input management

PLANNING
Strong links between predictive analytics and demand forecasting process; ability to pivot to alternative sources and destinations quickly based on new input

FINANCIAL WORKING CAPITAL
Working capital ratio supports productivity objectives; Cash flow supports speedy access to capital in response to changes in supplier ecosystem
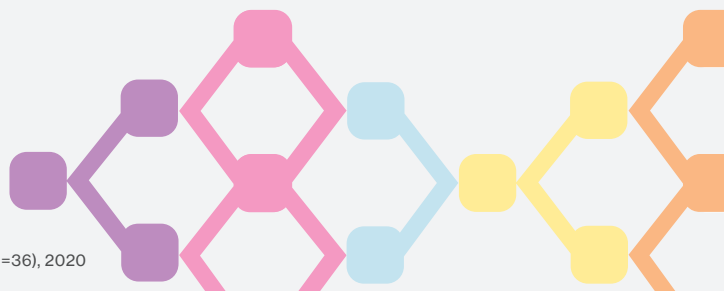
Source: Kearney data compiled by MIT Technology Review Insights, (n=36), 2020

processes by creating digital twins of assembly lines to simulate different configurations, and how to blend processes, speeds, and volumes before translating them into a physical production line. "Our digital twins will allow us to standardize a process, increase its robustness, and translate it into a smooth, fast rollout when we produce—whether in Thailand, the US, or Italy," he says.

Another shift for the manufacturer is to design more standardized containers for consumer products and medicines, so that they can be produced, filled, and shipped to customers ultimately in a seamless factory-to-consumer supply chain. "We are working towards smart solutions which leverage data to increase production proximity to the customer, to ultimately ship directly all with common packaging."

Fast and flexible

A major shift in supply chains has stemmed from same-day or next-day delivery terms that are becoming the norm for e-commerce and third-party logistics players. "E-commerce dynamics are shifting supply chain responses, as smaller minimum order quantities cascade into smaller fulfilment strategies," says the senior vice president and head of global sourcing for a US-based toy manufacturer. "The size of the average purchase order has decreased 70%, while the number of orders has increased by a factor of more than 100; this requires all players to create tremendous scale in transaction volumes."

As online retailers place smaller orders but in larger volumes, producers are abandoning traditional cargo loading tactics (bundling large volumes of similar goods) and finding ways to use more accurate cargo shipment and delivery data to build precise and customized shipments. Online retailers are developing new ways of partnering to reduce inefficiencies and increase the reliability and resilience of their networks. "There are three major new modalities that the industry is exploring to drive competition and efficiencies," he says. "One is to create massive new warehouses, to create efficiency through consolidation. The second is to build many more, smaller warehouses in more disparate locations. The third is where e-tailers and distribution players build fulfilment centers within the warehouses of producers and suppliers." This, he observes, optimizes supplier assets while distributing—and ultimately reducing—inventory risk.

2020 SECOND QUARTER ONLINE SALES

$201bn

The US Commerce Department revealed that online sales surged 44.4% in the second quarter of 2020 over the previous year.

This blended "warehouse-within-a-warehouse" approach represents the most innovative departure from traditional supply chain practices, and requires significant systems investment by all parties, as well as a willingness to open inventory and shipment data to other parties in the chain. Sharing order data allows suppliers to build more precise lot orders, which optimizes inventory by product type, lowers capital investment, and increases inventory efficiency across the value chain.

E-commerce continues to grow as a percentage of overall retail, and the pandemic has only accelerated this. Figures released by the US Commerce Department reveal that online sales surged 44.4% in the second quarter of 2020 over the previous year to nearly $201 billion—or 20% of all retail sales in the country, the highest growth ever recorded. Covid-19 lockdowns have made dynamic, market-responsive inventory management processes the new normal. All players along the supply chain—producers, logistics providers, and both online and traditional retailers—are increasingly using forecasting algorithms to reduce order lead time and provide more precise order information to manufacturers, allowing them to ship highly customized orders at scale with greater speed and efficiency across the entire value

chain. This will require significant changes to physical logistics infrastructure, such as creating more common space to accommodate the weighing and measuring required by specialist logistics players to collapse parts of their supply chain into just-in-time (JIT) delivery loads. Resource-constrained port operators and warehouse operators currently only allocate small amounts of berthing space for JIT processing. Resilient supply chain participants thus have to help solve these physical distribution challenges by creating digital transparency across the entire supply chain.

