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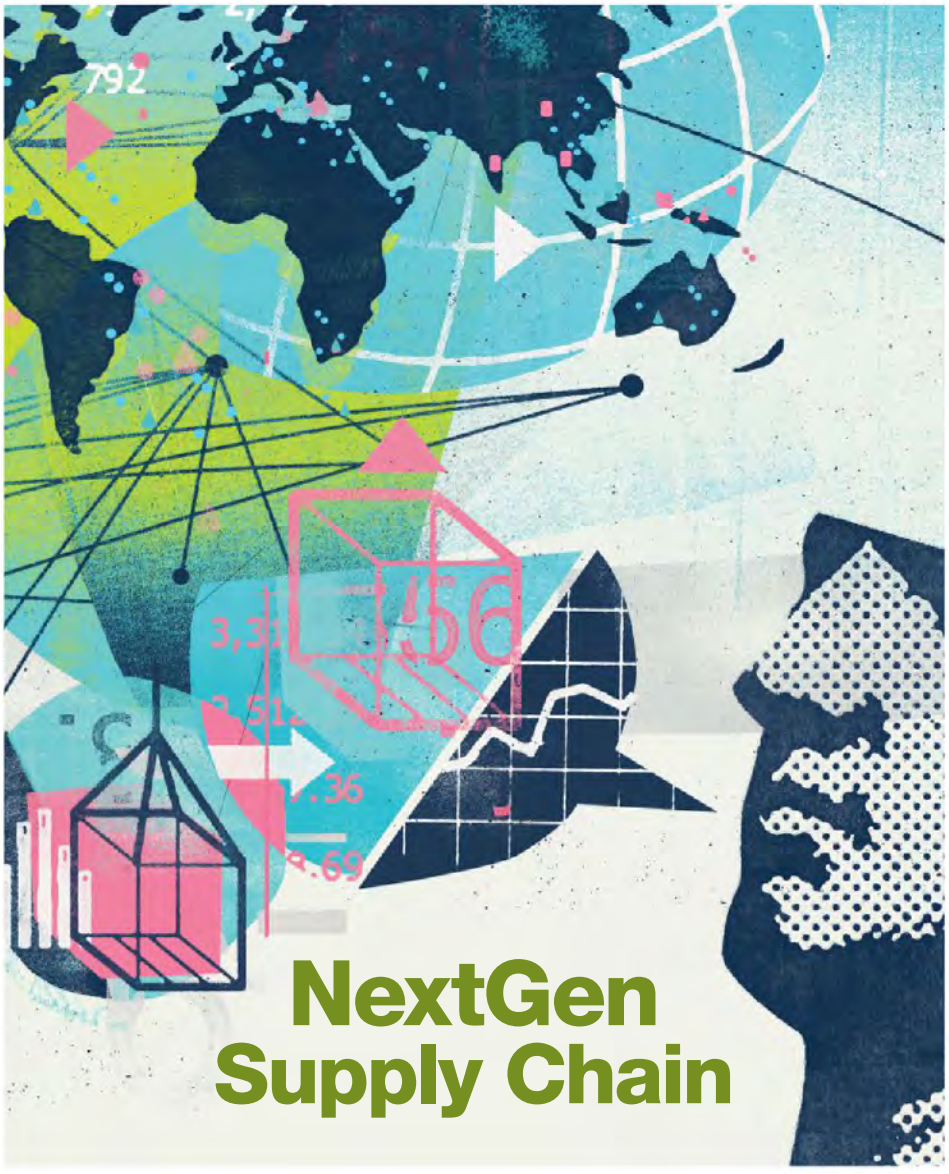

NextGen Supply Chain

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Get ready for the NextGen Supply Chain

If you frequent supply chain conferences, as I do, you've probably noticed that some of the best-attended sessions are the ones that focus on emerging technologies—or what we're calling the NextGen Supply Chain.

You may have noticed something else: While topics like Big Data, artificial intelligence, augmented reality, blockchain and robotics play to standing room audiences, there's a lot of confusion about what to do with the information. At the 2016 APICS conference, one member of the audience asked a direct question at the end of an excellent session on Big Data by Hannah Kain, the CEO of Alom: "This sounds great. But there's not a single individual in our operation who knows anything about this. Where do I start?"

Where do I start? It's a question we've been thinking about a lot. To that end, we launched the NextGen Supply Chain newsletter in August. Once a month, we're posting six brief articles about one of the emerging next generation technologies and sending it out as a newsletter. If you're interested in the topic, I'd urge you to sign up for our newletters. Just click on the "subscribe" drop down menu on the top right-hand side of the scmr.com home page, choose newsletters, and go from there.

The NextGen Supply Chain is also the theme of this month's issue of *Supply Chain Management Review*. We lead off with an article on the way that new connected devices, like Amazon's Dash button and HP's smart ink model, are upending the way supply chains will replenish products in the future. Sean Monhan's "Operations Advantage" column furthers the conversation on artificial intelligence.

Bob Trebilcock, Editorial Director
btrebilcock@peerlessmedia.com

MIT's Ken Cottrill performs double duty, with both an "Innovation Strategies" column and a feature on the possibilities and limitations of blockchain. You'll also find new research into blockchain in this month's "Benchmarks" column from APQC.

Finally, John Santagate, the research director for service robotics at IDC, gives us an update on how a new generation of flexible, mobile robots is moving from the factory floor to the distribution center as well as other areas of the enterprise. While the broad adoption of smart replenishment and blockchain may be years away, Santagate believes that robots are ready for prime time now.

I hope you find this look at the NextGen Supply Chain both informative and useful as you think about where your supply chain is going next. As always, I look forward to hearing from you.

Bob Trebilcock

SUPPLY CHAIN MANAGEMENT REVIEW

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Oil Update: Back to the future, again

A look forward—and a look backward—on oil consumption and pricing.

Dr. Lapide is a Lecturer at the University of Massachusetts and an MIT Research Affiliate. He has extensive experience in industry, consulting, business research, and academia as well as a broad range of forecasting, planning, and supply chain experiences. He was an industry forecaster for many years, led supply chain consulting projects for clients across a variety of industries, and has researched supply chain and forecasting software as an analyst. He is the recipient of the inaugural Lifetime Achievement in Business Forecasting & Planning Award from the IBF. He welcomes comments on his columns at llapide@mit.edu.

This represents an annual update on oil pricing that began 11 years ago with my first two Insight columns *. I began researching this issue in 2004 when I launched MIT's Supply Chain 2020 Project. Since then I have been espousing a reduction of oil consumption in global supply chains—by slowing them down and developing cost- and energy-efficient networks, in contrast to cost- and asset-efficient ones.

The position was based on two assumptions. While oil would be available into the foreseeable future: 1) its price would rise in the long-run as demand for it rose with global economic growth; and 2) oil extraction costs would continue to rise over time because it was getting harder to extract it from the earth. I did not focus on the popular "peak oil" proposition that focuses on oil production, because it would not be as robust as considering demand-supply imbalances.

It's time to do a post-mortem on those assumptions because oil prices appear to have flattened to an "era of cheaper oil," in which oil pricing is about double (in real terms) what it was during the "cheap oil era." That era started three decades ago and coincided with the reconfiguration of globalized supply chains. It appears that while my assumptions held for several years, the recent past has created a different picture of both the demand for and the supply of oil.

Oil price update

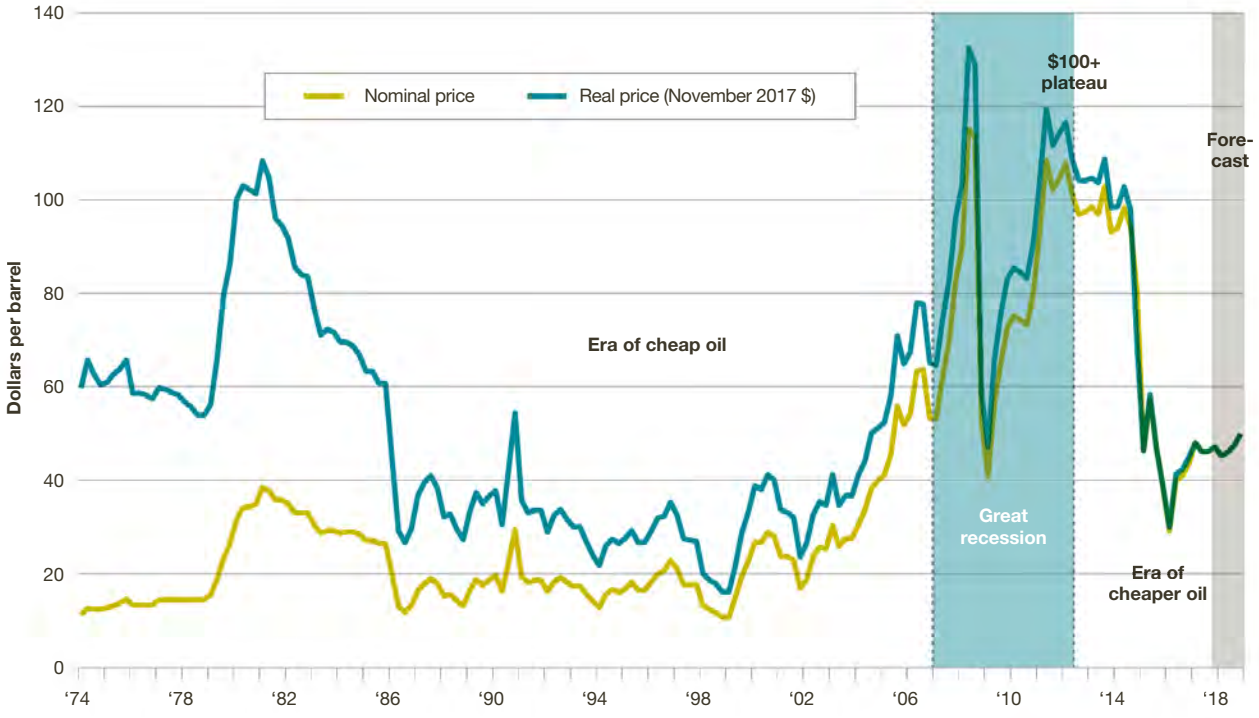
Figure 1 shows that there was a "cheap oil era" from the mid-1980s until early 2004, in which real (deflated) prices bounced around from $20 a barrel to $30 a barrel. Beginning in 2004 prices started to rise. At that time, the Supply Chain 2020 project team decided that oil price growth needed to be a macro-factor that we would keep our eyes on. Supply chain operations consume lots of oil and other carbon-based energy sources, and the heydays of supply chain management coincided with the "cheap oil era" (thus affecting business practices).

The price rise continued for about four years until it peaked to over $132/ barrel in mid-2008, at which point it dropped precipitously for the next three quarters to a low of around $40/barrel. For the next five years it rose sharply and appeared to stabilize on a "$100+ plateau" for about three and a half years; after which it dropped again to recent prices that hover around $50/barrel in today's "era of cheaper oil."

Summarizing, there were wild up-and-down swings in oil prices and now pricing appears to have stabilized to another low plateau. Will they stay here or will they rise once again? What caused the swings? In short, the answers are: The demand and supply assumptions no longer hold.

FIGURE 1

Quarterly imported crude oil prices



Source: EIA Short-Term Energy Outlook, November 2017
http://www.eia.gov/forecasts/steo/realprices/

The global economy tanked

The first precipitous drop in oil pricing appears to be the result of the Great Recession that depressed economies and the demand for oil around the world. According to Wikipedia: "The Great Recession (2007–2012) was a period of general economic decline observed in world markets…" It coincides with the period of drastic swings in oil prices. (Oil consumption tends to correlate with a country's GDP.)

When the recession ended, oil prices had reached their "$100+ plateau" that lasted for about two years, at which point oil prices dropped precipitously to the "era of cheaper oil" level. Why did this happen? Simply put, the energy supply picture had drastically changed.

When the recession ended, oil prices had reached their "$100+ plateau" that lasted for about two years, at which point oil prices dropped precipitously to the "era of cheaper oil" level. Why did this happen? Simply put, the energy supply picture had drastically changed.

The new supply picture

In considering the supply of oil, one has to consider the overall energy market of renewable vis-a-vis non-renewable energy sources. Oil is supply chain's most important energy source because transportation operations run on liquid fuel. Alternative renewable energy sources that are changing the overall energy picture (especially in electricity generation) are not suitable for transportation. At least not until electric vehicles start replacing today's fleets.

After huge reserves of natural gas were found in the Gulf of Mexico, former President Obama called America the "Saudi Arabia of natural gas." He said, "The country should start using natural gas to power more cars and trucks." Natural gas is becoming the energy source de jour for electricity generation, replacing coal-fired electric generators.

However, liquid natural gas (LNG) will not change the energy picture much for transportation until LNG-fueled vehicles replace fleets, as well as until a network of fueling stations is in place.

Over the period of increasing oil prices, U.S. oil fracking operations came on-line with abandon because prices were high enough to economically justify them. U.S. frackers used the opportunity to innovate their techniques to reach a point where fracking operations are now flexible enough to easily turn on and off as oil prices vacillate. The fracking industry has made the United States a top oil supplier, and is responsible for creating the oversupply of oil stocks that drove prices down to the "era of cheaper oil." This has drastically affected oil suppliers.

The biggest immediate uncertainty is how long the "era of cheaper oil" will last. This is predicated on how and when there will be significant shifts in either the demand or supply of oil.

Since the Arab oil embargo in the early 1970s, the developed countries had been held hostage by oil producing countries—including some that are run by corrupt leaders to whom other world leaders have had to cater. Fracking has essentially broken the back of these suppliers' hold on oil pricing. At the same time, many suppliers have brought their costs more in line with the "era of cheaper oil." According to the Wall Street Journal: "BP says its breakeven is now $47/barrel" and that "it is girding for oil prices of $45 to $55 a barrel for the next five years." Like BP, oil suppliers are aiming to become more efficient to compete in this era.

In addition, this is leading suppliers to shift their strategic focus from selling oil for making fuel to making petrochemical products (such as plastics, chemicals and other oil-based materials.). Therefore, suppliers are acting as if today's oil price era will last for some time, now seeing "peak oil" coming.

What about the future?

In my class on quantitative decision-making, I teach that bad outcomes do not necessarily mean managers had made bad decisions. Because uncertainty abounds in the future, it just means that all decisions have a chance to lead to bad outcomes. So, in retrospect, I do not regret advising managers—11 years ago—to squeeze oil out of their supply chains. Oil pricing did rise, and is currently double what it was during the "era of cheap oil." In addition, oil prices have become more volatile, and reached the $100+ level for several years.

Rising oil prices forced industries—including the oil industry—to make their supply chains more energy and operationally efficient. They developed practices such as ocean freight slow steaming and reducing the use of oil-based packaging.

I believe that the only future certainties are: the "era of cheap oil" will never return and that oil price volatility is here to stay. The biggest immediate uncertainty is how long the "era of cheaper oil" will last. This is predicated on how and when there will be significant shifts in either the demand or supply of oil. Some issues to consider include: will global economies get healthier; will the glut of oil turn into shortages; will geopolitics change; and are fracking techniques increasing the chances of earthquakes.

My advice remains that it will always be prudent to reduce the use of non-renewable, carbon-based energy sources by making your supply chains as energy-efficient as possible. (For those that worry about CO2 emissions it will also help the earth.) Eleven years ago, with oil prices rising, it was easy to convince your company to save energy because it also saved costs. Without energy prices rising, energy efficiency may not save dollars and therefore might be harder to sell to your executive teams.

* "Is Your Supply Chain Addicted to Oil?" *Supply Chain Management Review*, January/February 2007.

"The Link Between Oil and Supply Chain Design," *Supply Chain Management Review,* March 2007.

Can we trust the "trust machine?"

By Ken Cottrill

In 2015, *The Economist* magazine famously dubbed blockchain technology "the trust machine" owing to its ability to create trust in business networks. This capability resonates strongly in the supply chain world, where a lack of trust is a major obstacle to high-level collaboration. The promise of blockchain may be fulfilled in time, but at present its progress is impeded by—ironically—a lack of trust in the technology.

By Ken Cottrill is the global communications consultant for the MIT Center for Transportation & Logistics. He can be reached at kencott@mit.edu.

To some extent the problem has its roots in the industry's healthy skepticism of much-hyped innovations. But there are other trust issues related to the way that supply chains operate. The challenge for blockchain developers and proponents is how to reconcile the technology with these misgivings.

This was a central theme at the recent "Blockchain in Supply Chain: Looking Beyond the Hype" roundtable hosted by the MIT Center for Transportation & Logistics. At the event, some 30 organizations talked frankly about the potential benefits of blockchain in the supply chain domain.

Delivering on the promise

Blockchain is a secure, distributed ledger of transactions that can update all authorized users in real time. All records are timestamped and unchangeable. It has the potential to be a powerful technology from a supply chain perspective because it offers the possibility of a single source of truth that facilitates the kind of collaboration that the industry has long struggled to achieve.

That's the promise. And a slew of test projects in 2017—with many more slated for 2018 as well as some possible deployments—suggest the promise is attainable. But supply chain is far from a greenfield application. To deliver, blockchain must adapt to ingrained supply chain practices.

Smart contract conundrum

An example discussed at the roundtable is classic "tragedy of the commons" situations, where the inclinations of trading partners mitigate against the proper execution of service agreements.

Cargo overbooking and no-show problems in the ocean transportation sector involve this type of behavior. Container shipping companies hedge the risk of sailing with empty slots by overbooking their vessels and bumping booked cargo when they don't have enough space to carry it. Shippers reserve slots on ships but fail to deliver the cargo for the slots (i.e. a no-show), leaving the carrier with empty cargo spaces that drain revenue.

