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SUPPLY CHAIN MANAGEMENT REVIEW

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FEATURES

COMMENTARY

SPECIAL REPORT

For the supply chain, 2021 has been déjà vu all over again

This is the last regular issue of *Supply Chain Management Review* for 2021. Normally this time of year, I look forward to what's in front of us. That's turned out to be a fool's errand over the last year and a half. So, instead, I looked back to see what I wrote this time last year. My column was titled "COVID hasn't stopped supply chain progress."

The opening paragraph went like this:

"Supply chains have been in the spotlight like never before over the last eight months. That hasn't always been a good thing. The perception, reinforced by shortages of products essential to our daily lives, is that supply chains were not up to the task and failed. The reality, as argued by MIT's Yossi Sheffi in his new book The New (Ab)Normal: Reshaping Business and Supply Chain Strategy Beyond Covid-19*, is that supply chains performed as designed—they did what we expected them to do. Going forward, we need to reshape our business strategies, and, as the title of the book suggests, rethink the way we operate supply chains to perform in a new business—and social—climate."*

Those sentences are as pertinent today as they were in November 2020. We are still in the news like never before, as supply chains and ultimately our customers grapple with one shortage-led disruption after another. It's the supply chain equivalent of the Old Testament plagues. Indeed, I won't be surprised if there's a shortage of something as a result of locusts. As Yossi Sheffi suggested, we will need to reshape our business strategies and the way we operate our supply chains to keep up with customer expectations. That bar has already been set. There's no lowering it.

One of the things I've come to understand, and maybe appreciate in a new way, is the impact of all these disruptions on planning. Not to minimize operations, but it all starts with a plan; when there is no reliable visibility into what's happening, forecasting and planning will fall short.

Bob Trebilcock, Editorial Director
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That has been the theme of all of Larry Lapide's Insights columns for 2021, including the one in this issue. It was also the topic of a panel discussion I moderated for Bluecrux with Jake Barr, a former P&G executive, and supply chain leaders from Kimberly-Clark, The Estee Lauder Company and the Pet Care division at Mars. All four discussed the challenges their organizations confronted during COVID and how they are investing in planning going forward.

In the remaining features, we look across the spectrum of the profession, with articles on 3D printing, the promise of an inland waterway from New Orleans to St. Louis and one leading supply chain executive's take on the challenges in front of us.

Let's hope that when I write the November 2022 column, it's not déjà vu all over again. As always, I look forward to hearing from you.

Bob Trebilcock

SUPPLY CHAIN MANAGEMENT REVIEW

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Short lifecycle (SLC) forecasting for "muddling through" uncertainties

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The pandemic has upended virtually every supply chain process, from procurement to final-mile delivery, but perhaps none so much as planning and forecasting. I suspect managers now realize that when the COVID-19 virus started spreading and lockdowns were instituted, customer demand for all their products changed drastically.

Conceptually, this rendered all products as newly introduced products, or mature products introduced into new markets. Historical demand was often useless, as demand varied during multiple phases in virus contraction and ensuing lockdowns. All product demands looked different, especially country to country.

What's a demand planner to do? Muddle through the uncertainty.

In recent months, *The Wall Street Journal* has published two articles that illustrate the difficulties of forecasting during uncertainty. One detailed the plight of Driscoll's, a distributor of strawberries, as well as producers of other perishable food products who have to provide a forecast to farmers in advance of the planting season. Fourteen months into the pandemic, Driscoll's Mr. Soren Bjorn said that he "considers the models that once guided him inadequate for gauging how consumers or prices will behave once the pandemic subsides."

Meanwhile, AB InBev, one of the world's largest brewers, said that its data-scientist team had to pivot from making sales forecasts to focusing on "projecting where and when COVID-19 restrictions would ease or tighten around the world," as well as tracking "hospital rates, mobility data, Google trends, and other [casual] data." The brewer had resorted to using publicly available Australian data to help project EU sales, despite the fact that it did no business in Australia. Both *WSJ* articles inform managers on the types of data that might be used

during and after a pandemic in lieu of historical demand. (You can read more about how some leading CPG companies are working through forecasting and planning issues in "The Roundtable: The future of probabilistic planning," in this issue of SCMR).

I have been writing about the impact of the pandemic on forecasting almost since the start of the pandemic. In this column, I am offering an article that I wrote for the *Journal of Business Forecasting* titled "A Simple Approach For Short Product Lifecycle Forecasting."* It focused on approaches to demand forecasting for short product lifecycle forecasting (SLC), which is forecasting for products that are merchandized—especially by retailers—during multiple seasons in a year and typically have no historical data. It was based on forecasting methods learned during consulting engagements with the Limited Stores, a retailer with four merchandizing seasons. Life Cycle methods were used because most products were new or revisions from prior years.

While the article was published 20 years ago, the forecasting methods developed to deal with products for which there was no historical data are relevant to today's managers muddling through disruptions and uncertainty.

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Most people think that forecasting is about esoteric forecasting methods that only technically savvy statisticians can understand and use. What typically comes to people's minds are time series-based methods that use reams of historical data, sorting through it to determine repeatable patterns that can be used to project the future. To use them two or more years of data are needed to ascertain recurring yearly patterns.

Wouldn't it be easy for forecasters if this perception about forecasting was real? That there was, indeed, plenty of historical data to analyze. Unfortunately, in most cases nothing could be further from the truth. Oftentimes these time-series methods can't be used because there is not enough data about a product's historical demand, a product's demand is sporadic, or the product has never existed before in its current incarnation. In this column we'll discuss a simple method for forecasting an important class of these short lifecycle (SLC) products.

Utilizing special techniques for these types of products is important because given that they are sold for only a limited amount of time, accurate pre-launch forecasts are needed to assess how much to initially make and supply, helping to avoid large surpluses at the end of their lifecycle. In a similar way, accurate updated forecasts generated during the early phases of a lifecycle are needed to support manufacturing and distribution decisions, avoiding shortages and surpluses of the product during and after the selling period. Thus, it is important to use data collected early in a product's selling lifecycle to help identify hot sellers and slow movers, and where those are occurring.

What is an SLC product?

An SLC product is one that is only sold for a limited or finite period of time, at least in its most recent formulation. This means that the product has never been sold before exactly as it is now sold. Therefore, it has no direct history upon which to project demand. Some

products that can be viewed as falling under this general class of products include:

- Recurring seasonal products that are sold for a limited period of time during the year. This includes items such as Halloween candy, snow blowers and suntan lotion that are sold primarily during a holiday season or largely only when customers need them. While many of these items have a history of sales from prior years, most often the year-to-year demand patterns are difficult to ascertain. In the case of snow blowers and suntan lotion, ascertaining weather conditions is difficult; and in the case of Halloween items, determining which characters for masks and costumes will be hot is a gamble.
- Seasonal fashion products that are sold for a limited period of time, such as spring wardrobe items, designer gloves and bathing suits. Once again, while these types of items have been sold before, their styles change every year making it difficult to forecast annual demand patterns.
- Non-seasonal fashion products are hot sellers for a limited period, such as music, videotapes and books. While these kinds of items have been sold before, these are brand new products.
- Model replacement and upgrade products that are meant to replace existing products. These include product lines that change every year such as automobiles and white goods, as well as upgrades and new versions of software. In these cases, these types of products have been sold before, but not in their exact formulation.

Developing forecasts before product introduction

In each of the cases described above there is no history on a product's demand, so prior to a product's launch, a forecast of future demand needs to be developed. Time series methods are no help here. For example, forecasters might need to resort to lifecycle forecasting methods that rely on ascertaining a similar prior product's demand patterns and using it to project this new product's demand.

Conceptually, I refer to two steps to develop a pre-launch forecast, which require estimating both the shape and height of the demand curve over time. Represented by its cumulative demand curve—that often takes the shape of an "S" curve. As can be noted in Figure 1, this curve can be used, considering the following two characteristics and related estimation procedures.

1. The shape of the demand curve, which represents how fast the product's demand ramps up to 100% of total cumulative demand over its lifetime. This shape is typically estimated by keeping a library of past product cumulative demand curves and picking one or a combination that this new product's demand will likely follow—that is, developing the shape of the demand curve for this new product.

2. The height of the demand curve, which represents the cumulative demand for the product during its lifetime. That is, in terms of the demand curve, what does 100% of the final cumulative demand represent? This is more difficult to estimate but is normally done comparing the product to past products and ascertaining how much more or less this product will sell. Market research studies typically support this, helping to assess the portion of a total potential market a product is expected to penetrate or how interested customers are in purchasing a product.

Taken together the estimated shape and height of the demand curve become the cumulative demand forecast; and the demand forecast over time is generated from them.

Updating the demand forecast

Once a product is introduced and selling, data

can be used to update the cumulative demand curve. This involves both estimating or updating the shape and height of the cumulative demand curve. For products with shorter lives, for example up to three months long, often you will not have enough data to ascertain a new shape—as it takes many data points to discern a significant difference in shape from a product's original curve. For these product situations, only the estimated height would be updated using the cumulative demand to-date and the original demand curve as follows:

1. Assess the percent of demand expected to-date using the original demand curve. For example, 25% of total cumulative demand is expected within 4 weeks of a product's launch.

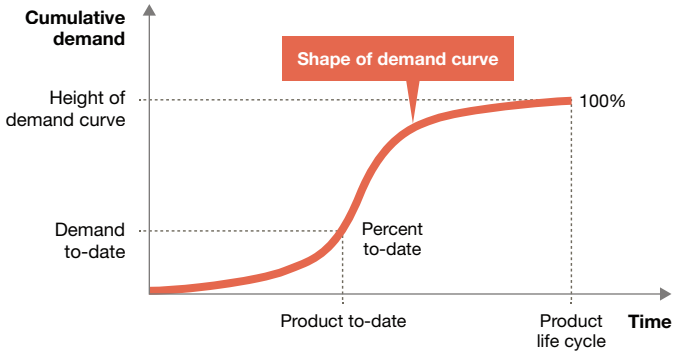
2. Compute the ratio of actual demand to expected demand to-date and multiply by the original height estimate to come up with an updated estimate of the height. The formula would be:

UHE= OHE x (ADD/EDD)

where : UHE = Updated height estimate
OHE = Original height estimate
ADD =Actual demand to-date
EDD = Expected demand to-date

FIGURE 1

Typical cumulative sales demand pattern for a short life cycle (SLC) product



Source: Author

On the other hand, if a product has a longer product life, say over six months, then it might be possible to update both the shape and the height of its curve based on data collected following its launch. A way to do this involves the use of curve-fitting techniques, where the cumulative demand curve is plotted over time and an "S" curve is fitted to the data.

Improving a forecast

One thing to keep in mind in updating a short product lifecycle forecast is that demand data needs to be captured in as close to real time as possible, for one to be successful in identifying a quick change in a product's demand. This will help to identify hot selling products from among a variety of slower-moving ones. These methods work best in environments where point-of-sales data about demand consumption is used for updating forecasts.

Hopefully this short tutorial on the use of lifecycle forecasting will aid forecasters and planners, in general. It should especially help those that work for companies that sell and market a significant number of SLC products—such as those in retail, fashion-oriented and high-tech industries. Try them, they work.

Will they yield 100% accuracy? Of course not. Will they improve your forecast accuracy? I believe so.

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Challenge-based research can open new avenues of innovation

By Matthias Winkenbach

Route planning is essentially an optimization exercise that uses modeling techniques to optimize a route for a certain objective, such as minimizing cost or distance traveled. But this traditional approach to route planning falls short in one key respect: It doesn't sufficiently capture how driver know-how can influence the efficiency of delivery routes.

A research project we recently completed aims to bridge this gap by using data-driven methods such as Machine Learning to incorporate driver behavioral factors in route planning. The project represents a departure from established optimization modeling approaches. It also demonstrates how an innovative approach to research—the use of public challenges to engage a wide community of researchers—can unlock new knowledge about supply chain planning and performance.

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Taking directions from drivers

Optimization models have done a good job in helping companies improve the efficiency of product delivery networks. However, there are variables that are difficult, if not impossible, to encode in these models. One standout example is driver behavior. The use of Machine Learning to capture drivers' specialist knowledge may increase the quality of route plans by better reflecting the real-world environment in which delivery vehicles operate.

A typical example of a human intervention often ignored by traditional route plans is a delivery driver's decision to avoid a certain urban area at a certain time. Even though this "off-book" change may add miles to the route, the driver probably has a sound reason for altering the official route plan. Perhaps he or she knows that parking is particularly scarce at the target location during the period concerned. Maybe a customer will be unable to receive the delivery if the truck arrives at the designated time on the official schedule.

Machine Learning methods present opportunities to leverage data to detect such behavioral patterns by analyzing how drivers operate. Traditional optimization-based analyses might not be able to identify or interpret such patterns, especially when looking at route execution data for certain areas of demand across an extended time period. A similar logic can be applied to other variables unknown to route planning systems, such as unexpected weather conditions or traffic delays.

The advance of Machine Learning techniques in supply chain management makes it possible to sensitize models in this way. Also, thanks to increased levels of digitization in the supply chain and logistics domain, today's modelers have access to greater volumes of data to work with and these data sources continue to evolve and grow.

Paucity of knowledge

Despite these advantages—and the huge potential of this line of research—research into route planning applications of Machine Learning presents a challenge. While the broad topic of planning and optimizing delivery routes has been investigated for many years, up until now relatively few research publications have investigated the use of Machine Learning in this context. Moreover, the research community is lacking sufficiently large and realistic datasets to develop, train and test potential new solution methods.

This shortcoming incentivized us to adopt an unconventional approach to our route planning research. The idea was to engage the global

research community on the project, crowdsource ideas and then make them available to the public in an attempt to jump-start research in this domain. Fortunately, the online retailer Amazon had a similar research interest, and the Amazon Last Mile Routing Research Challenge was conceived as a collaboration between the two organizations.

The Challenge was open to any non-commercial, academic researcher or research team. The winners were awarded cash prizes. Contestants were given access to a massive dataset provided by Amazon and were required to compete with each other to develop the best-performing route planning algorithm.

The data covered key parameters such as approximate delivery locations, package dimensions and travel times and distances between locations for around 6,100 historical delivery routes from five major metropolitan areas in the United States. It also included a categorical route quality score for each of the historically followed route sequences, which encodes the drivers' perception of the route. After the researchers submitted their models, Amazon provided the MIT team with data on an additional 3,000 routes for evaluation purposes.

Forty-five submissions from teams in 29 countries reached the Challenge's finalist phase. The top prize was awarded to a team with members from Canada, Germany and Denmark.

Although the overall goal was to find the best solution, we also wanted to spark new ideas. To this end, we made the rich bank of knowledge created by the contest available for future research by publishing a technical proceedings document with short articles written by the participants to document their ideas and methodological approaches.

Look before you leap

The Challenge provides some valuable lessons about using this research approach to improve the efficiency of route planning—and other areas of supply chain management.

First, traditional optimization modeling is still a powerful tool that is hard to outperform and will continue to play an important role in solving complex route planning problems. In some instances, Machine Learning can be used to calibrate traditional models. It seems that the most effective way forward is to combine established optimization methods and Machine Learning-based methods, an approach taken by many of the participants in the research Challenge with notable success. In fact, we did not observe many pure-play Machine Learning solutions in the Challenge.

Another important lesson is that although the competition format used in the Challenge is only viable for investigating certain types of supply chain problems, there is potential for applying it more widely.

In general, this approach can be effective when there is a lack of published research and/or a lack of data to support research on a particular topic. Projects high in complexity are good candidates, such as a complex, data-driven planning problems that are computationally expensive to tackle. As the route planning challenge illustrates, problems that involve the vagaries of human behavior also lend themselves to this research approach.

For example, inventory planning might be fertile ground for a public challenge-based research project. Planning and creating sustainable supply chains or distribution networks is another area worth considering. A research project could model human behavior and identify ways to incentivize buyers to choose sustainable purchasing options.

But before organizations pursue public challenge-based research, they should take note of the demands that come with this type of project.

First, these projects require massive amounts of data, and are likely to need corporate sponsors willing to share operational data. Running a global challenge smoothly, reliably and fairly requires a lot of administrative effort and considerable infrastructure.

The organizer must be able to respond quickly to questions from a large group of researchers in different geographies and with disparate backgrounds. Also, the criteria used to evaluate the submissions must be carefully crafted. For instance, how innovation is evaluated objectively is an issue that must be resolved at the outset. An innovative solution can be one than proposes a completely new method or one that combines existing methods smartly.

A rich legacy

In the future, there will likely be more opportunities for applying this type of research approach in line with the growing complexity of supply chains. For example, the inexorable growth of e-commerce is creating more complex problems in need of solutions in various areas—including route planning.

One of the most important advantages of public challenge-based research is that it generates a large number of rough and unpolished starting points for potentially fruitful future research avenues within a relatively short time period. The breadth and speed at which these initiatives can pollinate future research cannot be achieved by traditional projects aimed at high-quality, peer-reviewed publications.

More is said about sustainability than done: It's time to clear the air

There's a lot of talk about sustainability. But what does it mean when it comes to businesses?

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By Mudit Bansal and Prasanna Thawait

The synchronization between the business interest with the environmental impact and with the social effect on the communities together creates a sustainable business strategy sometime referred to as environmental, social and governance, or ESG. It leads to more efficient resource optimization by companies and the reduction of the negative impact on the environment due to it.

Customers and consumers are demanding that companies be responsible for the environment. Leveraging a sustainable model will build brand loyalty with a brand identity that connects with customers not only at a transactional level but also at an emotional level. For example, the 2020 Gartner Group's "Chief Supply Chain Officer Survey" found that 84% of CSCOs said they plan to invest in reviewing their capital investments and mitigating the emissions affecting the environment.

Clear the air with "green procurement"

Green procurement includes the sourcing and procurement practices that will ensure no or minimal negative impact on the environment. Many companies are seeking and implementing sustainable supply chain solutions to achieve ES&G sustainability metrics to benefit the environment. Traditionally supply chain strategies are only focused on KPIs such as on-time in full (OTIF) delivery, low inventory cost and low logistics cost; but today businesses are conscious of the benefits of eco-friendly decisions.

Advantages in adoption include:

- long-term cost benefit;
- reduction in environmental impact;
- improvement in brand value; and
- encouragement of innovation.

Some examples of sustainable solutions for the sourcing and procurement process are:

• **Using eco-friendly packaging.** Plastics, in most cases, cannot be recycled and are detrimental to the environment. The use of cardboard boxes for packing is an alternative that is biodegradable and can be reused in other forms such as toys for kids or home décor fixtures. KPIs such as % of bio-degradable package of total packaging can be used to track the performance of the organization to achieve this metric.

• **Supply-side efficient logistics.** Implementing efficient logistics strategies such as route optimization, adopting electric vehicles, order batching and reusable plastic pallets in place of wooden pallets in transportation reduce environmental impact. Local sourcing from nearby suppliers helps reduce travel miles and emissions in the environment. KPIs such as CO2 emission in kg per shipment/mile can be used.

• **Adopting ecosystem resource planning (ERP4).** Leveraging the emergence of multi-enterprise ecosystem commerce platforms (ECP) based on Cloud deployment and digital technologies, companies can adopt collaborative planning and execution from connectivity of the market ecosystem community network. Applying Artificial Intelligence and Machine Learning to ecosystem federated data increases revenue, profitability and capacity utilization reducing the environmental impact while lowering the cost of operations in a shared network. KPIs such as weight in kg of papers per process/supplier, and energy saved per process can be used.

• **Automated efficient warehouse management.** Adopting automated material handling, storage and retrieval systems and robotics can improve warehouse operations and capacity/space utilization to reduce the environmental energy footprint of the facilities. KPIs such as fuel saved in material movement and carbon emission in kg per supply material can be used.

• **Leading to more energy-efficient processes.** Using renewable energy sources to operate offices, warehouses and manufacturing facilities/processes can be beneficial as it has minimal or no carbon emissions. KPIs such as kwh per contract/supplier, and percentage renewable energy consumed of total consumption can be used.

Create supply network collaboration with suppliers and suppliers' suppliers

Suppliers can be evaluated and certified based on their environmental strategies and sustainability initiatives taken. What measures are they taking to reduce air pollution? How do they recognize care for biodiversity? How are they efficiently utilizing their resources? And how are they dealing with the waste in their system? These are just a few of the criteria that can be used to evaluate supplier performance. Reward incentives can be developed to recognize the best performers in a category. KPIs such as percent of suppliers trained/participated in trainings of total number of suppliers and total number of green suppliers of total number of registered supplier base can be used.

Leveraging a circular supply network

Simply stated, a circular supply network is a

method to promote the reuse of waste or discarded materials. This method encourages creating a loop network rather than an in-out network so that the discarded materials can flow back into the supply ecosystem. Some brands, like Nike, have initiated a movement that encourages consumers to recycle their old shoes and give them a new life. KPI such as recycled products/services out of total products/services in the business unit can be used.

How to clear the air on sustainability?

To begin, the vision of the business and the supply network leadership must be aligned and communicated to the organization (governance—the "G" in ES&G). The vision and purpose of the business to adopt sustainability is the foundation upon which the green supply network strategy can be built. A top-to-bottom leadership approach will boost and accelerate adoption. A holistic, end-to-end strategy drives maximum benefit from the market ecosystem in which the enterprise operates (see Figure 1).

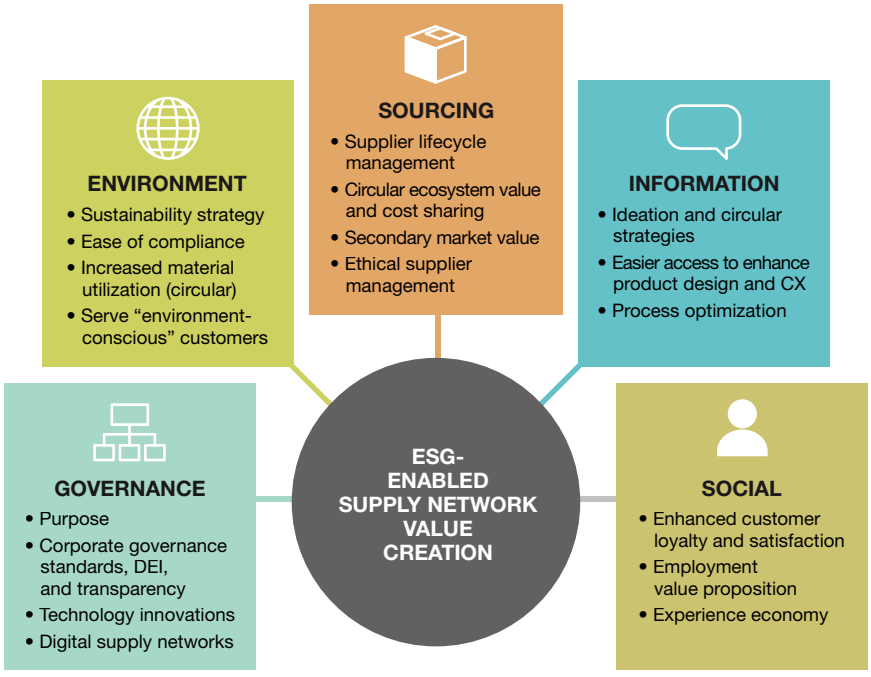
As Michael Porter defined the types of market competitive advantage, such as low cost and differentiation, a sustainable supply chain can be leveraged to achieve both through innovative solutions.

Take, for an example, a company adopting a diversification strategy to create a steel recycling business focused on sustainability. The initiative would leverage sustainability benefits as recycling 1 ton of scrap saves 1.1 tons of iron ore, 0.6-0.7 tons of coking coal and around 0.2-0.3 tons of fluxes.

Specific energy consumption for steel production through primary and secondary routes is 14 mg/kg and 11.7 mj/kg, respectively. Thus, it leads to energy savings by 16%-17%. Further,

FIGURE 1

Purpose-striven ES&G enabled supply network ecosystem impact



Source: Authors

water consumption is reduced by 40% and GHG is reduced by 58%.

The sustainability solution implemented is a digital sourcing platform leveraging circular economy principles in which the supplier sells their scrap online through a mobile app. The order booking is as easy as booking an Uber or ordering food online. The solution resulted in reducing carbon emissions in the procurement process. The company also increased margins through disintermediating the supply network and creating trust in the market. The initiative resulted in a win-win outcome and created value for the company and the environment.

