

SUPPLY CHAIN

MANAGEMENT REVIEW[®]

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BE PREPARED



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A 2019 motto: Be prepared

Truth be told, I was not a Boy Scout, or at least not a very good scout and not for very long. But I think there are some lessons for supply chain managers in the Scout motto: Be prepared. When I Wiki'd it this morning, I found the following: Be prepared, which means you are always in a state of readiness in mind and body to do your duty.

That seems to be the precise job description for today's supply chain manager: Be ever vigilant without really knowing what's coming down the pike. The usual duties of procuring inventory, getting orders out the door on time and putting out fires has been exacerbated by the volatility and uncertainty in the global economy.

Be prepared is also the theme for the January issue of *SCMR*, and it starts with our lead article by MIT's Nima Kazemi and Bruce C. Arntzen. It's the second part of a two-part series on whether supply chain managers have learned any lessons from the Great Recession and prepared themselves for the economic downturn. It's a sobering read—and you can find Part 1 on scmr.com.

We also have two looks at the driver shortage in the transportation industry. Special projects editor Gary Forger looks at the underlying root of the issue, but also offers some potential solutions to what is a long-term issue. Meanwhile, Heather Monteiro details how the Port of Willamette Brooks Intermodal and Transload Facility is easing the need

for drivers in Oregon, a solution that may be replicated in other parts of the country.

We round out the issue with two articles looking at the NextGen technologies that will shape tomorrow's supply chains. Accenture's Vikrant Viniak walks readers through some of the emerging applications for blockchain while Nada Sanders and Morgan Swink provide a roadmap to the building blocks behind the digital transformation of the supply chain. Both should be of value to supply chain managers that seek to be prepared for the future.

Last, we hope you'll check out—and register—to attend *SCMR*'s first NextGen Supply Chain Conference, which will be held April 16 & 17, 2019 at the historic Chicago Athletic Association hotel in Chicago. Designed for senior level supply chain executives—like you—the conference will offer educational sessions and networking opportunities to learn about the emerging technologies that will power tomorrow's supply chains. You can find more information about the conference at nextgensupplychainconference.com.

As always, I look forward to hearing from you and seeing you in Chicago next April.



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MANAGEMENT REVIEW



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If history is our guide, economies take a turn every nine years. Yet time and again, a strong business cycle and fading memories convince us the good times will go on forever. Ten years after the great recession, we surveyed 100 manufacturing firms to find out if businesses are ready to fight through the next recession.

14 No one behind the wheel

With a 100% annual turnover, everyone knows there's a problem keeping truckers in the driver's seat. There are some short-term aids such as higher pay, a more diverse workforce and an improved lifestyle. But it's going to take more. New practices and advanced technology are approaching on the ramp.

20 Intermodal to the rescue

There are no easy answers to the trucker shortage, but a project in Oregon demonstrates that intermodal could help save the trucking industry.

26 Beyond cryptocurrency: Blockchain as a value creator and connector

For companies reliant on strategic partnerships or those that are seeking to increase the transparency of interactions between consumers or business partners, blockchain presents a world of possibilities.

30 Digital supply chain transformation: Visualizing the possibilities

Many supply chain leaders view digitization as a mandate for competition, yet the first steps to developing an overall strategy are unclear. We take a deep dive into the questions of the state of digital implementation and try to separate hype from reality.

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Oil Update: Specter of \$100/barrel



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This column is my annual update on oil pricing that began with my first two Insights columns, 12 years ago.* I began researching the topic when I began the launch of MIT's Supply Chain 2020 Project in 2005. Prior to last year's update, I had been espousing a reduction of oil consumption in global supply chains by slowing them down and developing cost- and energy-efficient networks, in contrast to cost- and asset-efficient ones. The position was based on two major demand-supply assumptions. While oil would be readily available into the foreseeable future: 1) its price

would rise in the long-run as demand for it rose with robust global economic growth; and 2) oil extraction costs would continue to rise over time because it was getting harder to extract it from the earth.

Last year's update

Last year I noted that both demand-supply assumptions no longer held, as postulated back then. As a result, prices had not drastically risen over the long run as expected. So, I re-analyzed the historical oil pricing data in last year's column. My analysis postulated that recent oil prices appeared to have flattened to an "era of cheaper oil" (in contrast to "cheap oil").

From the demand side, the first signs of cheaper oil appeared as a precipitous drop that was the result of the Great Recession, which drastically depressed worldwide economies. Hence the demand for oil. This was followed by a three-plus year period, termed the "\$100+ plateau" before reaching cheaper oil. Today that plateau still ominously looms in the rear-view mirror as a reminder of what could happen if worldwide economic and supply conditions reach the levels seen prior to the recession.

From the supply side of oil, there was a new picture. In considering the supply of oil, one had to evaluate the overall energy market of renewal vis-a-vis non-renewable energy sources. That said, oil is a supply chain's most important energy source because transportation operations run on liquid fuel. Alternative renewable energy sources that are changing the overall energy picture (especially in electricity generation) won't be suitable for transportation until electric vehicles start replacing today's fleets. Natural gas is becoming the energy source de jour for

electricity generation, to replace old coal-fired electric generators. However, liquid natural gas (LNG) will not change the energy picture much for transportation until LNG-fueled vehicles replace fleets, along with a network of fueling stations is in place.

The major change in the supply picture involved shale-oil fracking. Over the period of higher oil prices, U.S. oil fracking operations came on-line because the prices were high enough to economically justify them. U.S. frackers used the opportunity to innovate to reach a point where fracking operations were flexible enough to easily turn on-and-off as oil prices went up-and-down. The fracking industry has made the U.S. the world's top oil supplier. (As I write this column, the United States just became a net exporter of oil!) In addition, fracking output caused a worldwide oversupply of oil and kept the era of cheaper oil going.

I concluded last year by writing that the only future certainties are: the era of cheap oil would never come back and price volatility was here to stay. The biggest shorter-term uncertainty was how much longer cheaper oil would last. It would depend on how and when significant shifts in either the demand or supply of oil would take place. Some shifts included: Would global economies get healthier? Would the glut of oil turn into shortages? And, would geopolitics change?

Review of the past year

Figure 1 is an updated historical chart of real quarterly imported crude oil prices over the past 40+ years. The chart shows the various pricing levels defined in last year's column. As Figure 1 shows, oil prices (in real terms) are still in the realm of cheaper oil with

prices significantly higher than during cheap oil. (About \$40/barrel to \$60/barrel vs. \$25/barrel to \$35/barrel, respectively; on average about two-thirds more expensive in real terms, or about 2% higher annual growth rate when adjusted for inflation.)

News articles published on oil pricing issues in 2018 were mixed in terms of whether \$100/barrel would re-immerge or stay at cheaper oil levels. Apparently, the specter of the \$100+ plateau loomed in the industry's thinking. Below are some examples.

- On May 17, the *Wall Street Journal* (WSJ) published an article, "Oil Supply Hits Three-Year Low." At that time the International Energy Agency (IEA) had announced that "commercial oil stocks in industrialized economies have fallen to their lowest level in three years." IEA suggested this was the result of OPEC production cuts done to bolster pricing. Meanwhile, the U.S. pullout from the Iran nuclear deal also bolstered pricing.

- In its May 28 issue, a *Bloomberg Businessweek* article, "Who's Afraid of \$100 Oil?" postulated that world economies would not be affected as much as in the past if this should happen. "UBS Group AG found that the world economy needs 7% less oil to produce the same amount of GDP than it did in 2007." This suggests that even if robust worldwide economic growth reappeared, price changes might not reach the \$100 level because businesses have become more oil-efficient.

- On October 1, the WSJ published an article titled "Oil Rally Reignites Talk of \$100 a Barrel." It argued that geopolitical risks related to the impending Iranian sanctions and the decline in Venezuelan oil production would force OPEC to hold steady on production to bolster this higher price rally in the crude oil market, and possibly bring the world once again to \$100/barrel.

- Two short months later, thinking reversed. On December 3, the WSJ published "Oil's Rout Raises Stakes for OPEC's Next Move" and the "The Downside of Dropping Oil Prices." Both articles discussed the impacts of dropping oil prices, showing that OPEC's actions were ineffective in bolstering the price of oil, and that \$100/barrel was unlikely. One pointed out that "the U.S. economy relationship with oil is changing." A source was quoted saying that: "Fuel-efficient vehicles and a transition away from heavy industry mean the U.S. economy now consumes just 0.4 barrel of oil to produce \$1,000 of gross domestic product, down from 1.1 barrels in 1972."

- A December 5 WSJ article, "Oil's Fall Throws Doubt on Fracker Profit Outlook," stated that: "The rapid decline of U.S. oil prices will test the claim of fracker companies that they can now prosper at \$50 a barrel or less." Essentially, it speculated that frackers would need to shut down operations should oil drop

below \$50. It begs the question: Is \$50 the floor price during cheaper oil? If so, it will keep prices above cheap oil.

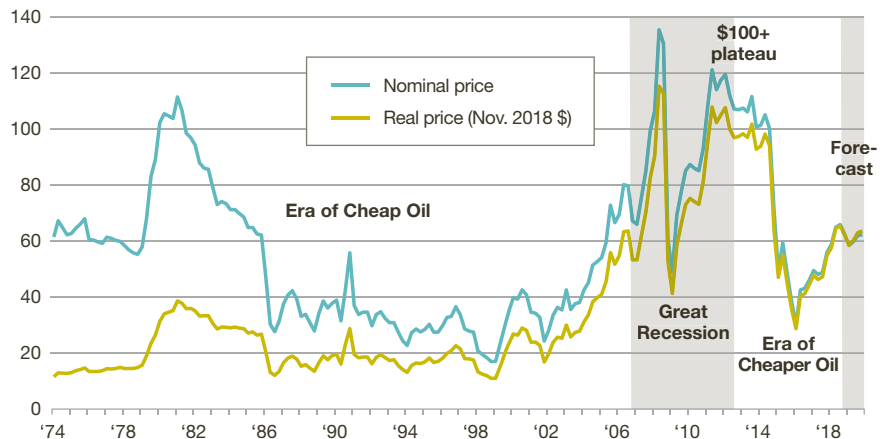
What about the future?

So, what have we learned about the new demand-supply picture? First, from the demand-side, world economies need less oil to grow. If robust pre-recession world economic growth rates return, it is unlikely to lead to the \$100+/barrel plateau. Second, from a supply side, the cartels lost their control on oil pricing. It appears that much of the history of oil, before the Great Recession (cheap oil) was geopolitical in nature. Today's global oil market may behave as a "true market" in the sense it is largely dictated by demand vs. supply. So, all told: cheaper oil might be the new normal (with it, of course, significant price volatility).

FIGURE 1

Quarterly imported crude oil price

(Dollars per barrel)



Source: EIA Short-term Energy Outlook, November 2018

However, my advice stays the same as last year. It will always be prudent to reduce the use of non-renewable carbon-based energy sources by making your supply chains as energy-efficient as possible. (For those who worry about CO2 emissions, it will also help the earth.) Eleven years ago, with oil prices rising, it was easy to convince your company to save energy because it also cut costs. Without high energy prices, energy-efficiency may not translate to cost saving. Thus, it will be harder to make the case to executive teams. ☺

*Previously published columns referenced in this article are:

"Is your supply chain addicted to oil?" *Supply Chain Management Review*, Jan/Feb 2007

"The link between oil and supply chain design," *Supply Chain Management Review*, Mar/Apr 2007

"Oil Update: Back to the future, again," *Supply Chain Management Review*, Jan/Feb 2018

Navigating the road to digital supply chain transformation

By Maria Jesus Saenz and Ken Cottrill

Maria Jesus Saenz, Ph.D., is research scientist, executive director of the SCM Blended Master Program at the MIT Center for Transportation & Logistics (MIT CTL). She can be reached at mjsaenz@mit.edu. Ken Cottrill is the global communications consultant at MIT CTL. He can be reached at kencott@mit.edu.