Using smart contracts housed on blockchains could potentially eliminate these long-standing practices. Essentially, a smart contract encodes the terms of an agreement, and the terms are triggered automatically when the required conditions are met. The process has been likened to a vending machine, which receives

an input (a coin), verifies that the input is genuine and responds by triggering the delivery of an item and change if necessary. Such a mechanism could act as a deterrent to overbooking/no-shows by establishing consequences for agreement failures in advance, and then automatically executing those penalties on the carriers and shippers that ignore agreement terms.

In practice, however, a smart contract might create some awkward situations by automating decisions that remove the potential to consider commercial implications. Imagine a large-volume shipper that knows it will not be able to fill the cargo space it has booked on a container vessel. If it's very near to the time when the shipper and carrier are due to renegotiate their service agreement, will the carrier willingly allow a smart contract to exact punishment on the shipper, knowing that this major customer might take its business elsewhere?

Supply chains are replete with these situations. A change in its service network—volumes have dropped in a lane making it unprofitable, for instance—persuades a trucking company to reject loads in that lane from a shipper, even though it has contracted to move the cargo. The shipper is planning for a peak season; will it risk losing the carrier's capacity in a tight market by calling out the shipper for not accepting its loads? Wiggle room can be built into smart contracts, but allowing such discretion undermines the advantages of automating the contract process. Also, a pattern of non-enforcement recorded on the blockchain—which is supposed to be immutable—could weaken a company's legal case should it go to court over accusations that it contravened the contract terms.

Recall limitations

Improved traceability is often touted as a main benefit of blockchains; the technology excels at recording the status of product based on inputs from supply chains, and disseminating detailed information to authorized parties.

This capability is especially valuable in a recall situation. If a recall is to be successful, it's of paramount importance that the faulty product is located, withdrawn and replaced as speedily as possible. But current tracking technology may not be up to the task, particularly when large, complex distribution networks are involved.

Several retailers at the MIT CTL blockchain roundtable agreed that a blockchain-based tracking system could be extremely valuable—with some important riders. Consider, for example, a recall operation that involves food infected with salmonella. Even if the blockchain solution rapidly pinpoints the whereabouts of infected product in supermarket outlets, the retailers concerned might have protocols that require each store to clear entire shelves and not just the affected lot numbers. Perhaps the companies fear legal action should they miss an infected item, or don't trust store personnel to remove all tainted product.

Worries over losing customer trust can also cause retailers to overreact, even if they have detailed information courtesy of a blockchain on the whereabouts and status of faulty products.

Worries over losing customer trust can also cause retailers to overreact, even if they have detailed information courtesy of a blockchain on the whereabouts and status of faulty products. For instance, it was pointed out at the roundtable that even though the food scares that have hit the Chipotle restaurant chain in recent years only affected a limited number of outlets, the brand suffered a broad loss in market share.

Data doubts

A general lack of trust could blunt the potential of linking IoT technology to blockchains. This appears to be a formidable combination, in that IoT sensor networks could feed blockchains with huge volumes of product data.

As roundtable participants pointed out, however, that's assuming the sensor networks are unfailingly accurate. As an example, consider a sensor in a reefer container that activates a high-temperature alert. The sensing system indicates that the perishable cargo could be spoiled. A smart contract receives and verifies the data, and triggers a payment for damages as it has been programed to do. Later, the parties discover that the sensor was defective. Or perhaps they find out that the device was tampered with. Either way, catching and fixing the error can be more complicated when the transaction is committed to a blockchain.

Participants also agreed that more thought needs to be given to the value of data generated by such solutions. How might trading partners and technology providers use the data streaming through blockchain systems; who owns the data and how will the value of the data be shared?

Complexity issue

Roundtable attendees fretted about the sheer complexity of today's supply chains and the task of building blockchains able to cope. Examples include the consolidation of inbound raw materials in large storage facilities, and multiple transfers of co-mingled materials by third parties such as brokers. A manufacturer of consumer goods noted that it supplies product to supermarkets, but has no control over shipping arrangements that are handled by its retail customers. Yet the manufacturer must have visibility into shipping processes, so it can synchronize its production schedules with supermarkets' distribution requirements. A blockchain solution would have to provide these various levels of access to supply chain data.

Taking the plunge

A common problem when deciding if/when to invest in an early stage innovation is getting the timing right, and blockchain is no exception.

Roundtable attendees expressed trepidation over the possibility of moving ahead with blockchain solutions, then having to write-off their investments because the technology did not prove its worth. What legal problems could they face if service agreements were committed to smart contracts that were invalidated? To some extent, an organization's willingness to take a leap of faith is a function of its tolerance for risk. Blockchain as a concept is so new and unfamiliar, that even companies that have a high tolerance might be circumspect about venturing too far into blockchain territory. Several attendees recommended an incremental approach to adopting the technology.

Procurement is getting its digitized act together

While supply chain managers have been slow to integrate digitization in the procurement function, the trend may finally be gaining traction, says a new report.

"The Future of Digital Procurement," a new report released by Accenture, maintains that many supply chain managers are seeking to modernize this function, but may not have the tools to get started.

"The digital revolution has largely overlooked procurement," the consulting firm declares. In its report, analysts examine how artificial intelligence (AI) and analytics add to the equation, thereby expediting digital procurement to produce better informed buying decisions, open new channels for engaging suppliers and drive new efficiencies through smart automation.

Art Nourot, vice president of Carrier Procurement, at UNYSON, notes that as the industry becomes increasingly digitized, new demands are being made on the suppliers and service providers, such as 3PLs in North America, that interact with the procurement function. "More transparency leads to greater efficiencies," he says. "But at the same time, we must all be building better firewalls and find ways to keep our data secure."

Patrick Burnson is the executive editor at *Supply Chain Management Review.* He welcomes comments on his columns at pburnson@peerlessmedia.com

Stepping up

In today's economy, many companies are racing to embrace digital to transform key areas of their businesses. These include "customer-facing" functions such as marketing, sales and service. To date, procurement hasn't commanded the same kind of attention or investment, according to Accenture. "True, companies have enthusiastically embraced eProcurement systems and even cloud-based procurement tools," writes Managing Director Kristin Ruehle. "But it's time to move beyond simply replicating the same tedious procurement processes with new software. Leading companies are taking the next step to create a true digital procurement organization."

According to Ruehle, a true digital procurement organization automates repeatable tasks to boost efficiency and potentially drive down costs. It equips stakeholders across the business with real-time access to easy-to-use online tools. It deploys new and smarter ways to infuse data models to enrich daily operations and decision-making. And it transforms how buyers interact with suppliers and other third parties by serving as a platform for new levels and types of collaboration.

New upstart

Accenture is not alone in identifying the need for new levels and types of collaboration. Adrian Gonzalez, president of Adelante SCM, argues that today's businesses expect the same experience that consumers get from their online vendors with full visibility in real time, regardless of mode. "The need to convert data into actionable insights is more important than ever," Gonzalez says. "Industry business networks, which enable trading partners to connect, communicate, and collaborate in more scalable and efficient ways, are responding by innovating their platforms with machine learning, artificial intelligence and predictive analytics capabilities."

Gonzalez and other analysts have recently identified Elemica as a new upstart in this arena, having recently introduced real-time predictive visibility from customer order to supplier delivery and the complete order-to-cash and procure-to-pay process.

In essence, digital procurement enables the "Amazon-like" experience employees now want—but currently aren't getting—in the workplace. "This is easier said than done," observes Rich Katz, chief technology officer of Elemica. Katz notes that Amazon has a relatively closed system—it controls the majority of the process from search to delivery—and where it doesn't have direct control it can dictate how partners will interact with their customers. Procurement organizations are in a very different spot—they deal with thousands of suppliers and carriers operating in their own unique ways.

"Digitization provides a path to get there," he says. "By fronting the supplier ecosystem with a common user interface (UI and) backing that up with real time information exchange with suppliers and logistics providers, procurement can create a sort of 'virtual' Amazon for their users."

In other words, while supply chain visibility is not new, the ability to gain deep visibility with embedded predictive analytics is. "Gleaning historical data from disparate enterprise systems including the customer, supplier and logistics providers is what businesses have been needing for a long time," Katz says.

Elemica, a leading business network for process industries, recently introduced an extended end-to-end supply chain visibility service called "Elemica Pulse" for the procure-to-pay function. Accenture maintains that this trend, too, is gaining traction.

Stakeholders expect the ease and elegance from the "procurement" tasks they do at home as consumers on Sunday to apply to the work they do for the company on Monday. But current procurement policies and tools are geared toward driving a process—with a lot of rigor and controls—versus an experience or outcome.

So it's not a surprise that stakeholders find the procurement process too cumbersome, slow and rigid. In their minds, procurement is an obstacle to be avoided rather than a useful tool.

Conversely, digital procurement is defined not by a rigorous process but by deep and rich data. It assumes business controls are built into AI models so users can do what they want to do without having to go through many painful steps.

Embracing the process

By streamlining and simplifying how people make and execute buying decisions, digital procurement encourages stakeholders to "embrace the process" instead of circumventing it in favor of the experience they prefer. In other words, users aren't necessarily fully aware of procurement's influence and guidance, and they don't feel like they're "going through a process." They simply see valuable information presented that they can act on. Compliance and controls are inherent and embedded in the model instead of being visible obstacles to be overcome.

"It's critical to increasing the procurement organization's influence over the half of the company's spend it doesn't control—and, by extension, increasing the effectiveness of how that spend is managed," says Accenture's Ruehle.

"Gleaning historical data from disparate enterprise systems including the customer, supplier and logistics providers is what businesses have been needing for a long time."

—Rich Katz, chief technology officer, Elemica

She concludes that "digital is the foundation of procurement 3.0," whereby digital procurement isn't just the next phase in IT's evolution, but rather the genuine step-change—a dramatic departure from both procurement's use of technology and its operating model of the past few decades.

Today, the vast majority of companies have what Accenture calls "a Procurement 1.0 organization." This is characterized by a focus on using technology to automate processes and record what has happened: a transaction executed, an invoice paid, an item purchased, a contract signed. And, unfortunately, it's also marked by systems of record that generally have made the procurement process overly complex.

The encouraging news, add analysts, is that some leading procurement organizations are making strides toward 2.0, in which they're using technologies to dig deeper to get much more contextual information about what happened and why.

Such information is critical: It's foundational to building AI-enabled predictive models that help improve future decision making, and are at the heart of a Procurement 2.0 organization. The next advance will represent a true digitized "revolution."

Get Smart (about replenishment)

Smart replenishment systems that continuously track inventories at the point-of-consumption (POC) are powerful technologies that can radically change supply chains.

BY KAI HOBERG AND CHRISTINE HERDMANN

Sensors, computing power and connectivity are becoming cheaper, smaller and more powerful every day. Many companies leverage these advanced technologies to remotely access machine data to schedule maintenance operations, optimize the daily performance of assets and help customers who experience problems with their products. With Internet-of-Things (IoT) technology, transparency and visibility across the entire supply chain is now possible. This also enables manufacturers to change their interactions with consumers—and their business models—when it comes to re-ordering products.

Currently, most manufacturers sell consumables (such as toothpaste, laundry detergent or ink cartridges) to the end consumer using traditional retailers. However, with the retail channel as an intermediary, manufacturers have little knowledge of consumers' actual demand and consumption patterns. Retailers

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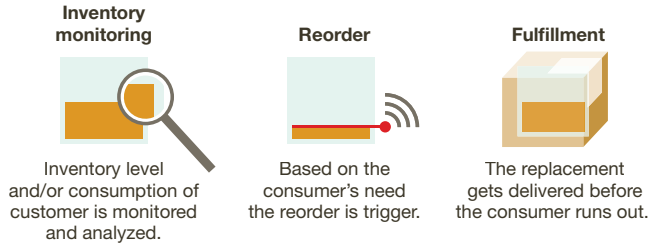
often charge for the point-of-sale data that provides some insights into consumer behavior. In addition, retailers ask for a large share of the product margin, run costly promotions to lure customers into the store and tempt customers to purchase a competitor's product if they run out of stock. Some manufacturers have developed subscriptions models whereby customers receive products in regular time intervals to lock in the customer relationship and thereby bypass retailers. This approach works fine if consumers have stable usage patterns. However, because consumption often fluctuates widely, time-based replenishment and actual consumption may not match, resulting in stock-outs and high overstocks, which require manual intervention.

FIGURE 1

Smart replenishment



Source: Kai Hoberg and Christine Herdmann

With the advancement of IoT technology, companies now have the opportunity to develop new business models by directly interacting with their customers through smart replenishment systems. Amazon's Dash button is probably the best-known "smart" replenishment system. A consumer triggers replenishment by pressing a button for a product that is linked to a corresponding button on Amazon's Website. However, Dash buttons have a number of drawbacks. First, customers need not just one or two of those buttons, but require a separate Dash button for each product they reorder. To appreciate the resulting inconvenience, imagine a refrigerator decorated with dozens of buttons for detergent, coffee capsules or dishwasher tabs instead of your children's artwork. In addition, the Dash buttons are not really smart because the consumer must manually push the button to place an order. This may occur on time, too early, or, as is often the case, too late. Because consumers aren't logisticians, they don't think in terms of lead times and inventory management and risk running out of products when they really need them.

More and more companies are starting to integrate smart replenishment solutions into their products to obtain real-time point-of-consumption (POC) data. For example, Hewlett-Packard created the "smart ink" model that follows the servitization trend (see "Servitization Definition"), or selling product use rather than the product itself. Instead of selling ink cartridges to its customers, HP now offers consumers a printing plan. Consumers need only to sign up to a monthly page volume while HP supplies ink management. HP sends new cartridges as required and ensures that the customer does not run out of ink. Customers no longer need to pay attention to their ink level or worry about when to buy cartridges. Many other manufacturers of consumables are now working on similar approaches. In the remainder of this article, we'll outline how smart replenishment systems work, discuss the benefits of these systems for manufacturers and illustrate how they can be implemented.

Three elements of smart replenishment systems

Smart replenishment is generally a vague term for many different technologies. B2B solutions have been in place for some time now, but the technology is spreading widely and moving towards private households. The spectrum of possible smart replenishment solutions is vast, but the main idea is similar: taking over the re-ordering decision from the consumer. The methods of collecting information about inventory levels and consumption may vary, as well as the degree of autonomy and freedom of the system. Any smart replenishment system generally consists of three unique elements: inventory monitoring, re-ordering and fulfillment (see Figure 1).

Inventory Monitoring. The system needs to collect data on inventory levels and/or consumption patterns and process them. This can be directly integrated into the hardware. For example, premium white goods manufacturer Miele has the TwinDos washing machine that uses detergent cartridges. The machine directly measures the level of laundry detergent in

the cartridge. Similarly, the Budweiser Bud E-Fridge tracks the number of cans and bottles stored in a refrigerator. An alternative approach is to track usage or consumption rather than the inventory level directly. By tracking how often a coffee capsule machine is used, say using a sound sensor or electricity meter, it is possible to track the number of capsules consumed. Inventory levels can then be easily calculated based on replenishments and consumption. An advantage of this approach is that even an old coffee machine can be retrofitted with a replenishment system, while the tracking device can come from a different brand. Another example for consumption tracking is the German online grocery retailer AllyouneedFresh, a subsidiary of DHL, that introduced a smart trash can with an integrated barcode scanner. By scanning the discarded package, the system is able to deduct the package from the customer's inventory and calculate how much product remains.

TABLE 1

Benefits of smart replenishment systems

	SC 4.0 technology	Description
1	**Additional service offering**	Products offer innovative, convenient solution for customers that avoids effort in replenishing consumables
2	**Disintermediation**	Manufacturer serves the customer directly and cuts out the retailer and wholesaler as middlemen
3	**Customer insights**	Collection of usage patterns from individual customers directly at the point of consumption for new level market intelligence
4	**Planning improvement**	Transparency on usage patterns and stock levels improves planning and inventory management across the supply chain
5	**Drive consumers' consumption**	Increased service levels, lower stock outs and customer discipline drives the overall consumption
6	**Customer lock-in**	Smart replenishment system enforces customers to replenishment from provider without the need of promotions

Source: Kai Hoberg and Christine Herdmann

Re-ordering. Based on observed inventory and consumption rates, a reorder point (and re-order quantities if the package size is not fixed) can be calculated. These reorder points need not be fixed over time but may be flexible and adjusted as consumption changes. The required analysis can take place within the machine at the consumer site, or the necessary data can be shared and processed at an external server. This is an important technical difference, as the provider can leverage additional intelligence and data such as weather, holidays or own inventory levels when defining the re-order points. When the inventory level reaches the re-order point, a re-order is triggered. The autonomy and order power of smart replenishment systems vary. For example, since HP is not selling ink cartridges but rather printed pages, it can replenish the cartridge without the consumer's active consent. The replenishment does not trigger additional cost for the consumer because he pays based on his printing plan. In contrast, users of Miele's TwinDos washing machine pay for each detergent cartridge. Thus, the replenishment system only suggests that the consumer re-order a cartridge, and the consumer needs to confirm and ultimately trigger the order.

Fulfillment. Based on the triggered re-order, the consumer should receive a shipment of consumable before she runs out of stock and a new consumption cycle begins. Companies must make numerous decisions on their fulfillment strategy with respect to physical, information and financial flows. In particular, a manufacturer may choose to adopt a direct-to-consumer model. In contrast, a manufacturer can decide to pass the customer's order information to a retailer (potentially for a fee) that subsequently fulfills the order. Thus, the retailer is able to bundle multiple products from different brands. A wide choice of alternatives, such as collaborations with brick-and-mortar retailers or the introduction of mediators as well as hybrid forms, can be considered. The different options for aligning the three flows result in numerous, very complex strategies, which we will discuss in more detail later.

Benefits for the provider

As outlined above, more and more companies are considering smart replenishment systems since they benefit from such systems in multiple ways. Table 1 provides an overview of the smart replenishment benefits, which we outline next in more detail.