Less talk, more action

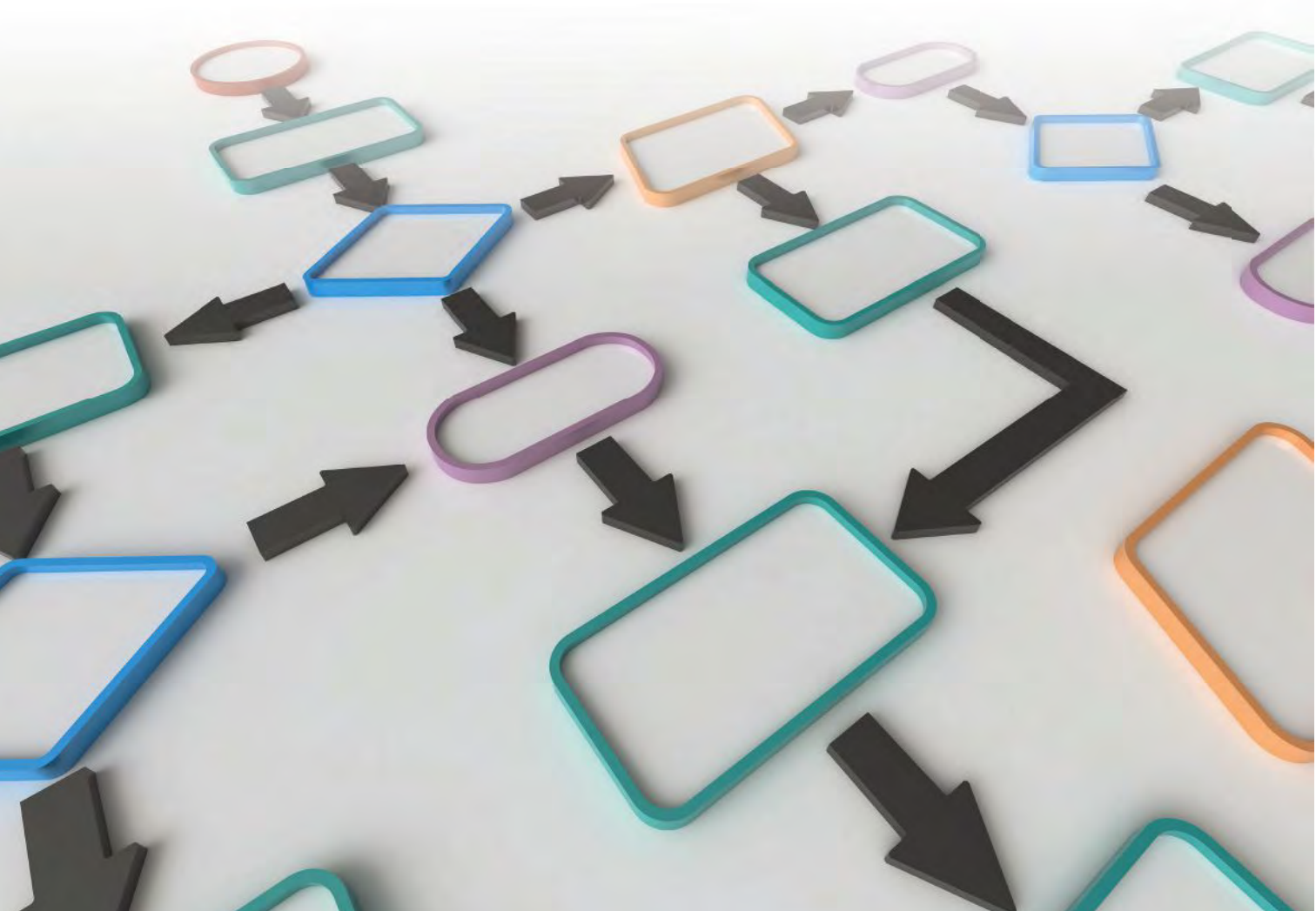
Recent market studies appearing in the literature indicate that consumers place sustainability high on their list of buying incentives when purchasing products. Both companies and consumers participate in the transformation from a traditional to a purposeful sustainable business model. Looking at the environmental impact, improvement can be in forms such as gas emissions, deforestation, inefficient energy usage and many more. In the consumer goods segment, the bulk of the environmental impact (on land, water, air, geological resource and biodiversity) is within the supply network ecosystem. According to most sources, the world population is expected to reach 9.7 billion in 2050. The resources to sustain that population growth are limited and are depleting rapidly. Sustainable processes, ecosystem value creation and circular economy strategies are slow to be adopted. Green procurement will help to reduce the depletion rate of resources, improve company performance and ensure a better future for our planet.

THE ROUNDTABLE

The future of PROBABILISTIC PLANNING

In a world of uncertainty, the one thing supply chain professionals know for sure is that planning needs to adapt to a rapidly changing landscape. Our panel of leaders discuss the future of supply chain planning.

BY BOB TREBILCOCK AND KOEN JASPERS



A few months ago, I interviewed the chief supply chain officer for one of the world's largest distributors of alcoholic beverages. When I asked what was his biggest challenge, I expected to hear about port congestion or under-staffed warehouses. Instead, it was planning. None of his company's historical records prepared his planners for dealing with the shutdown of bars, restaurants and hotels in the spring of 2020, or the explosion in wine and spirits being consumed at home.

Now, as business was picking back up in 2021, his planners were equally flummoxed because they didn't know if consumers would return to bars and restaurants or continue entertaining at home. With many services businesses struggling again from the impact of the Delta variant, the outlook remains cloudy at best.

Clearly, planning is ready for a transformation. That was the topic of a panel discussion I moderated last May for Bluecrux, a value chain process and technology firm with a NextGen Digital SC Twin for probabilistic planning. I was joined by Koen Jaspers, the co-founder and CEO of Bluecrux.

The panel was organized by Jake Barr, the CEO of Blue World Supply Chain Consulting, a firm he founded after a 33-year career with Proctor & Gamble, where he was global director, supply chain network operations. Barr was joined by three experienced supply chain executives:

- Jay Koganti, vice president of supply chain COE at The Estée Lauder Companies Inc. He leads supply chain planning, including center of excellence activities and supply chain transformation.
- Scott DeGroot, vice president, global distribution and planning at Kimberly-Clark. He leads global planning and distribution, including the physical movement of goods.
- Eliza Simeonova, vice president, global supply chain, Pet Care at Mars. Her role includes planning, physical logistics, network design and digital transformation.

SCMR: *Koen, how do you see planning evolving?*

Jaspers: As we think about the next generation of supply chain planning, we're asking how should we include risk in our planning decision making. Internally, we call this probabilistic planning. Let me frame that a bit.

Over the last 12 months to 18 months, the level of systematic variability in demand and supply has increased dramatically, and we believe that's here to stay. So more than ever, traditional approaches to planning that work with number values that have a deterministic way of balancing supply and demand are under pressure. And guess what? The world is not deterministic and never has been.

For example, a lead time isn't really 10 days; more likely, it's between eight days and 16 days. And depending on conditions, there's a certain value between that range. You can extrapolate that example to almost any parameter that drives our value chains, especially now with so much uncertainty in the supply of critical materials, capacities, distribution lead times, demand signals and so on. Yet most planning processes still work with a simplified and deterministic view of supply chains.

Increasingly, committing to a plan with a level of certainty is becoming a major challenge for many of our customers. And throwing more horsepower at it simply doesn't work. It requires more sophistication. In the end, it requires us to answer a fundamental question: Do we need to add risk and uncertainty as the fourth supply chain dimension next to service, cost and cash, along with a probability of a plan's accuracy?

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SCMR: *Thank you, Koen. Jay, how is Estée Lauder approaching planning?*

Koganti: When we look at planning, a few things clearly come to mind. As planners, we are very deterministic; we like things in black and white. So, dealing with probabilities in scenario planning requires a mind shift for the planning community, and that's not an easy thing to do. The second important thing is that nothing can substitute for execution excellence, no matter how good the planning. At EstéeLauder, we did well during the pandemic because the investments we have made in probabilistic planning systems, but more importantly, the abilities of our processes to execute really paid off.

SCMR: *Scott, what has been the impact of the pandemic on Kimberly-Clark?*

DeGroot: Never before in our nearly 150-year history have we seen the kind of demand uplifts that we witnessed during the COVID-19 pandemic with people hoarding products like toilet paper. Our Cottonelle brand even launched the #ShareASquare campaign last year—and asked consumers to stop hoarding and buy less toilet paper—so that we could help ensure that more people had access to our essential products during this health crisis. At the same time that consumer toilet paper demand increased, our B2B business with hotels, restaurants and many offices dropped substantially. Now we're seeing an equally unpredictable and highly variable change in the demand pattern as the pandemic continues to evolve. So, we learned three things.

One is that we absolutely need real-time visibility into what's happening with demand as well as our suppliers in order to understand the supply response. It's not just about what we can produce in our plants, but where can we place inventory to satisfy demand.

Two is the ability to speed up the planning cycle. If we're going to create the most optimal supply chain response to meet demand, we need to speed up planning and S&OP. We need to be able to replan on a weekly basis and even develop a daily cadence. This all requires a lot of manual work by the planning team, in addition to rigorous collaboration across the organization, which leads us to accelerate our digital transformation. For example, we are currently working with a demand planning tool from Arete.

And the third thing that is really making me think about the future of planning is the interconnectivity of the supply chain. We need to all understand the same thing at the same time.

The pandemic has been difficult for everyone, and we are proactively acting to accelerate our transformation plans. As part of that, this makes me want to bring risk into the conversation in S&OP. A highly interconnected, real-time, always on, analytics-driven planning response is going to be foundational to what we do next.

SCMR: *Eliza, with all of the pandemic pet adoptions, Mars' pet care business probably also experienced a lot of unanticipated demand.*

Simeonova: That was exactly the case. Over the last 18 months, the size of the category, and our share in the different partitions, has grown beyond what anyone had anticipated. That's a good problem to have, but it's one that affects our entire organization. We're exploring several dimensions.

One is how we think about supply chain excellence and customer centricity beyond product availability. There's much more that we can do to be the supplier of choice than to just be at 99.5% of customer service level. Back at P&G, we used to say: "If you can't ship the product then you have to ship the information." That's a very important aspect of customer centricity, which in a real-time data environment becomes an essential competitive advantage. We must have visibility and the data models to provide an accurate trajectory of availability.

The second dimension we're exploring is scenario planning. There are two elements to that. The first one, is the need to teach our planners how to think differently, before we overwhelm them with new tools and systems. The focus must be on how to adapt our processes to use technology versus the implementation of more and more tools. In addition, we need to challenge a few paradigms, one of them being the "one number" theme of S&OP. We need to recognize that financial targets must be managed differently than the signals we give to our supply system. And we have to adapt our ways of working to face that reality. That's a very difficult paradigm to challenge. But we need to realize that our long-term resource plans, our financial commitments

and our short-term sales plans cannot be based on the same number. Unless we have a very unique rewards system, and that's just not the case at most organizations.

SCMR: *Jake, what are you clients telling you?*

Barr: What you just heard is not unique; today, all companies and verticals are on overdrive. How each individual vertical is responding differs a bit based on their maturity, and whether a company has advanced planning operations in place and can connect the ecosystem to understand where things are in their supply chain.

That has ratcheted up the need for all the cogs in the wheels to accelerate and to be able to anticipate. Scott mentioned always on analytics. The way I like to frame it is that at a gut level, we've always known that there was a level of risk to some of our operations. But we didn't have the capability of defining how that risk might affect the end state, such as the availability of labor for your operations, the timeline for the delivery of production materials to the deployment of product into the market. Meanwhile, the C-suite wants to know what it can commit to for the financial community. So, the risk element has grown in importance.

A client recently told me an anecdote about having to segment customers and allocate product because they were constrained on material. Based on that, they made a commitment to fulfill orders for one segment partner, and then had to short them. The reason was that they didn't have visibility; they couldn't look at the moving parts across their operation and determine how much risk there was in the answer they were giving to that customer.

SCMR: *Risk is a great segue to our next question. Traditionally, there are three dimensions to the supply chain: Customer service levels, the cost of providing that service and cash flow. Is it time to include risk as a fourth dimension, as Koen suggested, and if so, how do we factor it into our planning processes? Scott, we'll start with you.*

DeGroot: At Kimberly-Clark, we're constantly asking ourselves, what additional intel do we need to gather to fully understand the sensitivities of the marketplace and consumer behavior for restocking? It's not sufficient to say this plan has a 60% confidence level. We are generating a series of three or four "if, then" scenarios that say, if demand profiles in these ways and in these channels, these are the different ways we could execute the supply chain response. We'll put inventory here. We'll work with this supplier here. We'll change this sourcing pattern here. But, then we'll have a Plan B and Plan C. Those back-up plans are critical, and we are putting as much, if not more, time into building those out than we are for Plan A.

The idea is to always have three options to five options so that we can ask questions such as: Are we optimizing service? Are we optimizing fill? Are we optimizing availability? Are we optimizing profit? What do we need to maximize our capabilities? Of course, we have that conversation in real time.

That's the conversation we're having with the C-Suite, and it's the one that will drive the next level of development that is required in this space. The tools are available, which is important, because tools can definitely augment our capability. That's how I think about it.

SCMR: *Jay, with continued disruptions, how are you addressing the unpredictability of supply at Estée Lauder?*

Koganti: We began looking at risk even before the pandemic, and we realized we had to evaluate it in a more institutionalized fashion. So, we brought in a new metric that we call "value at risk." We use this new metric to look at every level of the portfolio, whether it's a category, subcategory or brand, and then we dimensionalize the risk from a supply standpoint and a demand standpoint. You don't have to act upon every risk—looking at the value at risk to the organization, we can prioritize and make sure we're going after the most relevant risk. These variables are here to stay, so we need the right metric.

SCMR: *Eliza, can you talk a little bit about risk?*

Simeonova: To me, risk is a type of business impact that must be addressed differently based on magnitude and time to respond. It's the likelihood for something to happen to my supply chain. We don't see predictability as a risk, but it is the aspect we have to deal with every day.

On one side of risk is a statistical metric—such as standard deviation of my forecast that needs to be addressed with the right methodology. This methodology is needed to define the right classification of product flows and the buffers that correspond to the level of predictability of those. I'm using the word buffers in the generic sense, not only relevant to inventory.

Second, to create a resilient supply chain, we have to take a long-term perspective. Do I have the right manufacturing asset strategy? Have I designed flexibility in my supply chain (with flexible sourcing concepts, formulation menus, etc.), and do I have the right flexibility in my materials supply pipelines?

The "extreme" definition of risk is when something completely unexpected happens. Most organization don't ask themselves: "Do I have a business continuity plan?" Do I have processes in place for what to do if I have an interruption? Those are three very, very different tasks and require different methodologies to solve.

We simply can't use the same processes to manage those three types of risk, so we have to approach the 18 months to 24 months of future uncertainty in a different way than my day-to-day forecast variation.

A paradigm shift here is to move the time spent in defining corrective measures toward time spent in evaluating risk and mitigation plans. For example: How do I make sure that I can ship into the UK although my lead times are now longer because of Brexit? That not only requires a shift in mind set, but also in the capabilities within the organization. People in the planning community spend most of their time looking backward at root causes and trying to course correct. Now, we need to tell them to spend more of their time looking forward and anticipating—designing the network and the portfolio for fast reaction. That change will take time.

SCMR: *Jake, how are your clients assessing the factors that affect S&OP or the business plans that they present to the executive team?*

Barr: I think we just heard it. Scott talked about scenario planning. The reality is you can't have an effective S&OP if you're not talking about scenarios because you have so much volatility in the mix. That's what commercial leaders want, and its uniform across industries, because the dynamics of the market aren't static right now.

Now, let's layer onto that what Jay offered, which is to look at the whole basket full of risk in the supply chain, but then to prioritize those that will cause the most disruption to the business, or, in the alternative, offer the most opportunity. You need a process to identify the most important pressure points, and the levers that you can pull to address them.

Then Eliza pointed out that some want you to stress test the supply chain: For instance, do I have the flexibility to quickly make packaging changes? Can I deliver the supply upside with the supply partners? Those take work, but that's where we're going.

SCMR: *Scott, early on, you reminded us of the importance of execution. If you're going to execute, how do you plan around the many things that are in short supply right now?*

DeGroot: There's this complex duality. Being deterministic, you think that all of the factors can be known and put into a model, an algorithm or a set of tools that will generate the perfect outcome. That's the point of having scenario and probability planning. But, on the other side, we can't know everything. We know what we know, but there are elements we cannot know that will affect execution.

If I have a real-time control tower, I won't know everything, but I can know which trucking routes are being delayed, which suppliers are delayed or which of my assets is behind schedule. I can then take steps to mitigate those issues. For instance, if I know a truck will get here in the next hour in the morning, I can look at my labor plan. Based on that, I can look at what I need to change in my inventory allocation that afternoon. By using this always-on visibility, I can challenge the team to make better decisions for the afternoon based on what's happening in the morning. If that's automated, machine learning can tell me—based on patterns of past behavior—what's likely to happen in the next eight hours to 12 hours, and I can drive a higher level of performance and execution.

Thanks to technologies like control towers, physical logistics are a bit ahead of the business processes. The planning and logistics communities are pretty tapped into what is happening, but can commercial teams make decisions fast enough to make the right allocations? In the future, we should probably talk about that as a supply chain community.

SCMR: *Each of you has touched on the idea of assigning a confidence level to the plan. Can you do that now in your organizations? I'll start with Eliza.*

Simeonova: Objectively, no. Today, we can give an indication, but how accurate that indication is depends upon the person who makes the judgement. I think the other question is: If we were to invest in the effort to be able to make these kinds of predictions, what are we going to do with

that knowledge? For instance, customer listening is a key here. Customers need information so that they can adjust their supply chains. So, that's one thing we could do—understand what matters really to those that we serve. We are exploring that dimension and talking to our customers to get their feedback. The second thing is how we manage costs and cash at risk. We don't yet have a methodology for that, but we are investing a large amount of effort to develop use cases.

SCMR: *Jay, where are you in the ability to assign a probability to your plan?*

Koganti: We've made a lot of investments in terms of creating the ability to make a risk prediction in planning. Intuitively, everyone gets it, but we have the same challenge that other panelists have talked about. Planners want to know what to do if there is a 60% probability or an 80% probability. You can give a little bit of prescriptive direction to give guidance to the planners, but we also have to ask how to prioritize.

Scott's point about execution excellence is important. In some cases, we felt that execution and planning converge to really manage the probabilistic ways of planning, so we created the role of execution planner. They're not just planning, they're also responsible for execution in real-time as well. Some of those shifts are already working, and others have a ways to go.

SCMR: *And Scott, to you at Kimberly-Clark.*

DeGroot: We're very similar. I will only add to the mindset shift of the planning community. I will say that if you are the conductor of the orchestra, you need to be in a position to know what to do when the drummer doesn't show up or the tuba is out of key. The whole risk of probability is what will we do with the plays in the playbook when the unexpected happens. It's not okay to say to a business leader that we're about 60% confident. Well, what about the other 40%? The point is to come in with plans, and the alternative plans are key. As we've all heard, hope for the best but prepare for the worst and the unexpected—that's the only way to ensure long-term success.

SCMR: *Jake, anything to add?*

Barr: I want to add to something that both Jay and Scott said. I go about things in a very pragmatic crawl, walk, run kind of way. There is no doubt that there is a need to understand the probabilistic determination of what certain plans will deliver. Full stop.

But in a crawl methodology, you have to ask, who and where would we begin to use this knowledge? In the crawl step, what we're doing is using a little bit better math to support our intuition. And that's really at an executive level.

In the walk stage, we've all got deterministic supply chains that we've worked with for years. Knowing where the trigger points are, having a better way to identify where the risks might be bubbling, is a great first step.

From there, building out what Scott was talking about. You need to have a playbook. Nobody wants to just know that this is a big risk area. What do I do about it? What are the typical plays that I could actually put in place and run? That's makes it more operational. That's where you can go from a crawl to a walk. As Jay said, this is where you take it into the operational phase.

At the end of the day, you've got to execute a plan because you've got customers and clients who are expecting you to perform. So, what you're really trying to do is figure out the pinch points, and leverage that knowledge quickly in a matter of minutes or hours. So, we can turn the big machine to be able to respond.

SCMR: *Each of our panelists used the word mindset. What do you think are the barriers to making probabilistic planning a reality?*

Barr: Number one, let's just be honest: We're in the infancy state when it comes to most supply chain organizations even being able to talk to the commercial community about scenarios. We've been so used to: Here's the demand number and here's the supply number; let's go have an argument about it. So now we've just morphed to the state where we're starting to have discussions about a range for demand and supply.

The first step is getting to a comfort level to engage the commercial leaders about the fact that there isn't a single number. That's taking some time.

The next step, is like it or not, a pivot point that has already occurred. The pandemic has forced the commercial side of the C-Suite to respond in the financial community for large scale gaps in their balance sheets. Not small gaps, but huge gaps on the top side and the bottom side. The pandemic has created both opportunity and failure.

So, you're talking about a C-suite that expects more from the supply chain organization. I think all of our panelists would agree that what is expected now is much greater than before.

Unlocking the value of DEMAND SENSING

The six factors critical to the successful implementation and adoption of demand sensing.

BY HEMANT R. BONDE AND ALLISON AHDIEH

As toilet paper, hand sanitizer and chicken parts began to fly off the grocery store shelves in March of 2020, it became increasingly clear to many consumer-packaged goods companies that any semblance of normal and predictable consumer behavior would cease to exist for the time being. As consumer demand continued to shift, shortages and stockouts soared. For other industries, inventory stockpiled, became obsolete and had to be discarded. This sudden change in demand during the pandemic begged the question, when would consumer behavior return to normal and whether it did or did not, would companies pick up on the changes quick enough in the short term?

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Without question, demand planning and forecasting was one of the early losses of COVID. Those processes are dicey under the best of circumstances, and the last 20 months have been anything but the best of circumstances. While some supply chain leaders have been using demand sensing technology for a number of years, the pandemic has pushed many others into seeing the value in extending demand sensing within their traditional demand planning organization. This is especially true for CPG firms, but not limited to that vertical.

Given this uptick, and especially for firms utilizing systems applications and products in data processing (SAP) Integrated Business Planning (IBP) software, it will be extremely important for these companies to understand the most critical considerations for a successful implementation of demand sensing.

In this article, we outline six critical success factors (CSF) that are key to a successful implementation of demand sensing technology, in our experience. Our research for this article, and our experience as consultants, is primarily with implementations of SAP Integrated Business Planning (IBP) demand sensing solutions, and with CPG organizations. For that reason, we focus on SAP technology and CPG companies; however, we believe our findings are valid for firms in industries other than CPG, and those using planning and demand sensing technologies from other solution providers.

These success factors focus mainly on approaches to organizing internal and external data inputs, running the demand sensing algorithm, building an exception-based process that balances autonomy and planner control with explainable results and, lastly, rolling out the system and process using a crawl-walk-run approach.

Just what is demand sensing and why does it matter?

Definitions are helpful here. Traditional demand planning typically contains a statistical forecast utilizing historical time series data layered with sales, planner, product and merchandising and other inputs that drive toward a singular consensus demand plan. While these traditional methods have been bolstered in the past with more sophisticated statistical models and collaboration tools, the benefits in most cases have been largely relegated to the mid-term horizon, with forecast accuracy increases seen in bi-monthly and quarterly time periods at aggregated levels.

Demand sensing, on the other hand, tackles the most prized possession in forecasting, especially for CPG firms: the immediate short-term horizon. It does this by applying Machine Learning (ML) and pattern recognition algorithms to analyze shorter-term internal data such as sales history, external data, point-of-sale (PoS) data and future and past consensus forecast data. It analyzes these to ferret out present trends, adjust for bias and produce a near term forecast in the immediate weeks or even days. Given the shorter time horizon, and additional data sources, those forecasts are more accurate than most traditional models out there. And in the coming years, as ML algorithms progress, we expect this gap to grow wider.

Critical implementation success factors

Following, we discuss the six critical success factors identified in our research with organizations that have implemented IBP demand sensing technologies.