It seems that no self-respecting company can be without a digital transformation (DT) strategy these days. But shifting an organization from an analog mindset to the brave new world of digitalization is a long and challenging journey. Where do you start, how do you prepare employees, and once there, how do you engender trust in digitalized processes?

These issues were explored from a retail industry perspective at a recent MIT CTL roundtable. The Future of Retailing roundtable took place on November

14-15 2018, and brought together supply chain practitioners from various organizations including manufacturers, retailers and third-party logistics providers.

The discussions did not yield any magic bullets—there aren't any, of course—but they did produce a number of insights that can help companies tread easier as they quest toward a digitalized supply chain future.

Getting started

Identifying a starting point in the journey is not easy, especially when companies are deluged with information and advice on how they should proceed. But rather than spending vast amounts of time considering possibilities and generating a lot of frustration, another approach is to opt for any project that gets you on your way and is likely to deliver some successes—even modest ones—that can be easily shared and engage the organization.

This might seem a little too serendipitous, but you can refine your search criteria to increase the chances of success. For example, choose an external supply chain partner that is motivated and needs your contribution, has experience and knowledge it is willing to impart, and is interested in a specific project that can be scaled and quantified. As the partnership develops, you can expand your horizons to other partners.

A global developer and manager of retail supply chains took this approach and is now well into its DT journey. The enterprise chose to partner with a leading apparel manufacturer that has decided

to do business only with suppliers that are digitally-able. The overarching aim was to reduce the design-to-store cycle time for garments. To achieve this goal, they developed a digital platform that enables stakeholders to interact with designers in real time, and to collect feedback from customers on prototype designs. Ideas on aspects of garment creations, such as the colors, fabrics and styles used, can be input into the platform any time, from anywhere during the design process. Immediate customer feedback is used to further refine the concepts. In addition to speeding up the design phase, the platform increases the chances of producing designs that are attuned to current demand.

“Don't attack everything at once,” said the supply chain company. Learn as much as possible from the venture, and build on this knowledge to take the next step in your DT journey. Importantly, don't stop after taking this initial step.

A motivated partner that is digitally smart can spark interest within your organization. “Sometimes you need an outside champion, so the organization can see success and gets motivated to transform,” said the company.

A caveat is to be careful not to rely too heavily on the expertise of outside organizations. DT often involves a change in corporate culture, and while external experts enhance your knowledge, they also bring their own corporate cultures that might complicate the task of reorienting your own.

Two-way flow

Having taken the decision to take a leap into the digital unknown, how can you prepare your organization to take on the challenge and go on to greater wins?

All the roundtable attendees highlighted the need to have the right capabilities and talent as the main challenges for DT in retail supply chains.

A fundamental question is whether a DT strategy needs to be executed in a top-down or bottom-up manner. Should senior management drive digitalization through recalcitrant business units or should the mission start within the units and work its way to the top?

A retail company from a developing country pointed out that it does not have the financial resources to invest heavily in technology. As a result, it relies on a top-down approach to reorienting the company's culture and waiting for potential results.

In general, however, it seems that a combination of both approaches gets the best results. This is borne out by the initial findings of a study underway at MIT CTL Digital Supply Chain Transformation research initiative (digitalsc.mit.edu) that is analyzing 17 large-size, international and long-term established companies from manufacturing and retail industry. The initiative's main aim is to identify the roles played by dynamic capabilities, motivation and leadership in digital supply chain transformations.

However, it is necessary to facilitate the flow of digital innovation in both directions. For example, projects should be allowed to fail fast and progress within a framework that readily connects data with performance outcomes, both in terms of digitalizing operations, as well as understanding the effects and drivers of new digital offers.

Another way to foster digitalization is to employ evangelists to spread the word. For instance, some companies hire recent graduates with relevant advanced analytic degrees to explain and promote DT projects to the workforce.

Again, there are important caveats. Make sure that these young proselytizers have a firm grasp of the managerial and organizational—not just the analytical—implications of DT. And they also need to be experienced in change management.

But not only are top-down/bottom-up vertical flows within the organization important; horizontal flows outside the organization might be key to adopting digitalization along the supply chain and finding synergies with the most talented partners.

It's worth noting that supply chain representatives are good allies in such projects, and hence productive partners. Practitioners in the supply chain discipline are boundary spanners, connectors with other functions, have the holistic picture, understand how the customer behaves and are data-driven; all ingredients of successful DT.

Building trust

Even though DT is attracting much attention in the corporate world, it still has to overcome yawning trust gaps within organizations.

Experienced employees often see DT as a threat, or are skeptical that new-fangled, high-tech solutions can be trusted. Examples include drivers who mistrust delivery schedules generated by algorithms, and sales reps that scoff at the ability of machine learning to improve monthly sales projections.

To some extent, their misgivings are justified. Algorithms are created by humans, and hence can reflect human fallibilities. Pointing out that algorithms are only as good as the human rationales that create them helps to demystify the technology.

A key question is how to balance data-driven machine learning algorithms with human factors and processes. Achieving integration between these two disparate worlds is critically important and not easy.

Value streams


Another way to build trust is to focus on how DT can deliver measurable benefits. Examples of solutions that, say, shorten innovation cycle times or increase distribution network density lessen the cynicism that DT projects can provoke. Demonstrating how machine learning helps employees to perform better is another useful approach. Sales reps become more amenable when they realize that machine learning can improve their figures with more accurate and granular demand forecasts.

Monetizing data and outcomes helps to elucidate the value streams; putting a monetary value on increased network density may not be easy but it sure helps to give meaning to DT strategies. Clarifying the monetary value of projects also enables teams to better operationalize inter-organizational relationships with partners such as logistics service providers.

Fresh perspectives

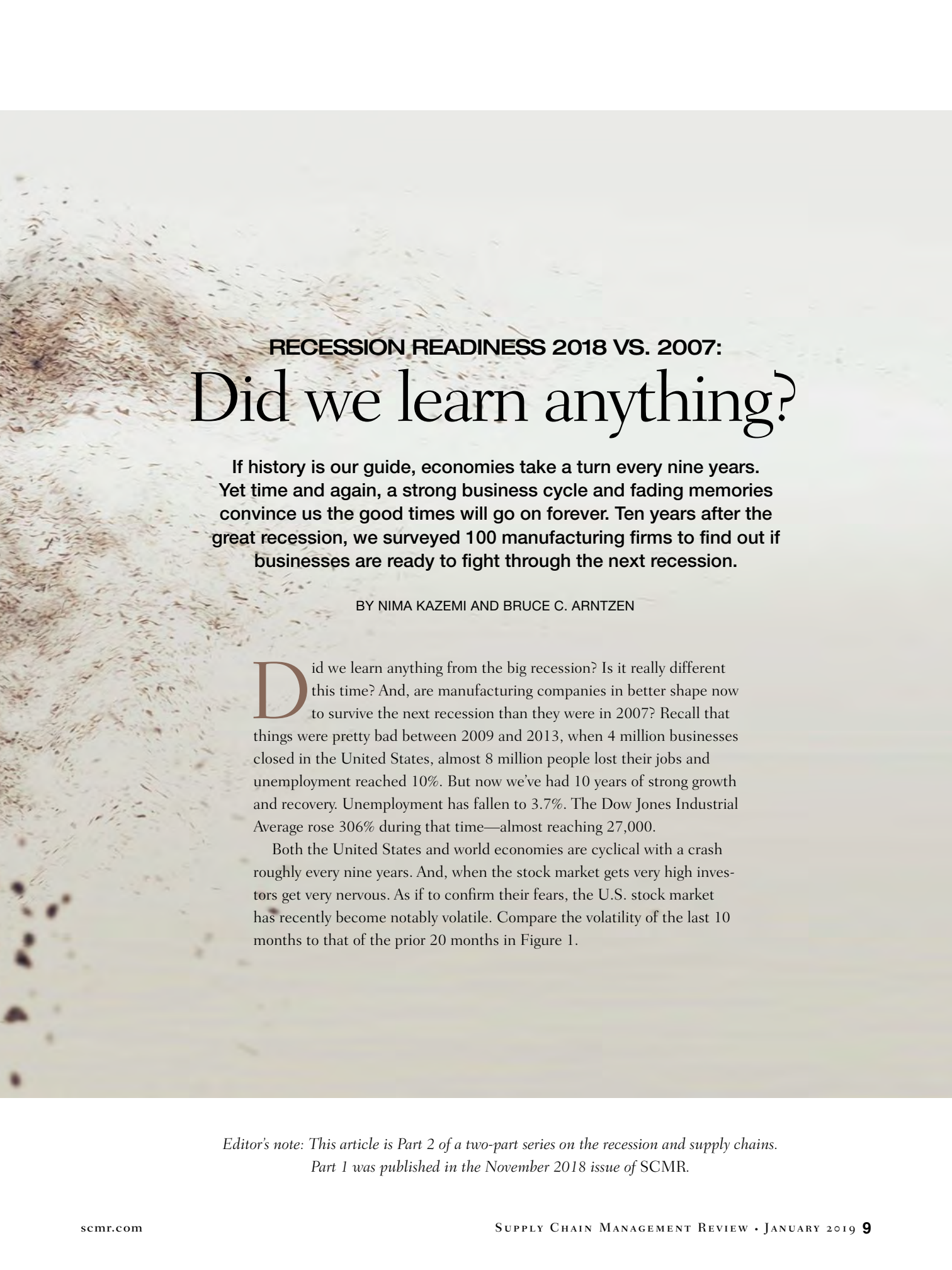
We are in the early stages of DT, and are only beginning to identify and address the challenges that impede the transition to a digitalized world.

A benefit we should not underestimate is how a well-executed DT strategy creates new knowledge and insights about deeply ingrained practices and processes.

But perhaps the most important imperative is that DT literacy is fast becoming an essential ingredient of competitiveness. As one CTL workshop attendee pointed out: "DT is attacking your supply chain, whether you are ready or not..." 



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RECESSION READINESS 2018 VS. 2007:
Did we learn anything?

If history is our guide, economies take a turn every nine years. Yet time and again, a strong business cycle and fading memories convince us the good times will go on forever. Ten years after the great recession, we surveyed 100 manufacturing firms to find out if businesses are ready to fight through the next recession.