Additional service offering. Improved customer

experience has been at the heart of many emerging business models. Smart replenishment systems can help boost customer convenience by providing a complete service experience instead of merely a product. Relieving the consumer of the tiring task of replenishing consumables (and spare parts) has already become successful in a B2B environment. For example, Kaeser Compressors has introduced a model for compressed air by the cubic meter, and Winterhalter provides industrial dishwashers with a pay-per-wash pricing. Both companies use IoT technology to ensure uninterrupted service. With the widespread, cheap availability of the technology, consumers at home can likewise benefit from not having to worry about inventories and reorders. While the added convenience is likely to provide a competitive advantage against competitors, B2C consumers (in contrast to B2B customers) are unlikely to pay more for it. Accordingly, providers need to find other ways to leverage IoT technology for financial advantage.

If a manufacturer uses a smart replenishment system to directly serve the customer, it in fact cuts out the retailer (and potentially wholesaler) as a middleman.

Disintermediation. If a manufacturer uses a smart replenishment system to directly serve the customer, it in fact cuts out the retailer (and potentially the wholesaler) as a middleman. In economics, this removal of an intermediary in the supply chain is called "disintermediation." Disintermediation is the result of direct customer access and may allow the manufacturer to capture the profit margin previously earned by the retailer. However, even though the manufacturer obtains an additional profit margin, it also incurs higher fulfillment costs due to handling and shipping single products rather than full pallets. Thus, the direct-to-consumer model does not automatically result in higher profits; rather, profits depend on the margin captured versus the incremental costs.

Customer insights. Collecting individual usage patterns directly at the point of consumption is a treasure trove for any market researcher. Instead of surveying customers or using data from a small test sample, the widespread use of smart replenishment systems enables companies to understand how all customers use their devices. Thus, companies can draw a much more complete picture of the impact of peak times, holidays or weather on consumer behavior. Based on this huge pool of data, an analysis of individual behavior is possible, and customized offerings can be made available if customers agree to have their data used for this purpose.

Planning improvement. The transparency of usage patterns and stock levels can help to improve planning and inventory management across the supply chain. With non-distorted POC-information, manufacturers have more precise information on the customer's replenishment needs and can better plan raw material orders, production runs and transport needs. This is particularly interesting if the manufacturer can shape customer demand. If a customer pays for each individual order and has to agree to a replenishment, it may be difficult to push out goods to the consumer. However, if the manufacturer offers a servitization model, he can smooth shipments to the consumer as required.

Drive consumers' consumption. Based on increased service levels and lower stock-outs, smart replenishment systems can drive the overall consumption by consumers. Clearly, a customer who runs out of stock cannot consume the product and this directly results in lost demand. Further, a customer might reduce his consumption if he realizes that he is running low on inventory and will not be able to replenish immediately. Finally, a smart replenishment system can enforce customer discipline. For example, a consumer might need to replace the head of his electric toothbrush but forgets to buy a new one in the store. He thus still uses his old toothbrush and thereby compromises his brushing. Again, this results in lost sales for the manufacturer. A smart replenishment business model can ensure that the toothbrush is replaced on time, thereby increasing consumption.

Customer lock-in. Many customers buy consumables during promotions when brand loyalty is low, in

particular for fast moving consumer goods such as toilet paper, dishwasher tabs and coffee pods. Accordingly, a competitor's promotions drive away consumers and reduce sales. With a smart replenishment system, customers do not have that choice—they are locked into the replenishment plan of the provider and cannot easily opt out. However, providers need to be very careful in pricing smart replenishment systems. Amazon has received some bad press after increasing the price for Dash button products, as customers were not aware of the change in price.

Challenges for smart replenishment

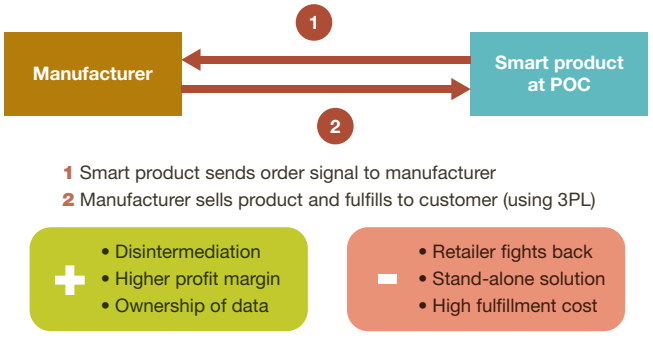
Smart replenishment systems may offer many advantages for customers and providers. However, they have to overcome a number of implementation challenges, in particular with respect to fulfillment efficiency, retailer interaction and consumer acceptance.

While information on orders or inventories can be easily exchanged over the internet, the flow of products remains completely physical. Therefore, managing the shipment of low-value consumer goods requires new, intelligent solutions. Currently, consumer goods are primarily shipped in bulk to supermarkets, thus minimizing logistics costs. Shipping each and every product individually to the consumer will result in enormous handling, packaging and delivery costs. In particular, fulfillment costs might easily exceed profit margins for low margin products. In addition, environmentally concerned consumers will carefully consider carbon emissions and waste of packaging material for single-item shipments. A further complication is the number of packages a customer has to handle if each manufacturer independently ships single packages of coffee, detergent and water filters. Being flooded with packages seems to contradict the goal of relieving the consumer. Accordingly, the likelihood of consumers' long-term adoption of dozens of stand-alone solutions is rather small.

Another potential challenge is the reaction of the middleman who is eliminated by a smart replenishment system. If a manufacturer is able to introduce such a system for all its products and can smartly bundle shipments, it can potentially capture a relevant share of retailers' revenues. While the manufacturer can thereby attract new consumers, it may also very likely divert consumers who traditionally shop in retail stores. Accordingly, adding the direct-to-consumer model (see Figure 2) will affect the traditional manufacturer-retailer business model. While the manufacturer obtains ownership of the POC data, retailers might fight back due to lower sales volume by offering worse contract terms and reallocating shelf space, thereby diverting customers to competitor's products or even delisting products. Given the distribution of market power, the retailer might need an incentive to still sell the principal product, such as a printer, if consumers buy the ink cartridges, or other consumables, via a smart replenishment system. As a consequence, HP offers retailers a commission for each consumer who signs up for a smart ink system bought in stores.

FIGURE 2

Direct-to-consumer (DtC) operating model



Source: Kai Hoberg and Christine Herdmann

Finally, smart replenishment systems may raise privacy concerns as a wealth of data is gathered over time. On the one hand, consumers might be worried that the data collected would reveal information about their habits and even their whereabouts. A hacker breaking into the data might be able to tell that a person is on vacation or is absent on a certain time. On the other hand, it is unclear what is going to happen to a product that is returned or disposed. After a few years, the consumer is exchanging the product using a smart replenishment system that has collected voluminous data on its former owner. Both challenges need to be carefully considered, particularly in countries where consumers are very concerned about their privacy.

FIGURE 3

Retailer-enabled operating model

1 Smart product sends order signal to manufacturer
2 Manufacturer processes and forwards order
3 Online retailer sells product and ships to customer
4 Online retailer pays fee for order information

+
- Manufacturer and retailer share margin
- Lower fulfillment costs compared to DtC model

–
- Retailer can bundle other products
- Customer deals with different retailers for different products

Source: Kai Hoberg and Christine Herdmann

Smart replenishment operating models

To define the right operating model for smart replenishment systems, providers must consider various factors such as product characteristics, profit margins, market conditions and bargaining power. For high-value, high-margin, low-volume products, a direct-to-consumer approach might work just fine. The manufacturer can directly sell the product and disintermediation would enable him to more than make up for high fulfillment costs. However, introducing smart replenishment as an additional channel can have a strong effect on the entire market, and the manufacturer might have to carefully review its relationships with retailers in other channels. For example, pricing might be constrained by recommended retail prices in traditional channels.

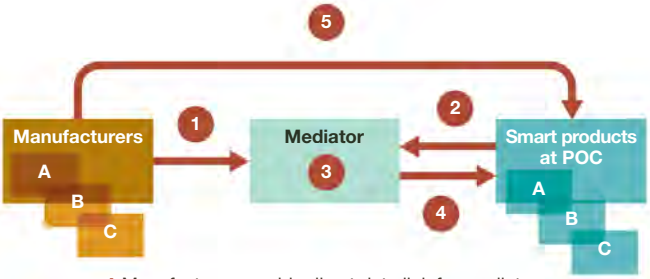
An alternative is partnering with an online retailer (see Figure 3). The manufacturer forwards order information at fees similar to current referral bonuses. The retailer then fulfills the order independently.

An ideal solution for the consumer is an integrated solution across multiple companies. In that way, the consumer can auto-replenish the products that he wants and register with only one website, get used to one user interface, and manage all products in one system. Accordingly, products can be bundled across manufacturers, thereby reducing the number of shipments. The challenge is to get competing brands to join a single platform. An external mediator is needed both to coordinate the different stakeholders and to generate a platform of trust. Competing companies are not too likely to share confidential data with one another or help their competitors to gain an advantage. An external neutral party might therefore be a solution. The role of this external mediator can be filled by different parties, such as a retailer, a 3PL or a cooperative.

Figure 4 provides an example of the mediator-enabled operating model. Here, the consumption and inventory data are transmitted directly to the mediator rather than the manufacturer. The mediator defines individual re-order corridors for each product at each consumer. Based on these corridors, products will be replenished: Whenever a product falls into the replenishment corridor, it is added to the shopping basket. If the inventory for one product falls into the ordering corridor, all products in the basket are replenished (see Figure 5). However, alternative fulfillment triggers are possible, too. For example, a replenishment of goods in the basket could be triggered in fixed intervals (e.g., every second Thursday)

FIGURE 4

Mediator-enabled operating model



1 Manufacturers enable direct data link for mediator
2 Smart products share inventory data with mediator
3 Mediator processes data and monitors inventories
4 Mediator bundles and ships products as required
5 Manufacturer invoices customer

+
- Disintermediation
- Bundling across brands
- Lower fulfillment cost
- Single system for consumer

–
- Organizing collaboration among competing brands

Source: Kai Hoberg and Christine Herdmann

or, if customers decide to order items manually, they will also receive the items in the shopping basket.

However, identifying a neutral party might be challenging. Amazon is currently partnering with different manufacturers using the Dash Replenishment System (DRS). Instead of the stand-alone Dash Button approach, Amazon's replenishment ecosystem is directly integrated into products like Brita water filters, Brother printers or Purell hand sanitizers. Accordingly, Amazon can provide customers additional value by bundling shipments with other ordinary products that are less time critical for the consumer.

In the end, many more operating models are possible. For example, manufacturers could auction order information across different online retailers to enable them to directly access the customer. The operating model could also be extended to physical stores. If the manufacturer shares the data with a brick-and-mortar retailer, order information could be put on the person's individual shopping list when that person is shopping in the store. Thus, no shipment would be required, as the consumer picks up the product.

Opportunities

Until now, we have only found some pioneering smart replenishment systems, which are mostly stand-alone solutions. As the technology matures and becomes cheaper, we might witness the development of many interesting and new business models. However, like most innovations, smart replenishment systems do not spread overnight. The substantial problem of smart replenishment is to overcome a wide range of possibilities and narrow them down to beneficial implementations.

It may take time before a direct-to-consumer model becomes a dominant route-to-serve strategy. For that to occur, there will need to be a mechanism for cooperation among different manufacturers of consumables to drive integration into a user-friendly system. In this model, the consumer signs up only once and does not have to handle dozens of stand-alone solutions. This will increase the acceptance and long-term adoption rate of replenishment systems among consumers. In addition, bundling shipments for multiple items is necessary to overcome the last-mile delivery challenge. To enable such an operating model, a horizontal cooperation among FMCG producers seems essential unless they would like to leave the enabler role to Amazon.

FIGURE 5

Inventory-monitoring for bundling

- Individual replenishment corridor for each product due to different consumption pattern and package size
- Products C, E and F in replenishment corridor
- Replenishment is triggered as inventory of product F drops to ordering corridor

Source: Kai Hoberg and Christine Herdmann

However, if manufacturers can overcome these hurdles, there are opportunities in the future for smart replenishment. Supply chains will become more tightly integrated as firms will be able to build closer relationships with the end consumer and leverage point of consumption information for their planning. At the same time supply chains will also be more segmented as manufacturers increasingly sell their products in small quantities directly to consumers rather than only in bulk to retailers. This requires a tailored setup with customized products and processes. In the end, the increased complexity will pay out for the manufacturer that benefits from wealth of advantages in smart replenishment.

Servitization definition. *Servitization, according to Emmanouil Alvizos of the University of Warwick, is often viewed as the way in which firms provide an integrated bundle of both goods and services or add extra service components to their core offering. A differing notion, however, suggests that servitization is any strategy that changes the way product functionality is delivered.*

The Benefits of Blockchain: Fact or Wishful Thinking?

Blockchain is still a largely unproven innovation in the supply chain, but it's also one that companies can't afford to ignore.

BY KEN COTTRILL

Blockchain is the new buzzword in supply chain circles. Unfortunately, there are many examples of much-hyped innovations that promised to transform supply chains overnight, only to peter out or take much longer to gain traction than originally claimed.

Is blockchain technology any different? We are still early in the process of answering that question.

The level of interest and investment in this digital tracking technology suggests that it's not going away any time soon. The financial community is probably the leader in blockchain tests, spending more than $1 billion so far.

Results from one of the more high-profile tests were released in late November. That's when Goldman Sachs, JPMorgan, blockchain startup Axoni and others concluded a six-month test of blockchain to track equity swaps contracts after they were executed. That means all amendments, deal terminations, stock splits and dividends were tracked by blockchain for those six months.

The results were impressive. "We know the thing works now," said the CEO of Axoni. That's strong confirmation for both the mechanics of blockchain and trust in the technology's ability to deliver on its claims. That also shows how early we are in blockchain's development.

The financial community is not alone here in developing the technology to reduce back-office operations. Both the food and drug industries are testing blockchain's ability to track the flow of goods and money in their supply chains. Walmart and IBM are two of the better known names involved.

It's no wonder that blockchain is of interest to so many leading industries and companies. The potential benefits

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2,512.9
3,31
€36,73
$67.68

of this highly sophisticated digital tracking technology are both broad and impressive.

These include a consensus mechanism that assures users the supply chain data is timely, authentic and secure. Furthermore, blockchain transactions can occur from any node in the supply chain, making the technology widely accessible without compromising data security and veracity.

Encrypted entries are stored in blocks. EACH BLOCK IS TIME STAMPED AND GIVEN A DIGITAL FINGERPRINT linked to the digital fingerprint of the previous block (hence, blockchain).

Beyond that, blockchain can be married with other, potentially groundbreaking innovations such as Internet of Things (IoT) sensor networks. In other words, we have only started to scratch the surface of what's possible with this technology.

But before we get ahead of ourselves, it is important to understand the technology's unfamiliar mechanics.

Kicking the tires

At their core, all blockchains are distributed digital ledgers. Data is stored and replicated across multiple computer systems synchronized in near real time. There is no central administrator, unlike most other transaction or financial systems. The system is entirely self-governing.

When a transaction is recorded digitally in this distributed ledger, cryptographic technology makes it very difficult to change that entry. This feature renders the blockchain database almost tamper-proof. That's both a key characteristic and a distinguishing one that separates blockchain from other transaction systems with a central system oversight.

Encrypted entries are stored in blocks. Each block is time stamped and given a digital fingerprint linked to the digital fingerprint of the previous block (hence, blockchain).

Linking the blocks in this way means that a mischief-maker intent on meddling with the data would have to break the linkages, overcome the cryptographic defenses of the target transactions and reconstitute the inter-block links before leaving. A tall order—to say the least. And the task becomes progressively harder as the blockchain matures and its time-ordered string of blocks lengthens.

These formidable defenses, and the fact that data is immediately accessible to every authorized participant, make blockchains an extremely powerful and secure type of database.

Such capabilities are the underpinning of the trust factor of blockchains. That's especially important in supply chains that historically lack trust, which inhibits information sharing and undermines collaboration.

Blockchains come in different flavors, and more are emerging as the number of applications increases. At the most basic level there are two types: permissionless and permissioned. In other words, there are ways to mask who sees what details using pre-agreed protocols.

In permissionless blockchains, any participant can read and write data. However, companies are not generally thrilled with the idea of exposing commercially sensitive information to such an open environment.

As a result, private or permissioned blockchains have emerged as an alternative. Accessing a permissioned blockchain usually requires some form of authorization, and there can be various levels of accessibility. Authorizations are granted by an oversight function controlled by a participant or group of participants working in concert.

The number of participants can be as many or as few as the application requires. The blockchain could encompass all the parties involved in delivering a single shipment, a global supplier base or functional entities across an entire industry.

Potential uses in supply chain

Benefits such as the digitization of manual documentation are driving the advance of blockchain technology in international trade. But what other supply chain hot spots are there for the technology?

Track and trace is one. Establishing chain of custody and verifying ethical and environmental supply chain credentials is another. Trade and supply chain finance applications are also near the top of the list. For example, blockchains could help buyers, sellers and financial institutions synchronize the flow of goods and money.

But the most compelling application areas are driven by combinations of market and regulatory demands. Two prime examples are in the food and pharmaceutical industries.

Contamination of the food supply

In food, the travails of companies such as restaurant chain Chipotle encapsulate the challenges that make blockchain solutions attractive. Chipotle has been trying to recover from food poisoning scandals since 2015, despite its best efforts to tighten safety procedures.

Chipotle's problems reflect wider issues in the food industry where operational complexity and entrenched organizational silos frustrate efforts to improve supply chain transparency. More stringent regulations, such as the introduction of the Food Safety Modernization Act in the U.S., add to the pressure on companies to address these issues.

An incident, separate from any at Chipotle, involving infected food illustrates the difficulties faced by the industry. In June 2016, an outbreak of food poisoning occurred across nine U.S. states involving 32 patients.