CSF#1: Take a data science-based approach

Estimating aggregated demand months in advance is an established practice, but accurately predicting customer orders over a time horizon of several weeks is next to impossible without advanced data science. SAP's IBP demand sensing application uses automation and ML technology to analyze real-time supply chain data, determine the influence of multiple demand signals and produce an accurate daily forecast for every item at every location (see sidebar).

Near-term forecasting must consider the latest data on open orders, shipments and consumption. Data might also include customer and channel inventory, weather, social sentiment and other demand signals. This information can help companies detect shifts in demand that will affect customer orders. PoS and channel data can come from a company's existing systems.

There are some critical data aspects that should be considered before starting an SAP IBP demand sensing pilot/project to avoid the "garbage in, garbage out" conundrum. They are as follows.

- Is the data available at the right levels of product-location-customer combinations? If not, do we have the data transformation logic built in?
- Is there any latency in receiving this data? Not having almost real-time data can have a significant impact on the demand sensing results as the ML algorithms may not consider the latest data for pattern recognition.

- Data requirements may be different for simulation runs vs. real production runs. It's important to analyze the results from simulation and extrapolate the same to actual production results with real- time data coming at the time of the actual run.
- It's important to start taking data snapshots much in advance as that will provide the ability to start measuring forecast accuracy at multiple lags immediately once the demand sensing algorithms are turned on.

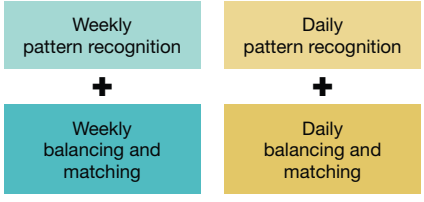
Addressing these issues is half the battle in the journey to making data-driven decisions using IBP demand sensing.

CSF#2: Understanding pattern recognition/ML for demand sensing, model parameters and running simulations

Being able to adequately explain how SAP is using ML and pattern recognition will be critical to convey confidence to users and owners to increase adoption.

FIGURE 1

Machine learning/ pattern recognition



Source: EY

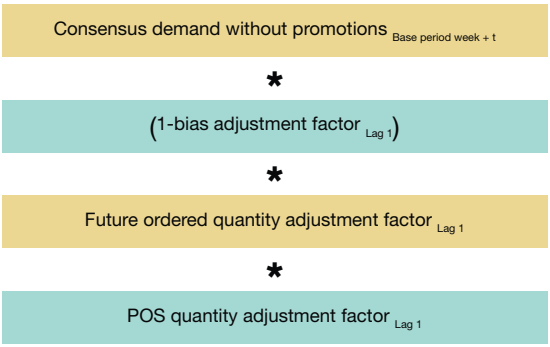
On a basic level, predictive ML uses data, probabilistic models and algorithms to make more accurate, data-driven predictions. SAP's demand sensing model produces two main outputs, and additional optional outputs depending on the external inputs, that drive the sensed demand values (see Figure 1).

- **Forecast bias adjustment:** Learns how forecasts vs. sales correlate and adjusts the forecast.
- **Future open order adjustment:** Understands historical correlation of open orders to final demand and predicts future demand utilizing bias-adjusted forecasts and current open order trends.
- **Extra demand signal adjustments (optional):** Learns from how other demand signals (e.g., PoS, social sentiment, retailer inventory, etc.) and correlates to forecasts and final demand.

The output of these key figures is used to calculate the optimized sensed demand, which results from the ML algorithm adjustment factors before any post-processing. It is calculated exactly according to the logic in Figure 2.

FIGURE 2

Weekly optimized demand for week
(base period week + t)



Source: EY

It is crucial to hone in on several model parameters that are key to setting up the first simulated demand sensing run. The first is the *forecast periods*, or the number of time periods in the future for which you want the system to calculate the forecast.

The current period (for example the current week) is the first time that will be forecasted. Defining this period will depend on the business's specific requirements, but should generally be no more than eight weeks into the future and no less than two weeks. Also, separate demand sensing forecast models containing different sets of parameters may be required according to business need by segmentation or other classifications. This may be determined upfront or down the line as the demand sensing processes matures.

The second critical parameter to establish is the *maximum forecast increase and maximum forecast decrease (%)*. This threshold is set at the planning level at which demand sensing is run and it is recommended that these values are no more than 50% respectively for initial testing. Depending on the current forecast accuracy of the business, greater values can be inputted, but greater variability of the sensed demand output will result. An analysis of the *capped sensed demand and optimized sensed demand* key figures can be used upon testing to adjust this parameter. SAP recommends values of 30% for maximum increase, and 50% for maximum decrease, which can be a useful

starting point for testing. Additional parameters, such as *the BIAS horizon and baseline WMAPE threshold (%)*, can also significantly affect outputs.

One crucial implementation step is to test the model parameters and the impact of additional optional data inputs (such as the additional of external variables) to run simulations in the past of the demand sensing model and to take snapshots of those outputs. SAP provides a way of doing this through the *update offset* operator that can be set up in an application job template along with the additional steps of coping the consensus forecast lag-based snapshots back into the consensus plan key figure, running the demand sensing model, and taking lag-based snapshots. Alternatively, the planning area can be manually offset in the past and the model can run with snapshots captured. This provides historical snapshots of the sensed demand assuming all relevant data known at the time, like the preparation of an ex-post forecast. Implementors can then compare consensus demand outputs and sensed demand outputs through forecast accuracy and absolute error measures to adjust parameters and ensure relevant impact of external data inputs.

CSF#3: Use advanced predictive analytics to explain demand sensing results

SAP provides several intermediary analytical output key figures that provide insight into the demand sensing results. This helps to reduce the "blackbox" conundrum many implementors face in trying to explain results to users. It is crucial to begin familiarizing users with these key figures from the onset, and to build views that allow them to immediately answer questions regarding why the sensed demand values increased or decreased for certain periods and to compare the sensed demand to the consensus demand values.

As demonstrated earlier, the bias adjustment factors relating to the ML algorithm of SAP's demand sensing model can directly calculate the optimized sensed demand and come standard with the SAP6 model. Training users on how to calculate this early on will allow for earlier adoption and helps users feel that there is rationale to the sensed demand values.

Another critical set of standard key figures are populated in post processing and can aid in not only user understanding, but also can be used by data science teams to continue to build and adjust model parameters. These key figures below are optional, but are highly recommended.

- Capped sensed demand: Capped sensed demand according to maximum increase/decrease settings in the forecast model that are applied to optimized sensed demand.
- Weekly open orders: Sales orders where order creation date ≤ base period and material availability date >= base period.
- Weekly balanced sensed demand: Sensed demand results after base balancing and open order matching steps are executed on capped sensed demand.

Analytical key figures are crucial during the post-implementation period, where adjustment factors can point to issues with data and help explain demand sensing outputs to wider groups of planners. As an example, in one implementation to troubleshoot a drop in forecast accuracy improvement, an analysis of the adjustment factors revealed that the future ordered quantity adjustment factor was responsible for this drop, and upon further investigation, it brought to light an integration issue of open sales orders.

CSF#4: Drive toward a touchless, autonomous, exception-based process

At the onset of a demand sensing implementation, one of the most critical design decisions will be to determine exactly how the sensed demand output will be incorporated into the overall demand plan.

To get the most value out of demand sensing, the sensed forecast should cover the deployment horizon and may also cover some of the production horizon. While the sensed demand outputs can always cover this full horizon, how much of that horizon to incorporate into the final forecast sent to supply can be determined manually by planning unit or product grouping, or through a detailed analysis utilizing simulations run to determine optimum accuracy horizons, which can dynamically change over time.

Once the demand sensing horizon is established, it's important to consider whether the sensed demand values will override the consensus forecast or be utilized as another consensus input. To the latter point, it is possible to approach demand sensing in this way, but the overall business value starts to decrease as planner workload increases and the sensed demand forecast is treated as just another statistical forecast input.

To the former point, for the sensed demand values to override the consensus forecast, it will have to answer to one of the biggest concerns for companies implementing demand sensing, which is how to ensure that the best performing

forecast is consistently utilized. This can be achieved through configured automated stage gates around comparative measures such as forecast accuracy, variability and other custom measures. This approach is the most used and provides the best path toward a more autonomous demand planning process that incorporates sensed demand into the consensus demand forecast that is sent downstream.

The most prevailing stage gate determination for blending the sensed demand into the consensus forecast is that of historical forecast accuracy. By utilizing the historical lag-based snapshots of the sensed demand and consensus forecast, an automated comparison between these forecast accuracies can be done to always utilize the most accurate of the two for the determined horizon. It is highly recommended to apply a cumulative forecast accuracy measure over time to reduce week to week volatility. The number of cumulative periods to be used can be the same as the sensed demand horizon or another custom determination if it will vary by product or other segmentation.

Balance tradeoffs to increase adoption. While automated stage gates help to blend the sensed demand forecast into the consensus forecast with no planner intervention, there will be exceptions where neither the sensed demand nor the prevailing consensus demand values need to be passed to supply. For these instances, it is recommended to configure a planner override key figure driven by key figure alerts in either the Web or Excel user interface. This can be accomplished using either the pre-configured *adjusted sensed demand* key figure that comes standard or another key figure used for blending the consensus forecast and sensed demand.

It will be equally important to allow for planner control of the use of the sensed demand forecast at some place in the product hierarchy or combination of planning attributes. For example, for many demand sensing users, this means having an on/off switch in the master data; this allows planners to turn off incorporating the sensed demand into the final forecast for various exceptions. This gives planners a sense of control, which can reduce workloads for individually overriding sensed demand values and can overall increase adoption more quickly with this option.

In doing so, planners can still allow sensed demand forecasts to run every week and to take lag-based snapshots. It will not adversely affect the final demand forecast sent to supply in the case of exceptions such as special promotions, allocations and other exception-based reasons as to why demand sensing should be turned off.

CSF#5: Crawl-walk-run for quick wins

For many organizations, a demand sensing implementation may appear to be a daunting undertaking to implement all at once. It is therefore critical to adopt a crawl-walk-run approach whereby companies can realize value in a narrow scope of products or customers before heavily investing in an entire solution that modifies their current demand planning processes. One way this is accomplished is through a pilot implementation. In this crawl phase the following objectives and success criteria can be undertaken for a given scope driven by customer, location or product groupings.

Pilot objectives:

- validate the concept of demand sensing from a technology, processes, people, organization and performance improvement perspective; and
- implement and run demand sensing with internal data and/or external data (such as PoS) for a limited scope.

IBP functional scope:

- running single-sensed model; and
- running full-sensed demand model (without daily update run).

Success criteria:

- stand-up a demand sensing model for the pilot scope in their productive environment as defined by the project timeline;
- ensure demand sensing data flows seamlessly inbound & outbound from IBP;
- ensure users have a strong initial understanding of the demand sensing model and how to incorporate the outputs in their overall demand planning process; and
- incorporate lessons learned and plan to efficiently design iterative rollouts of demand sensing model to wider scope of business.

After the pilot is implemented and results are carefully measured, the business can then determine a rollout plan that slowly increases the scope and widens the solution to additional planning areas if applicable. In increasing the scope in a single planning area, if the solution took a measured approach that balanced planner control and automation as mentioned earlier, the design should allow for demand sensing to be turned on/off quickly and easily for a wider scope of products and customer. While additional enhancements may be required, designing the planning area with the wider rollout in mind from the initial phases can also help to scale up the solution quickly and reduce re-work.

CSF#6: Measure and improve forecast accuracy at multiple levels

Measuring forecast accuracy may be the single most important measure organizations will regard to determine whether their investment was worth it. It is therefore critical to outline requirements for measuring forecast accuracy of the sensed demand forecast early on. The forecast accuracy for their current consensus forecast should be exactly replicated for the sensed demand in their business intelligence tools and in IBP itself if applicable.

These measures should also show forecast accuracy comparisons across multiple lags and multiple levels in the hierarchy by calculating absolute forecast errors at lower levels while being able to view the accuracy at aggregated levels. This will help to determine where the greatest value is being realized and where greater scrutiny of the model is required. Analyzing and comparing these accuracies over time will help weed out normal volatility and it will be crucial after going live to allow for at least two weeks to three weeks of lag-based snapshots to be captured to be able to fully capture live non-simulated values.

An overview of the forecast accuracies should be reviewed weekly with business leaders to further encourage adoption and showcase any missed opportunities for where demand sensing may yet to be incorporated into the consensus forecast. This will help to slowly bridge the step between the "crawl" and the "walk-run" phase for quicker adoption and full implementation of the demand sensing solution.

Demand sensing success

Demand planning will remain a critical area of focus for consumer goods suppliers and retailers for the simple reason that they cannot sell products that are not on the shelf. Implementing a demand sensing solution is a key backbone to becoming demand-driven, and the benefits of doing so are quite significant to many CPG organizations. Moreover, CPG organizations need to ensure that they follow a structured, data-driven approach to implement any demand sensing solution. ML, AI and predictive analytics play a key role in implementing demand sensing solution, but they need to be balanced with a process-centric, planner-driven crawl-walk-run approach to adoption across the entire organization. Data science needs to be integrated with an agile implementation approach to add additional affecting external variables like Google trends, restaurant traffic, store traffic and weather, to name a few, in order to improve the forecast accuracy further across multiple segments.

Measuring and tracking results right from the start paves a smoother path to derive the benefits and continuous improvement essential to successfully drive the business case. The benefits do not just exist within the supply chain functions, but extend to other functions in the organization and thus cross the entire value. However, CPG organizations need to assess the benefits that would be applicable to them and then ensure that measurement can be obtained before proceeding forward with implementation.

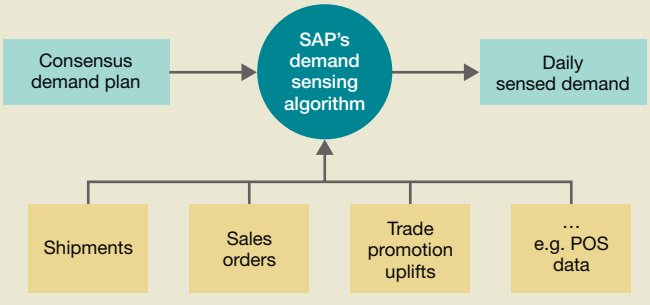
Implementation itself needs to be undertaken with care, as many organizations, especially in the CPG arena, tend to implement solutions before they are ready for them. Ensuring that the demand planning function is at a mature stage not only allows organizations to implement the solution effectively, but also enables larger benefits to be achieved more quickly.

Demand sensing software and IBP

As we noted at the outset, our practice is focused on SAP IBP implementations. Powered by SAP HANA in-memory technology, SAP's Integrated Business Planning Cloud-based solution for demand sensing generates short-term forecasts that consider multiple inputs. The functionality lies in the IBP for demand module that provides powerful supply chain analytics, what-if simulations, alerts and more to stay ahead of change and improve responsiveness (see Figure 3).

FIGURE 3

SAP's demand sensing algorithm



Source: EY

And, as previously noted, while our discussion focuses on SAP IBP demand sensing software, many of the key points and considerations are applicable to other demand sensing implementations and verticals other than CPG.

Case study

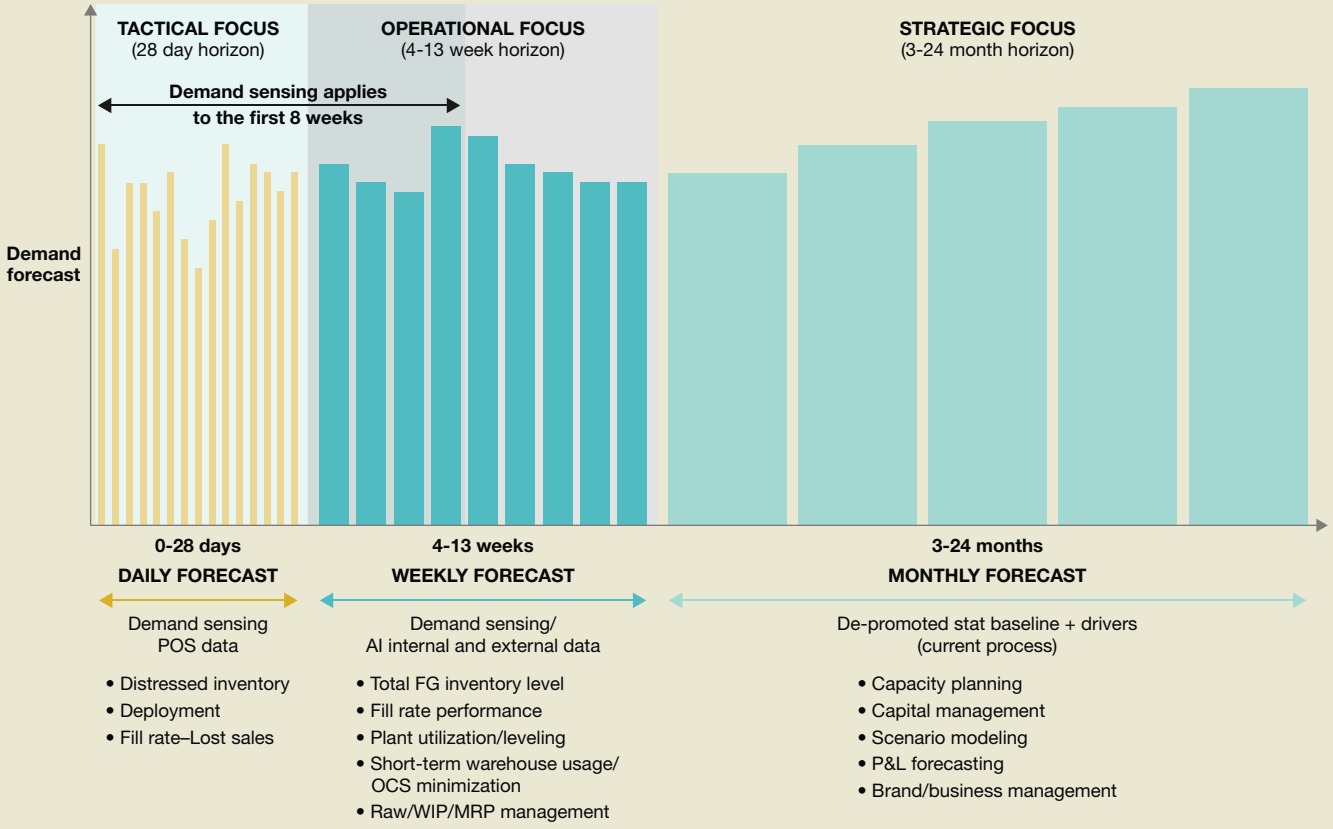
One of the largest meat producers in the world had a significant opportunity to incorporate technology in the planning space. Based in the United States, the company was a modern, multi-national food company producing beef, pork and chicken products. It's current demand planning capabilities weren't sufficiently reactive and couldn't adequately anticipate sudden changes in the market, such as the unprecedented demand for chicken during the early days of the COVID-19 pandemic, for example. In addition, it's then current demand planning models didn't incorporate readily available upstream data sources, such as consumption and social media data.

This organization started the SAP IBP demand sensing implementation with a four-week-long proof of concept to identify and test additional external data sources for relevancy within the demand sensing module. That was followed by applying learnings from the PoC and the implementation, including a continuous improvement phase with further process and system enhancements (see Figure 4). The total implementation took between five months and eight months. Some of the key benefits realized were:

- forecast accuracy estimated to increase by 7% to 15 % from a pre-COVID average level to a post-demand sensing level;
- a 5% to 10% reduction in distressed product losses and a 1% to 3 % reduction in deployment freight; and
- annual savings between $15 million and $20 million, including $13 million to $15 million in distressed improvement and $2 million to $5 million in freight expense.

FIGURE 4

Demand sensing scope

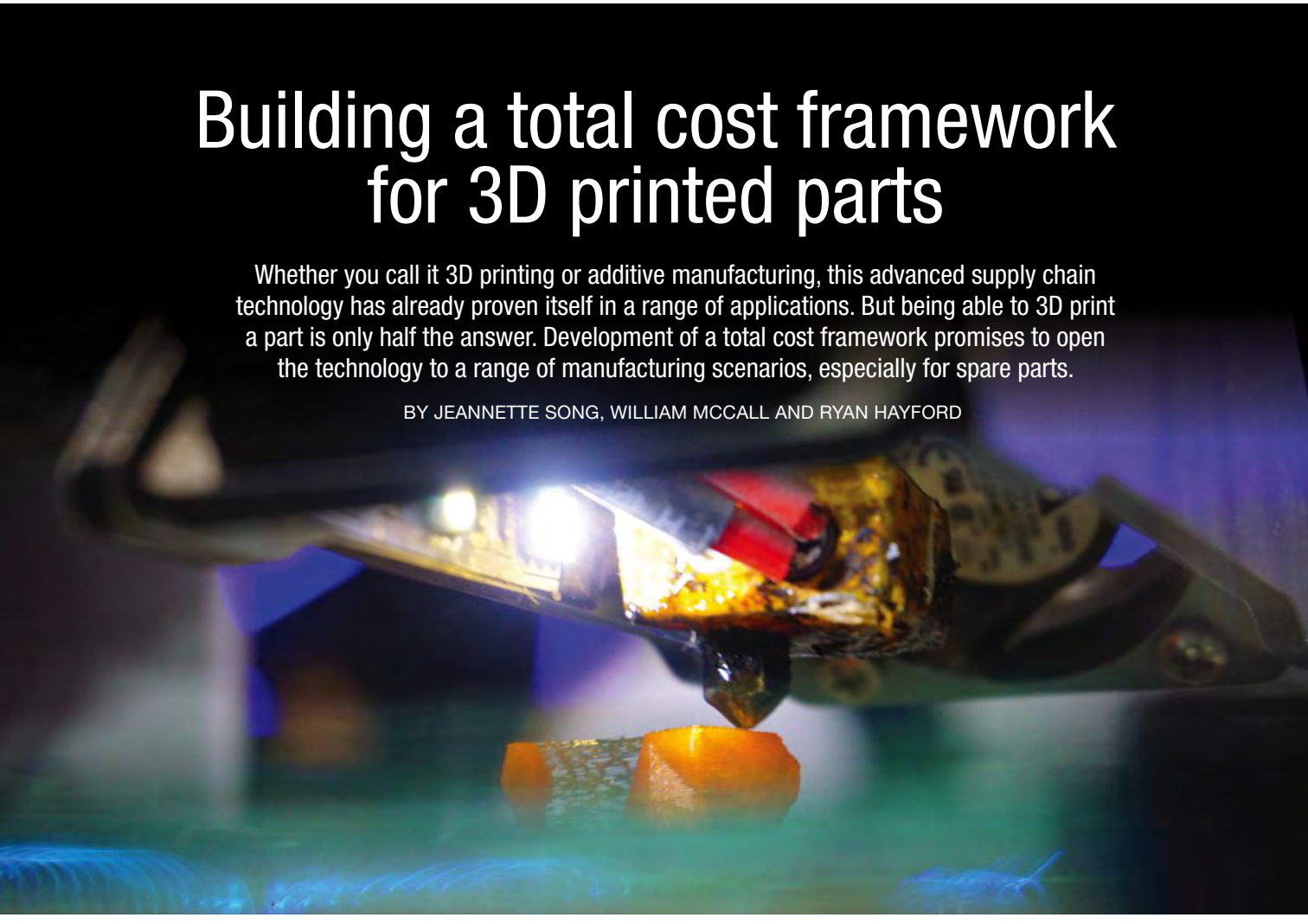


Source: EY

Building a total cost framework for 3D printed parts

Whether you call it 3D printing or additive manufacturing, this advanced supply chain technology has already proven itself in a range of applications. But being able to 3D print a part is only half the answer. Development of a total cost framework promises to open the technology to a range of manufacturing scenarios, especially for spare parts.

BY JEANNETTE SONG, WILLIAM MCCALL AND RYAN HAYFORD



Despite more than 25 years of success, 3D printing/additive manufacturing (AM) finds itself in a peculiar spot.

Thanks to the efforts of countless researchers and engineers, the core AM technologies have matured into competent and dependable manufacturing processes. And it's happened in industries as diverse as automotive, aerospace and medical implants, to name three. In terms of engineering performance, there is an AM technology for nearly every need.

For many companies, AM is the go-to technology for producing functional prototypes and manufacturing aids. For these limited-quantity items, AM is a natural fit, far more economical than CNC machining or injection molding. At-scale production, however, is still a ways off for all but the most advanced and dedicated manufacturers.