BY NIMA KAZEMI AND BRUCE C. ARNTZEN

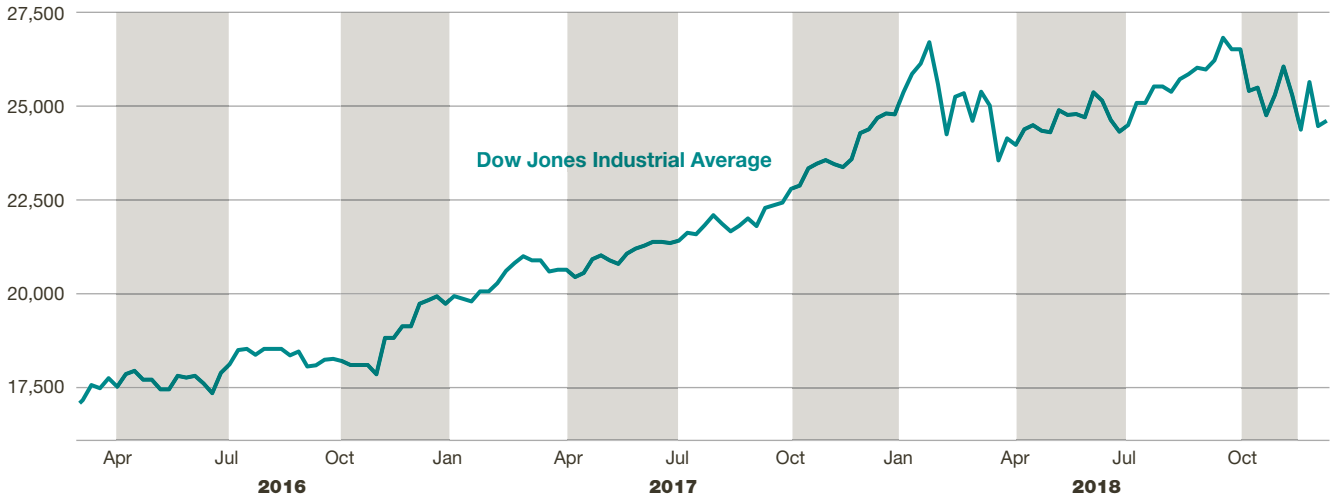
Did we learn anything from the big recession? Is it really different this time? And, are manufacturing companies in better shape now to survive the next recession than they were in 2007? Recall that things were pretty bad between 2009 and 2013, when 4 million businesses closed in the United States, almost 8 million people lost their jobs and unemployment reached 10%. But now we've had 10 years of strong growth and recovery. Unemployment has fallen to 3.7%. The Dow Jones Industrial Average rose 306% during that time—almost reaching 27,000.

Both the United States and world economies are cyclical with a crash roughly every nine years. And, when the stock market gets very high investors get very nervous. As if to confirm their fears, the U.S. stock market has recently become notably volatile. Compare the volatility of the last 10 months to that of the prior 20 months in Figure 1.

Editor's note: This article is Part 2 of a two-part series on the recession and supply chains. Part 1 was published in the November 2018 issue of SCMR.

FIGURE 1

The U.S. stock market has become more volatile in the last 10 months



Source: finance.yahoo.com

It's a given that the stock market will crash again, and that might happen fairly soon. So we sought to determine if companies are now in a better or worse position to fight through the next recession than they were in 2007, just before the last recession. Have fading memories and 10 years of good times allowed bad business practices to creep back in? Have they increased their debt? Has their workforce ballooned? Have they added more fixed costs so that their cost structure is less resilient? Have they relaxed their collections of accounts receivable? To find out, we surveyed 100 manufacturing firms.

What we studied

We focused on publicly traded U.S.-based small- to medium-sized manufacturing companies. We chose manufacturing because these companies have complete supply chains with all of the players and all of the flows. We explored publicly traded U.S.-based companies to facilitate data collection. And we studied small- to medium-sized companies (average revenues of \$3.3B, range of \$0.5B to \$24B) so that the financial statements would not be distorted by other businesses such as insurance, finance or leasing. We chose to compare their financials for three years: 2007, 2009 and 2018. 2007 is the year right before the market crash, 2009 was the bottom of the recession and 2018 is the year right before the next market crash (perhaps).

We collected data for the 100 companies from the database Capital IQ Compustat. The data included balance

sheets, income statements and other information such as the number of employees. Note that companies that were too weak to survive the 2009-2013 recession are obviously missing from our study. Thus, our findings are limited to those companies that were already strong enough to survive the last recession. For our analysis we used eight metrics outlined in Figure 2.

These metrics were selected or created to be indicators of good (or bad) supply chain business practices. All monetary values for years 2009 and 2018 were converted back to constant 2007 dollars to enable the comparisons. We carried out two different analyses on these metrics to get different insights into the recession readiness of companies. The details of the analysis are provided below.

Horizontal analysis

The first analysis was to look at one metric at a time across all companies. We call this "horizontal analysis." The method compared the average value of each metric in 2007, 2009 and 2018 to see if companies did better or worse in each year.

Revenues. Starting at \$3.32B in 2007, average revenues dropped by 9.4% during the recession, but now have risen to 7.8% above pre-recession levels. Since revenues have recovered and companies have grown, they are overall in a stronger position in 2018.

Profitability. Starting at 6.8% in 2007, average profitability was cut in half during the recession, but has now

recovered to about 85% of pre-recession levels to 5.8%. Thus, companies are in a slightly weaker situation now than in 2007.

Leverage. During the recession, leverage grew from 43% to 46% as companies took on more debt. Nevertheless, they did not recover after the recession and leverage has continued to grow, now to 49%. In our survey, 14 companies reduced their leverage by 25% or more from 2007 to 2018 while 35 companies increased their leverage by the same amount. According to S&P Global Ratings, U.S. companies are sitting on \$6.3 trillion of debt, the most they have ever recorded. Overall, this puts them in a weaker position than in 2007.

Working capital. Companies grew their working capital even during the recession and have further grown it during healthy times. But, working capital is a double-edged metric for a recession. It is usually good to have current assets, but as we noted in our first article, inventory is hard to move in a recession short of a fire sale (not liquid, ties up needed cash) and accounts receivable are much harder to collect. Therefore, the negatives offset the positives.

Variable cost structure. This metric got significantly

variable cost structure for more resilience, but instead more are doing the opposite. This puts them in a weaker position than in 2007.

Revenue per employee. This metric dropped about 8.3% during the recession indicating that company revenues shrunk faster than companies could shed their employees. After the long recovery, the revenue per employee is still down 6.8% from the pre-recession levels. Verdict: They are in a weaker position compared to 2007.

Accounts receivable. This metric shows the opposite of what you would expect: as sales drop, existing accounts receivable should represent a higher and higher DSO (days sales outstanding). But, it actually improved (shrunk) during the recession likely due to strenuous efforts to collect. Now, however, during good times, it has expanded again. This is the opposite of good recession preparedness.

Number of employees. During the recession, firms shed 7.1% of their employees. However, revenues dropped 9.4%. Now revenues have climbed to 7.8% above 2007 levels but the workforce has ballooned to 16.7% above 2007 levels. In our survey, 33 companies increased their headcount faster

than their revenues between 2007 and 2018 and nine of them increased headcount more than twice as fast as revenues. The number of employees fell too slowly during the recession and rose too fast during the recovery. It is easy to add people during good times but much harder and more painful to get rid of them during a recession. This greatly dampens efforts to scale back costs and is very dangerous heading into a recession.

Figure 3 summarizes the horizontal analysis including our conclusion about the preparedness in 2018 versus 2007.

FIGURE 2

Explanation of metrics used in the analysis and their impact on recession-readiness

METRICS FOR EACH COMPANY	IMPACT ON RECESSION-READINESS
Revenues (in 2007 bill \$)	Usually the higher the better
Profitability (net income/revenue)	Higher is better
How leveraged? (total liability/total assets)	Lower is better, less debt is desirable
Working capital (in 2007 bill \$)	Usually higher is better but in a recession some current assets (inventory, A/R) are much less liquid
Variable cost structure (COGS/PP&E)	Higher is better, more resilient.
Revenue per employee (in 2007 \$K)	Higher is better.
Accounts receivable (expressed as DSO, days sales outstanding)	Lower is better.
Number of employees	Lower is better. This part of the cost structure is very hard to reduce quickly.

Source: Authors

worse during the recession and has continued to decline during the recovery. Fixed costs are now a bigger part of companies' cost structures. In our survey, 16 companies moved closer to a variable cost structure by at least 25% from 2007 to 2018 but 34 companies moved the same distance away. Companies should be moving toward a more

Vertical analysis

In the vertical analysis, we compared each company to itself over time by looking at all the metrics for one company at a time. We calculated the percent change in each metric for 1.) 2007 vs. 2009 and 2.) 2007 vs. 2018. The first

FIGURE 3

The average values of metrics for 100 U.S. companies in the horizontal analysis

METRICS	AVERAGE VALUES			IS 2018 STRONGER OR WEAKER THAN IN 2007?
	2007	2009	2018	
Revenues B (in 2007 \$)	3.32	3.01	3.58	Stronger
Profitability (net income/revenue)	6.8%	3.6%	5.8%	Slightly weaker
How leveraged? (total liability/total assets)	0.43	0.46	0.49	Slightly weaker
Working capital \$B (in 2007 \$)	0.62	0.83	1.15	Mixed message
Variable cost structure (COGS/PP&E)	3.72	2.36	2.26	Weaker
Revenue per employee (\$K)	331	303	308	Weaker
Accounts receivable (as days sales outstanding)	58.1	56.5	60.9	Slightly weaker
Number of employees	10266	9538	11980	Weaker

Source: Authors

comparison tells us how much the company suffered during the recession and the second tells us how they stand today vs. the year before the last recession. For each metric, we classified the percent change for each company into one of four categories based on these criteria:

- significantly better (the percentage of change was more than +15%);
- not much change (the percentage of change was between +15% to -15%);
- slightly worse (the percentage of change was between -15% to -30%); or
- significantly worse: (the percentage of change is smaller than -30%.

Each company could then have a mixture of some metrics that were significantly better, some with no change, some slightly worse and some significantly worse. We did not include the “number of employees” in this part of the analysis because it was already partially accounted for in the metric “revenue/employee.”

To aggregate the overall impact of these seven metrics we invented a weighting method. Not all metrics have the same importance. For guidance, we studied the weighting methods used by the credit rating agencies including Moody’s, Standard & Poor, and Dun & Bradstreet. We then assigned the following weights: revenues 25, profitability 30, leverage 10, working capital 10, variable cost structure 15, revenue per employee 5, and accounts receivable 5 for a total of 100 points. Note that these weights reflect only the informed opinions of the authors and other investigators may well invent different weighting methods.

So how did the firms do? How many companies are in each category?

Significantly better. Not all firms suffer in a recession. In fact, 19% did significantly better during the recession, meaning that their metrics were at least 15% better. And it shows that 26% of the firms are now in much better shape to withstand a recession than they were in 2007.

Not much change. Similarly, about 29% of the firms had not much change during the recession meaning that their metrics were within a range of +15% to -15%

of pre-recession levels. Overall, that means that nearly half of the firms surveyed did either better or no worse during the recession. This is surprising because the general impression was that nearly every firm suffered.

Significantly worse. That said, one-third of companies did significantly worse during the recession—their metrics were at least 30% below pre-recession levels. And 19% of the companies are now in worse shape to withstand a recession than in 2007.

Mixed Signals. Finally, many of the companies surveyed had mixed signals, some metrics positive and some negative preventing us from drawing any conclusions about their recession readiness.

We also wanted to test the resiliency of specific groups of companies: How did those who suffered do? What about those who did not suffer? Did their experience during the recession cause them to behave differently now?

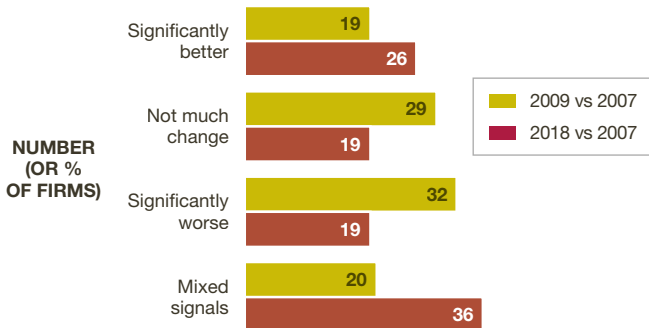
Group 1: Significantly worse in 2009 but now significantly better than in 2007. Recall our initial question: “Have companies learned anything about recession preparedness from the severe 2008-2010 recession?” From our survey, only about 9% of the companies both suffered significantly in the last recession and are now in a better position to withstand the next one. One would hope for a larger percentage.