The outbreak strain of bacteria was isolated from imported Anaheim pepper. An investigation by the Centers for Disease Control and Prevention (CDC) revealed that fresh hot peppers were the likely source of infection, but a single pepper type or source farm could not be isolated. Even though the CDC was armed with advanced detection techniques such as genetic testing, it could not pinpoint where the infection entered the supply chain.

The complexity of the pepper supply chain was a huge challenge in tracking the flow of peppers. There are numerous growers, and the product is consolidated before it gets to retail outlets. Moreover, peppers are an ingredient for prepared dishes, and the epidemiologic investigations had to rely on a review of restaurant-specific recipes to track where the peppers were used.

Blockchain technology provides a tamper-proof, up-to-date database of transactions available to all verified users, a powerful tool for monitoring product chain of custody from farm to fork. Vendors are already developing these applications for the technology.

Consider, for example, a pilot project that involves Walmart and IBM to track mangoes using blockchain. The test project has reportedly chalked up some notable successes, such as reducing the time to identify and pinpoint packs of mangoes moving through the supply chain from days to seconds. Improving supply chain visibility yields operational efficiencies.

There's also the matter of speedily locating spoiled product so supermarkets can alert consumers much quicker and retrieve defective items with much greater precision.

Product tracing in the drug supply

Supply chain complexity is a challenge in the pharmaceutical industry, which is compounded by legislation including the Drug Supply Chain Security Act (DSCSA).

The Act imposes deadlines on manufacturers, repackagers, wholesale distributors, dispensers and third-party logistics providers to comply with stringent product tracing requirements. A major driver of the legislation is the need to combat unacceptably high volumes of counterfeit drugs.

Blockchain technology provides A TAMPER-PROOF, UP-TO-DATE DATABASE of transactions available to all verified users, A POWERFUL TOOL FOR MONITORING PRODUCT CHAIN OF CUSTODY from farm to fork.

The complexity of supply chains compounded by trust issues in the pharmaceutical industry traditionally impede the flow of information between trading partners. Fortunately, blockchain's immutable and widely distributed database of transactions is a compelling solution. These benefits, coupled with the rigorous DSCSA product tracking requirements, are driving the development of blockchain solutions. But many difficult issues must first be resolved.

To begin, there is not an industry-wide blockchain solution. Which means the various entities involved in the pharma supply chain must learn to navigate between multiple blockchains. There are also the questions about what data will be available from each node in these blockchains, and who owns the data.

Issues like these are challenging but by no means insurmountable, especially where a clear imperative for improving supply chain traceability and trust already exists.

Smart contract smarts

Meeting these and other challenges is aided by an important component of blockchain-enabled commerce: the smart contract.

A smart contract is basically computer code housed on a blockchain that defines and executes the terms of an agreement between parties. The smart descriptor is a little misleading because smart contracts are relatively uncomplicated devices that execute "If this happens then do that" instructions.

That said, smart contracts deliver some outstanding benefits. They are relatively secure thanks to blockchain's distributed database technology. This validates the parties to an agreement and streamlines the contract process. For example, by reducing or eliminating the use of unwieldy, error-prone manual documentation and speeding up transactions, these digital documents are less prone to fraud as they also cut costs.

Smart contracts are visible to all parties rather than residing in multiple systems and departments across the supply chain as is the case with traditional contracts. They also are self-executing. A payment can be automatically triggered when a shipment is complete and meets all relevant contractual terms, for instance

The number of potential supply chain applications is huge. Multi-party agreements with suppliers and customers that include operational milestones, such as on-time delivery deadlines and quality inspections are well suited to a digital environment. Imagine the cost savings possible by eliminating physical inspections. A smart contract would verify that the delivered product complies with agreed upon specifications by linking contracts to electronic sensors affixed to the shipment that verify the status of the product.

Another obvious candidate is international trade transactions that rely on time-honored, manual documents such as letters of credit vulnerable to fraudulent practices. Many proof of concept (POC) projects have affirmed the potential of these applications.

For example, in July 2017, Mizuho Financial Group, Mizuho Bank, Marubeni Corporation and Sompo Japan Nipponkoa, completed a trade transaction between Australia and Japan using blockchain technology. Every related process from issuing the letter of credit to delivering trade documents was completed using a blockchain-enabled digital platform. The participants reduced the delivery cycle for trade documents from days to just two hours.

Smart contract development challenges

There are some significant hurdles to overcome before smart contracts can become commonplace in the supply chain domain.

The status of a smart contract in a court of law is still something of a gray area. Work is underway at international and national levels to establish a firm legal foundation.

In the U.S., some states such as Arizona and Vermont have passed legislation to facilitate the use of electronic contracts. Even so, variations in national regulatory codes and a lack of global standards slow the progress of smart contracts.

In addition, although the underlying code is not complex, these contracts are intolerant of software bugs and ambiguous language. For instance, it's difficult to encode an "obligation" to do something.

The Mizuho project highlighted two key limitations in the trade arena. First, all the parties involved in the transaction had to use the same platform. Second, the application could only work if the transactional information exchanged between trade partners was standardized.

Will such problems prevent smart contracts from fulfilling their potential? Possibly, but solutions to most of these issues are on the horizon, and industries such as

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pharmaceuticals that could benefit greatly from blockchain technology are keen to embrace smart contracts. The number of vendors offering related services—including smart-contracts-as-a-service options—is on the increase.

Look for more POC projects over the next one to two years, and live applications in the trade documentation area that involve comparatively straightforward transactions that do not have a complex, global footprint.

Is blockchain for your supply chain?

How do companies wash away the hype to get a clear view of what blockchain solutions may or may not do for them—especially where there is no burning platform for evaluating the technology?

First, it's useful to understand what blockchains can and can't do.

Blockchains shine when there is a need for a widely accessible, distributed database of verified, pre-authorized transaction data that does not require a centralized application to police or maintain. The blockchain itself is the consensus mechanism that assures users they are retrieving data that are timely, authentic and secure. Moreover, because multiple authorized nodes process transactions, there is a lot of redundancy and hence robustness built into the system.

But this clever architecture is not always needed. If a trusted central administrator already exists and a conventional centralized database meets users' needs as a repository of information, then investing in blockchain technology might not make sense. That disconnect is further underscored if substantial investment has already gone into the incumbent database.

In other words, it's important to identify why a database is needed in the first place. Bear in mind that beyond an organization's natural resistance to change, there may be significant integration issues to address.

The search for proof

Having decided that blockchain technology is worth a serious look, assemble a multi-disciplinary team to identify potential applications. If the possibilities are persuasive, a POC is advisable to test the use cases and the infrastructure needed to support it.

Even at the POC stage, it's still possible to keep the time and financial investment to a minimum.

For example, in a POC project created to test the viability of smart contracts in trade transactions, the participants completed an international shipment blockchain in parallel with a conventional transaction. A sensor on the shipment alerted the parties when it arrived, and a smart contract issued a payment. To minimize costs, the sensor signal was transmitted to a freight forwarder that relayed it to a smart contract by email. The parties did not invest in mapping technology and a third-party vendor supplied the blockchain.

One of the TOUGHEST CHALLENGES when building a blockchain is ESTABLISHING THE ECOSYSTEM OF USERS. This task is much easier when a community of users already exists.

Joining an existing blockchain industry initiative is an effective way to lower the risk and defray the cost. Generally speaking, the more a blockchain is scaled the more effective it is. One of the toughest challenges when building a blockchain is establishing the ecosystem of users. This task is much easier when a community of users already exists.

The trust premium

From a supply chain perspective, trust is one of blockchain's biggest paybacks. The fear of ceding competitive advantage by sharing information throws sand into the gears of effective collaboration.

Blockchain participants are not suddenly able to join hands and sing kumbaya; business common sense still prevails. But a blockchain shoulders the burden of proof users need to exchange information, and, in doing so, could unlock huge efficiencies.

Such benefits will increase as blockchains are linked to ever-expanding IoT networks and more powerful analytical capabilities. Smart contracts have the potential to become much more than electronic administrators of contract terms. These instruments could function as critical trigger points in global supply chains.

At this point, blockchain is still a largely unproven innovation in the supply chain field. However, it's also one that companies can't afford to ignore.

The Robots are Coming Here

BY JOHN SANTAGATE

Long a fixture on the factory floor, a new generation of robots are ready for a broader range of applications. The only thing standing in their way is end-user adoption.

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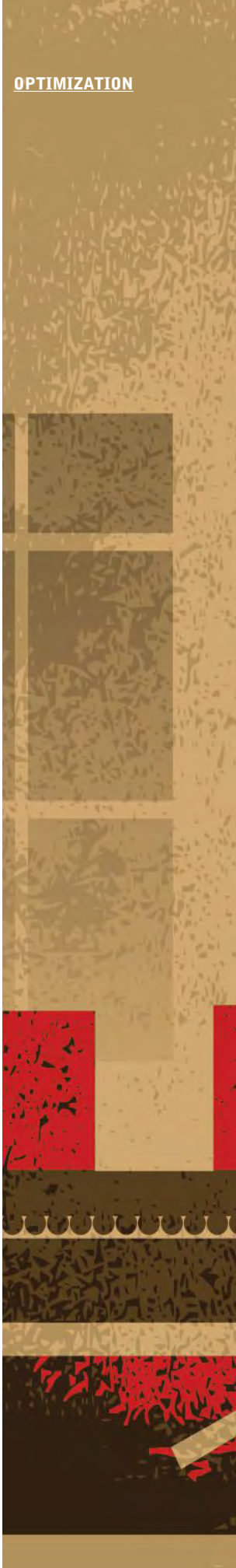
Robots have been a fixture of science fiction books and movies for decades. Perhaps our infatuation with them stems from some innate need to reproduce humanity in the form of a machine. Or, perhaps, it comes from a desire to create machines that can take over the mundane tasks of our everyday lives. Whatever the reason, the fact is, the idea of robots has prompted innovators to go out and build the robots that we see today and will continue to see into the future.

But robots aren't just a plot device in sci-fi or plaything for the nerds in the "Big Bang Theory" when they aren't in a comic book store. In the business world, robots have been in use in industrial manufacturing since their introduction in 1962 in a GM automotive plant. But, until recently, they haven't gotten much traction beyond the assembly line or one-off use cases. In part, that's because the industrial robots used in manufacturing differ quite significantly from the new generation of robots making their way into a broader range of industries and applications. Industrial manufacturing robots are designed to operate at a high rate of speed, precision and strength. While these traits are good for automating manufacturing



processes, they don't translate well to other areas of the business that require more human interaction. Indeed, they are part of the reason why industrial manufacturing robots have to operate in "cages:" areas where human workers aren't permitted to enter during operation.

It's safe to say, however, that the development and maturity of industrial robotics has helped to pave the way for the new generation of robots that is quickly being introduced across business functions and industries. Robotic technology has been on a continuous path of improvement over time as robotics manufacturers look to improve their technology and layer modern digital technologies onto the mechanical elements of robots.

Referred to as collaborative robots, or co-bots, the new generation of robots are safe, smart, collaborative and can work side-by-side with people. They have become immensely sophisticated, resulting in modern robots that are increasingly being used as a mechanism to automate business processes that have historically been incapable of automation.

Indeed, over the past several years, robots have increased their level of intelligence and flexibility as machine learning and artificial intelligence (AI) have been built into the systems; there have been significant improvements to the mobility of robots, while the ability to connect robots via IoT and enhanced safety measures have also been built into robotic devices. The result of these innovations is a new style of robot that is more suited to work side by side with humans rather than be segregated in a human free zone.

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Disruptive processes

One business area ripe for business process disruption enabled by robotics is supply chain execution, especially in order fulfillment processes in the warehouse. These processes typically involve a high degree of human involvement as well as a tremendous amount of movement throughout a facility. Now, it's not as if robotics have been absent from these areas in the past; there are use case examples, but none at a large scale across supply execution. Those organizations that have introduced robots into their warehousing and fulfillment operations have delivered added value including productivity improvements, efficiency gains, the capability to better scale up/down with demand spikes and the ability to improve customer service levels.

The most familiar example of robotics in the fulfillment process is at Amazon. The e-commerce giant acquired Kiva Systems (now known as Amazon Robotics) in 2012 for $775 million. Since then, Amazon has continuously expanded their use to upwards of 80,000 robots across 25 distribution centers. Through their deployment, Amazon has been able to accelerate delivery times and reduce fulfillment related costs. According to a note published by Deutsche Bank, the deployment of the robots equates to a roughly $22 million per year savings in facilities where they are in use, or an estimated 20% reduction to operating costs.

If Deutsche Bank's estimates are close, Amazon has proven that there is tremendous value to be gained through the use of robotics within the fulfillment center. However, the acquisition and subsequent privatization of Kiva Systems created a void in the market. Companies that were interested in this type of robot for their fulfillment processes were no longer able to procure Kiva Systems robots; those who were already using Kiva were confronted with the eventual loss of support for their investment. That was a real disincentive to anyone considering an investment in robotics from another start-up that might be similarly acquired and taken off the market. On the positive side, business, like nature, abhors a vacuum. Kiva's exit from the market created an opening for opportunistic companies to create innovative new robotic technologies and solutions to fill the void, and to improve upon the technology itself.

Some of those companies are offering Kiva-like solutions, but we are also seeing the emergence of new competitors taking a decidedly different approach to robots in the fulfillment process from Kiva. The result is that fulfillment operations have a variety of robotic solutions from which to choose. And, as with most technologies, the first step is for organizations to define their needs in order to

choose an appropriate technology to meet those demands.

For some, a Kiva-type model will work quite well. These utilize fast-moving robots that shuttle entire racks of inventory from a segregated section of the fulfillment center to a picking station, where a picker selects the inventory needed to fill an order. After a pick, a robot returns the rack back to the floor and moves on to the next pick. Think of this as a goods-to-person, or better yet, a rack-to-person, solution. Solution providers offering this model include GreyOrange and Swisslog's CarryPick mobile system. A rack-to-person model is best suited to high throughput facilities where speed is the most important element. The benefits include the ability to rapidly move product to picking locations and accelerate fulfillment cycles. However, the rack-to-person model also has its drawbacks. For example, it requires some facility modification to create a segregated area where the robots can safely operate and it requires a guidance mechanism to ensure that the robots operate within the appropriate spaces. These systems are not necessarily collaborative because humans aren't allowed to work in the same aisles where the robots are operating. One final drawback is that with these models, half of the movement is spent returning racks after a pick, essentially retaining 50% of the wasted movement in the process.

That is one model. Still other companies have emerged with collaborative robots designed to complement traditional picking processes. Some notable vendors in this space include Locus Robotics, Fetch Robotics and 6 River Systems, to name a few. The devices from these companies have been designed to operate on the floor in the same spaces where associates are at work, often in collaboration with those associates. In this model, the robot is assigned a task by the WMS and automatically navigates to a pick location. When it arrives at a location, an associate will pull product from a shelf or carton and place it in a bin or tote on the robot. The robot is then directed by the WMS to the next pick location until all the items for an order are in the tote and ready for delivery to the pack station. Once the pick is complete, the robot moves onto the next pick order rather than returning to drop a rack.

This model can be very effective for fulfillment centers with a high variety of orders, including a significant number of multi-product orders. Because the robot is responsible for all of the non-value-added travel between tasks, associates on the floor are more productive because they remain in their zone where they are focused on picking items from the shelves. What's more, they can typically operate within an existing infrastructure, which can help minimize the upfront investment and accelerate deployments and go-live. The drawback: The robots sacrifice speed for safety, operating at slower speeds than their non-collaborative counterparts. That's not necessarily a bad thing, but it's certainly a point worth mentioning.

Sophisticated navigation systems are also essential in the collaborative mobile robot space. That is because co-bots are designed to autonomously navigate their way through a fulfillment center and around potential obstructions. Once the facility is mapped within the robots guidance system, the robots are free to roam where other systems require some guidance support, such as a beacon, white line on the floor, or some other type of physical marker to help guide the robots. However, co-bots must also be capable of decision making when it comes to selecting an initial route or creating a new route when the robot encounters an obstacle, much the way a GPS system recalculates to a change in the original route.

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As previously mentioned, both approaches are an effective means to deploying robots. The question becomes which approach is most appropriate for your individual scenario. Clearly, not all fulfillment center operations are set up the same. Just as its common to find more than one kind of picking process and technology in a conventional warehouse, different facilities may identify different strategies to achieve the increased value. For example, a mix of high-speed rack-to-person robots and co-bots may be the way to go. The objective of introducing robots into the fulfillment process is to improve the overall operation by reducing costs, improving productivity, improving efficiency or some combination of the three.

Why now?

Regardless of our fascination with robots, no organization is going to deploy technology for the novelty of it. There must always be a business case before a company makes a decision to invest in new technology. Robots are no different. The business case for their deployment is being driven by the value proposition of reducing costs, increasing productivity and improving efficiency. Sub-elements that contribute to achieving value include the ability to increase speed and inject flexibility into the processes, which support the objectives of improving productivity and efficiency.

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Still, the larger question remains, why now? Robots have been around for decades, so what is the breakthrough that is finally enabling robots to deliver value across the fulfillment center? There are several ways to address this question.