Aligning digital infrastructure and culture

Many of today's digital supply chain tools and applications gather actual and intermittent data on goods in transit. This plays an important role in increasing supply chain visibility, but there are often gaps between links in the chain, limiting the scope and capability of predictive analytics. Some of the emerging solutions for closing those information gaps include blockchain-secured containers and SKUs, which maintain visibility throughout the supply chain using estimated timestamp data. This facilitates the development of predictive storage planning analytics, and provides for greater accuracy in transportation, warehousing, and fulfilment strategies up and down supply chains.

"Putting advanced analytics or machine learning algorithms in forecasting process gives firms a good way of connecting their performance to outcomes," says Saenz. "These algorithms require input 'anchor points' from many different sources: downstream from the demand side, and upstream from suppliers." However, to gather these performance anchor points, Saenz stresses that it's not only the technology and supply chain processes that need attention. "Companies also need to change their business models—and even the culture to be comfortable with agile decision making."

"Digital transformation is change management," she says. "The way an organization thinks changes when it gains the ability to constantly gather and process tons of new data which can inform every decision. A responsive organizational culture drives their decisions based on data, and uses technology to take advantage of its data."
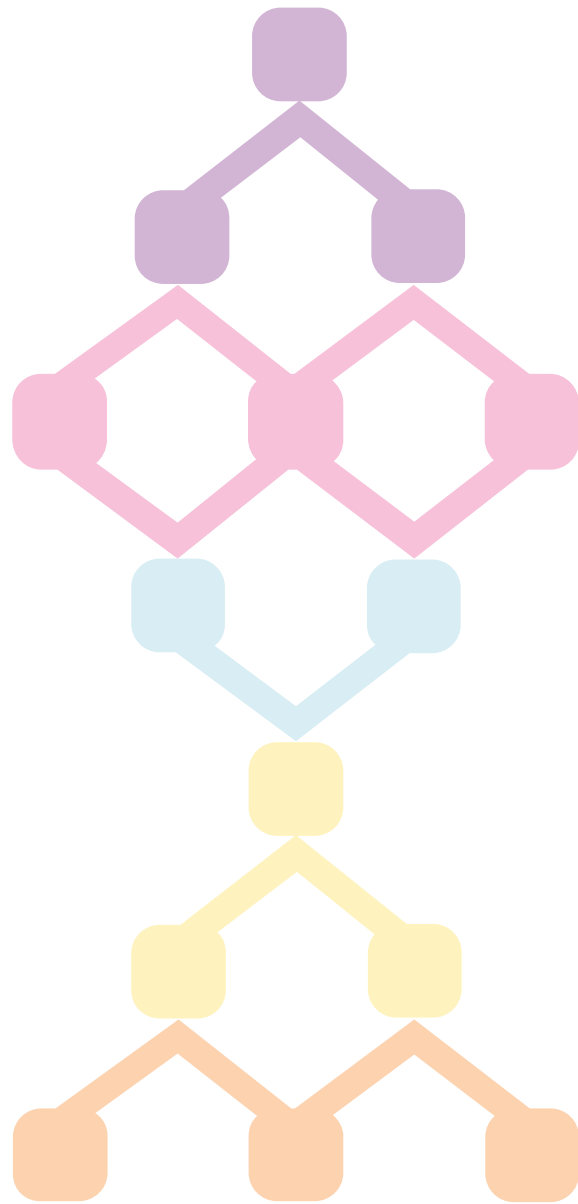
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