Group 2: Significantly worse in 2009 and now no change from 2007. There are another 4% of companies who both suffered significantly in the last recession and are in the same position now as they were in 2007.

Group 3: Significantly worse in 2009 and now significantly worse than in 2007. In addition, 10% of companies both suffered significantly during the last recession

and now after 10 years of good times are actually in a worse position to withstand the next recession. Overall then, we have 14% of the companies who both suffered then and have not improved their preparedness now.

FIGURE 4
Results of the vertical analysis
 (Performance versus 2007)



Source: Authors

Group 4: Better or no change in 2009 and now significantly better than in 2007. We have 11% that both did not suffer during the last recession and are now in an even stronger position to fend off the next one.

Group 5: Better or no change in 2009 and now significantly worse than in 2007. Conversely, we have 6% of the companies who both did not suffer during the last recession but are now in worse shape than they were in 2007.

Where we stand today

The horizontal analysis showed us that overall, based on averages, companies are stronger on one metric, slightly weaker on three metrics, and weaker on three metrics. The main takeaways are:

- revenues have increased nicely but at the expense of lower profits;
- companies took on more debt during the recession and are continuing that trend;
- companies have moved to a less variable cost structure and thus less resiliency; and
- headcounts were hard to shrink during the recession and have now risen faster than revenues.

The combined message of the horizontal analysis is that overall companies are in a weaker position now than

in 2007 to withstand the stress of a recession. However, individual companies can be in much better, the same, or in worse shape now than in 2007.

The vertical analysis is a little brighter. We see that 26 companies are in better shape compared to 19 companies that are in worse shape. However, 19 companies are in the same shape and 36 companies have metrics that are a mixture of very good and very bad. In terms of specific groups, we see that only nine companies who suffered during the recession are in better shape now to take on the next recession than they were in 2007. We hoped that this would be a much bigger number, that companies learned some lessons to make themselves more recession-ready. By contrast, 14 companies who suffered are now in the same or worse position than they were in 2007.

So, did we learn anything? Is it different this time? No doubt many companies have adopted better practices influenced by the turmoil of 2009-2013. It would be meaningful to repeat this study with 1,000 companies, enough to draw statistically significant conclusions. But for our study, we do not see a large movement of the metrics or the individual companies in the right direction for recession preparedness. Human nature and the drug of good times are likely too powerful to overcome. ☹️

FIGURE 5
Summary of the performance of specific groups of companies

GROUP	DESCRIPTION OF EACH GROUP	NUMBER (OR %) OF COMPANIES
1	Companies who suffered in 2009 but now are in better shape in 2018 than they were in 2007	9
2	Companies who suffered in 2009 but now are in the same shape in 2018 than they were in 2007	4
3	Companies who suffered in 2009 but now are in worse shape in 2018 than they were in 2007	10
4	Companies who did not suffer in 2009 but now are in better shape in 2018 than they were in 2007	11
5	Companies who did not suffer in 2009 but now are in worse shape in 2018 than they were in 2007	6

Source: Authors

***Part 1, "Is your supply chain ready for the next recession?" can be accessed at scmr.com/article/is_your_supply_chain_ready_for_the_next_recession.*

NO ONE BEHIND THE WHEEL



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Everyone knows the trucking industry has a problem behind the wheel. After all, who hasn't heard that annual driver turnover is 100%? Or, in a really good year, it's only 95%. If you think it's bad now, just wait: It's going to get worse. According to the American Trucking Associations (ATA), the industry is short about 63,000 drivers today. By 2026, the ATA estimates that number will be nearly 175,000.

In Houston and Sacramento and Chicago and Boston and everywhere in between, we have a problem. A big one by any measure.

The question is: What can be done to fill those jobs? If only the answer were as simple as the question.

A review by *Supply Chain Management Review* of the truck driver landscape makes it clear there are multiple levers that can help minimize the problems in the near term and beyond. These include pay, working conditions and workforce diversity. And while these are the topics most people focus on during trucker shortage discussions, they are only the tip of the iceberg.

Other key issues focus on the efficiency of moving goods by truck in the first place. Consider these two statistics. On average, most trucks are only 60% full. Worse yet, 25% of all trucks are completely empty. Neither of those numbers have anything to do with driver availability or turnover. They are all about how the trucking industry manages loads and fleets.

This isn't the first time that usage rate has been an issue in the transportation industry. When was the last time you got on anything but a packed passenger plane? In 2002, the occupancy rate of flights was 70%. In 2018, that's up to 85%, according to the U.S. Bureau of Transportation.

But that shift alone has had a major impact on airline profitability. And, in all likelihood, is part of the solution for the trucking industry. In other words, the driver shortage is what we all talk about. But, in fact, the driver shortage may just be a symptom of fundamental structural problems in how the trucking industry fills trailers and the technology it uses.

This article will not provide the solution. Just one won't be enough. But it is clear that the industry needs to start looking where few have looked to make any headway here. After all, several improvements have been made in the past 18 months, but the industry is still short more than 60,000 drivers.

More than one elephant

"Safe, reliable and efficient motor carriers enable businesses throughout the supply chain to maintain lean inventories, thereby saving the economy billions of dollars each year," says ATA president and CEO Chris Spear.

Or as President Trump put it: "When trucks are moving, America is growing." Spear and Trump are not overstating the importance of trucking.

According to the ATA, trucks moved 10.77 billion tons of freight in 2017, accounting for 70.2% of all domestic freight tonnage. Furthermore, the industry generated \$700 billion in annual revenue in 2017, 79% of the nation's freight bill.

The ATA's annual report on the industry goes on to say that roughly 3.5 million drivers are employed with 1.7 million heavy and tractor-trailer drivers. Minorities account for nearly 41% of drivers and women for slightly more than 6%. More on this later.

According to The National Transportation Institute (NTI) CEO Gordon Klemp, the average driver age is 52, retirements are up and new entrants don't make up for exits. His comments were made at the 2018 CSCMP conference this fall.

On the same panel as Klemp was Kevin Knight, executive chairman of the board at asset-based Knight-Swift Transportation Holdings. He says that during the next decade about 440,000 drivers will be needed just to replace retiring drivers.

According to ZipRecruiter, the national average driver wage is \$50,737. That's \$24 an hour. The annual range is from a low of \$22,000 to a high of \$82,500, says ZipRecruiter. The hiring cost per driver is just over \$13,000 at asset-based Maverick Transportation, said Chairman and CEO Steve Williams at the CSCMP event. Drivers at Maverick make an average of \$64,770 annually and turnover has dropped from 71% to 57%, putting the company well below the national turnover rate. While some will quibble over the numbers presented here, they are clearly indicative of the problem and its complexity.

All of that said, the truck driver shortage is certainly an elephant in the room for both the supply chain and the overall U.S. economy. And when you start to break it down, there is more than one elephant here. In other words, the crux of the driver shortage is multi-dimensional.

What can be done?

To summarize the situation at a high level, there are already too few drivers available as turnover, including retirements, continue the churn. Meanwhile, U.S. unemployment is at a low and the size of the workforce is not increasing appreciably. There's even talk of being at full unemployment already. Furthermore, the average driver age is above 50 and pay is comparable to the national average of \$23 an hour.

On the surface, that lineup sounds a bit like we're at a dead end. Maybe. Maybe not. Experts in the field generally agree that possible solutions fall into three categories: short-term, mid-term and long-term.

"Early in 2018, it appeared that the driver shortage created a tipping point of structural change in the industry." That's according to Michael Zimmerman, lead partner for the Americas in the analytics practice of consultant A.T. Kearney.

That said, start with what is being done now to ease the pain of recruiting drivers. "Let's face it. Long-distance truck driving is a tough job and it's always been tough to recruit people," says Ben Cubitt, senior vice president, procurement and engineering at freight broker Transplace. "Drivers are away from home for extended periods and the lifestyle is not for everyone," he adds.

Until just recently, recruiting long-distance drivers was much tougher than for short haul drivers who are home most nights. "However, that has now changed and it's tough to recruit even short-haul drivers," Cubitt adds.

One solution that is a short-, mid- and long-term solution rolled into one, says Cubitt, is to greatly expand the driver pool. In addition to recruiting more women, Cubitt says African Americans (14% of drivers today), Hispanics (12% today) and Eastern Europeans are all sorely underrepresented in the driver workforce. Others single out immigrant drivers from Somalia, the Middle East, Cuba and Asia.

Klemp of NTI is a strong proponent of recruiting more women. "Women take fewer risks, crash less, collaborate more, work efficiently, are eager to learn and train, and put more effort into choosing a company and staying longer," says Klemp.

Another short-to-mid-term solution is to lower the age when drivers can get their commercial driver's license (CDL). Just that shift would greatly increase the potential pool of driver candidates.

Today the age is 21. Unfortunately, that creates a three-year

gap between high school graduation and eligibility for a CDL. As a result, many potential drivers move into other fields rather than wait to drive. Reducing the driving age, however, is not without controversy. There is concern that younger drivers increase the risk of accidents on the road. "Do we just want more drivers or do we want the safest and best-trained drivers with fair compensation?" asks Knight of Knight-Swift.

The power of training

All agree that training is critical to making drivers successful and retaining them.

In November, the ATA's president and CEO Chris Spear pledged his organization's full support for National Apprenticeship Week (March 4-8, 2019). "We know the enormous value and incredible potential that apprenticeship programs offer—both to employers and job seekers alike," he says.

Early in 2018, ATA pledged to enroll 10,000 people a year for each of the next five years in enhanced career programs. Even Georgia Tech and JPMorgan Chase are part of this effort. To date, JPMorgan has funded \$600,000 in grants to the university's Logistics Education and Pathways (LEAP) program, explains Tim Brown. He is director of Georgia Tech's Supply Chain & Logistics Institute.

The program, says Brown, is focused on inner city youth from 16-24 years old in Atlanta and Savannah. He says that more than 500 students have been involved with or are now involved with the program and various aspects of trucking.

Knight-Swift is intensifying its training efforts through its 11 academies. The company is also a strong supporter of third-party driver training facilities around the country. Yet another approach is offered by Cubitt of Transplace. The idea comes from one of the company's LTL carrier partners.

The idea is to create a training program for recent high school graduates. Start them working on the docks. As 19 year-olds, make them part of a driving team, pairing up with one or more experienced drivers until they are 21 and eligible for their own CDL.

Increasing wages

Cubitt sums up the driver compensation problem quite succinctly: "Pay is not commensurate with sacrifice." Worse yet, increases in driver income have been "very slow" going back to 2007, says NTI. But that is beginning to change, especially in the past year. The ATA says that its

2018 survey shows 50% of carriers plan to either increase wages or offer a one-time bonus.

In fact, many companies report a 10% increase in driver wages in the past year with more to come. That could be an additional 8% in wages in 2019.

Another relatively new practice is catching on: signing bonuses. The range, according to NTI, is from \$2,000 to \$10,000. There are reports of team driver fleets offering bonuses as high as \$30,000. In addition, some companies offer referral bonuses. Walmart, in particular, offers referral bonuses of \$1,500.

But pay and signing bonuses are not the only issues here. Benefits matter too. Health care and paid vacation days are high on the list. Walmart, once again, is a leader here offering as many as 21 paid vacation days to its drivers. ATA chief economist Bob Costello says a recent survey of the association shows that some carriers also offer paid leave and 401K retirement savings.

Improving the driver experience

Then there is the matter of technology. It comes in two buckets. One is current changes in on-board technology that greatly improves the driving experience. The other is longer term as autonomous vehicle technology develops and provide driving assists to truckers.

To begin, truck cabs are starting to feature amenities not previously available. Falk of Nolan explains that technology in the cab is making it easier to drive a truck and be gone from home for extended periods. But these are only incremental improvements described by one expert as similar to moving from a typewriter to a computer.