The first is to look at how the advances in related technologies have led to improvements in how robots perform. They include:

- Artificial Intelligence (AI) and cognitive computing. AI is often associated with a humanoid robot that looks and sounds like a person. When thinking about advancements in robotics for supply chain applications, the AI and cognitive elements are more related to mobility. The collaborative mobile robots that have made their way into modern fulfillment centers are able to autonomously navigate a facility because they have the onboard intelligence to identify an obstruction and make a decision about how to respond to that disruption. Such an advance in mobility is quite significant in enabling mobile collaborative robots to add value to the fulfillment process.
- Internet of Things (IoT). IoT provides a mechanism to communicate with and capture data about an operation in real time. Robots are a connected asset and as such create a tremendous amount of data about the business processes they are involved in. Through such data capture, organizations can now capture data about previously manual business processes. But, it's more than just data capture; through IoT, we have the capacity for a WMS system to deliver a pick list directly to a robot that then knows exactly where it needs to go as well as the most efficient way to get there. Finally, consider the inventory management capability: Through connected robots, fulfillment centers have the opportunity to leverage connected robots to send inventory signals directly to the WMS.
- Cloud. The Cloud is helping to drive improvements in robotics. Through the Cloud, coupled with IoT, organizations are now able to monitor, manage and even operate robots from anywhere they have a connection to the internet. This point is drastically enhancing the usability of robots in the workplace and has even helped robot manufacturers to enhance their service to their customers. For example, through the Cloud, manufacturers can remotely monitor the health of their clients' robots. They also have the ability take control of a mobile robot that has encountered a situation that it can't resolve on its own and navigate a robot back towards appropriate operations without inconveniencing the client.

The second "why now" point is the continuous innovation in the field of robotics. Robot vendors have been able to build upon the technology over time to develop modern robots that significantly outperform the robots of the past. A big part of this continuous innovation is the application of related technologies (as mentioned above) to the field of robotics. Additionally, we must consider how robotic vendors have continued to improve the mechanical capabilities of robots. Consider the recent video from Boston Dynamics that shows an Atlas robot performing a series of box jumps, ending with a back flip. In fact, if you haven't seen this look it up, it's pretty cool. * While this motion does not perform a function that is useful in the supply chain, the display of dexterity showcases the rapidly evolving physical capabilities of robots, with each new innovation being built upon the existing set of robotic capabilities.

One final answer to the "why now" question is the readiness of the market. This may be the most important point in this discussion. As Daniel Theobold, co-founder and chief innovation officer at Vecna Robotics, recently mentioned: "We have been building and improving our robots for more than 20 years, with the military and in medical facilities, so that when the broader market was finally ready we would be ready to meet the markets

needs with a mature suite of products, the market is finally ready for this technology." Companies today recognize the value of robots in the supply chain, and are increasingly looking to deploy the technology to improve their ability to serve their clients and build a competitive position in the market.

Ultimately, the "why now" is not answered by any one of the aforementioned points independently, but rather through the combination of technology interplay, robotic technology maturity and market readiness. When you bring together a market that is ready to accept robots, robotic technology that is mature and continuing to innovate, and an abundance of related technology that are helping to advance robots, you arrive at the point where robots in the supply chain will become required to compete rather than a means to enable competitive advantage.

This already happening. Since its acquisition of Kiva Systems, Amazon has leveraged robotics to create a competitive advantage, and its competitors are now deploying robots just to keep up in the fulfillment market. "The ever-increasing demands for faster and more accurate order fulfillment requires IT tools that accurately track and measure both human and robotic performance," notes Bruce Welty, chairman of Locus Robotics. Companies that are better able to extract value out of the data related to their fulfilment processes will be in a better position to drive value for their customers. Robots are providing a mechanism to capture such data to drive this value.

Companies that are better able to extract value out of the data related to their fulfilment processes will be in a better position to drive value for their customers. Robots are providing a mechanism to capture such data to drive this value.

—Bruce Welty, chairman, Locus Robotics

The future of robots in the supply chain

Based on our research at IDC, we believe the future of robots in the supply chain is bright. A growing market demand will continue to encourage robotic vendors to innovate and bring advanced functionality to the supply chain. While robots have historically been built and deployed to perform a specific process or function, the constant state of innovation in robotic development will evolve here.

IDC's 2018 Robotics FutureScape report predicts "by 2019, 25% of mobile robotic deployments will include the ability to add on modular components enabling multiple uses on the same mobile platform, thus delivering up to 30% productivity and efficiency gains." Through this prediction, IDC is expressing the belief that mobile robots will be able to be outfitted with components that enable multiple business processes to be performed while leveraging a common management platform.

Melonee Wise, CEO of Fetch Robotics, agrees with this belief stating: "We are banking on the future success of the collaborative robotics market as a combination of common hardware platform and custom, task- or industry-specific software. Anyone can build a robot that does one thing well; the real opportunity lies in deploying a modular platform that can be extended to a wide variety of solutions." As with any technology, innovation in robotics and the use of robotics is paramount. A competitor that embraces change will quickly disrupt the company that sits idle and believes it's at the top.

Speaking on supply chain innovation and robotics, Adrian Kumar, DHL's vice president of solutions design, says: "We believe it's critical to identify and implement these types of advanced technology solutions in the warehouse so we can seamlessly improve our customers' supply chains." He adds that the implementation of a robotic pilot program within the life sciences sector at DHL Supply Chain "will inform the potential for broader deployment across different parts of our business. This is a natural evolution of our robotics program."

This is a testament to the importance or robotics on the future of the supply chain. Robots are not just an interesting technology for science projects. They are quickly becoming a critical technology that is helping supply chains to innovate and deliver exceptional customer service while improving business performance. Those companies that sit on the sidelines, rather than invest now, run the risk of becoming obsolete in a market that is increasingly reliant on technology—and more specifically robotics—as a mechanism to drive value.

**You can view the Boston Dynamics back-flipping robot at:* youtube.com/watch?v=fRj34o4hN4I

Transportation's Tricky Balancing Act

BY DARREN PROKOP

Done right, economies of scale can lower a carrier's average costs and the freight rates charged to their customers. Getting it right is a balance.

IN JUST ABOUT EVERY EPISODE OF SHARK TANK at least one of the wealthy investors will ask an aspiring entrepreneur if the deal they're pitching is scalable. It's certainly a good question for investors to ask. After all, they want to make their money back as quickly as possible and then sit back as the profits from sales roll in. Of course, that would be hard to do if the business in question needs to pile on costs just in order to increase its market share. In other words, investors like to see a business' sales revenue grow faster than its costs. This is what they mean by scalable or, more specifically, economies of scale.

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The term "economies of scale" is a popular one in the business world. Many, however, use the term incorrectly. Furthermore, many shippers who rely on inbound and outbound transportation to bring in raw materials and distribute their finished goods may not realize the multitude of ways that transportation carriers can achieve "scale." The good news is that economies of scale can lower a carrier's average costs and potentially lower the freight rates charged to their shipper customers. The bad news is that economies of scale don't go on indefinitely. There is a point when average costs will actually rise as scale increases. This is known as diseconomies of scale. Getting this right to maximize your transportation strategy is a balancing act—regardless of the mode or modes of shipping.

How economies of scale affect that balancing act is the subject of this article. We'll look at the specific costs involved in defining economies of scale and set out three items which are important in the definition. We'll distinguish between the internal and external sources of economies of scale and diseconomies of scale. Finally, we'll discuss the various ways "scale" can be achieved by transportation carriers.

Why is this important? Because an understanding of the

opposing forces of economies and diseconomies of scale is necessary for shippers and carriers to know how to strike the right balance in their transportation planning.

Defining economies of scale

Let's start with a definition of economies of scale and consider three critical items. The first item is that the term economies describes what happens to operating cost as the size of the operation itself increases. The term doesn't directly relate to sales revenue or to profit. Specifically, when a business takes advantage of economies of scale its total costs rise at a decreasing rate.

As a business increases in scale from a small labor force it makes sense to divide production into more specialized tasks with specific departments set up to manage these tasks.

Many business people make the mistake of thinking that costs will fall when economies of scale are exploited. Sorry, but that's just not the case. Technically, as total cost rises at a decreasing rate it is only the average cost that is decreasing. After all, it's hard to think of a business that increases its scale of operation by, say, 25% and finds that with all the extra labor and capital now employed that its total cost has actually fallen. No, what happened is that the scale of operation increased by 25% while total cost increased by some lower percentage. Because average cost is defined as the ratio of total cost over the current level of production, the ratio declines as scale increases when economies of scale are exploited. Conversely, when facing diseconomies of scale, total cost rises at an increasing rate. The result is that the average cost rises.

Item two is the role of technology. Economies of scale is assumed to occur over a production process experiencing no technological change. Simply put, the means by which inputs are turned into outputs—an equation that economists call the production function—does not change as the business increases its scale of production. The implication is that more qualitative inputs such as managerial skills remain constant and there are no scientific innovations taking place that would affect the production process.

While these don't hold in the real world, the assumption is that economies of scale looks at how a given set of inputs are turned into specific outputs. Changing the quality of inputs or substituting in other more innovative inputs means the equation for the production function would have to be redefined to account for these. This changes how total and average cost behave.

In this context, economies of scale have little meaning. The good news for businesses seeking innovations is that technological change has a long history of reducing production costs and bringing improved products to the marketplace. Innovations in science or management can, indeed, make a business more scalable; but one cannot explicitly build innovation into production plans. The sources of economies of scale to be discussed later in this article are more systematic.

The third item to be aware of is that the term economies of scale is what economists call a long run concept. This means businesses must plan in advance for a certain scale of operation and, once achieved, they have to live with the consequences until, in the long run, the plan can be revised to meet new market realities. This interim period is known as the short run: This is where some components of a business' operation are fixed in size, such as the capacity of a warehouse, the duration of a lease on a vehicle or union wages set through collective bargaining. Thus, the choice of scale is a strategic exercise because it involves a forecast of what market conditions are expected to be over the short run interim.

Inside and outside

Now that we have a definition of economies of scale, there are three important questions to consider from a supply chain management perspective:

1. Will the chosen scale provide enough product to meet downstream customer demand?
2. Will upstream vendors be able to provide enough inputs to facilitate the level of production necessary to fulfill point (1)?
3. Will financial and operational costs be low enough to set a product price that will generate enough sales revenue to stay in business in the long run?

Those are all internal questions that can be answered inside the enterprise. But, it's not that simple. Outside the enterprise, a business may face competitors who are likewise trying to achieve an appropriate scale of operations. With a fixed level of consumer demand, vendor

supply and financial capital, it becomes harder for one business to achieve higher scale if one or more competitors are already larger and have a lot of market share. Each business is striving for so-called internal economies of scale. On the other hand, more competition may be beneficial for all competitors in an industry if it attracts external players which help to grow the entire industry. This is what's meant by the term external economies of scale.

Consider more carefully the internal and external sources of both economies and diseconomies of scale. Internal circumstances can lead to either a decrease or an increase in long run average costs as the business grows larger. As a business increases in scale from a small labor force it makes sense to divide production into more specialized tasks with specific departments set up to manage these tasks. This division of labor can lead to efficiencies. The modern assembly line is the best example of this. If tasks become too narrow, they can become mundane and quality control can become a problem. Also, as the business becomes larger it may become more bureaucratic, mired in red-tape and less flexible because more and more time is spent pushing paper and attending meetings. Guarding against these pitfalls is a very important organizational task. In fact, it is a balancing act between lean and lethargy and flexibility and inflexibility.

As for external circumstances, as a business becomes larger it may make sense for local government to improve transport infrastructure in the vicinity in order to get workers, vendor supplies and customers to and from the place of business. On the other hand, a business can become so large that it creates congestion within a given infrastructure, or it begins to exhaust a free publicly-available input such as clean water, and costs begin to rise. Thus, it's also incumbent on a business to follow the workings of government and plan accordingly in order to strike the right balance when trying to exploit external economies of scale.

There is also an interplay between internal and external economies of scale through the set-up or sunk costs of a business. Any business will incur such costs because the production plan must be conceived, vendor relationships must be established and distribution channels created. The larger the business the more these set-up costs are distributed over the pool of output. In this way, long run average cost declines. As a simple example, consider advertising as an upfront cost to setting up a distribution channel. A minute of commercial TV time during the Super Bowl is so expensive it only makes sense for the largest businesses to pay for it. They have more output and sales revenue to validate such a purchase.

Size matters

Basic economics looks at scale in a singular fashion; just the size of the operation. But for a transportation carrier, the scale of an operation can take many forms. These include: the size of a vehicle or shipping container; the number of vehicles in a fleet; efficiencies in the transportation network; and a shipment's weight and distance carried. Each of these will be discussed in turn. But, recall, such sources of economies of scale will eventually become diseconomies of scale. Therefore, striking the right balance in transportation planning is very important. With that as backdrop, let's look at it in the context of transportation, using size as it applies to the most prevalent modes of truck, rail car, airplane, water vessel and pipeline.

Vehicle/container. Economies of vehicle or container size come about because the volume or carrying capacity of a truck trailer, rail car, airplane, water vessel or pipeline increases faster than the quantity of side material needed to build it. For example, compare a 3'x 3'x3' container with a 6'x 6'x6' container. The material used on each side would increase by four times; that is, each side increases from 9 square feet to 36 square feet. However, the capacity of the smaller container is 27 cubic feet while the larger one is 216 square feet, an increase of eight times. The good news is that carrying capacity, an important source of carrier revenue, increases faster than the material cost involved in expanding that capacity. The bad news, however, is that the vehicle or container can become too big to haul shipments

Economies of network efficiency come about when the design of the system of routes allows for the fleet configuration to be diversified.

along a given road or canal. An airplane could be so big that it takes too long to load and unload passengers. The pipeline could collapse under its own weight when loaded. These are all examples of diseconomies of scale.

Fleet. Economies of fleet size come about when considering how vehicles can be deployed efficiently within an interconnected market area. Consider one truck that heads only north-south and another that only travels east-west. Suppose their routes cross each other at some point. These trucks are independent operations within the motor carrier's fleet. However, the cross-point offers the opportunity to interline, or exchange cargo at a warehouse. The good news is that this interconnectivity effectively offers six routes of service instead of just two. Such interline points are essential in less-than-truckload (LTL) operations which are characterized by trucks filled with multiple shipments going to multiple locales. The bad news comes when the warehouse becomes too congested to effectively offer LTL service in a time frame that shippers are willing to pay for. Examples of important interline points are Chicago, where all seven Class I railroads converge, and Memphis, where FedEx maintains its "super hub" with all of its air cargo routes spreading worldwide.

Network. Economies of network efficiency come about when the design of the system of routes allows for the fleet configuration to be diversified. Consider the hub-and-spoke network that airlines have deployed since deregulation in 1978. Large capacity airplanes carry passengers from hub-to-hub while smaller airplanes are used along the spokes around an air carrier's hub airport. For example, a commercial flight from Anchorage, Alaska to Spokane, Washington will likely route through the SeaTac airport hub. Without hub airports it is unlikely that many city-to-city combinations would be cost effective. Of course, diseconomies of scale sets in when the hub airport becomes congested due to the multitude of spoke routes and their incoming and outgoing passengers. It certainly does not help that airspace in the United States isn't as efficiently utilized as it might be due to antiquated air traffic control systems.

Shipment. Economies of shipment weight and distance come about when considering all the costs that increase as a shipment's characteristics change. For example, doubling the size of a given shipment or hauling a given shipment double the distance should not double all of the costs associated with that delivery. Just one pilot and one co-pilot are necessary for a fully laden cargo jet travelling 5,000 miles or 10,000 miles, or carrying 50% or 100% capacity. These costs will taper off as weight and/or distance increase. In other words, these costs are spread over the extra revenue to be had through hauling more or hauling for longer distances. That's the good news. The bad news is that this only continues until it's necessary to increase the labor involved in the shipment. This could involve adding more shifts of drivers over long distances or more personnel to load and unload vehicles. Diseconomies of scale also occur when an infrastructure's capacity must be expanded but indivisibilities require expansions larger than needed. For example, if a truck trailer is at capacity and the motor carrier wants to expand operations, it must increase in increments of one trailer even if that is much more capacity than is desired. If a road is congested it must be expanded in increments of an extra lane. On the other hand, if market demand sufficiently expands then the investment in a new trailer or extra lane offers economies of scale up and until capacity is maximized yet again.

Consumption is governed by tastes and preferences and pricing transportation is more nebulous in this case. Furthermore, passengers are "freight that complain" and, therefore, must be treated differently than cargo.

Scale and scope

Two other related terms are worthy of mention in a transportation context. One is constant returns to scale. This is the absence of either economies or diseconomies of scale. The other is economies of scope. In this case, the carrier is trying to achieve efficiencies through a mixture of services instead of through a larger scale of one service. Constant returns to scale occurs when there is a built-in rigidity or independence to the operation while economies of scope indicate a degree of flexibility.

As an example of constant returns to scale, consider U.S.-Asia ocean vessel shipping. Many container vessels travel to and from ports on the U.S. West Coast to ports in Japan, South Korea and China with no stops along the way. Of course, the vastness of the Pacific Ocean necessitates this

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non-stop service. These vessels follow similar routes along the "great circle" between the U.S. West Coast and Asia, taking them through or near the Aleutian Islands in Alaska. While their routes may cross, there is no possibility of interlining in the way truck, rail and air carriers can. Each vessel in the ocean carrier's fleet in these waters serves as an independent network and enjoys no economies of fleet size. Expanding operations in these waters requires a different vessel, crew and port dockage authority. For these reasons, the carrier does not see its average cost rise or fall as the fleet expands. Long run average costs are constant and face indivisibilities as the fleet expands one vessel at a time. Of course, interlining in the ocean vessel sector does occur in other routes. The Port of Singapore is an example of an important container transfer point in Europe-Asia trade lanes.

Economies of scope offers carriers a chance to diversify their operations in order to expand market share or mitigate a decline in a current market. Many examples exist in transportation. A commercial airline can offer charter service if scheduled service is in less demand. A less-than-truckload (LTL) carrier can offer truckload service (TL) if the shipper is willing and able to fill an entire truck and pay a dedicated freight rate. Of course, it is certainly easy enough for a rail carrier to attach boxcars to passenger cars and provide a mixture of services.