That brings us to AM's peculiar spot. On the one hand, the technology has already answered the question: "can I print it?" with a resounding "yes." However, we aren't quite at the point where the same enthusiastic answer works for the question: "Should I print it?"

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A steppingstone to at-scale production may be spare parts. The on-demand nature of AM seems to be especially well suited to low-volume or unpredictable spare part production requests. Typically, 3D printing is well positioned to eliminate exorbitant retooling costs and seamlessly embraces the next generation of digital warehousing.

While focusing on spare parts helps to set the stage here, the crux of the "should I" question remains the economics of AM. At first glance, it seems that pound-for-pound AM is more costly than traditional manufacturing processes. But there are several decision points in any cost analysis that often shift the advantage to AM. These range from design flexibility to on-demand availability.

Clearly, what's needed is an operational and holistic total cost framework to decide when AM is the key to the manufacturing kingdom and when it's better to go traditional.

The academic research has focused on use cases where the lower inventory costs of additively manufacturing spare parts outweigh the increased unit cost. An excellent example of this is the 2020 paper "Stock or Print?" by Song and Zhang. Dr. Song and Xerox began a collaboration shortly thereafter with the intent of synthesizing the existing research, adding enhancements and packaging it into a new framework designed to be operationalized.

After several months our collaboration yielded just that, a set of calculations and recommendations that allow AM savvy organizations to include inventory costs in their breakeven analyses. The full explanation of the framework and supporting mathematics is available online at scmr.com.* For this piece, we offer an overview of the model and explore a few examples.

Established technology

Spare parts are a natural for 3D printing.

The most powerful argument is that 3D printed spare parts bypass conventional inventory processes by producing parts locally and on-demand. That results in significant speed benefits to get a new part in place and the machine back up and running, minimizing the various costs of downtime.

The 2017 whitepaper "The Future of Spare Parts is 3D" from Strategy& estimated that 10% of spare parts will be 3D printed by 2025. That's a big number considering the estimated global market for MRO parts is estimated at $660 billion across a range of industries including transportation, energy and defense.

Meanwhile, a shift in mindset and technology adoption is leading to a new age of innovation that is proactively developing new solutions to existing challenges.

For instance, the third largest aerospace MRO provider, Lufthansa Technik, signed an agreement three years ago with Oerlikon AM to begin identifying additive manufacturing parts and applications. Since then, Oerlikon AM has made significant strides within the industry and just recently expanded to a new state-of-the-art facility in Huntersville, NC.

And that is not a one-of-a-kind. From major transportation industries to consumer products and electronics, the spare part industry is beginning to look at additive manufacturing much differently. Better yet, this is not some head long rush to adopt new technology because it is "cool."

During the past decade, the AM industry has produced several mature and dependable processes for plastics and metals. These processes are toolless, on-demand and offer amazing design freedom. AM is often chosen for prototypes, manufacturing aids and end use parts with extreme complexity.

The barriers to entry are typically related to a lack of understanding the technology and effective comparisons of subtractive and additive processes side-by-side. Meanwhile, the AM industry is quickly growing and new technologies, materials and processes continue to hit the market with great regularity.

It is worth noting that each technology offering comes with its own specific challenges, guidelines, post-processing requirements and related issues. Each can become quite complicated. This typically leads to adoption hesitancy.

Ideally, most manufacturing or spare part production facilities would consider a hybrid approach (CNC plus AM, for instance) to determine the most efficient way to manufacture. Milling, molding and casting are typically the choice for large and simple parts. Additive manufacturing tends to get the nod for custom and complex designs. However, the two manufacturing camps often overlap depending on access and availability.

Evaluating the most efficient manufacturing method is continuously reliant on measuring time, quality and cost. However, the ability to redesign with additive manufacturing to improve product or spare part performance sometimes surpasses those metrics and must always be considered when evaluating the future of part production.

For example, the Caterpillar transmission assembly plant in Dyersburg, Tenn. faced a major catastrophe when a costly problem was traced to a faulty assembly procedure. Instead of shutting down the assembly lines, Caterpillar quickly 3D printed custom fixtures and got back on schedule immediately.

The automotive and heavy equipment industries are well known for detailed tracking and monitoring assembly line production. After all, downtime equates to lost revenue and missed opportunities with customers. It's important to note that 3D printing one-offs are likely more expensive than conventional methods but the design flexibility and speed more than makes up for the difference, especially for critical applications.

Can I, should I?

Clearly, AM and 3D printing are suitable for an extremely wide range of parts. Those successes have built a large library of positive answers to the "can I print it" question. But to expand AM into new application spaces, we need to answer the question "should I print it?" That question is even more important because AM can produce parts on-demand even if the parts were designed for a traditional process like CNC machining or injection molding.

The roadmap for the "can I" question touches on the following three key areas.

- **Geometry:** Can my AM process produce this specific geometry?
- **Material properties:** Will the resulting material properties meet requirements?
- **Post processing:** What kind of post processing is needed to achieve required surface finish and accuracy?

For "should I," the key areas are as follows.

- **Total cost:** What is the unit cost? Up front tooling cost? And, critically, the inventory cost?
- **Lead time**: Can I tolerate the lead times of traditional manufacturing, or do I need it now?
- **Flexibility:** Does this product need frequent design changes or customization?

As the answers to these questions make clear, not every spare part is the perfect candidate for AM. We recommend starting with a financial analysis that will better predict potential outcomes for today and tomorrow's supply chain challenges.

The general starting point is that AM is more costly pound-for-pound than traditional manufacturing. However, certain factors can shift the outcome of that comparison. Here are three common economic justification conversations that help to determine where the advantage really lies.

1. The first is a classic breakeven analysis showing that the higher cost of AM is actually offset by the high upfront tooling costs of traditional manufacturing. As annual demand increases and the pricy upfront tooling is spread over more and more units, the cost of traditional manufacturing plunges. At some point, it drops below the AM unit cost, and a breakeven point can be calculated. For plastic injection molding or metal casting, this is typically a few hundred units per year.
2. The second involves AM's exceptional design flexibility that allows the finished part to per form at a higher level. An example of this would be an additively manufactured heat exchanger that is highly efficient. Even if the AM part is double the cost of the traditional part, the increased efficiency can generate significant long-term energy savings for the end-use customer.
3. Lastly, some parts are designed in a way that they can only be made with AM. For example, internal features that cannot be cast or machined. In this scenario, AM wins because it is the only process capable of producing the part.

What is missing from all of these examples is quantifying AM's supply chain benefits. The on-demand nature of 3D printing permits batches to be as small as one with very short lead times, minimizing the number of units needed in stock. The result is that ordering costs, inventory holding costs and obsolesce costs are all far below what is typical for traditional manufacturing.

While often touted as key benefits of AM, these costs are rarely included in any cost analysis. This happens, at least in part, because they are significantly more complex to calculate than the typical breakeven point. As a result, we need an operationalized and holistic total cost framework to advance the conversation around the real economics of AM.

A total cost framework

The basic formulation is upfront costs + production costs + inventory costs = total costs. Simple, yes, but the devil is in the details; each of these cost areas further breaks down into sub-cost areas and each of those requires its own costing methodology (see Figure 1).

Our goal is to develop a holistic framework that shows how inventory costs change the picture. A business should deploy its own version of the framework by combining commercial off-the-shelf software packages with its own internal data.

To determine which process is the most cost-effective for a specific part, we can use the total cost framework as an eight-step sequence.

FIGURE 1

Example part information

	Value AM	Value TM
Volume	122 ccm	
XYZ dimensions	150 x 140 x 25 mm	
Material	Polymer (Nylon)	
Demand period	5 years	
Upfront costs	$500	$5,500
Production cost	$15.00	$5.00
Inventory costs		
Ordering	$10.00	$175.00
Holding	$1.59	$0.69
Lead time (L)	3.5 days	30 days
Minimum order quantity	0	0

Source: Authors

1) Collect data—overall business
   - Operations: resource costs such as equipment and labor rates, facility costs rates, distance to supplier.
   - Finance: interest rates, insurance rates, tax rates.
   - Supply chain: target service levels, warehousing rates, freight rates.
2) Collect data—specific to each part
   - 3D design files, technical specifications, material requirements.
   - Current traditional manufacturing cost.
   - Annual demand, lead time, minimum order quantity (MOQ).
3) Find upfront costs—everything needed to prepare a part for production
   - Engineering design.
   - Tooling.
   - Testing and verification.
4) Find unit production costs—cost to make or buy one additional unit
   - Machine depreciation.
   - Raw material and consumables.
   - Direct and indirect labor.
5) Estimate inventory cost parameters using data from previous steps
   - Cost per order: administrative, transportation, operations, supply disruption.
   - Annual holding cost: cost of capital, warehousing, (note scrap is separate).
   - Scrap costs: obsolescence, deterioration.
6) Calculate inventory policy: needed to find the inventory costs
   - Assume an rq policy.
   - Find the economic order quantity "q" and reorder point "r."
   - Find the expected number of orders and average inventory on hand.
7) Find the inventory costs = ordering + holding + scrap costs
   - Ordering cost = cost per order X expected number of orders.
   - Holding cost = annual holding cost X average inventory on hand.
   - Scrap cost = average inventory on hand X unit production cost.
8) Find total cost
   - Total cost = upfront costs + production cost + inventory costs.
   - Compare total costs for AM and TM sources.
   - Optional: recalculate at different annual quantities to find the breakeven point.

To show the quantitative impact of including inventory costs, we conducted an evaluation of a nylon part in three different scenarios. The results are summarized here, while the full details and calculations are available on scmr.com.

The three scenarios we evaluated are:

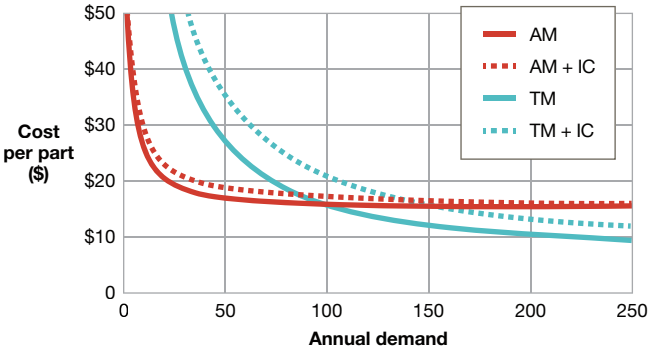
1) a new part, where the part is used in low-volume

series production of the original equipment;
2) a spare part, where the original equipment is not produced, but the part still is for aftersales spares; and
3) an end-of-life part, where the traditional manufacturing of the part is stopping, and an all-time-buy is required, but AM continues to be a sourcing option for unforeseen circumstances in the future.

Scenario 1: New part

A classic application of AM, as previously mentioned, is low-volume production, where the upfront tooling costs make traditional manufacturing very costly. Plotting out the total unit cost for the example part yields the cost curves in the chart below. When inventory costs are ignored, the breakeven point is 100 units per year (solid lines), meaning when the annual production quantity is larger than 100 units, traditional manufacturing should be used. However, if inventory costs are included, then the breakeven point is 138 units per year (dashed lines). To reach the same breakeven point without considering inventory costs, the AM production costs would need to be 20% lower ($12); see Figure 2.

FIGURE 2
Scenario 1



Source: Authors

The importance of this has not been lost on the U.S. defense industry, which is highly motivated to embrace additive manufacturing across all departments and disciplines. In January 2021, the U.S. Department of Defense published its first-ever AM strategy report focused on three key initiatives:

1. modernize national defense systems;
2. increase material readiness; and
3. enhance warfighter innovation and capability.

With a strategic interest to deploy additive manufacturing for battlefield equipment repair or emergency disaster relief applications, engineering teams on the ground will be expected to quickly print parts on-demand and solve problems immediately.

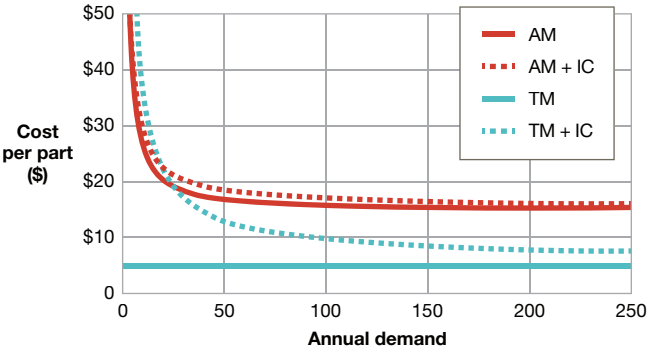
Naval Postgraduate School, located in Monterey, Calif., is actively pursuing this approach with liquid metal additive manufacturing. Instead of wasting valuable storage space on a ship for spare parts that may never be used, this strategy creates a path towards onsite (on ship) production of light fixtures, replacement valves, customized tools and more. Not to mention, redesigning parts for better performance on the ocean can provide immediate advantages. This takes readiness to a new level.

Scenario 2: Spare part

The same kind of breakeven analysis can be applied to spare parts. Here the example part does not have any upfront costs for traditional manufacturing because the tooling is already paid for, but additively manufacturing the part would incur switching costs (see Figure 3).

Convention would hold that continuing with traditional manufacturing is the least costly option and that there is no breakeven point (solid lines). But if we include the inventory costs (dashed lines), we can see the breakeven comes to 15 units per year. In this example, the change is driven by the relatively high obsolescence and tool maintenance costs of traditional manufacturing. Without the inclusion of inventory costs,

FIGURE 3
Scenario 2



Source: Authors

AM would need a unit production cost less than that of traditional manufacturing, because AM would have to overcome its switching costs.

A leading example here is the Shell Technology Centre in Amsterdam, a research and development facility focused on spare part production using additive manufacturing. This aligns with Shell's commitment to the digital supply chain and develops new opportunities to address major challenges such as obsolescence, just-in-time inventory and other material supply chain opportunities.

Several of their assets are aging and will eventually reach end-of-life status. For example, if a compressor is obsolete and it stops working then the entire compressor must be replaced because the individual components cannot be manufactured any other way. This enables Shell to keep equipment operational and improve asset longevity. In addition, Shell aims to redefine the conventional logistics supply chain and remove the headaches associated with long lead times and international tariffs. 3D printing spare parts on-demand will eliminate supply chain delays.

Scenario 3: End-of-life/all-time buy

Long before demand reaches 15 units per year, many businesses would execute an all-time buy to manage the future demand. Changing to new technology at this point in the product lifecycle is very uncommon, yet even in this scenario, AM has a role to play.

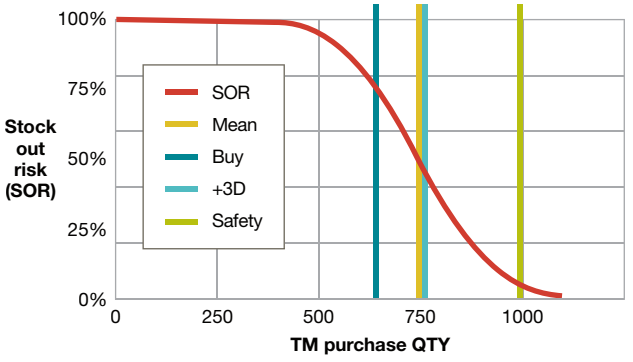
The core challenge with all-time buys is that future demand is uncertain, and by definition, there is no opportunity to reorder. In this example, the likely demand is somewhere between 500 and 1,000 units. To cover the uncertainty, businesses must order more units than they expect to need, only to scrap some of those parts at some point in the future. Until then, the parts are taking up warehouse space and capital.

By modeling expected demand on a bell curve (normal distribution), we can predict the likelihood of stocking out for any quantity of units purchased. This is where AM comes in.

Instead of buying enough units so the chance of a stock-out drops below some target (in this example 5%) the business should dual source the part (see Figure 4). The bulk of the demand (648 units) would be covered by an all-time buy of traditionally manufactured units. For this example, the remaining uncertain demand can be covered by AM parts with 113 units additively manufactured. That gives a total expected part production of 761 (648 TM and 113 AM). While single sourcing from traditional manufacturing has a lower cost than pure AM, this dual-sourcing approach offers an additional 7% cost reduction.

FIGURE 4

Scenario 3



	AM	TM	Dual source SOR = 75%
Production	$11,250	$3,750	$4,932
Upfront	$500	$0	$500
Inventory	$789	$5,738	$3,414
TOTAL COSTS	**$12,539**	**$9,488**	**$8,846**

Source: Authors

The total cost framework presented here is simple but powerful. By including inventory costs, the framework shows that AM can be cost-effective in scenarios where previously it would not have even been considered. Over the next decade, we expect that AM will continue to improve in cost and quality, and that it will augment rather than supplant traditional manufacturing.

The key to leveraging AM to its full potential is knowing when it should be used, not just when it can be used. This total cost framework needs to be tailored to the specific circumstance of each business, but undoubtedly will expand the scenarios where AM is the right choice.

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**3D Printing Spare Parts: A scalable total-cost framework for sourcing decisions*

A RIVER RUNS THROUGH IT

Is an inland waterway in our future?

Logistics is grappling with too many trucks, too few drivers and calls for more sustainable transportation modes. Maybe it's time to develop commerce on the rivers between New Orleans and St. Louis.

BY MASAO NISHI

Logistics and transportation is in the news like never before. There are bottlenecks at almost every critical point of a shipment's journey from point of manufacture to final mile delivery. Shipping containers are in short supply. If you can get your product into a container, available space on a ship is limited and must be booked weeks, and sometimes months, in advance. There is congestion at the ports, slowing down unloading. And, if you get your container off of a ship, there's a shortage of trucks and truck drivers to get them to a distribution center.

What if there was an alternative route from the port of entry to an inland container distribution point? One that avoided the over-loaded ports on the West Coast and significantly reduced the amount of truck travel? And one that presents an opportunity for some companies—not all companies—to gain a competitive advantage by creating a new network that better matches logistics needs with all available transportation modes.

That's the concept between utilizing an inland waterway for shipping ocean containers as an alternative to the rails and trucks—specifically using the Mississippi River with New Orleans as the point of entry and St. Louis as the point of distribution either to the final customer or to other distribution hubs, especially in the Midwest. The idea is to develop another option, especially for those projects where the speed of transportation is not as important as reliability.

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It does take a leap of imagination (and a leap of faith) and will require investments from some large global shippers as early adopters. However, there is already some support for the idea, as some large importers have begun to use multiple container ports around North America besides the West Coast ports. Sometimes called the four corners strategy, this is where companies use multiple points of entry that are far apart from one another. One major retailer, for example, is currently using LA/Long Beach, Houston, Mobile, Savannah and Norfolk as it's points of entry. That retailer is not alone: Other companies have applied a similar strategy.

We appreciate that this is a conceptual idea. But, the concept for an inland waterway utilizing the Mississippi is arguably a natural extension of the four corners strategy. We believe the new strategy would have several key components and benefits. They are as follows.

- Add a river link from New Orleans to the St. Louis region; use containers on barge or containers on specialized river vessels.
- Use low-cost water transportation as much as possible throughout the entire end-to-end supply chain, including on the Mississippi River.
- Get as close to the Midwest as possible by water, reaching a significant 20% of the U.S. market via this new mode.
- As a result, further diversify risk and contribute to sustainability.

In this article we will provide background information on the concept and then discuss what must happen to make it a reality.

Ocean containers on the river

Bulk commodities like grain, coal, gravel and chemicals have always moved by barge. The same can't be said for ocean containers on inland waterways, at least not in any significant way.

For this discussion, we are focusing on the ocean containers that move from Asia to the U.S. Midwest. Typically, these land at a West Coast port and then move by intermodal rail or truck to the Midwest.

In any transportation discussion we need to address the reverse flow to balance the front haul. We start with the traditional manufactured export freight originating in the Midwest. But in addition, there is an increasing volume of containerized agricultural products that originate in the Midwest destined for international markets. As a matter of fact, the St. Louis region is called the Ag Coast of America because it is the origination point for the barges that move agricultural products in bulk to New Orleans for shipment in bulk to the global markets.

In this new model, containers originating in Asia would travel through the Panama Canal to New Orleans, transfer to river vessels and then move up the Mississippi River to St. Louis for further distribution (see Figure 1).

Inland waterways

River travel is already established in the U.S. If you want, you can travel by river from New Orleans to Minneapolis and from New Orleans to Pittsburgh. But not all riverways are easy to navigate. For example, there are 29 locks and dams on the Mississippi just between St. Louis and Minneapolis, and 21 locks and dams from the point where the Ohio River separates from the Mississippi to Pittsburgh. Traversing through those locks takes time and large tows often have to be broken down into smaller tows.

FIGURE 1

The long stretch of the Mississippi River from New Orleans to St. Louis has no locks and dams

Source: Authors

The same is not true of the long stretch of the Mississippi River from New Orleans to St. Louis, where there are no locks or dams. It is a magnificent stretch of wide, free-flowing water that remains ice free all year. As a result, this is the ideal place to start to develop an inland waterway for container traffic; if it is successful, other river segments can be addressed later.

Moreover, it's no accident that the famous St. Louis Arch is a symbol of the city's unique geography. St. Louis has always served as a major transportation hub, featuring

access to four interstate highways, six Class I railroads and two international cargo airports. There is developed and developable industrial land on both sides of the river. And the St. Louis region doesn't have intense traffic and congestion, allowing truckers to quickly get out of the region and on their way. And because of how the natural river system favors St. Louis, we can argue that the region is ideally suited to serve as the Gateway to the Midwest for product coming up from the South.

Following are some of the arguments and benefits of an inland waterway for ocean containers.

Not a new idea

Shipping containers on riverways isn't new—it is simply uncommon in the United States. In Europe and China, on the other hand, the Rhine and Yangtze Rivers are major freight lanes for containers. Self-powered, specially-designed river vessels and riverside container handling equipment are used in addition to barges and towboats. We can be comfortable in knowing that well proven practices already exist.

Lower cost

Because the majority of containers from Asia come through the West Coast, the cost comparison is as follows: The cost of an ocean carrier from Asia to the West Coast plus intermodal rail cost to the Midwest, versus the ocean carrier cost from Asia to the Gulf coast plus intermodal water cost to the Midwest.

Inland water has several underlying advantages over rail. For one, a typical river barge can conservatively hold 36 40-foot containers (three containers across, four containers deep and three containers high). The containers just need to be stacked up and secured. Rail on the other hand requires one flat car for every two 40-foot containers, double stacked. Rail flatcars and rail tracks are costly and require maintenance. Barges operate on naturally existing riverways and require relatively low maintenance.

There is also a huge difference in scale between rail and water. For example, six standard barges can move the equivalent of a 110-railcar train (about 220 40-foot containers). A large tow with 50 barges can move the equivalent of eight of those trains, or nearly 900 rail cars. The optimal size of a tow will depend on demand, but there is great flexibility and a very significant economy of scale possibilities.

Now, we concede that there is great volatility in transportation rates for many reasons. Ocean rates and domestic transportation rates fluctuate widely with normal supply and demand, seasonal and competitive pressures. That's not to mention labor issues, container shortage issues and pandemics.

That said, let's attempt to ballpark the savings by focusing on a few items with the idea that many issues can be ignored for our purposes. For example, when it comes to serving the Midwest, a number of issues are the same whether you get there by rail or by river. Specifically, we are talking about return loads and empty containers, and the decisions around transloading. Also, port and other related costs are ignored because they will be incurred regardless of the port. The relative cost advantage can vary and change for multiple reasons.

For our calculations, we are using Chicago as the entry point to the Midwest by rail from the West Coast, and St. Louis as the entry point to the Midwest if we are coming upriver by barge. The key items, then, are as follows.

- **Ocean carrier costs.** We will assume the cost of shipping from Asia to the Gulf Coast is about $700 more than Asia to the West Coast. This is a rule of thumb that knowledgeable logisticians are comfortable with.
- **Domestic transportation costs.** We will assume that $1800 is the intermodal rail cost from LA/Long Beach to Chicago and that the cost of barge transportation from New Orleans to St. Louis is $600. That yields a $1200 advantage for barge transportation.
- **The difference:** The net benefit for barge travel is about $500 per 40-foot container.

We are making assumptions, but we believe this is a starting point for the cost benefit of river travel.