“We are now at a point where technology is becoming increasingly essential to improving the driver experience,” says Ben Harris, director supply chain ecosystem expansion at the Metro Atlanta Chamber. He says that technology in the cab will simplify the task of fulfilling operational requirements for drivers, some federally mandated, from driving regulations to truck maintenance.

Probably the most important here are electronic logging devices (ELDs), which are congressionally mandated. These devices log truck information from hours driven to miles covered. They also track hours of service that limit the time a driver can be on the road in a 24-hour period. ELDs are required on many trucks already with another year ahead for others to comply.

Quite simply, ELD devices greatly simplify the time and

effort drivers must devote to tracking required information. They also guarantee that the information is collected electronically and reported according to federal mandates.

Other technology advances in the cab include GPS and on-board mapping software. Both help to get drivers get from point A to point B. There are also lifestyle technology advances. These include more comfortable sleeper cabs and in-truck audio and video entertainment systems.

Fundamental shifts in trucking practices

Everything discussed so far is about making driving more attractive to those already involved and potential drivers. Now it's time to go off that grid and discuss potential developments that will fundamentally change trucking practices. These range from autonomous vehicles to collaborative shipping. One of the most comprehensive programs advocates completely rebuilding the trucking supply chain.

None of them are around the corner but all require attention now and into the future. Furthermore, none need be adopted in their entirety to remove at least some pressure from the driver shortage.

ELD devices greatly simplify the time and effort drivers must devote to tracking required information. They also guarantee that the information is collected electronically and reported according to federal mandates.

The one solution that everyone is at least slightly familiar with is the autonomous vehicle. It is worth noting up front that autonomous trucks are a long-term solution that will make driving easier in the short term before they potentially replace some drivers in the long term.

Talk autonomous vehicles and most people immediately go to the driverless stage. Fact is SAE (originally known as the Society of Automotive Engineers) established five years ago six distinct levels of automation for vehicles. This framework has been adopted by the U.S. Department of Transportation and the National Highway Traffic Safety Administration.

The levels range from no automation to partial and full automation. For instance, the first stage includes blind spot detection and lane departure warning systems. Move up a couple of levels to partial automation and lane change assist is part of the technology. Full automation does not occur until

the sixth level. And we are a long way from that.

That is especially important. Driverless trucks are some time away, if the ever pull onto the highway. There are almost as many timelines out there as there are experts. But the general consensus is that driverless trucks are at least five, if not 10 or 15 years away. And no one expects the technology to entirely replace drivers at any point.

In the meantime, the first four levels of the technology will assist drivers, enhancing the driver experience just as other devices are doing today. The hope is that driving will become sufficiently easier that it will appeal to a broader range of people than it does today.

The ATA, in particular, sees “driver-assist technology” as a powerful addition to trucks that is akin to auto-pilot on airplanes. In addition, ATA expects that a key component of this technology will be a network that will connect trucks on the road. Its own internet of things, so to speak. Such connectivity has a strong potential to improve safety and reduce traffic congestion, says the ATA.

Moving loads differently

“More efficient trailer utilization is a big opportunity,” says Brown of Georgia Tech. That can come in different forms. One is to ship more product and less air. Another is to build more efficient routes. There’s also the matter of collaborative shipping. The most disruptive of all is rethinking routes to the extent that drivers are never more than a few hours away from home.

This is also where solutions that will help alleviate the driver shortage get complicated. Even very complicated. While all of these ideas are under development today, none have what could even remotely be called critical mass. “All of us in logistics are working to drive miles out of the system,” says Cubitt of Transplace.

The first three forms just mentioned do just that and are central to a practice Cubitt calls lane matching. It combines shipments from two similar but non-competitive companies.

Both want to ship product to the same area but don’t have a full load. Lane matching combines product from both, filling out the trailer. Better yet, mix the right products by weight to stay under the trailer weight limit, avoiding what otherwise would have been another partial load.

This practice is only in the early stages in the United States, but is more widespread in Europe.

Collaborative shipping, also known as shared shipping, manages fluctuations in supply and demand as parties from

different supply chains combine their shipping operations more efficiently. That’s according to professors Robert Boute and Tom Van Steendam of Belgium’s Vlerick Business School and University.

As they point out in SCMR in November 2018, the general concept is not new. However, there is a new twist. Companies now adjust their planning and bring forward or delay the shipping until it is most advantageous for all. The result, Boute and Van Steendam say, is more combination of less-than-full truckloads and fewer empty trips by backhauling full truckloads. That takes miles out of the system.

Making all of this happen is not easy, however. A cornerstone is a strong partnership between companies. To be successful, collaborative shipping requires all participants to feel that they are benefitting equally from the arrangement. That does not always happen. However, collaborative shipping offers strong upside for those who can make it work.

On a completely different level is a radically different concept for managing shipments called the Physical Internet. It is an idea developed a decade ago by professor Benoit Montreuil of Georgia Tech. As the supply chain’s metaphor for the information internet, the Physical Internet is a handling and logistics system for moving and deploying goods.

More specifically, says Montreuil, “it is a meshed multi-party network of hyper-connected facilities that cross dock and store goods across the supply chain. It’s a continuous flow, multimodal logistics model with a network of hubs on one side and of open distribution and fulfillment centers.”

In the Physical Internet model, those hubs and DCs are never far apart. That makes it possible for drivers to drive four hours or less between locations. They can deliver one trailer and return with a second one and sleep in their own bed each night, vastly changing the current trucker paradigm.

Montreuil is currently developing simulations with several companies in the United States and internationally to see how the Physical Internet would work in their network. “We are taking a long-term view on this. And there is no question the Physical Internet will be in place, at least in part, before completely autonomous trucks are on the roads,” says Montreuil.

Clearly, the driver shortage is a major challenge for the supply chain and the U.S. economy right now. And most expect that it will become more acute before it gets better. But as others have said, where there is motivation and money there is sure to be innovation. ☺☺

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Intermodal to the rescue

There are no easy answers to the trucker shortage, but a project in Oregon demonstrates that intermodal could help save the trucking industry.

BY HEATHER MONTEIRO



While the truck driver crisis seems to have stabilized recently, there remains a dramatic shortage of drivers with no solution in sight. Yet, as this article will discuss, the development and growing use of intermodal facilities around the United States could play an important role in increasing the number of truck drivers on the road.

One example of this emerging phenomenon is the development of the Port of Willamette Brooks Intermodal and Transload Facility*. There, the Oregon Department of Transportation is funding a single site for development of an intermodal transfer facility to serve the market of abundant agricultural products exported from the Willamette Valley Area. One of the two finalists for the proposal for funding is the Port of Willamette in Brooks, Oregon. While the state's highest intent for funding the facility is to provide better logistics connectivity for the region's producers, the facility will also considerably improve conditions for the region's truck drivers. The following passage is a brief excerpt from the Oregon Port of Willamette Brooks Intermodal and Transload Facility proposal submitted to the Oregon Department of Transportation. It tells the story of a day in the life of a driver delivering an imported container from Seattle and then returning the empty container:

[After picking up a container at the Port of Seattle] the driver then heads south to Eugene, which is 283 miles from the Port of Seattle. This trip will take the driver about six hours on average including stops at inspection stations, which could put the driver into Eugene at 3:00 p.m. Upon arrival

at ACME Products in Eugene, the truck/40-foot container must be offloaded. The amount of time needed to do this varies, but can take approximately 1 hour to 3.5 hours per container. Using the worst-case assumption, the container would be completely unloaded by 6:30 p.m. The driver can then head back toward Seattle.

Drivers must strictly adhere to Federal Motor Carrier Safety Administration (FMCSA) hours-of-service rules. Generally, a driver may drive a maximum of 11 hours after 10 consecutive hours off duty. So, our driver who delivered the ACME Products load used 9 of her 11 allowable drive hours for the day when the container was emptied at ACME. The driver then may be able to make it as far as Portland with the empty container, where she will have to park and rest for 10 consecutive hours before driving again. The driver can then drive the remaining 171 miles to Seattle to return the empty container to the port.

This process needs to happen with multiple drivers in order for ACME to receive 10 containers from one vessel. Add highway congestion and unexpected events to this scenario, and the situation becomes more problematic and expensive for drivers and ACME.

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The proposed intermodal and transload facility will reduce the number of miles drivers must travel to deliver one load, or one container, and send it on its way to the Port of Seattle or Tacoma by providing a rail connection for the largest segment of the container's journey. By reducing these miles, the drivers' efficiency increases exponentially, making them now able to deliver many containers per day instead of one container with two days of driving, as in the example above. This intermodal facility is positioned within a 50-mile radius of the majority of agricultural producers in the region, thereby requiring truck drivers to travel 50 miles or less one-way to discharge their load before returning for an additional load. While this is a boon to the area's agricultural producers, it is also an incredible benefit for the drivers employed there. The proximity will allow drivers adequate rest time at home, with their families.

While this article focuses on intermodal facilities' benefit to the truck driving industry, this practice also increases efficiency and saves money for shippers and ergo, for consumers.

Many regions have created and benefited from intermodal facilities, particularly on the East Coast in locations such as Cordele Intermodal Services and the Appalachian Regional Port, both affiliated with the Georgia Ports Authority; and Virginia Inland Port in Front Royal Virginia. There are many other intermodal facilities across the country, particularly to satisfy the growth of e-commerce fulfillment.

While the goal and intent of these intermodal centers is generally to improve the efficiency and effectiveness of distribution and logistics, they have multiple collateral benefits including congestion reduction, fuel emissions reduction, improved customer service, improved transportation efficiency and a potential positive impact on the truck driver shortage.

Congestion. Ultimately, the best way to achieve

the reduction of highway congestion in the Portland area and to provide businesses in the Willamette Valley with reliable, predictable and cost-effective transportation over long distances is to establish rail service with a facility in the Willamette Valley. Businesses and farmers should be able to rely on short-haul trucking to and from an intermodal facility, with an associated transload facility, to minimize the use of trucks on highways.

Fuel emissions reduction. An increased use of rail instead of truck for transporting cargo results in much lower emissions rate. The reduction in congestion resulting from the increased use of intermodal facilities also contributes to a reduction

in fuel emissions.

Better customer service for shippers.

The use of intermodal facilities can reduce overall transportation costs and, in cases where there is a shortage of truck drivers, makes the truck driver's work much more efficient in terms of total delivered loads.

Increased efficiencies at ports. Individual drivers coming into ports to pick up individual loads face a multitude of delays; the required volume of drivers also contributing to the delay therein. Fewer individual drayage trucks in the port will lead to a more efficient port, increasing its effectiveness.

Potential impact on driver shortage. The presence of additional intermodal facilities will help reduce the truck driver shortage through several mechanisms.

Calling all truckers

The shortage of truck drivers in the United States has been well-documented. While estimates vary, they range from 35,000 to 63,000 depending upon the year and reporting source, with general agreement that about 100,000 new drivers must be employed per year to keep up with demand. The shortage is causing delayed deliveries and higher prices at the store as

While the goal and intent of these intermodal centers is generally to improve the efficiency and effectiveness of distribution and logistics, they have multiple collateral benefits including congestion reduction, fuel emissions reduction, improved customer service, improved transportation efficiency and a potential positive impact on the truck driver shortage.

companies pass on the higher costs to consumers.

Many factors are attributed to the difficulty of finding and keeping qualified truck drivers in the seat, including a lack of young drivers entering the profession, regulation compliance challenges and lack of job satisfaction. The lack of job satisfaction is most often ascribed to excessive time away from home, perceived lack of transparency in pay rates, health problems and burnout.