Diseconomies of scope emerge, however, when the carrier begins to forget its core competency and diverts too many resources into its secondary operation. In transportation, this is best explained in terms of cargo services versus passenger services. Cargo transport is always a part of the production process while passenger travel is often a part of the consumption process. Inputs such as cargo and carriers facilitate the production process by moving inputs to where they need to be. Passengers on vacation are enjoying the "consumption" of their leisure time and carriers facilitate this consumption process. Indeed, cruises and train tours are themselves an act of consumption. Why is this distinction important? Because production is governed by the state of technology and this is a large factor used in pricing the provision of transportation. Consumption is governed by tastes and preferences and pricing transportation is more nebulous in this case. Furthermore, passengers are "freight that complain" and, therefore, must be treated differently than cargo.

As noted above, economies of scale don't directly relate to a business' sales revenue and profit. Achieving the lowest long run average cost makes sense when market conditions suggest that low cost businesses will have staying power. But there is no reason to believe that such a business will maximize profits. Markets that are easy to enter and exit tend to be very competitive and do not offer many options to increase scale at the expense of competitors.

However, for businesses such as the railroads and pipeline companies, economies of scale can act as a barrier to entry for other competitors. Once the railway or pipeline infrastructure is in place there is little incentive for a direct competitor to challenge the incumbent along that route. In this way, monopolistic profits are possible if the market is unregulated or uncontestable.

Finally, when considering transportation hubs, it is no coincidence that shippers and carriers tend to locate in areas which are hospitable to them. As noted above Chicago, Memphis and Singapore are important examples. These are also sources of external economies of scale because business and government are able to serve each other's needs, with the latter via infrastructure provision and the former via taxes and fees. Urbanization policies that take into account these businesses help to insure a steady pool of labor, vendors and customers. Applicable R&D through local universities may come about as well. Of course, as noted above, R&D benefits deviates from the assumption of constant technology. Nonetheless, these are all very important aspects of successful logistical hubs and knowledge clusters.

Achieving balance

While all five modes of transport (truck, rail, air, water vessel and pipeline) have been used to illustrate various examples of economies of scale, some modes are more prone to it than others. For a variety of reasons, it is more likely that less competitive markets will benefit from economies of

scale. Why? Barriers to entry in the form of set-up costs. As long as most roads are publicly provided it will always be easier for a motor carrier to buy a truck and offer, say, a 100-mile route than would a railway or a pipeline company.

Worse still, if railways and pipeline companies are less competitive, why should they take full advantage of economies of scale and try to lower the costs of their operations? The answer, in part, lies with intermodal competition. If one mode offers some level of alternative service in the eyes of shippers then these "contestable" markets may see a greater exploitation of economies of scale than might otherwise be the case. Shippers must maintain a discriminating eye when it comes to the mode of transportation they choose. Therefore, they have a balancing act to perform as well.

While it might seem that this balancing act is something for the transportation carrier to handle alone, it's not. Their shipper customers have a role to play as well. After all, transportation is part of supply chain management which is, of course, at its most effective when collaboration takes place both upstream and downstream. As we've seen, shippers can wait for, or hope for, scientific innovations to help lower the cost of transportation. But until then a transportation carrier has a menu of options through which to find appropriate economies of scale when providing services to shippers. Collaboration would certainly improve the flow of raw material, components and goods along the supply chain.

Consider economies of scale from the shipper's perspective: Shippers who are able to provide loads that fully utilize vehicle capacity can reap the benefits of economies of vehicle/container size.

Consider economies of scale from the shipper's perspective: Shippers who are able to provide loads that fully utilize vehicle capacity can reap the benefits of economies of vehicle/container size. Because the carrier's costs do not rise as fast as its carrying capacity it's likely that the freight rates paid by the shipper won't rise as fast either. But what about small shippers who can't provide such large shipments? Well, they have the option to utilize the services of a third-party logistics provider (3PL) whose job it is to consolidate small loads into larger ones and negotiate favorable freight rates with the carriers. This intermediate step helps to create loads with similar physical and delivery characteristics which, in effect, passes the benefits of economies of vehicle/container size on to many shippers within a transportation network.

If shippers are moving numerous loads from multiple origin-destination points within a given transportation network, there is a benefit in timing the pick-up and delivery requirements so that the loads can be interlined by the carrier at appropriate cross-points and hubs. Doing so helps the carrier achieve economies of fleet size.

Barring any emergencies most shippers prefer lower cost to faster delivery within the norms of a given mode of transport. Transportation carriers, therefore, have incentives to design intricate transportation networks. By routing the heaviest traffic from hub-to-hub and moving lighter traffic along spokes, carriers can take advantage of the economies of network efficiency. Routing through hubs may add more time to the delivery of shipments but the cost efficiencies can help keep freight rates paid by shippers lower than they would be with more direct transport.

Finally, globalization and the rise of information technology have made it easier for businesses to seek out vendors and customers all over the world. Off-shoring parts of the supply chain has necessarily increased the distance of shipments. Bulk discounts when available have necessarily increased the weight of shipments. In other words, longer supply chains created by their shipper customers have prompted carriers to take advantage of the economies of weight and distance.

Transportation planning is a very complex task. It is dependent on the nature of the marketplace, the state of technology, government regulation and cost control. As we've seen, economies of scale is an important concept when it comes to cost control. Transportation offers rich variants on the concept of "scale" and these demonstrate that transportation is by no means a homogenous activity along the supply chain.

Keeping it FRESH

Enabling the global promise of fresh food requires a new framework

IF YOU FREQUENT TRENDY RESTAURANTS or shop at your local food co-op, you know that the emphasis on fresh and local ingredients has never been more intense. Waiters regale us with the provenance of the artisanal cheese from Vermont, the herbs picked fresh that morning from a plot behind the restaurant and the free range organic chicken from the farm just out of town. The apotheosis may have been the episode of the television series Portlandia, in which the lead characters visited a farm to find out if the chicken they were about to eat for dinner had lived a good life before driving back to the restaurant to enjoy their meal.

While you might be tempted to dismiss it all as a passing fad, remember that Papa John's has built a brand around the concept that better ingredients lead to a better pizza, and has created a supply chain designed to deliver on that promise. It's distribution centers even feature production areas to make fresh pizza dough right before a shipment to its stores. As the Huffington Post once noted, the freshness movement "is more than just a buzzword — it represents an important cultural shift over the past 10 years in both the food industry and in the dining public's priorities."

Nor is it a North American phenomenon that is limited to the farm-to-table movement. As the population grows, governments around the world are ramping up their imports and exports of fresh agricultural and food products to feed a hungry world. In the United States, Europe and Latin America, export volumes of food have reached between 18% and 30% of

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total production, according to 2016 data from the U.S. Department of Agriculture's Economic Research Service. More recently, MENA (Middle East North Africa) countries such as Saudi Arabia, Egypt and the United Arab Emirates have been importing more than ever, with Saudi Arabia increasing its year over year imports by 20% and the UAE declaring that food imports will increase from $100 billion to a projected $400 billion annually in the next 10-plus years. These will comprise of all human and animal grade fresh and processed foods. The result is that human and animal grade food products are under heightened scrutiny for freshness and palatability.

With fluctuations in commodity prices, the growers in the value chain have come under tremendous pressure in recent years.

That's all well and good, but it has not been without its problems. At the local level, where most of us shop, the Huffington Post reported that "as more farmers, restaurants and food purveyors try to source and serve food grown locally, infrastructure needs have grown." That has led to solutions like Farmers Web, described as "an online portal that aims to connect farmers and producers with food buyers, making the farm-to-table process seamless." At the global level, agencies such as the USDA have struggled to distinguish what constitutes local in the common lexicon, according to Pierre Desrochers, author of The Locavores Dilemma. What's more, the industry continues to do business utilizing processes that are years, if not decades, behind the times. Agricultural production, after all, is as old as time—and so are some of the approaches to the supply chain.

Over the years the entire industry has suffered from huge variations in the value and delivery chain responsible for moving fresh fruits, vegetables, grains and meat. With fluctuations in commodity prices, the growers in the value chain have come under tremendous pressure in recent years. So has that segment of the industry that is engaged in producing, processing and shipping fresh agricultural products and dealing with the associated value chain challenges that have to be managed.

Over the past decade, I've seen this first hand while working extensively in this industry. Explaining the importance of value chain excellence to producers, processors and shippers who continue to do tasks the way they've always been done has been a tough sell. In fact, I could argue that the fresh product supply chain (FPSC) is generally decades away from achieving the levels of excellence that are commonly found in the value chains of fast moving consumer goods (FMCG). Even the simplest adaptation of the SCOR model (supply chain operations reference model) has been a herculean task for this segment because concepts such as planning and postponement strategies are assumed to be impossible in an industry where the mindset is that weather and planting schedules are the only variables in an otherwise archaic method of operations.

That doesn't mean there isn't a better way to enable companies to deliver on the promise of keeping it fresh. Other industries that were slow to adopt best-in-class supply chain management, such as the maintenance of commercial aircrafts, are now leading the way in the use of new technologies. There are similar opportunities for FPSC organizations. In this article, we will focus on three categories of players that define the FPSC supply chain: They are growers; growers and packers; and grower packer shippers. The goal is to help the value chain improvement programs for companies that deal with the production and processing of fresh food products (human and animal grade) as well as companies that rely heavily on natural production for their raw material inputs (consumer durables and perishables).

The framework presented here is developed

from my work in this field. While I believe it can be generalized and applied to other industry sectors in the process of moving their supply chains forward, for the purpose of this article, I'm using the food/agriculture sector. After all, it is not only one of the oldest sectors in the world, with the increased need to deliver fresh and nourishing food to feed a growing population, it is one of the most important industries.

The grower/ packer/ shipper value chain framework

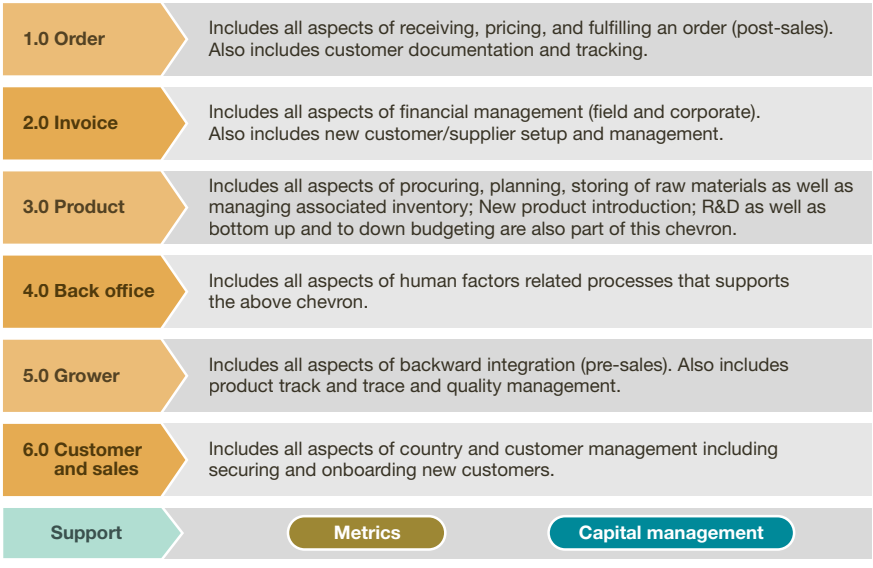
You might ask: Why do we need a special value chain framework for the fresh food industry? One answer is that the status quo is no longer good enough. When I first became involved with this sector, the commonly available value chain frameworks used in other industries weren't easily adaptable to the growers (the farmers and producers); the grower packers (fresh food and value add processors) or the grower packer shippers (the processors that also take their product to market inside the U.S. or globally).

Coming up with a framework that depicted the end-to-end value chain for this group of companies required the segmentation of the major tasks that were conducted in the current state, with no misses because every task was assumed to be value add, into a mechanism that mirrored the commercial cycle in the minds of the various proprietors that participated in the value chain. In many respects, it was like defining the various aspects of a supply chain for the first time to an audience working with centuries old business practices. The framework presented here is a variation of several that we have used with many of the companies my colleagues and I have worked with over the past 10 years.

The major buckets/areas in the framework depict a backward cycle in the life of commercial activity: It starts with the placement of the order; traverses through invoice generation; product allocation and fulfillment; the extremely complex settlement with the grower (or producer); and culminates in the satisfaction of the customer order along with any post sales service processes.

FIGURE 1

Grower packer shipper value chain framework



Source: The author

Activities such as marketing are embedded into the invoice as well as the customer task area, and detailed activities that are inherent in farming are allocated in the grower task bucket. Finally, we note that all logistics activities are treated under the customer task area or the product task area depending on whether the logistics activity is related to inbound delivery to the processing unit or outbound delivery to the end customer. The framework is illustrated in Figure 1.

Let's take a closer look and break down the major task areas in this framework.

Area 1. The order process in the fresh product supply chain (FPSC) is more complex than among fast moving consumer goods (FMCG) organizations. This is primarily because pricing can fluctuate daily based on the volume of inputs that are offered for sale. Often, a delivery date and

window are required for a quotation to enable a seamless transfer of goods between the producer, processor and shipper segments. Letters of credit and bank guarantees are often required if the product is destined for an overseas shipment or export. In an inventory-driven businesses, such as consumer goods, pricing and order management are determined against the safety stock already in inventory; in the FPSC supply chain, pricing and promise delivery dates are often made against the projected receipts of goods and the actual pricing parameters can vary significantly. I have seen batch variations of as much as 10% in pricing and product availability for the same quality of products due to this uncertainty.

Bottom up, field-by-field or lot-by-lot planning is most often done under this function/capability. Hence, the harmonization of the top down sales plan and the bottom up input availability is crucial.

Area 2. The invoice process doesn't vary much from traditional consumer facing industries, such as FMCG. Variations, such as they are, have to do with the plethora of grades (SKU's) that can arise from the variations in the incoming raw material sources. If the incoming material is processed as opposed to raw, then the number of SKUs decreases significantly and the process would operate in exactly the way as consumer facing industries. Small nuances are often due to a lack of standardization among the suppliers of raw and finished materials because the various countries of origin may have unique locale characteristics, processes or regulations that have to be normalized before the order can proceed any further in the value chain.

Areas 3 and 5. The product and the grower/producer elements in these areas are more intertwined than any other segment that I have worked with. The product segment handles the minimal stocking levels or available stocking levels (to preserve the freshness or to create the cold chain required) as well as the simple innovation (mainly pack size variations) that are required to move the product once it has been harvested or extracted in the case of products that require a two-stage harvest. Bottom up, field-by-field or lot-by-lot planning is most often done under this function/capability. Hence, the harmonization of the top down sales plan and the bottom up input availability is crucial. The reason that the grower/producer portion of the value chain is so tightly integrated is driven by the fact that most of the companies that operate in the segment tend to have large captive but outsourced agreements for production and, in some cases, the value-added processing of the goods.

This coupling is an essential mechanism to ensure that end-to-end traceability is available across two distinct value chains. What's more, payment processing, in many cases called grower settlement, is triggered by the acceptance of the product and grade in real time for the buyer and the seller. The synchronization and visibility into grower/producer quality management and record keeping must be integrated in a closed loop between these two groups in the event that a trace back, or even worse, a recall is necessary.

Area 4. The back office process does not vary much from most traditional consumer facing industries. It deals with the normal finance and human resource functions but has to grapple with the added complexity of environment, health and safety issues as well as regulatory compliance that is often mandated by the FDA or other health agencies due to the types of products being manufactured.

Area 6. The sales and customer management process highlighted in this segment is mainly pedantic since the major elements that makes the push segment, in which sales need to be rapidly originated and marketing messaging to be more real time, extremely complex is handled between areas 1, 3 and 5. However, in some cases aspects

of vendor, market and category planning need to be heavily cross-pollinated with intelligence from Areas 1 and 3. Unlike other consumer durables segments, this function is not as complicated as it seems and hence can quite easily be automated.

The tie-in for this entire framework is the use of simple but easily measured and replicated metrics as well as efficient usage of capital (plant, property and equipment) across all elements of the end-to-end value chain. This is due to its expansiveness as well as the number of participants and hand-offs that are required. Given that many of the products in the fresh food supply chain have lower profit margins than do processed foods, the capital required for assets can be very large compared to the potential return; as a result, capital must be used in a measured way to avoid debt leverage issues in any part of the value chain.

An industry as old and staid as fresh food production can certainly benefit from the adoption of the best practices and innovations from other industries.

Best practices and innovation

An industry as old and staid as fresh food production can certainly benefit from the adoption of the best practices and innovations from other industries. In fact, some elements of innovation are creeping in, albeit slowly, and have brought some outside in thinking to this industry. Here are some of the changes taking place and opportunities for improvement.

Area 1: Order management. Inventory-driven businesses like high tech often rely on available to promise (ATP) or capable to promise (CTP) processes when they are responding to customer orders. The first is made possible by having visibility into the inventory in a network that can be used to fill a customer's order. The other is made possible by having visibility into the product and production in the pipeline, including finished product already in route to a distribution center or that has been scheduled for production.

Of course, those industries usually have safety stock. That's not the case with the Fresh Product Supply Chain. But this segment can still utilize ATP and CTP capabilities if the company selling the product has visibility into the inventory pool that is already on hand at supplier and grower locations—that's ATP. This can be further enhanced by gaining visibility into the producer's harvesting and extraction plans—that's CTP.

The ability to view the extended inventory and the harvesting plans for short shelf life products allows the seller to gain significant advantages. However, implementing these strategies requires new technologies and a highly collaborative environment that transcends multiple organizations and levels. Industries in the assemble-to-order or engineer-to-order space have found mechanisms to do cross industry collaborative by using electronic exchanges as well as data interface (web and mobile enabled) in real time. These kinds of electronic exchanges could be applied to the FPSC. An example of this can be found in the fishing industry in parts of southeast Asia, where fishermen have benefited from securing higher margins for their products by sharing real time inventory information with the direct buyers.