Improved sustainability

Quantifying the effect on the environment is also difficult, but barge does have one clear advantage over rail in domestic transportation. The U.S. Army Corps of Engineers and the Tennessee Valley Authority (TVA) estimate that barges can move one ton of cargo 647 miles per gallon of fuel. In comparison, a rail car moves the same ton of cargo 477 miles per gallon of fuel, according to the American Association of Railroads (AAR). But the tradeoff is the additional ocean miles, where the age and the size of the ships make a significant difference. As an added sustainability benefit, a switch to waterways diverts volume from highways, bridges and rail and

will help slow the ever-increasing demand for infrastructure construction, rebuilding and maintenance.

Speed is not always important

The tradeoff for lower costs and improved sustainability is speed. River travel is slower, and the fact that barge travel will result in slower and unacceptable transit times is the most frequent push back we hear about this concept. Our estimate, based on input from logisticians, is that the transit time to St. Louis by inland waterway versus Chicago by rail and truck is an additional two weeks to three weeks after the initial startup phase.

The question is whether all products need the same time to market. In our estimation, the percentage of products that can be rerouted to an inland waterway may be relatively small, but the volume of freight would still be significant. Following are examples of items where speed is relatively unimportant.

Seasonal items. Retailers accumulate and hold seasonal inventory until the season hits. During the stockpiling phase, reliable and predictable service is important, but speed is not. Examples in this category include outdoor furniture and artificial Christmas trees.

Promotional items. This category includes items purchased by retailers in advance of major promotional campaigns.

Items with predictable demand. The transit time is not as important for items that have a steady and predictable demand. For example, if you know you will sell a container per month of an item, the transit time doesn't matter as long as you can reliably plan to receive a container a month.

Heavy items. Extra heavy items may result in overweight loads for highway travel. Keeping those containers on the water and off the highways for as long as possible may outweigh speed.

Low-value items. For low-value items, the cost of carrying additional inventory may be easily offset by lower transportation costs, especially if the low-value items are bulky, heavy or relatively expensive to ship.

Project items. These are items that are staged for projects, such as building materials, equipment, inventory for new warehouses, new manufacturing locations and new stores.

The key is that we are only interested in those items where speed is not as important of a factor. When you get into a serious discussion with shippers on this topic, surprisingly, they often suggest a variety of new ideas on items where added transit time would not be a problem.

Better manage risk

If the pandemic has taught us anything it's that risk management is a more important consideration than ever. Some of the known transportation-related risks include:

- labor issues at key ports resulting in significant disruptions;
- significant congestion in and around certain ports;
- weather and fires affecting ports or nearby areas; and
- flooding and freezing on rail routes.

Aside from known risks there are unanticipated disruptions that are occurring with increased regularity. In the recent past, for instance, we have seen the shutdown of the Suez Canal, the Colonial Pipeline, a bridge on I-40 in Memphis and, of course, the pandemic.

An all-water route from Asia to the Midwest can become an important part of a risk management strategy and offer diversification and redundancy to a company's transportation strategy.

What shippers have to do

To use the St. Louis region as an entry point for ocean containers, shippers must look at their entire supply chain network and their plans for a distribution network transformation. Considerations are as follows.

Understand speed. Shippers should classify all of the items in their portfolio by the speed-to-market requirements. By going through this process, the shipper will have a good understanding on where speed is and isn't important, and which items could be selected for an inland waterway.

Aside from selecting the right items, what else can the shipper do? Any company sourcing from Asia has already signed up for a lengthy order cycle time—times that are getting longer. Are there activities in the process where time can be taken out to make up for the increased transit time? Through technology, can we improve visibility and allow for dynamic action that lessen the need for speed?

Network re-design. Large global companies typically have multiple overlapping distribution networks. Some

facilities in the network serve one purpose; some serve multiple purposes. Some networks are designed around the products distributed (general merchandise, hard goods, soft goods, fashion, grocery, dry and temperature-controlled products) and some on how products are sold (single items, group of items, in single units, cases and pallets). Some are based on the type of destination (other internal DCs, customer DCs, cross docks, company or customer stores or the end consumer) and some are determined by inventory locations, cross dock locations or a combination of both. Some are import DCs; some are domestic DCs. And so on.

Companies might now consider facilities and outbound transportation for items that are appropriate for taking the all-water route into the St. Louis region. After arriving, two things can happen: The product can be inventoried in the St. Louis region or moved immediately to the next location in the Midwest.

As an example, companies may wish to establish a seasonal products inventory location in St. Louis, particularly if the products are heavy or bulky. Call it a seasonal distribution center (SDC). Product can accumulate there, and then ship from the SDC to other DCs in the shipper's network, to customers' DCs, direct to stores or directly to the end consumer as needed. Similarly, shippers could locate facilities designed for promotional items, the highly predictable steady demand items, heavy/bulky items or low-value items.

But beyond inventorying product in the region, 3PL services or freight forwarders can immediately get the containers or their contents moved to wherever the shipper wants the product to go after arriving in St. Louis.

Next steps

If you're still with us and entertaining the idea of an inland waterway, three things need to happen to make this a reality: demand by shippers; viable container service on the riverways; and more frequent calls on New Orleans by ocean carriers.

It's a chicken or egg problem.

There is some general interest among shippers, but at present there is no service for them to sign up for. To make this a reality, large shippers will have to play an active role to fully develop a workable solution. Before other companies will fully engage with the concept, they will want to see as many issues as possible resolved. That requires a few big players to get the ball rolling—or the barges floating.

Container service could be the easiest piece of the solution. Containers will comfortably fit on existing standard barges and will work with the existing fleet of towboats. For example, barges are already moving containers from chemical plants on the Mississippi River in Baton Rouge to the Port of New Orleans for distribution to global destinations. The distance traveled on the river is shot, but it does provide a proof of concept.

Other developments are in the works. We are aware of one company designing a new river vessel for containers that will provide service from Plaquemines, just south of New Orleans, to and from St. Louis and other cities. Another company is building and marketing double-wide barges that use the footprint of two standard barges but will carry more than double the number of containers. And, finally, an operation is already in service to reposition empty containers from the St. Louis region to Memphis and New Orleans.

Development of an inland waterway will also require some minimum level of consistent ocean carrier service from Asia to New Orleans. The greater the frequency of service into New Orleans, the more attractive the overall trip will become. We are encouraged by the increasing volume of containers now coming into the Gulf ports, led by Houston. That trend will make it easier for ocean carriers to add capacity and shippers to increase their reliance on the Gulf.

The whole idea of containers on the riverways is evolving. What began in a fragmented way could become an integral part of a broader network strategy. To move it forward will require the active involvement of a variety of groups: Supply chain strategists and network planners at large shipping or consulting firms could be key in designing a comprehensive network of facilities and transportation, which more precisely match true requirements.

At the same time logistics service providers will have to work together to develop workable solutions, including ocean carriers, river carriers, ports, 3PLs and freight forwarders. And significant leadership—and imagination—will be needed to make it happen.

THE ROARING 2020s
IN SUPPLY CHAIN MANAGEMENT

Three trends that will challenge supply chains in the coming decade.

BY GARY A. SMITH

As the world fights off the effects of COVID-19, the coming decade will bring its own unique operational challenges. Although I am not a futurist, I believe at least three compelling trends will affect supply chains in the decade of the 2020s. How we deal with them will significantly affect the way of life and standard of living for ourselves and future generations. These trends are as follows:

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1. the retirement of Baby Boomers;
2. more and more disruptions; and
3. the impact of climate change.

Daunting, yes, but these trends are not insurmountable. Let's look at each in more detail with an eye to how supply chain management can lead the way in the next decade.

Trend #1: The Boomer generation will soon be the Lost generation

The Baby Boom generation, born between 1946 and 1964, is now in the middle of retiring from the workforce. The last of this generation will reach full retirement age in 2031. As Boomers age out, they will take their cumulative skills, knowledge and historical perspectives with them, leaving a huge hole in the collective work experiences of organizations. When Joanna leaves procurement, where she has been a category manager for 20 years, who will do her job? In many cases, by the time people realize she is gone, no one will remember how she did her job. What will be missed is the value she added to the department, and while that may not be apparent right away it will eventually be missed. Multiply this across a generation that now numbers 78.7 million, and the loss is incalculable.

The Boomer generation experienced the first truly exponential leap in technological change of any generation. They saw the invention of the integrated circuit, men going to the moon and back, deep space exploration, advances in computing and the growth of the Internet. That just scratches the surface. This gives Boomers the advantage of *historical perspective*. Allowing for historical perspective, we can understand not only what decisions were made but why those decisions were made. Events happen surrounded by the political, economic, societal customs, practices and cultural norms of their times. The use of historical perspective helps to clarify the issue's context and normalize it in its time period. Historians call the judgement of events using the cultural norms of today *presentism*. It is a practice that is avoided by modern historians because it introduces bias and distorts understanding.

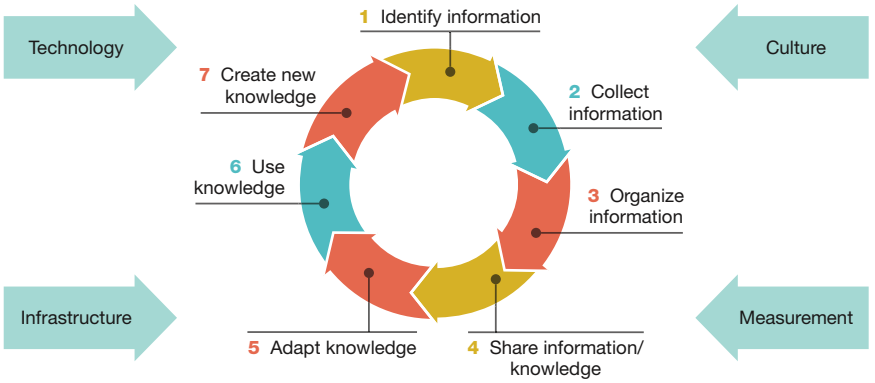
How can the cumulative knowledge of an entire generation the size and breadth of the Boomers be passed on to the workforce of the future? And how can we still maintain an historical perspective? There are several solutions to address this potential loss of institutional knowledge. One is to use knowledge transfer (KT). KT is a process by which an experienced employee transfers job-related knowledge to another person. Studies show that when an employee leaves the organization, they can take about 70% of company knowledge with them that is ultimately lost to the organization and will have to be re-learned. Most of the reason for this is that many organizations lack a formal knowledge transfer program. Your organization can develop a KT program using the following general steps (see Figure 1).

1. Determine what is indispensable for your employees to know. What specific knowledge does your staff need in order to do their jobs? Your most experienced people should be able to assist you in developing a list. The list should contain two things, indispensable job functions and indispensable job skills.
2. Develop a library of best knowledge transfer practices. Best practices can be culture-based so what fits your organization may not work in other companies. Best practices may include interviews, mentoring, storytelling, communities of practice, simulations, e-learning, instructor-led training and job shadowing.
3. Create a knowledge database. This step consolidates the information gathered and formatted in steps 1 and 2. Knowledge databases can include formalized procedures manuals, hardware and software training manuals, video or instructor-led training.

Loss of institutional knowledge should be part of any risk management program. As key staff leave the organization, it can be very useful to ask them to leave notes of what their job

FIGURE 1

Knowledge transfer process



Source: Author

duties included and a list of their annual goals for themselves and their direct reports. If a successor is named prior to their leaving, the new person should shadow the incumbent for as long as possible, to gain insights, job knowledge and historical perspective.

Short of cloning the best and brightest minds before they retire from the workforce, many organizations are leveraging Artificial Intelligence (AI) and including it as part of their digital transformation initiatives. AI software is designed so that it can actually learn and reason in a manner similar to humans. When leveraged as part of an organization's digital transformation program, it can add an entirely new dimension, allowing the organization to set up rules based on the input of trusted, experienced and tenured people. As the Boomer generation retires during the next decade these technologies, techniques and concepts will certainly help to incorporate, offset and replace much of the institutional knowledge that might otherwise be lost.

Trend #2: A decade of constant disruption and change

Change happens continuously. This is especially true of transformational change, where the result is a fundamental and significant to the organizational culture and work processes. Without transformational change and its siblings, innovation, progress, improvement and growth, we might still be hunting our food, sheltering in caves and living much shorter lifespans.

For millennia, change happened very slowly, with only one or two major events occurring every generation or two and sometimes not at all. The rate of change could best be described as logarithmic and could be shown graphically like Figure 2 on the left below. When change and innovation occurred, it could be easily absorbed by the populace and became part of the culture. It could also be easily transferred from one population group to another.

Then, beginning about the time Gutenberg invented the printing press, the rate of change began to increase; today it is practically exponential (Figure 3). The result has been a mixed bag. On one hand, much of the change has been for the better. We are no longer hunter-gatherers, most of us live in cities and not caves, and when we reach the age of 20 we are not considered ancient. On the other, change is now occurring faster than most people can absorb.

Change has provided a high standard of living, employment and, for consumers, price drops and service level improvements such as ubiquitous overnight delivery and free shipping.

But there is a darker side. Lost in the low unemployment numbers are the people who have permanently left the workforce because they lack the skills needed for these new jobs. Because they are no longer pursuing employment, they are no longer counted and are basically forgotten. An article in *The Washington Post* estimated this number to be about 5 million people above and beyond the 10.1 million people that the Labor Department officially recognized at the time as being unemployed.

To many, change is now viewed as another in a string of disruptions, causing job losses as manufacturing moved overseas, and digital transformation, artificial intelligence and automation seemingly conspire to throw even more people out of work. To them, it's a seemingly never-ending vicious cycle.

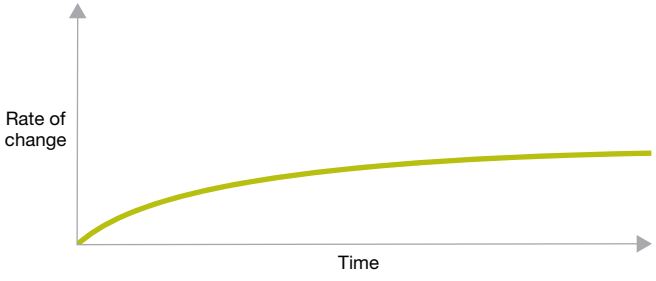
COVID-19 has proved to be the great accelerator of change. Trends that should have taken years or even decades to mature, occurred virtually overnight. Virtual meetings, including virtual doctor's visits, kept people connected and healthy and kept companies functioning. Brick-and-mortar retailing accelerated its downfall while e-commerce, including e-grocery, exploded. Travel dried up and streaming entertainment services blossomed. As someone once said: "There are decades when nothing happens and weeks when decades happen."

A paradigm shift for transformational change

People resist change that they perceive as contrary to their basic needs. Leadership expert Amir Ghannad says this is because they

FIGURE 2

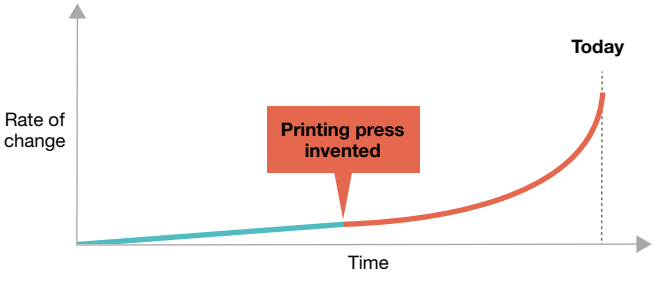
Rate of change-logarithmic



Source: Author

FIGURE 3

Rate of change-exponential



Source: Author

do not see the same benefits as those making the change do. They want the following questions answered.

- *Why are we doing this?*
- *What will the change look like?*

When people can get a picture of how change will improve their jobs, it makes a difference. When people understand what is in it for them and the broader organization, they too become believers.

In 1943, Abraham Maslow published "A Theory of Human Motivation." He determined that motivation was predicated on a hierarchy that begins with basic physiological needs such as water, food and shelter. As these needs were met, the next level of basic needs included security and safety. These basic needs form the essential requirements for human security. Transformational changes in an organization are usually immediately perceived by those affected by the change to be basic in nature (how will this affect my job and/or will I have a job?) and therefore run counter to human motivation at its most basic level. The result is fear, suspicion, insecurity, dread, non-cooperation and even sabotage.

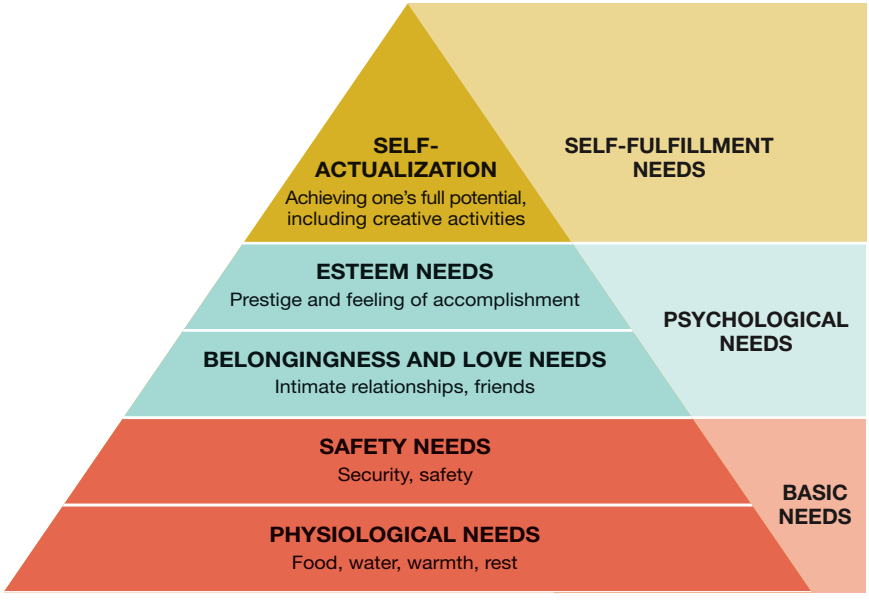
So why would anyone in their right mind want to implement change? As can be seen in Figures 2 and 3, transformational change is happening, and per Figure 3 it is happening now at an extraordinary rate. Instead of allowing the organization to view a transformational change project as an attack on people's basic needs, organizational change management (OCM) should address the change positively so as to appeal to the Maslow's higher levels. For example, instead of focusing on how much more productive the change will be and how much money, time or raw material the company will save (people read this as job loss), focus instead on how the change will improve workplace safety, how it will make the organization more competitive and jobs more secure or how it will reduce complexity and eliminate tedium. Change can also make the job more specialized and allow people to learn new skills, leading to promotions and higher pay. Don't be afraid to open the pocketbook and share the wealth.

Renowned behavioral scientist Dr. Natalie Hallinger, offers the following four tips for changing behavior.

1. **Make it relatable.** Brute force is rarely the path to least resistance. Work to align your company's goals with your team members' individual goals.
2. **Make it desirable.** Appeal to a sense of belonging. Everyone wants to be part of a group and the community.
3. **Make it contextual**. Focus on the actions that people can implement immediately.
4. **Make is easy.** If you want people to stop littering provide plenty of receptacles and make sure they are emptied often.

FIGURE 4

Maslow's hierarchy of needs



Source: Abraham Maslow, "A Theory of Human Motivation"

Trend #3: A more sustainable, cleaner world

The science of climate change has moved from theory to fact. A warmer world is leading to more powerful and frequent hurricanes, storms, tornadoes and drought. It is also causing colder winters; look no further than Texas, where two "100-year" cold snaps occurred in a decade. Climatologists now estimate the tipping point for climate change to be 2050, less than 30 years from now. Many of the people alive today, including some Baby Boomers, could witness this unfortunate event. What is now a crisis to many of us will become a true CRISIS if we don't act now. Supply chain professionals can do much to mitigate this crisis by reducing greenhouse gases.

In his book, *How to Avoid a Climate Disaster*, Bill Gates, co-founder and former Microsoft CEO, states that the world produces about 51 billion tons (gigatons) of greenhouse gases (GHG) annually. Gates writes that in researching the book he became convinced of the following three things.

1. To avoid a climate disaster, we have to get to zero emissions (reduce GHG emissions from 51 billion tons (gigatons) annually, to zero) by 2050.
2. We need to deploy the tools we already have,

like solar and wind, faster and smarter.

3. We have to create and roll out breakthrough technologies that can take us the rest of the way.

Gates says that we need to think past just renewable energy and electric cars, because while they are important, they will not get us anywhere near the goal of zero GHG. Essentially, the sources of GHG emissions falls into five categories shown in Table 1.

Getting to zero GHGs by 2050 will require approaching the problem from several different angles. The issues that must be dealt with are enormous. To paraphrase my friend and mentor, St. Claire Gerald: "It will be the ultimate goat rodeo."

But at a more practical level, how can supply chain professionals help to reduce GHGs? There are a number of ways that are both doable and effective.

1. Calculate your company's carbon footprint. Develop strategies to reduce it and track it annually. There are several websites where you can go to calculate your company's carbon footprint.

- Carbonfund.org: carbonfund.org/take-action/businesses/business-calculators
- Terrapass.org: terrapass.com/carbon-footprint-calculator
- EPA.gov: epa.gov/climateleadership/simplified-ghg-emissions-calculator
- University of California–Berkley: coolclimate.berkeley.edu/business-calculator
- Climate Neutral: bee.climateneutral.org

2. Consider an electric or hybrid fleet. If your organization has a private fleet, whether it consists of delivery trucks or company cars, a great way to reduce your carbon footprint is to switch all or part of your fleet to hybrid or electric. It is also great advertising, too.

3. Improve your packaging. Packaging is one of the greatest polluters of landfills. Additionally, the cost of corrugated has gone through the roof. Work on reducing the amount of packaging of both inbound raw material and outbound finished goods. Focus on providing just enough packaging to adequately protect the material. Procurement professionals should work with suppliers to find ways to reduce packaging or possibly utilize returnable dunnage. Effectively packaged products pay you twice; first on the cost of packaging and secondly on the cost of transportation.

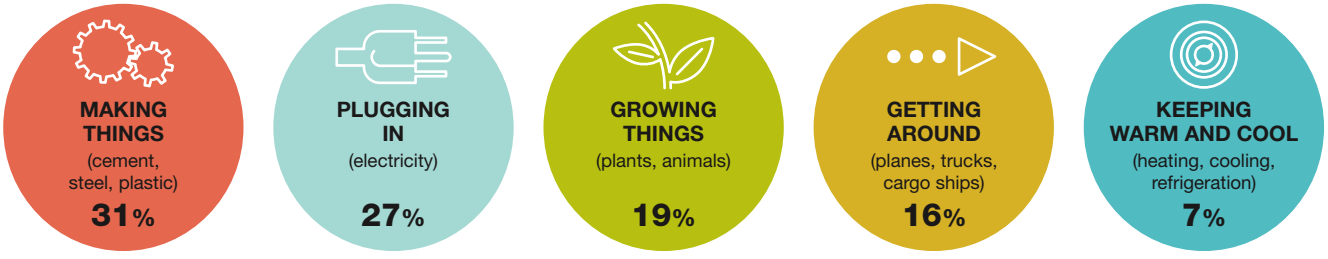
4. Consolidate your shipments. Manage both your inbound and outbound transportation. Wherever possible consolidate parcel to LTL and LTL to TL. Consolidation can save the cost of fuel, the cost of delivery (number of trucks) and the labor cost of double handling. A variation of consolidation is pooling were shipments from multiple companies (they can be suppliers of customers) are pooled together into a single shipment in order to reduce total costs.

5. Shorten your supply chain. According to a recent posting from the Circular Supply Chain Network, most food in the United States travels about 2,000 miles. Apparel, such as jeans, travel as much as 40,000 miles and the typical iPhone has traveled the equivalent of a round trip to the moon before it was purchased. COVID-19 proved that long supply chains were, in fact, fragile supply chains. In the post-COVID world, shorter supply chains may be the smarter alternative. Consider utilizing alternatives that include regionalizing, nearshoring or reshoring sourcing scenarios. Shorter supply chains, because they are simpler, are also less prone to disruption.

TABLE 1

Source of greenhouse gases (GHG)

(Percent GHG emitted)



Source: *How to Avoid a Climate Disaster*

6. Consume less energy. Implementing an energy management system reduces the need for energy and saves in two ways. First, by investing in equipment that uses less energy your organization will reduce GHG emissions, and secondly, because your supply chain uses less energy, it is saving the organization money. More information is provided in the Digital transformation section below.