While age is a barrier to entry, there are several other factors to which the driver shortage is attributed. While no one intermodal facility is panacea, some of these factors can be at least *partially mitigated by the increase in the use of intermodal facilities*. Increasing the nationwide network of intermodal facilities changes the regional dynamic for truck drivers. **Age.** The aging truck driver population is alarming in its magnitude. According to the American Transportation Research Institute (ATRI), the truck driver industry is aging, with about half of the workforce between 45 years old and 64 years old. There is a dramatic shortage of young drivers entering the workforce to replace the rapidly aging driver population approaching retirement. While the reasons for this lack of young drivers is not clear, there are some barriers to entry for younger drivers. The federal requirement for truck driver age is 21+ years old for interstate driving. However, most states allow 18+ years old drivers to drive intrastate.

The federal age requirement prevents the 18-20-year-old segment from entering the truck driving work force for interstate driving. According to the American Trucking Association (ATA), this age segment also has the highest unemployment rate of any age group in the US population. These 18-20-year individuals who choose not to enter college, frequently enter the military or other accessible careers in services or construction. By the time they reach 21 years old, they've spent several years working in their industry and, in some cases, are making a wage that is high enough to act as a switching cost.

While there is ongoing interest at the federal level to reduce the interstate driving age, the use of intermodal facilities can assist by making the majority of

truck driving to and from these areas intrastate driving, which is regulated by state laws; most states have an 18+ minimum age for intrastate driving.

Regulatory challenges. CSA regulations limit the number of consecutive hours that can be driven. In some cases, this division of driving time reduces the individual driver's effectiveness in terms of doing a full turn in a single day for long trips. These regulations make roads safer, but sometimes lead to drivers being stranded in a city that is neither their origin or their

What is an intermodal center/ facility and transload facility?

An intermodal center is a facility in which containerized cargo is transferred from one mode to another. For example, in the proposed Port of Willamette, containers will be transferred to and from truck and rail. This process requires that all cargo is in a container before arriving at the facility.

Within some intermodal centers, or facilities, there is a transload facility. Transload facilities are those in which cargo that is not containerized is packed into a container so that future transport legs can be conducted via intermodal transport. Incoming containerized cargo can also be unpacked and broken down for repackaging or reloading to be distributed by non-containerized vehicles. For example, a trailer full of loose hay bails may arrive at the proposed Port of Willamette transload facility, be loaded into a container, sealed, and placed on a train for transport to the Port of Seattle.

destination, as was the case in the example at the beginning of this article.

An increased utilization of intermodal facilities mitigates potential effects of CSA driving time regulations by creating an environment where drivers can deliver more

loads in a single shift leading to higher productivity and better customer service.

While age and regulatory challenges are external causes that may be reducing the number of truck drivers, several other factors cause dissatisfaction and, in some cases disease, for individual truck driv-

While there is no one solution to the truck driver shortage, increasing the number of intermodal facilities can allow truckers to sleep at home every night, in most cases get paid a predictable wage and be much more active vis-à-vis having more leisure time during their time at home.

ers, thereby diminishing interest in getting into or staying in the profession. The amount of time spent away from home and pay rates are cited equally as detrimentally affecting the satisfaction of truck drivers, while health challenges and burnout are also strong detractors from the profession.

Time away from home. Excessive time away from home is one of the top-cited reasons for truck drivers leaving the career. With this type of proximity to an intermodal center, the drivers using this and other intermodal centers run multiple short runs locally, often intrastate, instead of long-haul rides. This allows drivers to be home at night to spend time with friends and family and enjoy leisure time.

Pay rates. Long haul drivers are often paid by the mile, with frequent complaints of not being paid for loading/unloading time or wait times. Conversely, the drayage (short haul or last mile) driving industry is a mix of company drivers, owner operators and companies with a mix of both in their driver pool. Drayage drivers aren't usually paid with a pay-per-mile model. Owner operators are usually paid at a flat rate per turn for specific load-destination combinations with wait time paid to the owner-operator for drayage. When drivers are company

employees, they are typically paid hourly as the employers are held to state and federal labor wage and hour requirements.

Health challenges. The vast majority of research, literature and articles related to the health challenges of truck drivers study long haul truck drivers only. The most common challenges identified are obesity, a sedentary lifestyle leading to additional health complications, cholesterol and heart disease, circadian rhythm disturbances and fatigue potentially leading to unsafe driving conditions.

Burnout. Burnout is frequently associated with those who switch careers away from truck driving. Burnout is a feeling of exhaustion in tolerating a specific condition; in this case, driving a truck as a career. While extended time away from home is a large cause of burnout, truck drivers also perceive the cause of burnout to feelings of loneliness, stress and a perceived lack of control. Studies of burnout nearly always evaluate long haul drivers to determine their level of burnout and the causes of that burnout.

Because long haul truckers drive and sometimes eat and sleep in their cabs, there are frequently feelings of loneliness on the road. Intermodal facilities not only allow truckers to be at home most nights with their families, the frequent short stops, or drayage, provides casual social interaction that is unavailable during long haul trips.

While stress cannot necessarily be reduced by the presence of intermodal facilities, an increase in leisure time at home, as well as a more predictable schedule and paycheck can lead to a reduction in stress, in general.

Finally, the trucker's perceived lack of control over their lives and their schedules are another cause attributed to burnout. Short haul drayage trips, as would be the operational regularity at an intermodal facility and often regional DC, would have a more predictable schedule and pay, thereby reducing the trucker's perceived lack of control over their day-to-day job.

Remaining challenges

While reducing the truck driving age nationally to 18 may help draw in younger truckers, there is one additional consideration that may make that change moot. Underwriters in some states, such as Louisiana, will only insure individual owner-operators at 25+ years of age, making truck driving in these states uninsurable until the age of 25. While large companies employing truck drivers as employees are typically self-insured and can therefore insure 25 years or younger drivers, the truck driving industry is dominated by individual owner-operators. This means that even if for intrastate driving, and even if the federal age requirement is reduced to 18+ years old, some owner-operators under 25 years old will be unable to get insurance in their state. This is an additional consideration in extending the age requirement down to 18 years old for drivers nationwide.

Behind the wheel

While there is no one solution to the truck driver shortage, increasing the number of intermodal facilities can allow truckers to sleep at home every night, in most cases get paid a predictable wage and be much more active vis-à-vis having more leisure time during their time at home. Those can go a long way to mitigating the major causes of truck drivers abandoning the career for dissatisfaction. An increase in intermodal facilities also help mitigate the age challenges faced by young drivers, and the regulatory challenges

faced by all drivers. Intermodal facilities have the potential to make trucking a much more satisfying career, increase levels of customer service, and lessen community and

environmental impacts such as congestion and carbon emissions. ☺

**The full proposal for this project can be found at portofwillamette.com.*



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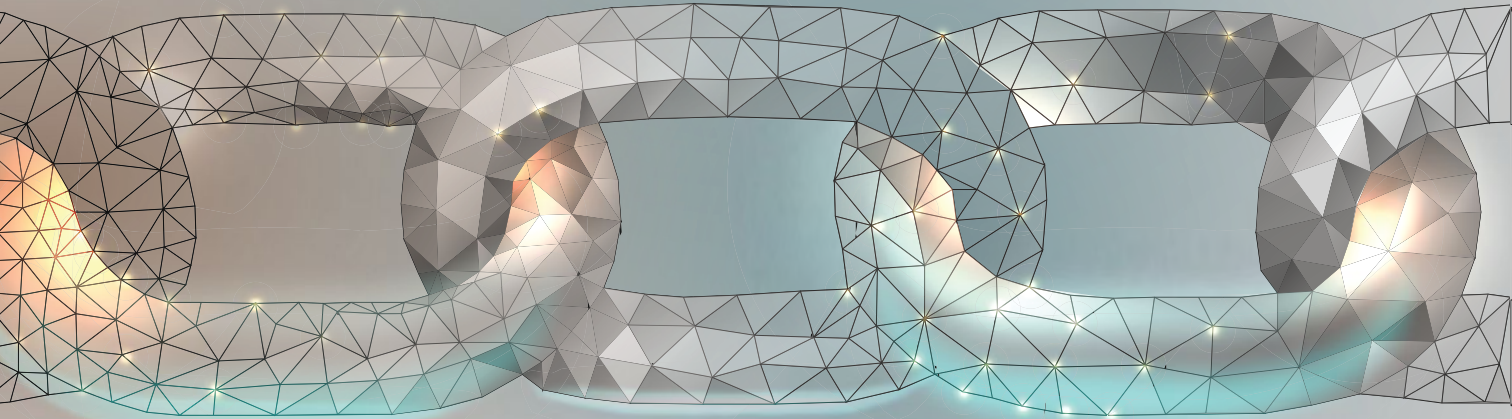
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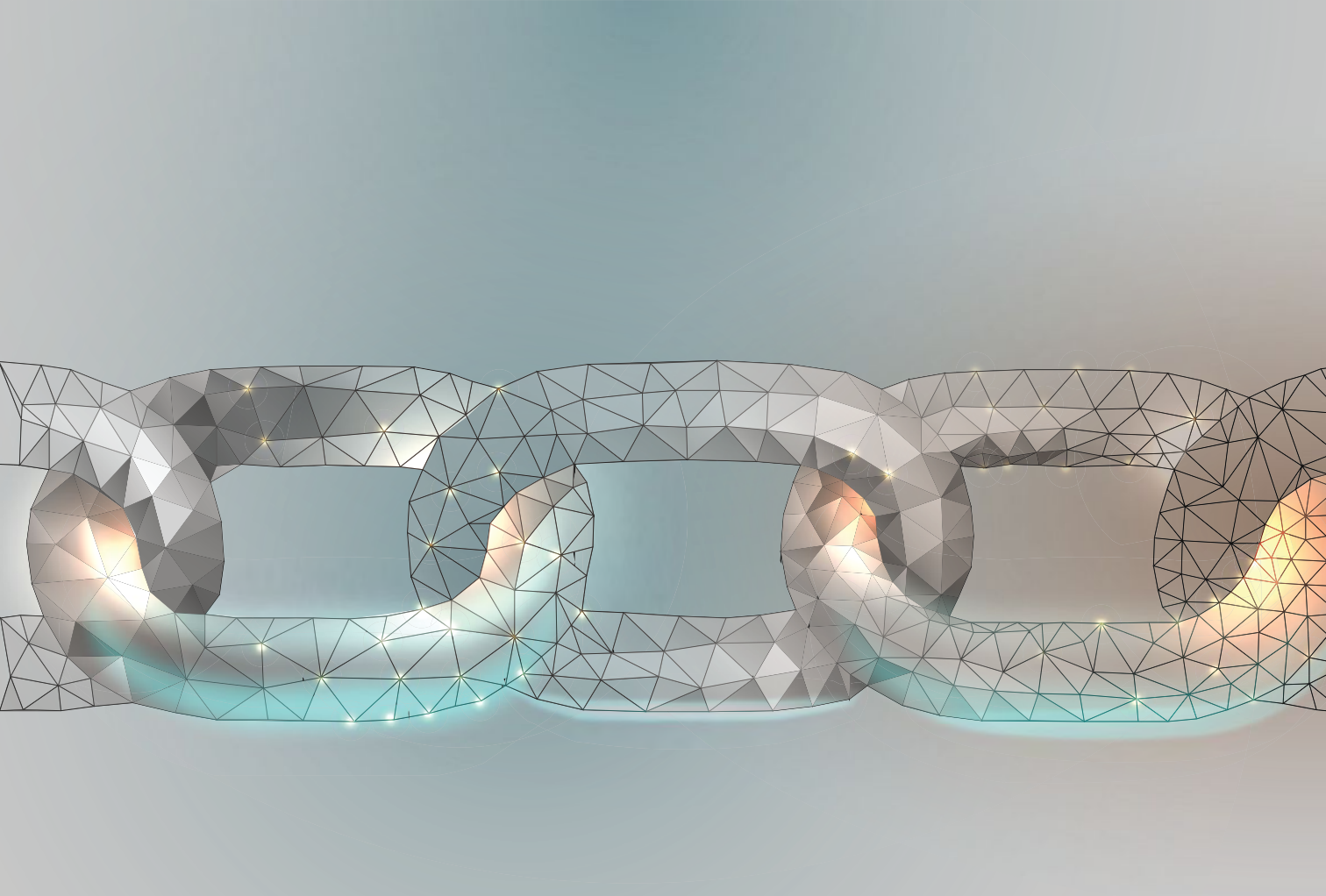
BEYOND CRYPTOCURRENCY: BLOCKCHAIN AS A VALUE CREATOR & CONNECTOR



For companies reliant on strategic partnerships or those seeking to increase the transparency of interactions between consumers or business partners, blockchain presents a world of possibilities.