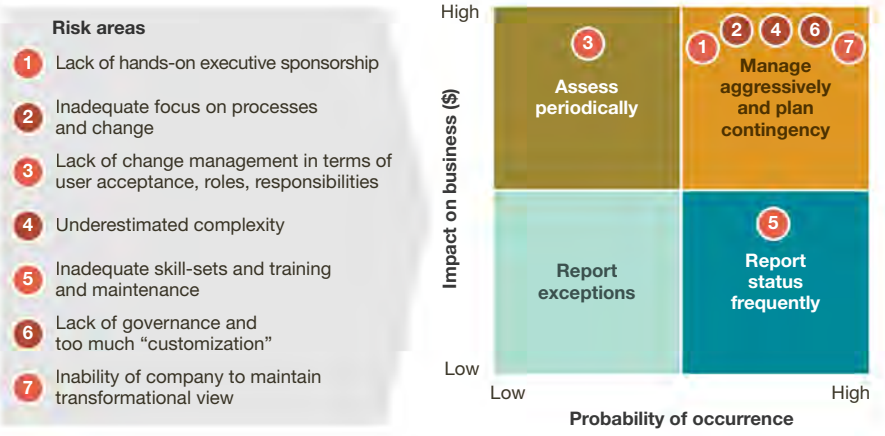
Another area ripe for significant innovation is sales price management. Given the degree of seasonality and product dependence from other entities, I have often used a concept I refer to as "drum, buffer and rope." Drum is the baseline price at which a certain percent of product or grade of product is moved—about 60% as a rule of thumb. Buffer is normally a price set aside for an additional 20% or 30% of product. Rope covers everything that remains. The percentages may vary by season, or by year, but the concept is simple: You sell enough product to cover your costs and deliver a minimal profit (best case), and then vary the remainder of sales over the season or the year based on the market dynamics. Alternate mechanisms such as setting a baseline price for the entire season and then managing the ups and

downs are also conducted in certain parts of the world. However, we must note that most of this works effectively if the product is non-indexed since futures markets in indexed products can swing the outcome significantly in some product categories.

The final innovation that could benefit this segment is to utilize the concept of push, or adjacent, selling. This implies that while we always offer the base product, the offer to sell other bundled items in the product family is just as crucial. This will allow us to get better traction with our customers as well as to create barriers to exit in case the major commodity has huge pricing issues. This concept is utilized very heavily by e-commerce sites and is also called intelligent shopping.

FIGURE 2

Risk management is the most critical aspect for sustained improvements



Area 2: Invoice. While most of the work in this segment is pedantic, as customers become more global (or at least international) the ability for a company and its subsidiaries to generate a single invoice that covers all sales becomes a strategic marketing and brand development tool. This is sometimes referred to as one face to the customer in other industries. This can be quite complex to initiate because it requires a single customer master file that can be accessed by all entities across all geographies where a company does business. This is tough to implement without having a synchronous enterprise wide system capability and deployment.

Areas 3 and 5: Product and grower. In the durable goods sector, factories can be slowed down, production lines can be taken out of commission and shifts can be added or removed in order to meet changes in demand, or to adjust the timing of when goods are produced, stored or shipped. The harvesting and extraction of fresh food products is a whole different animal. Crops can rot in the field and produce, fruit and meat can spoil in storage. However, simple concepts such as extending or shortening the harvesting window to match the incoming demand signals more closely can often result in better inventory and specific quality/grade product management. The concept of matching the harvesting window to match incoming orders is similar to the Sales and Operations Planning process in other industries. The implementation of postponement strategies in this process could yield higher margins and reduce wastage by almost 3% to 5%.

Additional constructs, such as real time extended supply chain visibility at the individual work center/field level, is crucial. This is common in high tech assemble-to-order environments and can offer immense benefits. Finally, applying Lean and Six Sigma to individual sub tasks across the product and grower portions of the value chain (which in many cases constitutes almost 75% of the total cost structure), such as harvest scheduling and farm yield management, can result in as much as a 1 basis point improvement. Given the input variations that tend to be present due to the nature of the input materials, well defined inventory management techniques of FIFO and LIFO should be implemented in sustained fashion as well as best practices from bio pharma on extending the life in a cold chain.

Area 4: Back office. Similar to Area 2, there is very little that is unique in back office processes. However, simple cost and productivity innovations like out tasking/ outsourcing, using technologies such as SaaS (software as service) and Cloud applications as well as adopting new methods to attract and retain talent, especially the millennials, should be applied effectively to match the continued cost pressures from the global economic environment. A recent discussion I had with a CEO from this sector revealed that over 60% of the company's workforce were millennials and the company had done nothing to retain that group.

Area 6: Customer and sales. Lessons gained from consumer products companies that serve the retail channel should be applied liberally to this segment. Processes such as vendor managed inventory to help channel partners manage their inventory or help retailers analyze seasonal waste and consumption data, can be beneficial. Additionally, applying category management related analytical measures could improve throughput and margins for all parties in the value chain. Finally, positioning product in the supply chain in advance to take advantage of upswings in seasonal fluctuations is a technique that works in some cases for staple products that always have an element of baseline demand.

Lessons learned from value chain transformations

Every transformation effort comes with a set of challenges that are usually split evenly between people, process and technology. Changing processes in an industry that has traditionally operated in a mostly unsophisticated environment is always a herculean task. This often gets multiplied by the fact that the people working in this area have been doing the same work for years (in some cases even generations) and the ability to adopt newer technologies is miniscule. While complexity in other industry transformations can be segmented based on the area that is being worked on, with the assumption that the other areas will just adapt, in the fresh product supply chain, the ability to transform is actually a bit of a simultaneous play. This makes the effort more complex than it should be and hence often needs to be managed by utilizing elements of risk management.

In past engagements, I have used the risk management framework illustrated in Figure 2 to successfully manage and drive the transformation. While no two efforts tend are the same, over the course of a many projects, a trend probably exists. In the illustration below, I list the ones that I have found to be common, along with the associated complexity and possibility of occurrence. The color coding resembles the normal criterion, with red being critical. The individual effort may vary in terms of probability and impact to the business so the illustration is merely intended to serve as a framework that can be used by others.

Processes such as vendor managed inventory to help channel partners manage their inventory or help retailers analyze seasonal waste and consumption data, can be beneficial.

Red box issues should always have a contingency plan because they will sometimes tend to just stop the effort all together due to the closed-minded behavior of executives. The contingency plan should be clearly articulated and signed off on by the entire transformation governing board and revisited once every quarter to ensure accuracy. Unlike other environments, where the desire to change is sustainable—this segment from my experience suffers from the worst case of short attention span and lack of attention to details.

Keeping it fresh

The promise of freshness is increasing globally. Value chains now cross many countries before a product is delivered to the end consumer. The ability to manage the freshness of the supply chain and yet not be subject to high degrees of spoilage, constantly escalating costs and increased recalls is paramount to the sustained growth of this sector. The world will always need fresh food and we must continue to find methods to deliver it.

A.I. and the path to breakthrough supply chain planning

Just as electricity transformed every industry 100 years ago, Artificial Intelligence (A.I.) is poised to transform every industry in the coming decade.

By Sean Monahan and Michael Hu

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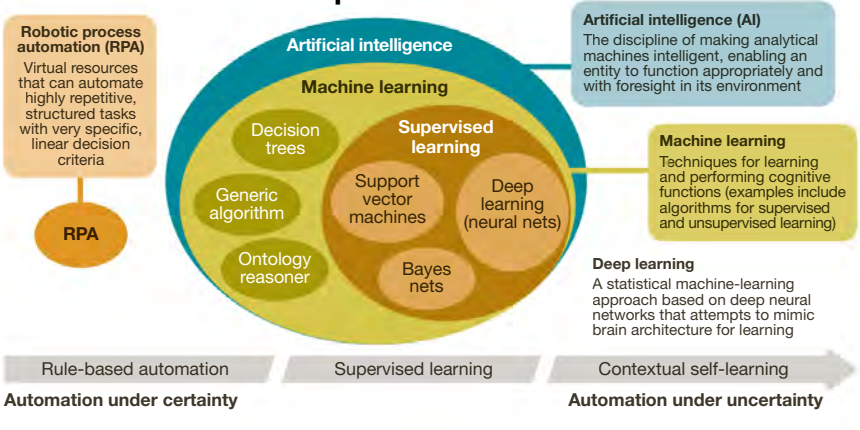
Just as electricity transformed every industry 100 years ago, Artificial Intelligence (A.I.) is poised to transform every industry in the coming decade. A.I. is already changing the ways that consumers and companies interact. Consumers rely on Siri, Alexa or Google Now for intelligent personal assistance. Companies employ predictive analytics to deliver coupons based on shopper preferences. Driverless smart trucks and cars are on the horizon. The consumer's heightened expectations of personalization, localization and speed are increasing the complexity of the supply chain. This complexity is resulting in growing cost inefficiencies in the supply chain as companies respond with increased numbers of functional planners, custom applications, and micro-segmentation of processes, metrics and a flurry of Excel spreadsheets straining a companies' ability to plan. Input signals such as POS data, CRM data and localized social media data are exploding, making supply chains data rich but insight poor. Organizations are realizing that traditional process improvement and optimization is not sufficient to solve these structural S&OP problems. Instead, companies need to pivot and leverage A.I. and related technologies to drive innovation in supply chain planning while making humans more agile and efficient.

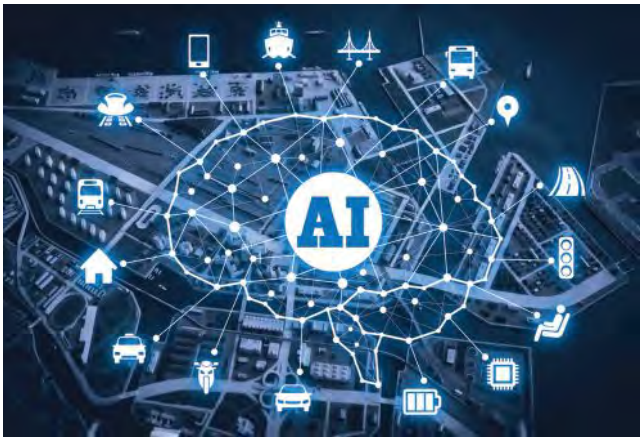
A.I. and Robotic Process Automation (RPA) represent two emerging areas that can significantly alter the supply chain planning ecosystem. (See figure 1) A.I. is the discipline of making analytical machines intelligent; enabling an entity to function appropriately and with foresight in its environment. Machine Learning is a subset of A.I. and consists of techniques for learning and performing cognitive functions; for example, algorithms for supervised and unsupervised learning. Deep Learning is contained within supervised learning and is a statistical machine learning approach based on deep neural networks that attempt to mimic brain architecture for learning. Separate but related to A.I., RPA is a virtual resource that can automate highly repetitive, structured tasks with very specific linear decision criteria.

FIGURE 1

Machine learning, and particularly deep learning, has accelerated in the past decade



Source: A.T. Kearney analysis



As A.I. and RPA take over manual, routine planning activities and decisions, planners can focus on understanding the drivers of new demand patterns, and work with other functions to create a best-in-class supply chain.

A.I. and RPA are well suited for addressing the underlying, structural challenges in end to end supply chain planning. Examples of these challenges include:

- **Order Management currently requires the manual validation of accuracy and completeness of order data from multiple demand streams.** Algorithm driven RPA can populate order attributes, process orders and manage commitments.
- **Demand Planning often suffers from inefficiencies in responding to unpredictable demand patterns and can be heavily influenced by external factors.** Deep learning can automatically recognize patterns from external signals, distinguish "signal" vs. "noise" and fine-tune demand bottoms-up forecasts for thousands of SKUs.
- **Inventory Planning often exhibits a reactive response in resetting inventory levels and consumption rules for products nearing end-of-life stage that leads to excess/obsolescence.** Deep learning can recognize patterns that correlate to declining demand and predictive analytics to set new inventory levels/consumption rules as well as create dashboards on "big data" platforms and alerts for planners.
- **Supply Planning involves planning and decision-making cycles to reroute supply orders to alternate sources and address near-term supply delays.** Genetic algorithms can identify batches that will be expensive to make in-house and automate procurement of alternate capacities. Decision-tree based machine learning can reroute deployments to alternate destinations while trading off cost vs. availability.
- **PO and Contract Execution involves a significant manual effort from purchase order generation to invoice processing to ensure contractual compliance.** RPA creates POs based on supply needs. A.I. validates invoice charges against contractual terms to detect non-compliance or fraud.

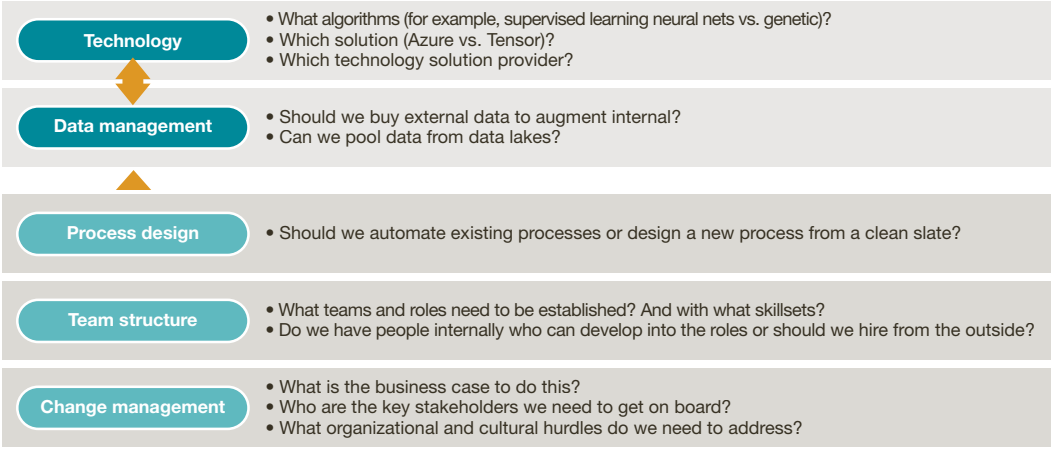
As A.I. and RPA take over manual, routine planning activities and decisions, planners can focus on understanding the drivers of new demand patterns, and work with other functions to create a best-in-class supply chain. Advances in RPA include automated processing of orders (form EDI, fax, email and mobile entry), scanning typed characters in format forms, root-cause identification for customer delivery issues and historic based predictive forecasting. Advances in A.I. include voice to text dictation, feedback of product quality and production machine sensor data into planning, tracking weather telemetry, commodity prices, spot market capacity to predict supply disruptions and identifying key variables driving demand in regions/SKU category.

One example of A.I. transformation is Blue Yonder, a company dedicated to delivering smart solutions to grocery, fashion and general merchandise retailers through a "forecasting and replenishment as service" platform. Demand modeling uses machine learning to interpret the effect of stimuli such as promotions and advertising and demand indications such as social media and the web to find the most reliable demand indicators. Two hundred indicators are analyzed to focus analysis on fundamental factors affecting demand to avoid overfitting of forecasts to demand signals correlating between each other. A minimum of three years of historical data are necessary, depending on the forecast timeframe. The machine learning suite learns the probability of specific demand based on the probability of demand signals, learns from past predictions by calculating error and feeding into the model and adapts itself every two to four months to changing patterns in demand signals. Results include a 40% improvement in forecast quality over 600,000 SKUs. The goal is to improve forecast and downstream inventory replenishment at the same time.

There are three success drivers to capture the benefits of A.I. while creating an intelligent supply chain.

FIGURE 2

A complete reorganization is necessary to win in artificial intelligence



Source: A.T. Kearney analysis

1 Adopt a segmented Minimum Viable Product (MVP) approach. Segment planning activities and prioritize solution development—impact vs. ease of automation and adoption. Rapidly deploy, experiment and improve solutions rather than aim for the "perfect" solution. Develop solutions quickly and flexibly—start with MVP, then experiment and scale. Considerations include compliance and data, technical build, operating model and partnerships.

A successful solution is more than just technology; it's a holistic ecosystem of the right algorithm, the right mix of internal and external training data, the necessary process design, and decision rights.

2 Consider the entire solution ecosystem. It's not just about rushing out and buying the latest planning software from an A.I. startup. A successful solution is more than just technology; it's a holistic ecosystem of the right algorithm, the right mix of internal and external training data, the necessary process design, and decision rights. Strong end-to-end change management starting Day 0 includes the evolution of human role (skills, input) to sustain solutions. What teams and roles need to be established? And, with what skillsets? Do we have people internally who can develop into the roles or should we hire from outside? (See Figure 2.)

Leverage the right technology partner ecosystem. Leverage strategic technology partnerships for capabilities and flexible ROI—but find the right model. The right model will have a sharpened focus on maximizing the return on current assets, rapidly prototyping and testing before scaling or abandoning. Legacy systems may shift to building new digital capabilities including mobile, social, cloud, and big data to expand the partnership between technology and business. Ultimately, digital solutions will impact all areas of the business.

To achieve breakthrough supply chain planning, companies need to recognize that today's complex business environment requires new technological solutions. Today, RPA and supervised machine learning are actively being used for computer vision, pattern recognition, reasoning and optimization. Soon, A.I. will expand from supervised narrow learning to unsupervised context aware learning. Within the next five to ten years, it is possible that broad A.I. applications will be able to determine store assortment/mix and volume planning based on social media trends and search queries, and creatively connect the dots to make planning decisions in response to the environment. A.I. will increasingly relieve human planners from the mundane heavy lifting and allow them to handle exceptions and focus on business and operational decisions. As the A.I. journey continues, and the roles of planners evolve, companies will need to integrate machine learning with human expertise to create a smarter and more efficient supply chain.

Blockchain's great potential

Blockchain's potential is immense, but most organizations have not yet made the investment.