7. Switch to renewable energy sources. Again, this is a win-win. Wherever and whenever possible, switching to renewable energy sources may save your organization money and reduce its carbon footprint. Modern warehouses are typically flat-roofed buildings that are highly conducive for solar panels and, depending

on the size of your facility, your company may be able to offset some or all of its utility bill. There may be also be subsidies available from local, state or federal agencies that can further reduce the capital costs.

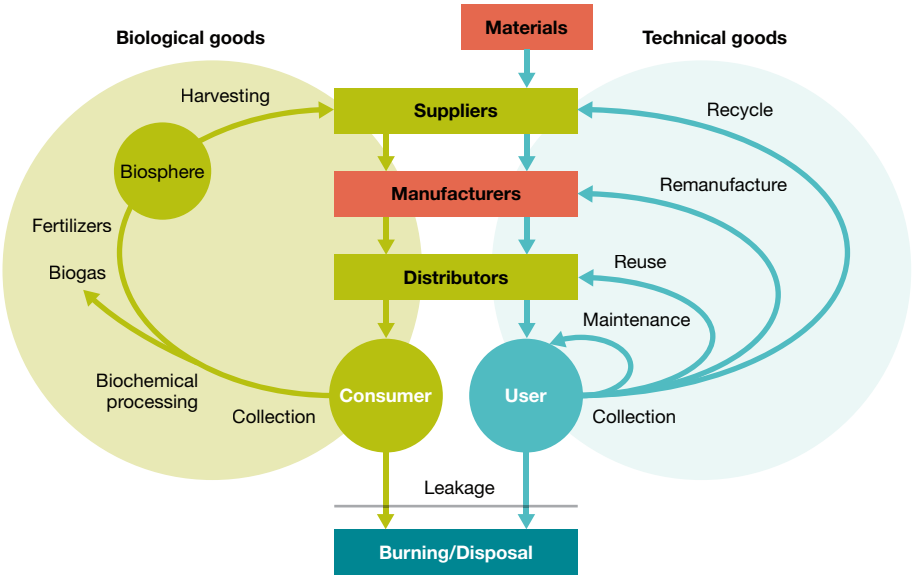
8. Utilize green building practices when building new facilities. If your organization is growing, look into green building practices. Concrete and steel generate a lot of GHGs in their manufacture (see Table 1) and there are new manufacturing processes available that can reduce it. Steel alone accounts for 8% of the total global emissions, according to "Decarbonization Challenge for Steel," a recent McKinsey study. Virtually all European producers of steel are developing decarbonization strategies; however, these are still several years off. Other green building concepts, such as energy management, can affect the overall carbon footprint immediately.

9. Leverage digital transformation to combat climate change. Most companies that implement digital transformation experience increased profitability, market share and revenue growth. They also experience increased collaboration, productivity, agility and customer service. Not to mention you'll get better data. Consider tying all this together and gain end-to-end visibility developing a supply chain control tower.

10. Incorporate circular economy concepts. Leveraging the circular economy starts with putting repair, refurbishment and remanufacturing programs in place, expanding them and then adding more programs to get to a goal net zero waste to landfills. This is a lofty goal, but it can be accomplished. It will require a change of mindset for organizational leadership, management and staff. It will require investment—but that investment will have a positive ROI.

FIGURE 5

The circular economy and supply chain cycles



Source: Laxness

May you live in interesting times

You're probably familiar with the curse: May you live in interesting times. The challenges and opportunities resulting from Boomers exiting the workforce, continued and more frequent change and disruptions, and the looming specter of climate change will conspire to make the next 10 years interesting times for supply chain professionals. Similar to the 1920s, they are likely to roar, promising both prosperity and uncertainty in equal measure. Billions will be invested in systems to capture and expand on the knowledge of the Boomer generation, train the workforce of the future, manage risk and plan for the changes needed to manage both the man-made and natural disruptions that will be made in the years ahead. Billions more must also be invested to decarbonize and digitize the planet and create circular economies in capital intensive, manufacturing and service industries. Much of the technology, products, services and jobs that will be required to meet this brave new world have yet to be invented.

The issues may seem overwhelming, but in reality, they are not. Leveraging technology is certainly one answer; it has the power to change the world. Human beings tend to work in their own self-interest, but when pushed, we also show an amazing capacity to cooperate for the common good. Positive disruption should not only seize opportunities to improve the organization, but should also be measured in light of how change will also ultimately improve the wellbeing of all stakeholders.

When it comes to the environment, we need to keep in mind the words of environmentalist Rob Watson who said: "Mother Nature is just chemistry, biology and physics. That's all she is. You cannot spin her. You cannot tell her that the oil companies say climate change is a hoax. No, Mother Nature is going to do whatever chemistry, biology and physics dictate, and Mother Nature always bats last, and she always bats 1.000."

Note: This article was prepared by the author, acting in his personal capacity. The views and opinions expressed are the author's own and do not constitute, nor necessarily reflect, a statement of official policy or position of the author's employer.

Supplier diversity: Procurement takes a star turn

By Tiffany Hickerson, Brittany Barclay and Ashley Rocha-Rinere

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Procurement organizations fulfill an indispensable role. Their rigor and innovation tangibly benefit the company's bottom line. Yet procurement is rarely seen as "out front"—breaking new ground that unmistakably elevates the company's strategic trajectory.

Supplier diversity offers procurement just such an opportunity. Why? In allocating their loyalty, today's consumers look beyond what you make to how you make it. Environmental, social and governance (ESG) concerns are also increasingly vital to your share price as a growing number of investors focus on companies that demonstrably serve as a force for good. Most major companies have responded via formal diversity, equity and inclusion (DEI) programs and well-documented ESG strategies. Yet DEI and ESG are increasingly viewed as table stakes. At this point, few companies would dare not have such programs in place.

Intriguingly, the same cannot yet be said for supplier diversity (SD). A handful of leading companies (e.g., Johnson & Johnson, AT&T, Verizon, Ford) have demonstrated a sustained commitment to SD, but they are very much in the minority. On the whole, SD is still far less obligatory than DEI and ESG, and so remains a shining opportunity to stand out.

As supplier diversity is not necessarily expected, pursuing an ambitious SD initiative can significantly enhance brand awareness and appeal. A 2019 survey conducted by The Coca-Cola Company found that consumers who were aware of Coca-Cola's supplier diversity initiatives were 45% more likely to perceive the brand as valuing diversity; 25% were more likely to think favorably about the brand; and 49% were more likely to purchase Coca-Cola products. In an era of evolving consumer expectations, those findings look like the tip of the proverbial iceberg.

A serious commitment to SD makes a statement to your employees and your industry talent pool, boosting your existing DEI efforts. Companies with SD programs have higher employee retention, and SD is an effective way to engage your company's business resource groups.

In sum, a visible commitment to supplier diversity can strategically enhance the company's standing with a broad array of important stakeholders. Procurement can lead the way, although this requires adopting an aspirational mindset that ventures well beyond procurement's customary concerns.

Procurement has traditionally focused on containing costs and ensuring reliable supply, often giving little or no thought to

diversity. Further, effective procurement organizations typically have trusted relationships with their existing supply base. There may be some discomfort with the idea of moving away from those familiar relationships to venture into the unknown, particularly if some in the organization assume that diverse suppliers lack requisite skills and sophistication. Some inertia should be expected.

Momentum builders

At the outset of a strategic SD initiative, procurement shapes the supplier diversity program in close consultation with executive leadership and a range of cross-functional partners including the D&I team, ESG, corporate and government affairs and marketing. Important early priorities include:

Executive sponsorship. Procurement should encourage the executive leadership team to play an active role in articulating the SD vision, and in ensuring that SD program objectives align with overarching corporate objectives. Direct executive team participation helps you establish strong senior leadership buy-in for the SD program, which in turn helps you secure access to the resources you will need to reach your program objectives.

Internal collaboration. Establish a cross-functional diversity committee to link SD to broader DEI efforts, business unit strategies and ESG goals (particularly social impact). Coordinate with corporate and government affairs to engage external stakeholders in the initiative as it expands.

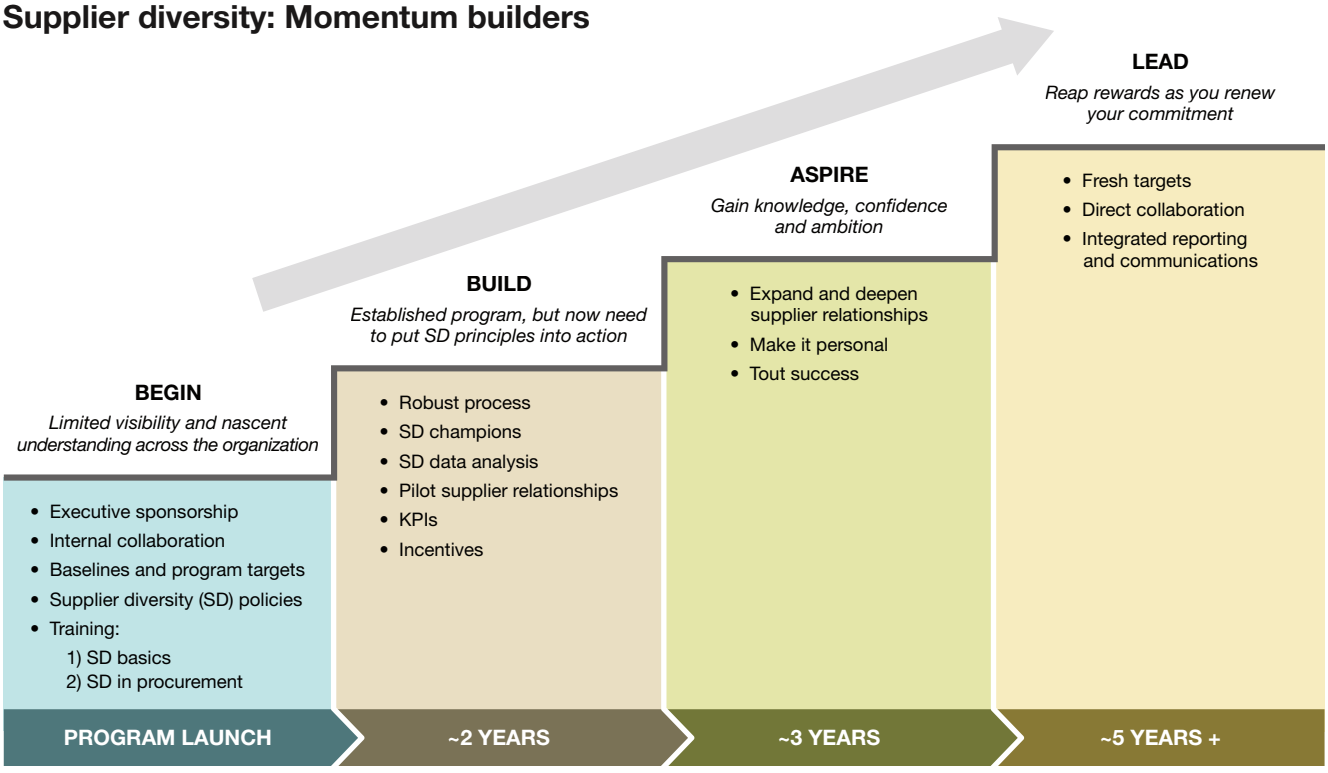
Baselines and program targets. Quantify current levels of diverse supplier spend, benchmark against industry peers and set SD spend targets (e.g., % of total spend, YoY growth).

SD policies. Define what constitutes a diverse supplier and make supplier diversity a formal and consistent evaluation criterion for supplier selection.

While people throughout your procurement team will likely view supplier diversity as "the right thing to do," many may be unclear about where to start. Indeed, a recent Kearney survey shows that the biggest

FIGURE 1

Supplier diversity: Momentum builders



Source: Authors

perceived challenge to SD is identifying diverse suppliers. Many in your procurement team may not know how to recognize diverse suppliers, nor where to find them.

We suggest you tackle that challenge head-on, with two-stage training as follows.

1) *Supplier diversity 101.* What SD is. Why it matters. How it fits into the company's goals and strategies.

2) *Supplier diversity in procurement.* How we will build SD into procurement's ways of working.

Generally speaking, SD seeks to engage with small businesses (fewer than 250 or 1,500 employees, depending on the industry, with a maximum of $38.5M in average annual revenue), and diverse businesses (51% owned, operated and managed by individuals with a designated diverse background, such as people of color, women, veterans, LGBTQ+ individuals, individuals with disabilities and other recognized minority populations). To jump-start the process, you can share diverse supplier data bases maintained by diversity councils and industry groups, and provide specific examples of diverse suppliers who could likely meet the company's needs.

Build

Now that the SD vision and goals have been communicated and the procurement organization is grounded in SD basics, the work of building your SD program can begin in earnest.

Much of the work to be completed at this point is procedural, such as making diversity criteria integral to your RFP documents and translating high-level SD policies into procurement SOPs. However, as with most major change initiatives, cultural shifts are essential to energizing and sustaining all that hard work. Key priorities in the Build stage include:

Robust process. Fully embed inclusion criteria into procurement procedures and select related business processes.

SD champions. Recruit and train respected leaders in all key categories to encourage and support procurement team members as they work to integrate an SD mindset and skillset into their everyday responsibilities.

SD data analysis. Continue to build out your diverse supplier database. Analyze and apply insights to reshape core procurement processes (e.g., sourcing, SRM).

Pilot supplier relationships. Immediately engage in transactional relationships with a manageable number of diverse suppliers to learn how they can be of service to the company and how you might help them to provide you competitive value.

KPIs. Measure what matters. Set category-specific targets that are ambitious yet attainable. Roll SD-based KPIs all the way down to each procurement team member.

Incentives. Motivate procurement leadership to fulfill your SD-based KPIs. Develop and communicate rewards and recognition programs for procurement team fulfillment of same.

Aspire

As your SD program gains traction, it becomes far easier for the procurement organization and the company as a whole

to envision how much you might actually achieve. Here are some ways to turn people's growing comfort and confidence into accelerated momentum.

Expand and deepen supplier relationships. Host matchmaking events/online forums to connect diverse suppliers with relevant categories in your procurement function. Proactively invest in deepening initial transactional interactions with diverse suppliers into more relational connections. Actively counsel suppliers on what they might do to become most-valued vendors in your supplier ecosystem. Mandate that suppliers report to you on their own internal and external diversity efforts.

Make it personal. Invite diverse suppliers to share their experiences and explain how your SD program is making a difference to their businesses and in their lives. Use these occasions as forums for mutual learning.

Tout success. Encourage and celebrate wins on a formal cadence. Encourage the SD program sponsor (typically the CPO or region's senior procurement officer) to report the program's progress and impact to other functions and key business partners.

Lead

By this stage of your journey, the C-suite views your SD program as a highly credible and rigorously quantified top-line and bottom-line value generator, and a clear source of competitive advantage. Supplier diversity is deeply ingrained in your procurement culture and is increasingly emblematic of your broader corporate culture. You have a network of partners who are actively engaged in the program and a robust supplier development program that effectively attracts and engages diverse suppliers. You have garnered the credentials of a clear SD innovator and leader. Your SD program is widely referenced by peer companies as a best practice benchmark.

Here are some keys to solidifying and expanding your gains:

Fresh targets. Your mature SD program needs to set its sights on new heights. Involve procurement, its key business partners and trusted suppliers in targeting ambitious YoY increases in supplier diversity spend and ecosystem.

Direct collaboration. Invest to expand the competencies and capabilities of your diverse suppliers. Increase the use of direct collaboration structures, such as incubators and joint ventures.

Integrated reporting and communications. Weave SD reporting into the mainstream of your company's annual report and and ESG/DEI reports. Marketing can also thoughtfully build SD success stories into brand campaigns.

The journey described above will be as arduous as it is exhilarating, but your efforts will be sustained by the intrinsic "rightness" of diversifying your supplier network, the quantifiable strategic advantages supplier diversity will bring to your company's operations and brand, and the elevation of your procurement function from "solid contributor" to "game changer."

Sustainability as a strategic imperative

Sustainability includes many factors, but organizations can address them all with a process-first approach.

By Marisa Brown, APQC senior principal research lead, supply chain

Marisa Brown is senior principal research lead, supply chain management, APQC. She can be reached at mbrown@apqc.org.

Sustainability is a concept that will continue to have an impact on organizations far into the future. Customer expectations, regulatory demands and environmental changes are increasing the pressure for organizations to take meaningful action. With no clear path forward, many leaders are unsure how best to take action.

Yet organizations often do have what they need to address the challenge of sustainability. APQC has found that organizations can achieve success by developing a strategy, focusing on processes, defining responsibilities and identifying necessary tools and approaches.

Understanding sustainability

The first step in addressing sustainability is to understand what it means. Unfortunately, this is difficult due to the number of buzzwords, jargon, frameworks and models used to describe sustainability. APQC has developed a simple, holistic and actionable definition of sustainability.

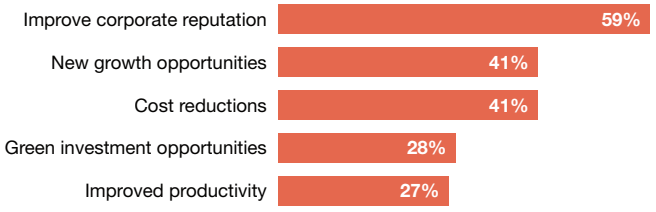
Sustainability is simply the capacity to endure. The primary components of sustainability include:

- environmental practices that protect natural resources needed by future generations;
- people practices that ensure workers within the organization are kept safe and treated equitably;
- social practices that promote community development and human rights for people beyond the organization; and
- governance, management and financial practices that promote ethical operations and long-term organizational health.

Sustainability is about more than preventing environmental harm. Organizations must also focus on taking care of people and communities, as well as ensuring their long-term health.

FIGURE 1

Top 5 drivers of sustainability



Source: APQC

Sustainability is a must

Interest in sustainability has steadily increased year over year, but in the past few years it has shifted from a "nice-to-have" to a "must-have." APQC's Process and Performance Management Priorities and Challenges research found that 60% of organizations have sustainability as part of their strategic plans for 2021. As shown in Figure 1, the top drivers for sustainability vary widely, from a focus on growth opportunities, to green investment, to improved productivity.

Organizations report a variety of areas of focus for their sustainability efforts. Overall, these areas fall into three categories: environmental, social and governance, or ESG. In the environmental category, energy is the top area of focus. For the social category, the top area of focus is local communities. For governance, diversity and equal opportunity is the top area of focus.

In supply chain, sustainability is a particularly hot topic because supply chain processes are often the biggest contributors to an organization's overall carbon footprint. APQC's 2021 Supply Chain Priorities and Challenges research identified sustainability as one of the top two trends expected to affect supply chains in the next three years.

Several factors have contributed to a heightened level of interest in sustainability in the supply chain. One is that the extreme weather events that climate change experts predicted started to become a reality. When the COVID-19 pandemic hit and consumers took more of their shopping online, many began to seek out information about companies' environmental and social practices before purchasing new products. At the same time, a series of supply shocks highlighted the complexity and fragility of organizations' supply chains. In 2020 and 2021, leaders struggled to balance long-term goals for sustainability with the short-term need to get products out to customers.

The focus on sustainability stems not just from how important it is, but also how hard it is (or how hard it appears to be). Leaders want their organizations to be more sustainable, but amid supply issues, cost pressures and other fast-changing circumstances, they are often unsure how to pursue sustainability goals while keeping their organizations afloat.

Sustainability and supply chain

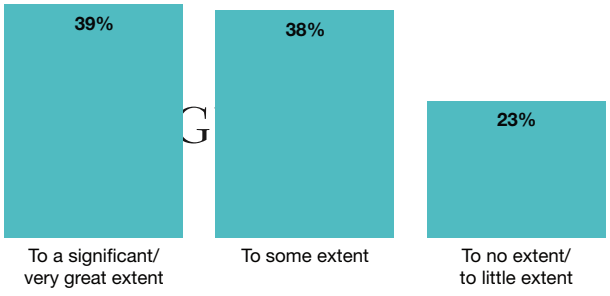
In 2020, shortages in key consumer products introduced average citizens to the term "supply chain." In 2021, many shortages from the previous year have continued (e.g., computer chips), and others have emerged (e.g., lumber).

Sustainability is about much more than the actions taken by just one company. An organization's suppliers—and its suppliers' suppliers—are key to its ability to achieve sustainability goals. Consumers cared about corporate sustainability and social responsibility before, but now they are much more aware of how supply chains affect these factors.

Distribution network design provides a valuable opportunity to improve sustainability, while trimming costs and achieving faster shipments. Ideally, organizations should create a holistic program that assesses location optimization, estimates life-cycle energy savings, coordinates source and demand points and accounts for

FIGURE 2

Extent of ongoing program for low carbon design for distribution



Source: APQC

reverse logistics.

As shown in Figure 2, less than 40% of organizations have adopted a program for low carbon distribution network design to a very great extent. Nearly one-quarter have done so to no extent or to only a little extent.

When it comes to these types of distribution networks, some industries are slightly ahead, such as the petroleum/chemical industry. Forty-three percent of these organizations have adopted these networks to a significant or very great extent. Other industries are lagging, such as retail and wholesale, with only 24% of organizations having developed these networks to a significant or very great extent. For some industries, such as petroleum, environmental impact is already top of mind for consumers and regulators, which can lead to broader adoption of carbon reduction efforts. APQC recommends that organizations consider integrating carbon reduction programs into the overall distribution strategy to expedite implementation. Programs can also align carbon reduction goals with broader business goals related to costs and efficiency.

Many of the world's largest and most influential companies have set forth bold plans to make their supply chains more sustainable. For example, consumer goods company Unilever and food corporation Cargill have both promised to make their supply chains deforestation-free. Several large companies have committed to reach net-zero carbon emissions, which will require a solid partnership with suppliers. Consumers will be watching closely to see whether organizations follow up their promises.

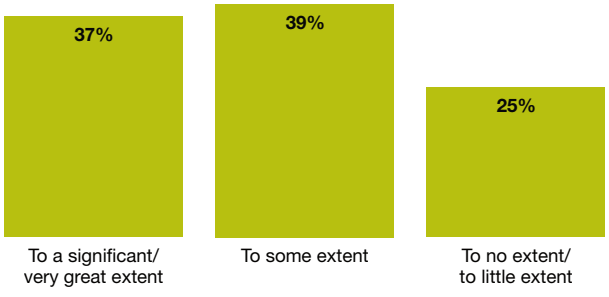
Organizations would be wise to favor low-emissions warehouse and distribution service providers to minimize their overall impact on the environment. However, as shown in Figure 3, only 37% of organizations across industries focus on securing contracts with low-emissions providers to a significant or very great extent.

In this area, the petroleum/chemical industry is again slightly ahead of the cross-industry results, with 41% adopting the practice to a significant or very great extent. The retail and wholesale industry is again behind, with only 29% of these organizations adopting the practice to a significant or very great extent.

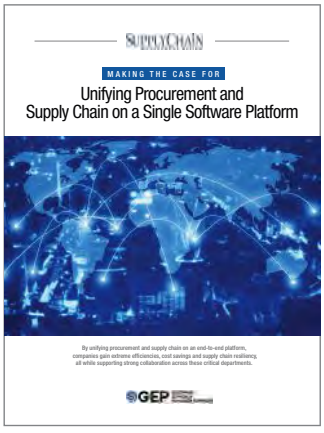
Consumers' demand for more sustainable supply

FIGURE 3

Extent to which contracts with warehouse and distribution service providers favor those with low direct and indirect CO_2 emissions



Source: APQC



MAKING THE CASE FOR

Unifying Procurement and Supply Chain on a Single Software Platform

By unifying procurement and supply chain on an end-to-end platform, companies gain extreme efficiencies and cost savings, all while supporting strong collaboration across these critical departments.

IN A BUSINESS ENVIRONMENT where breaking down organizational silos and promoting both internal and external collaboration have become imperatives, many companies are still running their procurement and supply chain departments as two entirely separate entities.

The flaws in this approach surfaced quickly during the COVID-19 pandemic, when supply chain disruptions, inadequate forecasting, and poor demand sensing converged. When that happened, even the most basic of items were unavailable on store shelves—a dearth that would soon spill over into the business-to-business (B2B) realm.

As companies struggled to correct these issues, a lot of finger-pointing was going on behind the scenes, as customers waited an inordinate amount of time to get their orders fulfilled. Those companies that got supply chain and procurement on the same page quickly were able to right the ship; those that kept their departmental silos intact faced steep challenges.