BY VIKRANT VINIAK

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Most people recognize blockchain as the underlying technology for en-vogue cryptocurrency, but few truly grasp the potential of this technology to substantially reduce operating costs for companies and enable new ways of creating value. For companies reliant on strategic partnerships, or those that are seeking to increase the transparency of interactions between consumers or business partners, blockchain presents a world of possibilities. Ultimately, as companies co-invest in blockchain solutions, we will see supply chains and business partner ecosystems become increasingly interconnected, enhancing a sense of shared fate and creating opportunities for joint ventures.

To understand the value of blockchain to companies, both as a cost savings and value creation mechanism, we will explore three key use cases. As we lay out these three examples, it will become clear how blockchain can enable a substantial evolution of partnerships along the supply chain. Our three use cases are:

- how blockchain can increase transparency in the supply chain by validating provenance;
- how blockchain can reduce costs and complexity in asset tracking and smart contracts; and
- how blockchain can drive upsell opportunities through data purity.

Understanding what blockchain does and what it looks like in practice

First, it's important to understand what blockchain does, how companies can cooperate to implement blockchain solutions and what that looks like in practice. Blockchain is a digital, distributed transaction ledger shared across a public or private computing network. Transactions are added to the blockchain only after the computers in the network confirm their validity through cryptographic challenge-response authentication. This feature eliminates the need for third-party intermediaries, as the network uses a consensus mechanism to execute transactions. Transactions are stored on the blockchain in groups called "blocks."

The blockchain ledger is immutable and append-only, meaning new transactions can be added to the ledger but previous transactions can never be edited or deleted. Each block that is added to the blockchain contains a cryptographic reference, called a hash, to the previous block in the chain. The hash ensures the immutability of the blockchain. To tamper with any transaction in the chain, the hashes of all subsequent blocks would need to be decrypted—a feat that many consider to be virtually impossible.

While this may sound technologically advanced, it is relatively easy for companies to join a public blockchain or even build out their own. Blockchain runs over the Internet, with each computer in the network maintaining the identical database of transactions. To join a public blockchain, one simply needs a computer to download and run the open-source code. Running the code sets up the computer as a node in the network. To set up a private blockchain, the easiest approach is to use a Cloud service to host the network. These services allow you to define the number of nodes in the network and connect each device accordingly.

Use Case 1: Increasing transparency by validating provenance and handoffs along supply chain

The first supply chain use case, that illustrates how companies can reduce expensive audit and compliance operations and greatly enhance their transparency, is monitoring provenance. Validating points of origin and handoffs along the supply chain has become increasingly difficult, with greater numbers of diverse stakeholders in a global business ecosystem. With shifting and often tightening regulations, companies have a greater financial incentive to minimize compliance costs, as well as to control the operating costs of reconciling transactions between an

ever-widening network of partners. Simultaneously, transparency has become a key attraction for consumers who are increasingly demanding ethically sourced goods and transparent business practices. Blockchain has the unique ability to create a perfect, un-hackable and accessible single source of truth for every transaction along the supply chain.

A blockchain-based system can help improve transparency and monitor provenance by amassing trustworthy and verifiable data on how goods are made, where they originate from and how they are managed. Sales receipts and other records exist today. However, their legitimacy rests on whether the party can be trusted to record accurate information. Blockchain ensures that data can be trusted through automated, immutable records. One example of how blockchain can help validate provenance is in preventing the use of banned conflict minerals in high-tech microchips. U.S. regulation requires American microchip manufacturers to audit their supply chains to ensure compliance. Using blockchain, each transaction would be validated by and visible to each participant in the network, substantially reducing the cost of compliance while also reducing the risk of inadvertently supporting illegal and unethical practices.

Use Case 2: How blockchain can reduce costs and complexity in asset tracking

Another key example of how blockchain can reduce costs and complexity for companies can be seen in the example of asset tracking. Asset tracking has long been an expensive, time-consuming process with significant leakage, especially for telecom and products companies. The bureaucracy and paperwork meant to safeguard players in the case of reneged contracts is a core source of unnecessary complexity and introduces room for error as supply chains scale. According to Supply Chain Dive, almost \$2 billion is wasted each year in the U.K. alone on requesting and funneling data between trading partners via phone or email. Just as blockchain can help validate a point of origin and handoffs along the supply chain above, so can blockchain create a record of handoffs between OEMs, maintenance partners and consumers. That record not only significantly reduces leakage but also creates a clear set of data, mutually agreed upon, that can be used as the foundation for performance analysis and maintenance partner optimization efforts.

A use case that illustrates the benefits of blockchain can be found in customer-premises equipment (CPE) tracking for telecom companies. A complex ecosystem of leases,

maintenance and transfers surrounds CPE, which is essentially any terminal or related technology in end-user possession but connected to a carrier's telecom network. In addition to the telecom company itself, there are also multiple third parties involved that lease and manage CPE owned by carriers. The result is suboptimal utilization of assets, poor visibility into asset location and status and leakage as physical assets disappear in the system, leading to higher capex for the CPE original equipment manufacturers.

Blockchain can lower data costs, generate insights and reduce friction across the partner network. By tagging CPE devices with unique identifiers and logging each handoff, carriers create exceptional supply chain visibility. Device transactions, CPE taken off-line for maintenance and re-introduced, are recorded. This prevents asset loss and de facto creates a utilization log as well. Now, the length of time an individual asset spends undergoing maintenance is visible to the telecom carrier. This enables them to proactively manage both their asset pool and their supplier contracts, informed by visibility into the time and success of service from different maintenance providers.

Use Case 3: How blockchain can drive upsell opportunities through data purity

With blockchain comes pure and immutable data, creating a strong foundation for analytics and insights that can identify upsell opportunities. The use case outlined above, of the server manufacturer that was able to reduce leakage in maintenance contracts, provides a perfect example. Through their blockchain solution, the server manufacturer had newly clean, accurate records of all maintenance performed for customers, the amount of maintenance required by each user, and other critical lifecycle data. These records created the opportunity for the server manufacturer to identify customers to target with better service packages, important CLV data for each customer and finally insight into the optimal service packages to offer, as well as the packages that were costly to offer but underutilized by customers.

Blockchain: An opportunity in the age of mutual investment and the conscious consumer

The digital revolution has resulted in increased connectivity and innovation, preventing companies from existing in a siloed world. Strategic partnerships and mutual investments have become necessary to boost competitive agility in almost every industry. Furthermore, the digital revolution has left

consumers with higher expectations surrounding brand engagement and transparency. The new conscious consumer is demanding visibility into the origin and handling of all products to assess the social, environmental and political implications across the production and consumption chain.

Blockchain is the technology that will alleviate the pain points that the digital revolution has brought upon businesses. The distributed, immutable ledger will enable trust between stakeholders, regulators and consumers due to its transparent and secure nature. This trust will lead to a substantially greater level of joint investment, communication and collaboration. Overall, blockchain has the potential to evolve today's increasingly complex network of diverse, independent stakeholders toward more frictionless, cost-effective and transparent partnerships.

Theoretical or tangible?

Blockchain is still in the early stages of development and few companies have pushed beyond the proof of concept stage to full implementation. This is largely because implementing blockchain in-house through open source code has proven to be expensive. Investment in server infrastructure and the necessary addition of specialized resources for development and governance has deterred companies from exploring it further.

However, 2019 is poised to see a significant increase in blockchain adoption due to the blockchain-as-a-service (BaaS) offerings of the largest cloud providers. These Cloud-based services eliminate the need for investment in supporting infrastructures and blockchain developers.

Regardless of the route chosen for implementation, it is important to note that the cost of blockchain will be dependent on the number of transactions that are being processed and required transaction speed. Furthermore, IoT integration will drive up costs because of the sensors needed to track physical goods and environmental conditions.

Blockchain has tremendous potential to transform the way entire industries operate, beyond the use cases detailed above. As more companies adopt blockchain technology, it will become even more valuable as a digital connector between companies. To allow it to reach its full potential, companies need to first look internally to adopt a collaborative, technology-first mindset to push for organizational change. ☺☺

This piece was co-authored by Alex Olea, Accenture Strategy functional senior manager with contributions from Madeleine Stanich, Bernice L. Hsu and Madeleine Cooney.

DIGITAL SUPPLY CHAIN TRANSFORMATION:

VISUALIZING THE POSSIBILITIES

Many supply chain leaders view digitization as a mandate for competition, yet the first steps to developing an overall strategy are unclear. We take a deep dive into the questions of the state of digital implementation and try to separate hype from reality.

BY NADA SANDERS AND MORGAN SWINK

Most, if not all, supply chain managers recognize that a digital revolution is overtaking supply chain management. It is fueled by three major trends.

Big Data. Data is being generated up and down the supply chain by transaction-based monitoring and enterprise systems, such as point of sale, RFID and ERP systems, as well as by unstructured data sources, including clickstreams, camera and surveillance footage, imagery, social media postings, blog/wiki entries and forum discussions.

Advances in computing. Enormous advances in computing power and intelligence are automating Big

Data processing and analysis. Computing architectures such as cluster computing, Cloud computing and mobile computing have made storage, retrieval, analysis, sharing and distribution of data faster and cheaper.

Advances in robotics. In combination with advances in hardware and software, robotics and robotic process automation are quickly making the automation of manual and transactional processes cheaper and more reliable.

Because of these advances and the hype surrounding them, many supply chain leaders view digitization as a mandate for competition, yet first steps and an overall strategy are unclear. Important questions include:



- What is the “digital supply chain” in terms of its definition and core elements?
- What are the main opportunities and challenges?
- What are the key enabling technologies?
- Are we already behind? Where do companies really stand compared to the hype?
- How do we move forward?

In the following article, we’ll address these questions with insights derived from our discussions with leaders from a range of supply chain firms in a variety of industry sectors (see About our research). We take a deep dive into the questions of the state of digital implementation and try to separate hype from reality.

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What is a digital supply chain?

While the term digital supply chain is widely used, there is little agreement on what it means. When we asked supply chain leaders: “What is a digital supply chain?” responses included:

- “Digitizing all transactions”
- “Connection of transactions and sharing plans electronically with partners up and down the supply chain.”
- “Replacing manual/people-based tasks with electronic and computing power.”
- “Data communications replacing verbal, manual, paper-based processes.”
- “Better visibility and tracking.”