By Becky Partida, APQC

Blockchain, or distributed ledger technology, has become well known among some circles because of its relationship to bitcoin. Conceived as a way to record transactions among those involved in a transaction without the use of financial institutions, blockchain's secure technology has additional applications in the business world. In a recent APQC survey of supply chain professionals, about one-third indicated that blockchain has the potential to create a competitive advantage for their organizations over the next 10 years. About 10% of respondents felt that blockchain would be a potential disruptor for their industry within the same time period.

Becky Partida is senior research specialist, supply chain management, APQC

However, there is a gap between the enthusiasm of organizations familiar with blockchain and its potential, and the opinions of organizations that have had little exposure to the concept of blockchain. A recent study conducted by the Digital Supply Chain Institute (DSCI) at the Center for Global Enterprise, in partnership with APQC, revealed that over one-third of supply chain professionals surveyed are either extremely or moderately unfamiliar with blockchain. Some organizations have begun investigating blockchain and considering its uses for their business, but they are still exercising caution as they weigh the potential benefits of this technology against the barriers to its implementation.

The technology and its current use

Blockchain technology enables each data element recorded in a ledger to be encrypted in a block. These blocks are chained together across a network accessible to the entities involved in the transactions (these could be suppliers, customers or any other key business partners). A collective agreement on the transactions that take place across the network is reached among the entities through a consensus algorithm. Once a consensus is reached, the data for the transactions cannot be changed and becomes the data of record. The storage of data across the network, rather than in one place, and the inability to change data make blockchain a secure way of recording transactions. For the supply chain, this means more consistent records rather than the disputes and corrections that occur for many organizations. This technology also has applications for any tracking that occurs in the supply chain because it enables organizations to maintain accurate and secure data among partners.

Blockchain clearly has the potential to improve the way organizations conduct transactions and track items within the supply chain. Yet the research conducted by DSCI and APQC indicates that only 1% of the responding organizations are currently using blockchain in their supply chain operations, and only 35% are currently exploring the use of blockchain. Nearly 50% of organizations are neither using nor exploring the use of this technology.

When asked where in the supply chain they are using or considering the use of blockchain, logistics (26% of respondents) and procurement (20% of respondents) are the key areas of focus. Fifteen percent are using or exploring blockchain

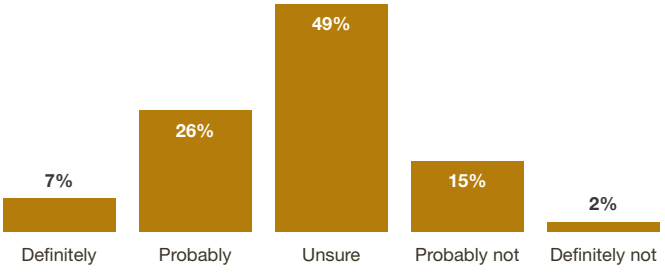
for manufacturing, and 13% are considering it for finance. These results indicate that some organizations are considering both established and new ways to apply the security and structure of the technology within the supply chain.

As illustrated by these tepid responses, there is still a good deal of uncertainty as to whether organizations' interest in blockchain will translate into investment in the technology. When asked how likely their organization is to invest in blockchain technology for its supply chain in the next one to two years, just under 50% of respondents indicated that they are unsure, whereas only 7% said their organization will definitely invest in blockchain. As shown in Figure 1, respondents who are unsure make up the largest group.

Organizations keeping up with technology trends seem to have high hopes for blockchain and recognize that they could directly benefit from the technology, but they hesitate to commit to making an investment in the near future. Because there is not yet wide use of blockchain technology, these organizations are waiting to see how others apply it before deciding to invest in it themselves.

FIGURE 1

Organization's likelihood of investing in blockchain in the next 1 to 2 years



Source: APQC

Future use

Despite the uncertainty around adopting blockchain in the immediate future, participants in the research recognize a variety of potential applications for blockchain technology. When asked to indicate the most compelling hypotheses about the benefits of blockchain, 34% of respondents selected the potential for cost reduction and the improvement of fragmented supply chains through real-time tracking of end-to-end product movement to better match demand. Close behind was the potential for visibility into multi-tier supply chains and distribution channels to reduce counterfeit goods and improve product integrity, which was selected by 29% of respondents. Improving data and process integrity, trust and control of confidential information was selected by 21% of respondents.

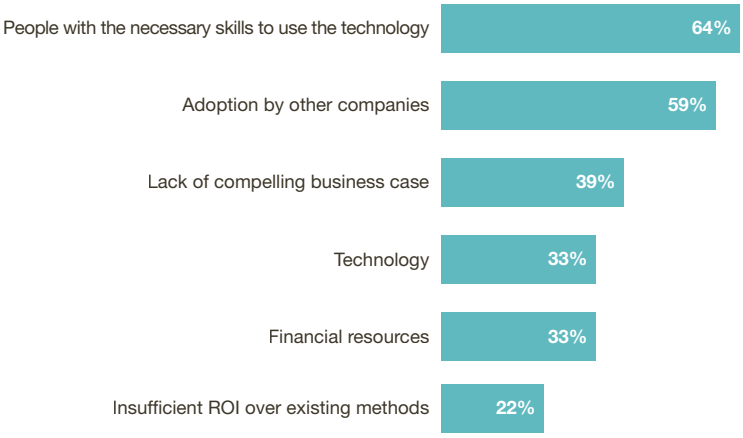
When asked to consider the biggest opportunities for blockchain by the year 2020, respondents rated billing and payment processing highest, indicating that many organizations recognize blockchain's strength at facilitating billing and payment processing. Beyond that, respondents see potential opportunities specifically within supply chain. They indicated that the second biggest opportunity is visibility into product tracking and integrity, followed by logistics, visibility into supplier compliance and self-executing (or smart) contracts.

Organizations also recognize that adopting blockchain has its barriers. As shown in Figure 2, the most widely held concern among organizations is finding people with the necessary skills to use blockchain technology. The adoption of blockchain presents a shift away from how organizations have stored and shared data. Because it has yet to be widely adopted, organizations may struggle to find qualified staff who can help them initiate and sustain its use.

The barrier rated a close second is the adoption of the technology by other companies, which is a great concern given that the use of blockchain by business partners is essential. This can be concerning because if many organizations are cautiously waiting to see how the use of blockchain technology plays out within supply chain, the number of partners willing to adopt the technology is limited. As is the case with other new technologies, few organizations want to be the first to jump into the pool.

Despite the uncertainty around adopting blockchain in the immediate future, participants in the research recognize a variety of potential applications for blockchain technology.

FIGURE 2
Biggest barrier for blockchain applications by 2020



Source: APQC

Other potential barriers indicated by organizations are standard fare for implementing new technology: the lack of a compelling business case for adopting something new and the technical requirements for adopting blockchain. There are also financial resources to consider. Organizations can only adopt a new technology if they can make the investment. Despite concerns about finances, less than one-quarter of respondents consider insufficient return on investment to be a barrier. This indicates that organizations view blockchain as a worthwhile investment, but that financial constraints may make the investment in any new technology difficult.

Balance caution with innovation

Blockchain technology presents an opportunity for organizations to create a shared network that builds on supply chain systems and processes already in place. In fact, several large organizations are already using blockchain technology for their supply chains. They have applied the technology to tasks such as tracking shipping containers and food products, as well as for more traditional uses such as facilitating financial transactions.

As shown in the research conducted by DSCI and APQC, some organizations have started considering how blockchain can help their operations and which areas of the supply chain would benefit most. As one of its initial steps, an organization considering blockchain should evaluate the types of relationships it has with its business partners and whether both they and those partners have the technological capability to adopt blockchain. If the partners are indeed able and willing to participate, it can be a way to strengthen those relationships while improving efficiency, security and performance.

There is uncertainty among organizations as to whether they will be willing to dedicate the staffing and technology resources to adopt the technology. Some of this hesitation is related to the largely uncharted waters of applying blockchain to supply chain processes. Although several leading organizations are well into the adoption of blockchain within their supply chains, those organizations not in a position to be on the leading edge of this trend must balance their need for caution with the potential benefits they could reap from blockchain's application. Organizations would do well to make sure they understand the investment required as well as the full scope of what they will need to do to establish a blockchain network with their business partners.

Blockchain technology presents an opportunity for organizations to create a shared network that builds on supply chain systems and processes already in place.

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noun

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"its landscape has undergone a radical transformation"
synonyms: change, alteration, mutation, conversion, metamorphosis, transfiguration, transmutation, sea change

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It's an era where the Amazon effect is making "same day" almost seem too late, pushing customers to expect their orders to be in stock and ready to deliver on demand, and making "connected commerce" affect everything from consumer goods to building materials to specialty chemicals—and everything in between.

To help companies operate successfully in this environment, the editorial teams at *Supply Chain Management Review* and *Logistics Management* assembled an impressive lineup of supply chain experts and keynote speaker for the 2017 Virtual Summit.

"NextGen Supply Chain: Keeping Pace with the Digital Economy" defines new concepts and solutions that are helping logistics and supply chain operations create complex, yet seamless supply chain networks comprised of connected customers, suppliers, competitors, carriers and third-party providers. Here are the key points covered during the conference and insights into how you can leverage your own digital supply networks and achieve your supply chain goals in 2018 and beyond.

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KEYNOTE

The sprint to digital success

In today's supply chain environment, no shipper can afford to stagnate at the gate. In fact, by launching "digital sprints" they're pushing through the hype and getting their logistics and supply chain organizations to real, tangible outcomes. It may not be today, it may not even be tomorrow—but certainly the digitization of manufacturing, distribution, logistics and supply chain is on the horizon.

In his keynote, PS Subramaniam, principal at A.T. Kearney, focuses on the digitization of the supply chain and what it means for shippers of all sizes, and across all industries. Specifically, he addresses how to successfully orchestrate "digital sprints" that can deliver quick and tangible outcomes without having to predict the future or rewire the entire IT infrastructure.

"People have always talked about the digital supply chain, but in the last five-to-seven years the idea has really evolved," Subramaniam points out in his keynote, adding that technology adoption rates "are increasing exponentially," and compares the first telephone to the modern-day tablet or smartphone. "It's not an IT project, nor

is digital a specific technology," he says. "It's an approach and an ability."

Pointing out that more than 150 technologies are having an impact on the supply chain at any given moment—but that not all of them are applicable to every supply chain—Subramanian says that the primary issue holding companies back is the process of filtering through these options.

"Digital is here and now; your companies are being disrupted today," he concludes. "It's not hard to get started. In fact, small experiments are a good way to 'dip your toes' and your teams most likely already know which experiments to start with."

SESSION 1

Benefits of Blockchain: Fact or wishful thinking?

With the buzz around blockchain getting a little louder every year, Ken Cottrill, research and marketing development lead at MIT's Center for Transportation & Logistics, focuses his conference session on defining blockchain technology; determining its potential in logistics and supply chain management; and unlocking the benefits blockchain may hold in the future.

A continuously growing list of records called "blocks," which are linked and secured using cryptography, blockchain is expected to affect the supply chain in big ways in the coming years. Giving examples of blockchain usage from the food industry, Cottrill helps attendees understand the fundamentals of the concept and why it has become such a big buzzword.

By serving as a virtual "ledger" across the supply chain, for example, blockchain establishes a reliable chain of accountability that's particularly relevant for the food industry and high-value goods.

"The bigger the blockchain, the more difficult it is to tamper with the contents," Cottrill points

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out. "This is especially important for supply chains because they share huge volumes of sensitive information." Collaboration is the biggest advantage that blockchain technology provides, he points out, with high-level collaboration being a true challenge due to trust issues.

"The fact that this trust is embedded in blockchain," he concludes, "we believe will pave the way for a much higher level of collaboration in supply chains in the future.

Session 2

The benefits of Cloud-based TMS & SCM

As one of the first supply chain applications to make its way into the Cloud, transportation management systems (TMS) have been steadily shifting away from on-premise/installed solutions to Web-based platforms where shippers, business partners, carriers, third-party logistics providers (3PLs)—and even customers—can access pertinent information via the Web on a 24/7/365 basis in real-time.

Both accessible and affordable for shippers, Cloud-based TMS offer distinct advantages in a world where transportation-related costs and complexities increase year over year. In this presentation, Dwight Klappich, research vice preseident at Gartner, highlights the strides that cloud-based applications have made in the end-to-end supply chain management (SCM) world.

Even with these clear benefits, however, Klappich says that Cloud-based TMS adoption isn't quite where it needs to be. That could be changing in the near future. Based on Gartner's "10th Annual User Wants and Needs Survey," Klappich's presentation introduces attendees to the newest Cloud trends in logistics, and points out that 43% of companies currently have at least one SCM application in the Cloud. Of those users, 58% prefer multi-tenant Cloud (i.e., the same instance for all clients) while 42% prefer dedicated Cloud (unique for each customer).

"Transportation is an industry with unique uses for the Cloud," says Klappich, "and right now, North America is leading in Cloud adoption compared to other countries."

Session 3

3PL Evolution: Meeting the digital commerce mandate

Spurred on by customer demands, a rapid growth in online sales, and a seemingly endless lineup of new technological innovations, the retail environment—and the global supply chain that supports it—is changing rapidly. In turn, it's pulling transportation and warehouse/DC operations right along with it.

And because so many shippers rely on reputable, reliable logistics partners to help them get their goods from Point A to Point B, third-party logistics firms (3PLs) are smack in the middle of this evolution.

In this session, Evan Armstrong, president of

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Armstrong & Associates, takes an in-depth look at how the world's 3PLs are adjusting to help shippers upgrade their transportation management IT; offer omni-channel fulfillment support; tackle mounting returns issues; and manage end-to-end logistics solutions designed to keep today's retailers on the cutting edge.

Pointing to cheap oil, an increase in Chinese wages, the proliferation of e-commerce, and the use of robotics in the supply chain as a few of the key trends currently affecting the 3PL industry, Armstrong says that companies operating in the space are adjusting their service offerings to help shippers "keep pace with digital commerce and meet the demands of the ever-fickle consumer."

He also discusses how shippers can benefit from fully leveraging modern 3PL services, and highlights how blockchain, 3D printing, and the ongoing push for more automation will continue to drive innovation for both 3PLs and shippers in 2018 and beyond.

Session 4

Solving critical last-mile challenges

The "last mile" can be a pretty confusing place for supply chain managers who are scrambling to figure out how to get orders from the last distribution point to the final destination in the most efficient, expedient manner possible.

In fact, finding solutions for the last-mile delivery challenge is an ongoing concern for companies that ship goods directly to customers. And as the volume of e-commerce shipments has grown exponentially, that problem has become even more acute. In fact, exactly how a shipper manages its last-mile deliveries can make or break a business.

Ready to help, Matthias Winkenbach, research scientist at MIT's Center for Transportation & Logistics, puts on a session meant to break down some of those barriers and to get shippers thinking about how to jump even their highest last-mile hurdles. He does this by presenting a number of growing last-mile options, a few new technologies and subsequent strategies for solving these challenges.

"The last mile is the most complex, and the most difficult to optimize part of a supply chain," says Winkenbach, noting that trends like urbanization are creating a continuous increase in the number, size, and density of cities—making operations more and more complex.

"Big city density is skyrocketing and is one of the main roadblocks for last-mile logistics."

With this in mind, Winkenbach says static inventory may not always cut it, and that mobile inventory will be the future. He sees data analytics and geo-referenced transactional data for more accurate planning, routing, dispatching and design decisions as key enablers of better last mile orchestration. "When you can visualize demand and see how it evolves, and see "hot spots" based on time of the day, you can better anticipate demand," he adds.

Session 5

Global trade management in the digital economy

On track to grow by 3.6% in 2017, world merchandise trade volumes hit new highs after growing by just 1.3% the prior year, according to the World Trade Organization.

And just when shippers thought global trade management couldn't get any more complex, a new presidential administration takes office and rocks the boat on existing and

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proposed trade rules and agreements.

In this virtual conference session, Beth Pride, president of BPE Global, covers how global logistics and supply chain operations will require more support than ever in navigating the continuous and ever shifting flow of global trade.

"Trade compliance is an integral part of the supply chain process," Pride points out, noting that Trump pulling out of the TPP trade agreement, the potential NAFTA renegotiation and the Korea-U.S. free trade agreement are all having an impact on global trade management right now. That's where global trade management (GTM) software comes in by offering benefits like risk mitigation, brand protection, cost savings, and scalability.

"Trade is more unpredictable than it has ever been," says Pride, "and GTM automation could help manage these changes—and potential changes—so that shippers aren't as drastically affected."

Session 6

Robotics in Supply Chain: The future is closer than you think

When it comes to the application of robotics inside the warehouse, distribution center (DC) and fulfillment operations, the time is now. In fact, recent research from IDC finds that global spending on robotics and related services will more than double by 2020, growing from $91.5 billion in 2016 to more than $188 billion in 2020.

While robotics may still be emerging in logistics operations, early adopters are finding that it is reliable, productive and cost effective in the right application. In this session, IDC Research Manager John Santagate discusses the current state of the logistics robotics market; talks about where and how robotics is most efficiently and effectively being applied; and discusses how early adopters are driving future innovation in the space.

"Robots are more than just automation, and they are more intelligent than just speed and repetition," Santagate says, pointing out that robotics increase productivity, reduce operating costs and improve product quality. "All of this is why people should start thinking about robotics— now."

Santagate says cognitive capabilities; movement and dexterity; and interaction all comes together to make robotics particularly useful in logistics and supply chain. Cognitive capabilities, for example, allow robots to move freely in a space and avoid barriers, while movement and dexterity allow the machines to pull boxes off shelves, pack boxes, load pallets, and handle assembly.

"Robotics are enabling people to do more with less," says Santagate, who advises shippers to embrace the inevitable proliferation of robots, identify where and how robotics can add value, and to "think of robots as modern tools to support business process execution."

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