Without a centralized technology platform to unify these departments, collaborate with suppliers, and communicate with customers, companies were spending an inordinate number of manhours and much effort shoring up their global supply chains. With a multi-process, multidimensional software ecosystem in place, procurement and supply chain can readily collaborate to create forecasts, determine capacity, improve quality, and manage inventories.

ERP ISN'T CUTTING IT

Many companies have long relied on enterprise resource planning (ERP) solutions to run their businesses. These vertically-integrated systems comprise different components—all of which are focused on managing a specific process or achieving a certain goal.

Bringing multiple departments or functions onto a single platform can be arduous, so most companies just stick to their siloed approaches. Then, they use a combination of spreadsheets and email to transfer data between those different ERP components.

By unifying procurement and supply chain on an end-to-end platform, companies can break free of those ERP ties and gain extreme efficiencies and cost savings, all while supporting strong collaboration across these critical departments. The platforms not only make it easier for procurement and supply chain to become part of the same ecosystem, but they also support good external collaboration with suppliers, logistics providers, customers, and other stakeholders.

WORKING FROM THE SAME PLAYBOOK

Even in a normal business environment, determining whether suppliers have enough inventory to fulfill orders or meet forecasts can come down to guesswork. When the pandemic hit, forecasting and demand sensing became even cloudier. In the absence of a centralized platform, procurement and supply chain professionals rely on disparate systems, spreadsheets, emails, and phone calls to track down and expedite orders.

When procurement places an order for 100 widgets, for example, the production department may be out of the loop until those widgets show up at the dock. The same goes for the engineer who is waiting for a shipment of raw materials or the quality control supervisor who has zero visibility into incoming orders.

In this Making the Case, we explore the many challenges that companies face when procurement and supply chain are operating in their own stratospheres, tell how one large utility effectively tackled this challenge, and explain the value of bringing both departments onto a unified, cloud-based software platform. •

COVERED IN THIS REPORT:

- Bringing procurement and supply chain into the same ecosystem
- Why aren't you looking at the bigger picture?
- Procurement-supply chain ecosystems in action
- It's time to answer the wakeup call

chains is translating into political action as governments introduce new regulations and enforcement processes targeting environmental, people and social impact. For example, U.S. Customs and Border Protection has ramped up enforcement of import restrictions on companies whose supply chains incorporate child and forced labor.

Taking action

To tackle sustainability, organizations should consider it another business challenge. The approach should be the same as for other challenges: define the strategy, execute the process, define roles and responsibilities and select tools and approaches.

APQC recommends organizations take the following steps to develop and deploy a supply chain sustainability strategy.

1. Document the organization's definition of sustainability and its high-level sustainability strategy.
2. Define ownership for sustainability within the organization. For example, will sustainability be owned at the global level, or regionally? Will supply chain have a seat on an enterprise-level governing body? Will it be owned at the level of supply chain or by those who own parts of the supply chain such as planning, sourcing, procurement or logistics?
3. Deploy and strengthen processes to ensure transparency with suppliers, monitor global disruptions, prevent behaviors that introduce risk (e.g., maverick purchasing) and provide employees with the knowledge they need to make sustainable decisions.
4. Assess sustainability factors within supply chain processes. For example:
   a. within supply chain planning, consider how network design can be optimized for sustainability;
   b. within sourcing and procurement, evaluate supplier diversity and supplier risk/sustainability;
   c. within logistics and warehousing, examine carbon emissions, fuel and routing; and
   d. within manufacturing, evaluate carbon emissions, water and electricity usage.

Take a process-first approach

Each organization's sustainability challenges are different; therefore, each will have different goals and different approaches to reach those goals. Some need a complete overhaul of their environmental, people, social and governance practices. However, organization leaders should remember that sustainability goals need not conflict with budgetary and customer service priorities, especially when those priorities are established with a long-term viewpoint.

Any organization that has experience applying a process-first approach to other business challenges will be at an advantage when it comes to meeting the challenge of sustainability. A focus on processes and embedding measures within those processes enables organizations to show how they are working toward their commitments. With this approach they can 1) pinpoint the right inputs, outputs and choice points; 2) empower employees to make sustainable decisions and informed trade-offs; and 3) collect metrics to know what worked and what did not. Updates to processes in the high-impact area of supply chain and logistics in particular, can create repeatable, consistent improvement with regard to sustainability.

About APQC

APQC helps organizations work smarter, faster and with greater confidence. It is the world's foremost authority in benchmarking, best practices, process and performance improvement, and knowledge management. APQC's unique structure as a member-based nonprofit makes it a differentiator in the marketplace. APQC partners with more than 500 member organizations worldwide in all industries. With more than 40 years of experience, APQC remains the world's leader in transforming organizations. Visit us at apqc.org and learn how you can make best practices your practices.

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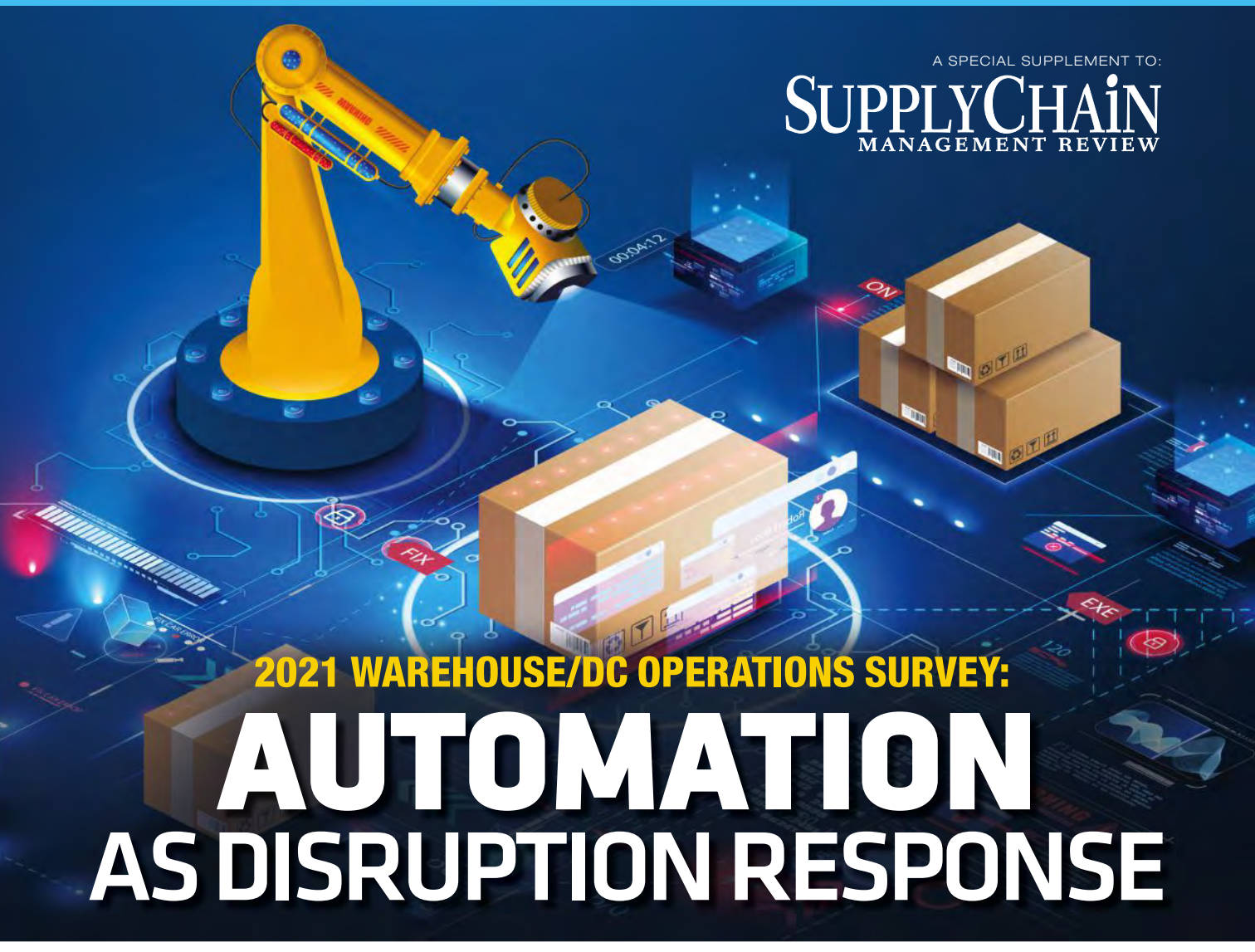


2021 WAREHOUSE/DC OPERATIONS SURVEY:

AUTOMATION AS DISRUPTION RESPONSE

Capex budgets and headcount are both up amid signs of expansion. But underneath those positives are strains, led by concerns about labor and inventory turns. Applying more technology, say respondents, is the path forward.

BY **ROBERTO MICHEL**, EDITOR AT LARGE

Upon first glance at some of the key findings from our annual Warehouse Operations & Trends Survey, industry participants are riding a pretty strong wave. Budgets are up, there are more respondents saying they're "adding staff" as well as planning for more buildings and square footage.

But on closer look, our research team finds deep strains in the world of warehouse operations, led by pandemic repercussions like massive supply disruptions and a highly challenging labor market. These macro-trends run smack into operations at the warehouse and distribution center (DC) level, where managers need to find a way to accommodate growing e-commerce fulfillment volumes and control inventory as best possible in a time of supply shortages.

The survey, conducted annually by Peerless Research Group (PRG) on behalf of *Logistics Management* and sister publication *Modern Materials Handling*, asks about operational factors at DC and warehouses, such as size of the DC network, number of employees, average annual inventory turns, use of temporary labor, strategies for coping with peak demand, and other challenges such as finding and retaining labor. This year, the survey drew 144 qualified responses from professionals in logistics and warehouse operations across multiple verticals.

First, let's start with some encouraging aspects of the survey because we've all heard about supply chain wide trends like microchip shortages. The good is as follows.

- Our findings around budgets for warehouse systems and technology are up significantly.
- Higher percentages of respondents (compared to last year) plan to expand in areas like more employees, buildings and square footage.

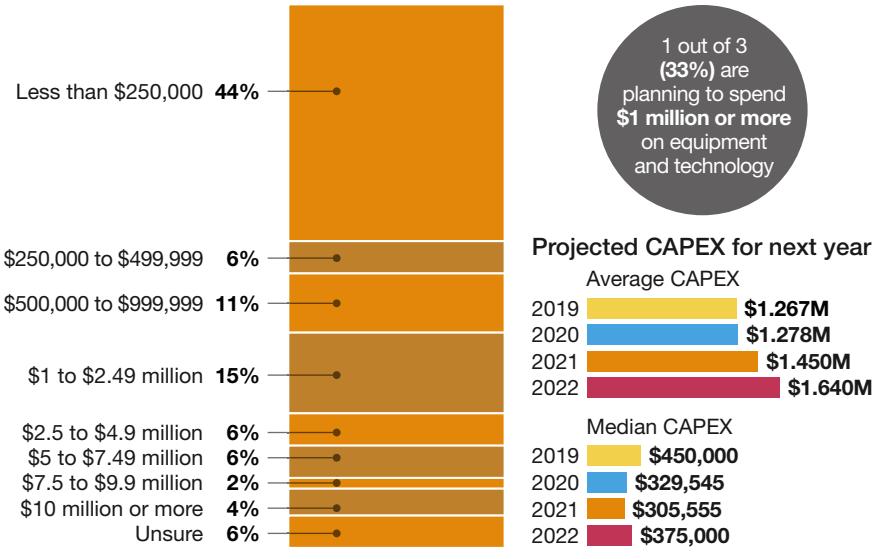
However, we're far from basking in normal growth mode because pandemic challenges remain with us. Inventory turns, which had been trending up in recent years, are down—likely tied to supply disruption and the decision to buffer more inventory as an enterprise strategy. Inability to find and retain labor, always a top challenge in our survey, grew even faster this year as the top concern.

There were also some unexpected findings, like more reliance on paper-based and manual processes; but on the whole, those involved with DC operations are planning to respond to disruption by applying more automation while fining tuning their processes.

A greater readiness to adopt automation is part of the industry response to disruption, according to Norm Saenz, Jr., a partner and managing director with St. Onge, and Don Derewecki, a senior consultant with St. Onge, a supply chain engineering and consulting company and long-time partner with PRG on this survey project. Both of them examined the findings from our survey, and note the challenges are formidable, while the data point to more use of automation.

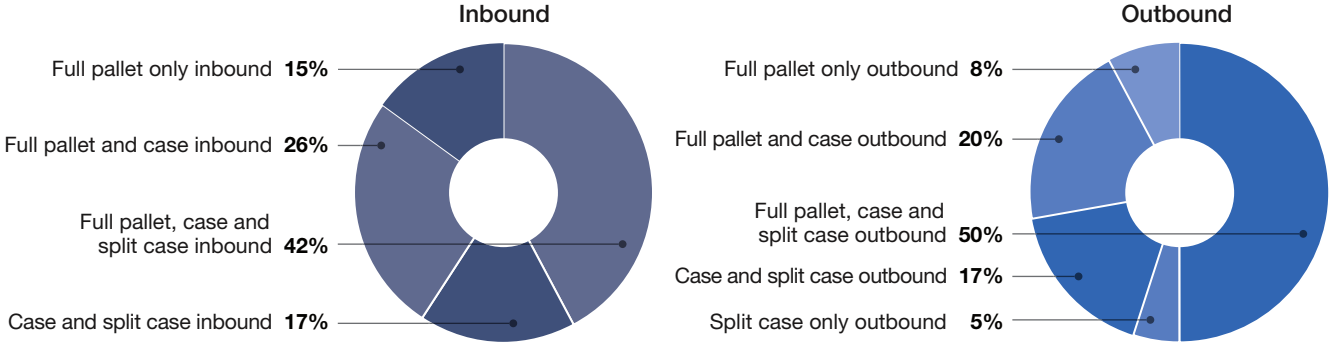
"Normal supply chain flows remain significantly disrupted, which of course impacts DC operations," says

Estimated capital expenditures for warehousing equipment and technology in 2021



Source: Peerless Research Group (PRG)

Nature of DC's inbound/outbound operation



Source: Peerless Research Group (PRG)

Derewecki. "As for the labor availability issue, it was already a problem in recent years, and now it's accelerating. All of these macro trends are getting company leaders more motivated to mechanize or automate more processes, because they know that can't count on getting enough people into the building to run a largely manual operation."

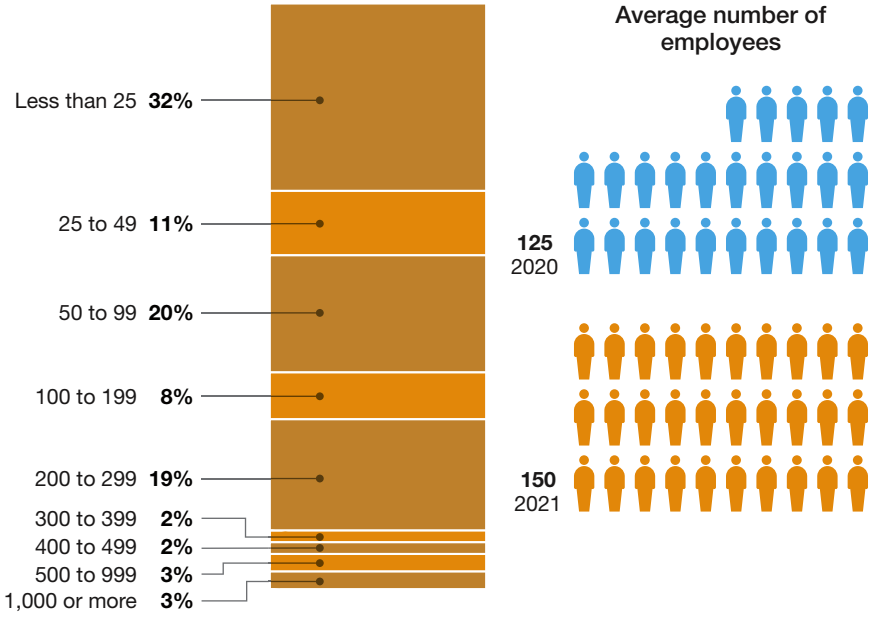
Operational shifts

Before getting into facility and workforce findings, it's notable that the march toward more e-commerce is once again reflected in the survey because we ask about channels serviced, including e-commerce, omni-channel, and for the second year running, micro-fulfillment.

Wholesale remains the most common channel, supported by 51% this year, down from 62% last year. Retail as a channel was named by 45%, up from 37% last year. Thirty-seven percent named e-commerce a channel this year, up just 2% from last year, but 40% said they had omni-channel responsibilities, up 10% from last year and the highest level in the past four. Additionally, 20% are with companies involved with micro-fulfillment customer pickup, and 17% checked off micro-fulfillment with delivery to customers.

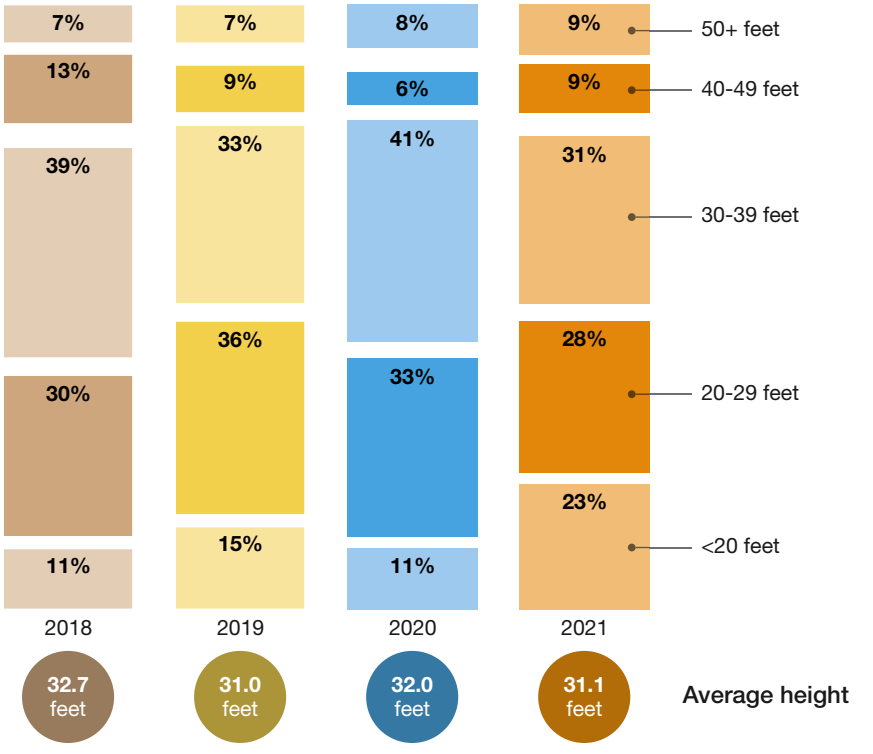
The nature of respondents' inbound and outbound operations continues to shift in ways consistent with e-commerce. On the inbound side, 17% this year said that they're dealing with case and split case, up from 8% last year. Full-pallet only grew 1% versus last year, but the rise in case and split case inbound may indicate that more DCs are seeing e-commerce returns and smaller replenishments as part of

Number of employees in company's main warehouse



Source: Peerless Research Group (PRG)

Size of distribution center network: Clear height of buildings



Source: Peerless Research Group (PRG)

e-commerce fulfillment changes.

On the outbound side, the changes weren't dramatic, though this year only 8% ship out full pallet only, down from 14% last year. Additionally, half of the respondents this year said they do full pallet case and split case outbound, up from 44% last year.

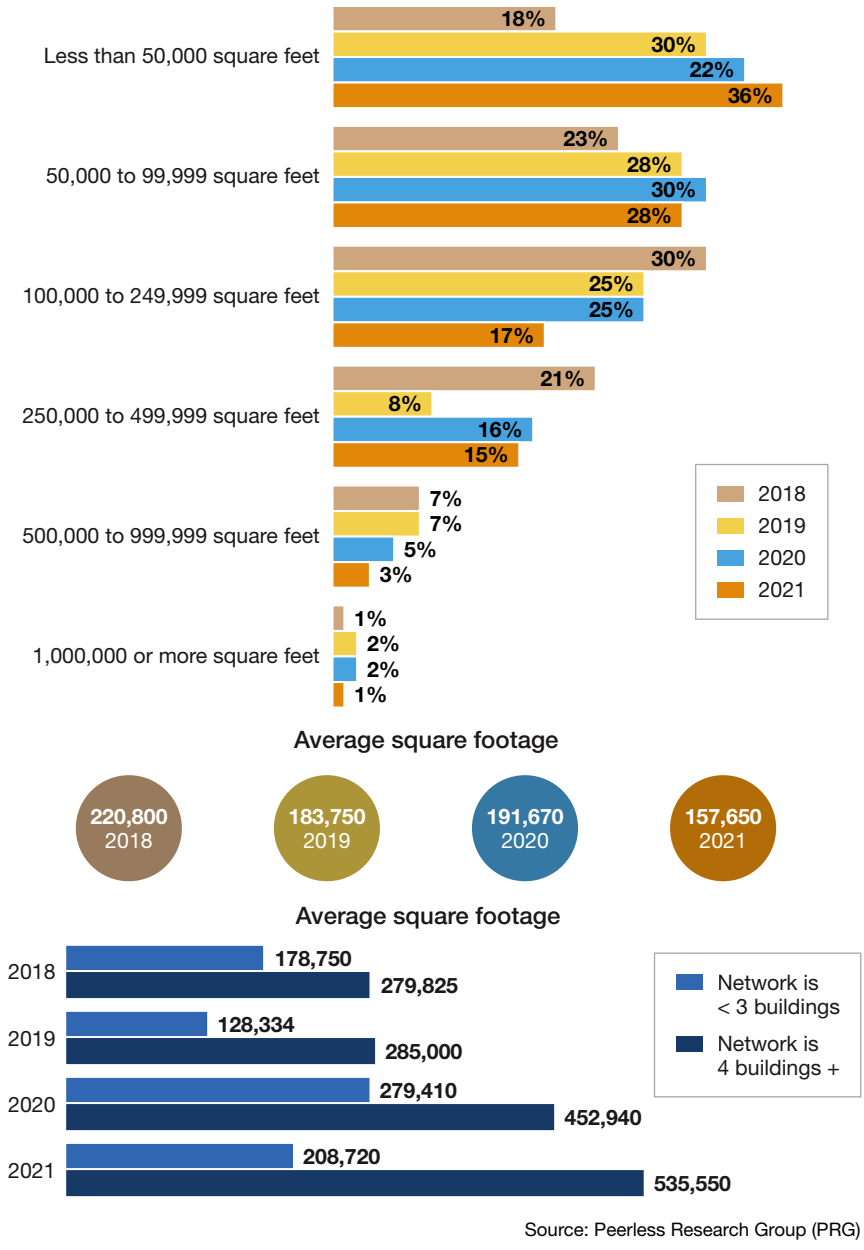
When we asked about space utilization and the most congested area in a warehouse, another notable change this year is that 24% named receiving, up from 18% last year. The e-commerce processing area was named by just 4%, down 1% from 2020, while storage, at 29% this year, was 5% busier than in 2020's findings.

The shift to more complexity on the inbound side is something Saenz sees among clients, as more operations are dealing with an e-commerce surge. "The concerns about e-commerce are real," says Saenz. "It's growing, and it's just flipping the script for some companies whose facilities were designed around wholesale or retail-sized orders. Some companies have managed to sort of shoehorn-in e-commerce processes, but now it's going to be driving everything from facility design to technology investment, just to be able to handle all of this e-commerce growth."

When asked how multiple channels are being fulfilled, the most common strategy remains to self-distribute from one main DC, named by 41% and up from 37% last year. Last year, self-distributing from separate DCs for different channels saw a big gain (to 36%), but this year it dropped back to 21%. While there was a slight drop in those saying they use a 3PL for all channels, 11% use a 3PL for e-commerce, up from 3% in 2020.

In terms of total square feet in the DC network, the average square footage was 570,395, down slightly from last year's average of 609,325 square feet. The big change this year was that just 13% said total network square footage fell between 500,000 to 999,999 square feet, whereas last year 27% said so.

Size of distribution center network: Most common square footage



Source: Peerless Research Group (PRG)

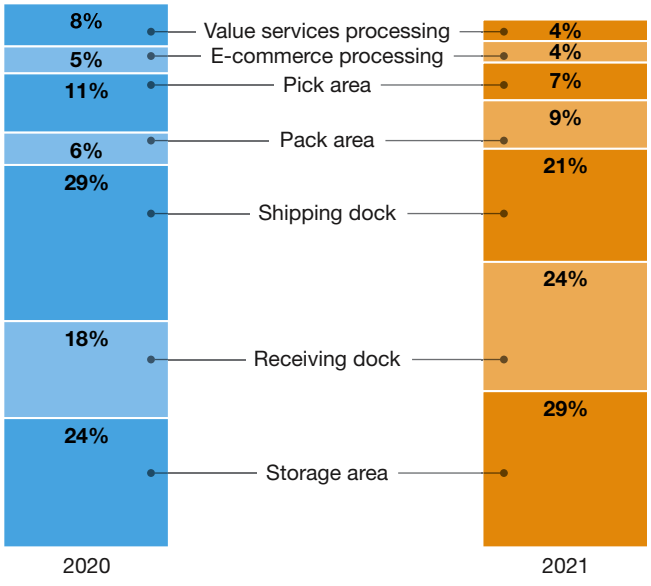
When we asked about the most common square footage in the network, the overall average fell from 191,670 square feet last year to 157,650 this year. However, average square footage was on the upswing for those with four-plus DCs—from 452,940 square feet

last year to 535,550 square feet this year. As Derewecki notes, it may be that rather than a definite trend toward smaller buildings for all, it appears to be a trend toward larger operations needing larger buildings, though some companies may be opening some smaller sites to get goods positioned closer to customers.

The findings on number of buildings in the DC network remained fairly stable compared to last year. This year, 43% have more than three buildings, just 3% less than last year, while 15% have two buildings, up by 4% from 2020. Of those with three-plus buildings, the percentage having six or more nodes was 28% this year, down by 2% from 2020,

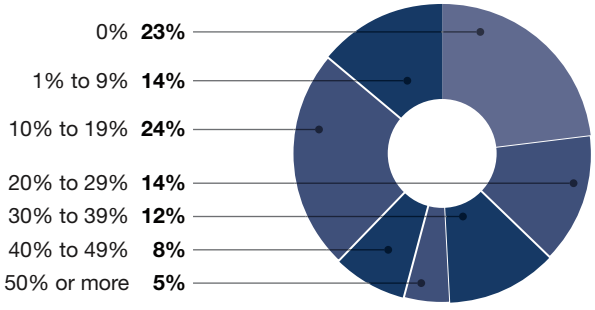
The findings on clear heights of buildings stayed fairly even. This year, the average clear height given the ranges presented was 31.1 feet, just lower than last year's 32 feet, and level with 2019's finding. There was a model increase in those reporting clear heights in the 40-foot to 49-foot range, but a 10% decrease in those with DCs in 30-foot to 39-foot range.

Space utilization: The most congested area in warehouses



Source: Peerless Research Group (PRG)

Percent of workforce who are temporary during peak volume periods



Source: Peerless Research Group (PRG)

Inventory issues

The tendency to hold inventories at higher levels to hedge against supply disruption is likely at play with the survey's results on inventory turns.

This year, average annual turns came in at 7.0, down from 8.2 turns last year and as high as 8.9 turns back in 2018. "Due to these supply disruptions, which many feel will continue into 2022, we're seeing a move away from just-in-time inventory strategies, to more of what you could call a 'just-in-case' approach," says Derewecki.

Our finding on average SKU numbers fell a bit this year, after growing last year. This year, the average was 9,376 SKUs, down from 12,922 in 2020. Again, it's a different set of respondents drawn from the reader base, but this decline does go against the notion of a "long tail" of inventory to accommodate the needs of e-commerce buyers.

One contributing factor, explains Saenz, is that ongoing supply disruption has caused many operations to refocus on a smaller number of SKUs representing their fastest movers. "It will be interesting over the next couple of years if a trend toward less SKUs is real, or a shorter-term trend that won't stick once these supply chain disruptions have settled down," he says.

One of the most encouraging findings was in regard to expansion plans. This year, 82% said that they plan expansion of some type (such as SKUs, employees, square footage, etc.), up from 80% last year and the highest number in the last four years. This year, 35% said that they plan on an increase in square footage in the next 12 months, 11% higher than last year.

Also up are plans for more buildings—35% this year versus 17% in 2020—and a 5% increase in those saying that they plan to increase the number of employees. However, there was a nearly 20% decline in those saying that they would increase SKU counts, and a 9% decrease in those expecting increased inventory turns. The

story here may be that many respondents know they need more space and people to fulfill orders for customers, but there are lingering concerns about supply disruption.

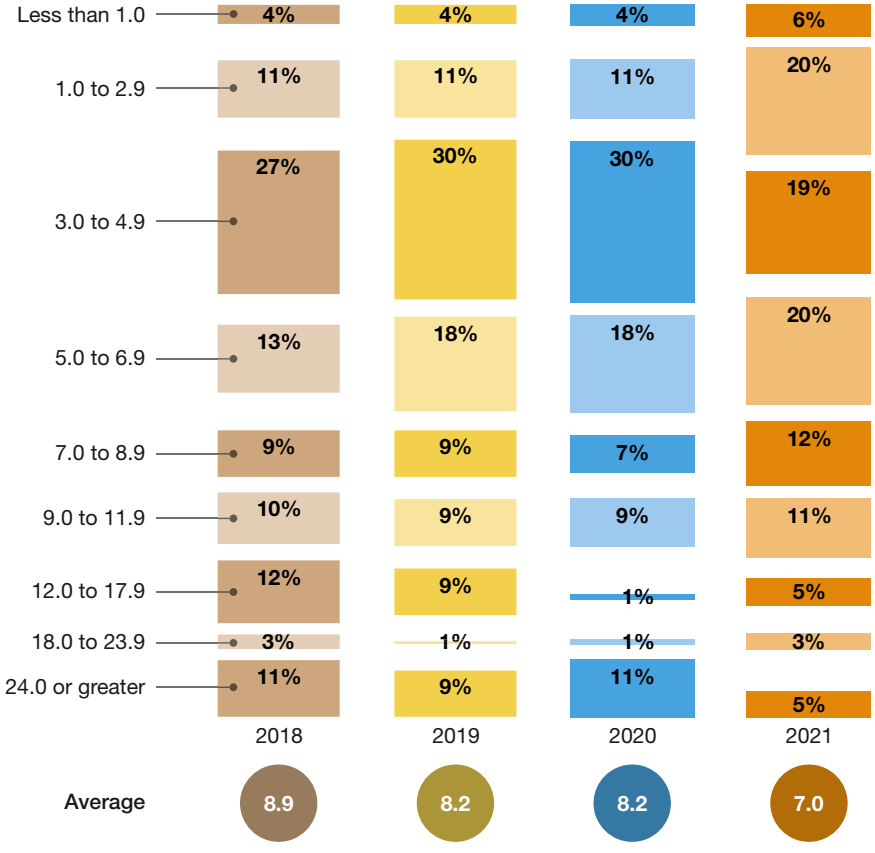
As we'll address later, labor availability remains the biggest operational concern, even though the number of employees in the main DC grew significantly this year in the survey, likely tied to growing e-commerce fulfillment work, which is labor intensive without automation. For 2021 that average climbed to 150 employees from 125 people last year. This year, 24% have between 50 employees to 99 employees in the main DC, and a combined 8% have 500 or more people at the main site.

The peak warehouse utilization finding also grew, on average, from 81.7% in 2020, to 85.4% in 2021. This year, 65% of respondents, nearly two thirds, report utilization at 85% or higher.

Our survey also found that, on average, more operations are using a greater percentage of temporary labor during peak volume periods. The average this year is 18.3% of the workforce being temps, up from 15.3% last year. This year, a combined 25% of respondents say that during peak periods, the percentage of temporary labor is 30% or greater.

E-commerce fulfillment is generally more labor intensive than wholesale or retail fulfillment, with more handling of each. When we asked what type of growth ranges respondents have seen for e-commerce, a third said that growth has been under 10%, but 21% said that it's been between 20% to 29%, 12% say that growth has been between 30% and 39%, and a combined 14% peg it as 40% or higher.

Scope of distribution center operations: Annual inventory turns



Source: Peerless Research Group (PRG)

COVID measures stick

We asked again about health and safety measures at DC sites in light of the ongoing pandemic, and we found that measures like mask wearing and social distancing remain in widespread use in 2021.

For example, 82% say masks are worn, and 76% practice some social distancing in certain areas. Additionally, 36% say they plan to continue their COVID health and safety practices, and 59% said partial or select measures would stay in place.

For the second year running, we also asked about actions taken since March 2020 to adjust operations in light of pandemic conditions. This year, the most frequently cited adjustment (57%) was to improve warehouse processes, followed by increase wage rates to attract and retain staff—48% this year, versus 42% last year. This year, 42% named warehouse information technology (IT) and software as an area for adjustment, up from 21% last year.

Likely due to the number of wildfires, hurricanes and other severe weather events seen in 2021, this year 36% said that they had experienced a catastrophic event in the past two years, up from 23% last year.

Our annual survey traditionally always asks about actions taken to lower

operating costs. For 2021, the survey found that 92% have taken some form of action to lower costs, down from last year's 98%.

Among the more specific actions taken to lower costs, 66% are improving warehouse processes, which was the top response. This year, 39% are improving warehouse IT and software, up by 4%, while improved inventory control was cited as an action to lower costs by 55%, down sharply from last year's 69%.

Capex on the upswing

Perhaps the leading bright spot in this year's survey are the findings around capital expenditures (capex) operations, as well as strong interest in materials handling systems and technology. Companies may be scrambling, but at least there's budget to be applied to their challenges.

The average capex budget for equipment and technology reached $1.64 million for 2021, up from $1.45 million in 2020. The median capex also increased, from $305,555 last year to $375,00 this year. We ask for budget ranges, and this year there was a higher percentage of respondents with larger budgets. A combined 33% have budgets exceeding $1 million, compared to a combined 25% in excess of $1 million last year.

As mentioned, in terms of actions to lower costs, there was a 4% increased focus on using warehouse IT and software. Adding automation equipment to processes was cited by 19% this year, down from 25% in 2020.

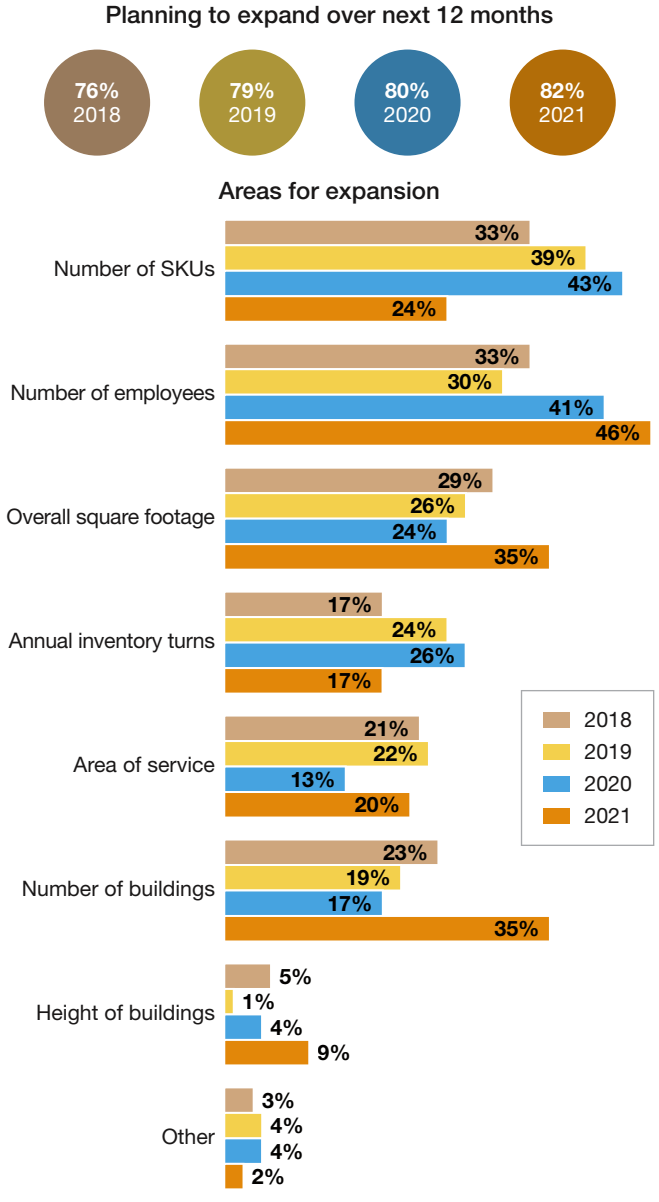
Meanwhile, 83% report using a warehouse management system (WMS) of some type, down slightly from the 85% level for use of a WMS seen in 2019 and 2020. The most frequently cited type of WMS is a WMS module of an enterprise resource planning (ERP) system, followed by legacy or in-house developed WMS, followed by a best of breed WMS.

When we asked about material handling systems currently in use, there were other signs of increased technology adoption. For example, use of robotics/articulating arms reached 12% this year (from 9% last year), while use of automated guided vehicles (AGVs) and autonomous mobile robots (AMRs) reached 9%, up from 6% last year.

There were some findings contrary to a more rapid embrace of technology, such as an increase in paper-based picking, up to 59% this year from 46% last year. Use of voice directed systems did climb this year by 2% to reach 9%. Similarly, when asked about data collection methods used to gauge productivity, there was a rise in manual data collection—at 59% this year from 43% last year.

While one year's findings on paper-based approaches is difficult to tie into one reason, other than a different set of respondents, it may be that the unusual supply shortages and rapid adjustments to warehouse workflows or SKU mixes experienced by operations during this second year of the pandemic

Distribution center expansion plans



Source: Peerless Research Group (PRG)

may have contributed to more use of paper-based systems or data collection.

When we asked about productivity metrics in use, 88% said they use some type of metric, up 1% from 2020. In terms of type of metrics used, percentage of an engineered standard dropped sharply to 11% from 22% last year. However, units/pieces per hour as a metric was up to 41% from 30% in 2020, and lines per hour and cases per hour as metrics also some modest percentage increases.

Technology adoption also supports and ties in with certain order-filling techniques, such as batch picking, wave picking, and the use of put wall systems. We found that put-walls, which typically are software-driven and light directed, are in use by 8%, while batch picking is used by 40% this year, nearly even with last year's 41%.

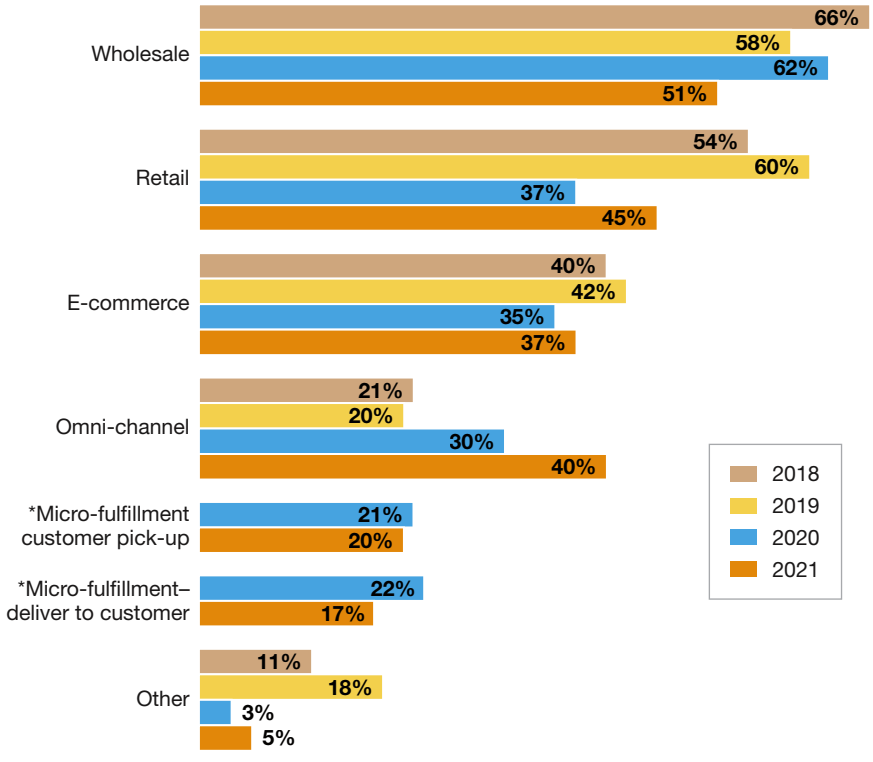
As Saenz notes, expect greater use of technology-enabled order filling methods like batch picking or put walls as the proportion of e-commerce fulfillment work increases, and a decrease in straight line order picking. "There's just no way to handle e-commerce fulfillment efficiently without batch picking technology and capabilities," says Saenz.

Labor tops concerns

Over the last four years, inability to attract and retain a qualified hourly workforce was already the most frequently cited industry issue impacting DCs. This year, it was even more so, with 59% naming it the top concern, up from 53% last year, and the highest in the past four years.

Three other issued tied at 36% as the second most frequently cited concern in 2021: insufficient space;

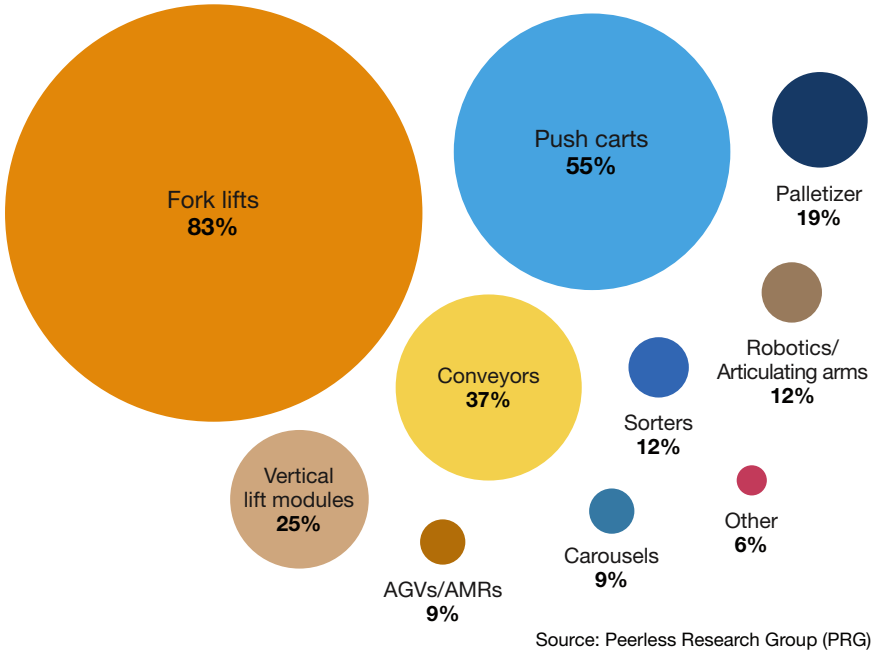
Market channels serviced by company



*Not asked in prior years

Source: Peerless Research Group (PRG)

Materials handling systems in use



Source: Peerless Research Group (PRG)

attracting and retaining qualified managers, and outdated storage and material handling equipment, which was up a fairly significant 7%.

Underscoring the concern about labor is that when we asked about WMS use we also asked about related software including labor management/planning (LMS). This year, 8% report use of LMS, up from 4% in 2020, though not as high as the two previous years.

For the second year running, we asked if challenges tied to a surge in e-commerce constituted a major operational issue. This year, 33% agreed it was a major concern, down from last year's 37%. One positive trend here is that this year, only 8% cited "lack of higher management support" as a major issue, down from 12% in 2020, and as high as 15% who felt that way in 2018.

Automation as response

Overall, the 2021 survey shows that readers tend to have bigger capex budgets and a healthy interest in technology, but face big strains when it comes to finding and keeping labor, slower inventory turns, and more respondents with a space capacity issues during peak times.

More deployment of technology could be the answer, say Saenz and Derewecki, although there's also typically some low hanging fruit with layouts or process improvements that could help those without growing budgets.

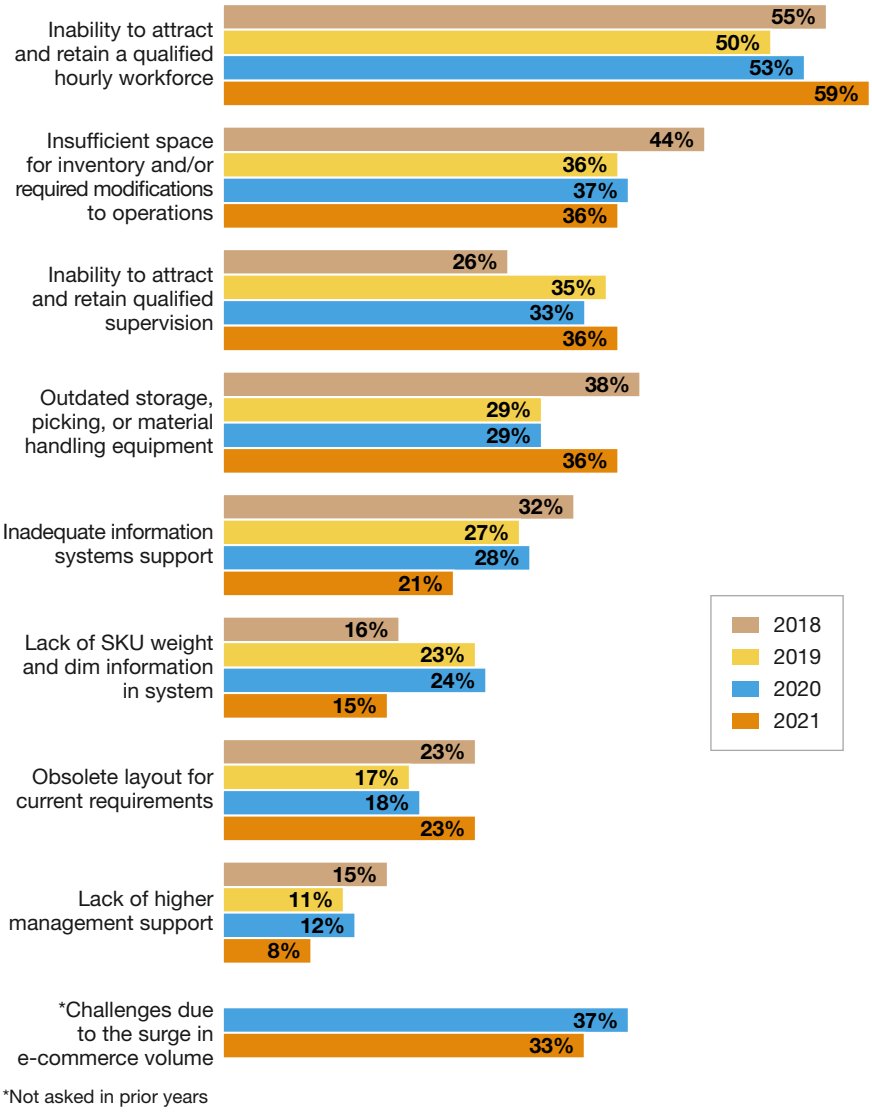
Saenz explains that the current pain points have led to some ironies, such as operations that keep temp workers on staff even when they don't absolutely need them at the moment because getting more labor into the building when needed is no sure bet—so it's seen as less risky to operational viability to keep them on.

In this climate, greater use of automation to help with reliable throughput and reduce reliance on manual processes is to be expected. Signs of faster-paced tech adoption is reflected in findings like the higher capex levels, adds Saenz, but he also sees it in interactions with clients.

As Saenz sums up: "There's never been a time when so much automation and different warehouse technologies are being evaluated in every one of our projects—and in industries you wouldn't think of as deploying technology heavily. In the past, people would talk about the potential benefits of more automation, but now more companies are considering it strongly. In all ties into the challenges around labor, and the growth in e-commerce." •

Roberto Michel is an editor at large for Supply Chain Management Review

Major issues as it pertains to warehouse/DC operations



*Not asked in prior years

Source: Peerless Research Group (PRG)

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