The responses clearly vary, with some leaders focusing on a single platform while others look at demand and supply visibility. From these and other similar responses, we found a unifying thread to define the digital supply chain: *A digital supply chain makes maximal use of “digital” technologies to plan and execute transactions, communications and actions.*

Embedded within this definition are fundamental notions of *dematerialization*, *automation* and *artificial intelligence*. Related applications show up in thousands of different ways throughout supply chain management processes. In the following sections, we describe the important core attributes and digital technologies that are defining and driving digital supply chain transformation.

A core attributes model

Digital supply chains sense, analyze, predict and respond to changes in the operating environment. Essentially, this means that supply chains use technologies, organizational structures and skills to capture data, convert it into information, analyze it and quickly adapt to it much more quickly, accurately and specifically than conventional supply chains could ever do. The leaders we talked to allude to these elements, though often only indirectly, and rarely in holistic ways. Nevertheless, their combined comments revealed a model of core attributes that provide both a useful description of digital supply chains and the

beginnings of a maturity model. Figure 1 illustrates these core digital supply chain attributes.

1. Digitized. It all begins with data. The primary virtue of a digital supply chain is that it reduces uncertainty by providing (hopefully) current, accurate, complete and useful data. While supply chain managers have access to lots of data today, typically only a small fraction meets these criteria. Accordingly, getting data that has strategic value in a useful form can be a huge first step toward digital maturity.

Throughout supply chains, sensors and systems produce and capture data, digitizing them at the source, in forms that are sometimes structured and sometimes unstructured such as text and visual media. Usually, these data sets must be standardized, “scrubbed” and cleaned, for stakeholders to be able to use them. For example, systems must standardize item identification numbers across vendors/sources in order for managers to track movements effectively. Our interviews pointed out the challenges associated with this first step. No company had all digitized data available in real time (immediately

About our research

In research sponsored by APICS, Texas Christian University (TCU) and Northeastern University (NEU) are partnering to perform a series of studies of digital supply chain transformation. In this initial study, our goal was to go beyond the hype to identify the true state of where businesses stand, including their transformation visions, current capabilities, enablers and obstacles.

We conducted in-depth interviews of senior executives at more than a dozen firms covering a wide range of industries, from healthcare to retail to aerospace to transportation. All firms are leaders in their industry segments. Our findings reveal where these firms really stand on their digital transformation journey, the challenges they are encountering and strategies for overcoming them. We are grateful to all the leaders that shared their time and insights with us.

when captured). One leader complained that data provided by a major customer was “not complete, not real time,” and subsequently, “not always used.” Important goals for many are to:

- identify and prioritize data needed to reduce uncertainties and guide actions;
- perform a data inventory identifying available data types and data deficits; and
- for important data, reduce the lead-time from data capture to data usefulness.

2. Connected. Digital supply chains convert data into information and convey it to stakeholders and decision makers in a timely manner. Information is created when data is combined, filtered and organized in useful ways.

Many supply chain managers complain that they are awash in data but lacking in information. Several leaders we interviewed expressed the aim to make information available to the right people at the right time as an important digital supply chain goal. For example, leaders stated the following related goals.

- “Create a centralized control tower sharing information in real time.”
- “Share information electronically with 1st and 2nd tier suppliers.”
- “Communicate with suppliers through design systems and ERP systems (PLM, MES, ERP), enabling analytics for optimization (e.g., transportation).”

These goals reflect the need for systems in digital supply chains to establish connectivity with trading partners and to create and share information.

3. Intelligent. A digital supply chain also provides insights and intelligence, beyond merely summarizing and organizing data. This requires applying analytics to diagnose situations and events, using algorithms to predict possible outcomes and risk assessments and prescribing courses of action with possible alternatives. As one leader noted, the digital supply chain needs to:

- “Develop information/insight so that supply chain

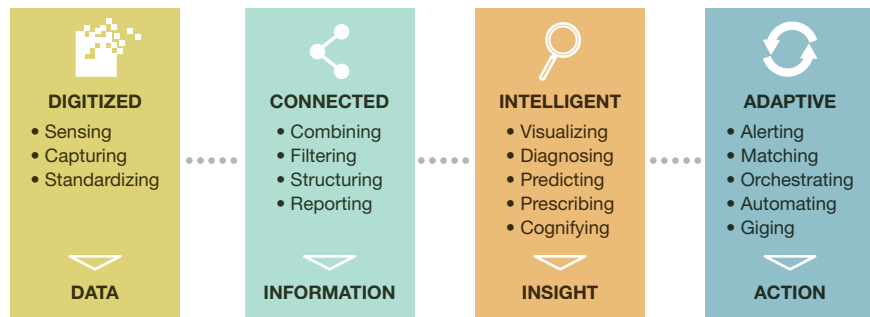
can provide options.”

- “Provide automation plus streamlining plus intelligence—making decisions, identifying risks, integrating data.”

4. Adaptive. The last core attribute of a digital supply chain is adaptability—the ability to act upon derived insights. This attribute is least commonly associated with digital, but it likely has the greatest impact on performance. Data, information and insights are of little value if operations are so fixed and immobile that managers are unable to pursue time-sensitive opportunities. Predictions from analysis are most accurate in the short term. Thus, to realize the full value of a digital supply chain, it must be able to quickly respond and act upon the

FIGURE 1

Core attributes of digital supply chains



Source: Authors

intelligence it creates.

Several of the leaders identified responsiveness as an important goal of their digitization efforts using statements such as:

- “Mapping out supply chains and developing more responsive strategies.”
- “Digital enablement to speed up and connect even more.”

These four foundational attributes of a digital supply chain can guide a beginning analysis of existing and needed capabilities. For many firms who are starting the digitization journal, an important question is: Which of the attributes presents the biggest obstacle or opportunity?

1. Getting the right data in the right form at the right time.
2. Communicating data as useful information to the right stakeholders.

3. Deriving actionable insights from the information.
4. Adjusting operations quickly enough to capitalize on the insights.

Enabling technologies

The popular press offers numerous examples of technology applications in supply chain processes, including artificial intelligence (AI), robotics and predictive analytics. Figure 2 groups these and other enabling technologies based on their primary purpose and capabilities.

Supply chain leaders indicated that keeping up with technology was a key challenge, highlighting the importance of working with excellent partners to evaluate, select and develop solutions. Equally important, the leaders suggested the need for a larger view of integration across technologies, due to the limitations of existing systems. For example, they said:

- “ERP is too transactional—it doesn’t give you the tools to do advanced planning and integration with external partners needed.”
- “As a technology company, we tend to be susceptible to the promise of technology without fully appreciating the cost/difficulty of the supporting changes required.”
- “Our supply chain personal still wonder if a given technology is sufficiently mature. We have questions about who should pay for the technology, how processes should be changed, etc.”

Technology adoption and enablement is clearly a huge topic in itself and an important differentiator in the maturity of digital supply chains. Our conversations with supply chain executives strongly suggest that leaders should focus on linking the core capabilities of technologies with business level strategies, rather than simply focusing on solutions to problems.

State of digital supply chain transformation

Our research examined the journey that companies are taking in their digital transformation, where they are along the path and whether they have precise goals and a roadmap. We specifically focused on the supply chain aspect of this process, not product or service design such as not analyzing consumer behavior or specific enterprise features.

One key finding: In a world filled with hyperbole and up-to-the-minute stories of technological advancements, the reality is that most firms, even leading ones, are not that far along with digital transformation. All the leaders

we spoke with stated, somewhat apologetically, that they believed they were behind the industry curve in digital processes, and certainly a long way from reaching “maturity.”

What does maturity look like?

That feedback posed an important question: What does maturity look like? One could think of overall digital supply chain maturity as the degree to which a firm applies enabling technologies in ways that provide the core attributes (digitized, connected, intelligent, adaptive). Most of the firms we spoke with are making progress along these lines in selected functional areas. However, supply chain “transformation” implies something bigger than applying specific technology “solutions” to localized problems. In addition to the *stage* of digital transformation as a dimension of maturity, we suggest that the *scope* of development is an important maturity measure. Answers to the following questions provide a snapshot on maturity:

- Have we defined a roadmap and a process for updating it?
- For how many key processes have we achieved core attributes: digitized, connected, intelligent, adaptive? At what stage is each process?
- How many of our initiatives are integrated, system-wide efforts and how many are localized problem-solving efforts?
- To what extent have all of the important enablers and challenges of transformation been identified and addressed?

Stage of implementation

We found significant variation in levels of investment and stages of digital transformation among the leaders we interviewed. Industries vary, especially in terms of technology investments.





Figure 3 shows average technology investments for the industries we sampled; some invest at two to four times the rate of others. Even with these differences, our findings indicate that most firms are in “infancy,” or early stages, of transformation.

Only a few of the leaders we interviewed stated that they had defined a guiding roadmap or strategy, and few identified specific measurable targets for achievement.

The following statements summarize the positions of many of the firms.

FIGURE 2

Technologies enabling the digital supply chain

TYPE OF TECHNOLOGY	CAPABILITIES	EXAMPLES
 ANALYTICS/ DECISION TECHNOLOGIES	Provide computing power, intelligence, and data management, making higher-quality decisions faster	<ul style="list-style-type: none"> • Advanced planning systems (APS) • Supply chain network design • Management and execution systems (TMS, WMS, MES, YMS, OMS) • Forecasting and demand management • Advanced analytics and machine learning
 PROCESSING TECHNOLOGIES	Automate transactions and material processing to provide 24/7 resource availability, faster processing, improved consistency, and cost	<ul style="list-style-type: none"> • Programs, software robots • Computer-aided design and machining, 3D printing • Industrial robots, flexible manufacturing systems (FMS) • Drones and autonomous vehicles • Automated storage and retrieval systems (AS/RS)
 COMMUNICATIONS TECHNOLOGIES	Create greater accuracy, currency, connectivity and visibility, speeding flows of richer forms of information	<ul style="list-style-type: none"> • Sensors, scanners and radio frequency identification (RFID) • The Internet: Wi-Fi, narrow band, cellular, microwave, radio, etc. • Satellites, fiber optics, etc. • Electronic data interchange (EDI), global data synch network (GDSN)
 INTEGRATIVE/ PLATFORM TECHNOLOGIES	Combine data management, communications, visibility, traceability, decision support, and processing capabilities	<ul style="list-style-type: none"> • Cloud computing and services/blockchain • Mobile applications and wearables • Augmented and virtual reality, global positioning systems (GPS) • Enterprise resource planning (ERP), product life cycle management (PLM), relationship management (CRM, SRM, CPFR)

Source: Authors

- “In infancy. Don’t have a strategy yet, embarking now to establish best in class.”
- “No well-defined roadmap.”
- “Several key initiatives under way and others planned about two years out.”
- “Three year roadmap, adjust as go with step function changes each third year.”
 - “Don’t really have guiding strategy. No one at the top really pushing the agenda.”
 - “We don’t have a strategy.”

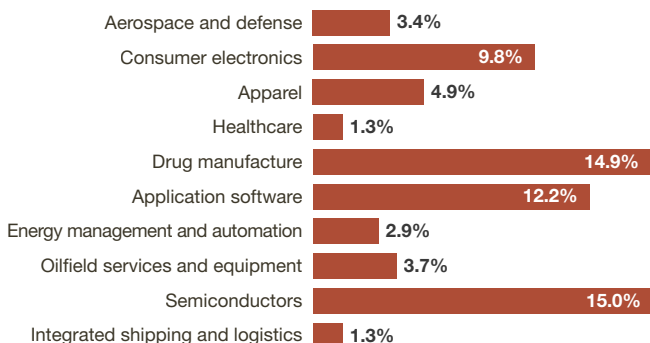
Despite the hype, few of even the most advanced firms have yet added advanced analytics or intelligence such as machine learning into to their digital supply chains. Most are focused on the early steps of digitizing data and connecting stakeholders in ways that provide greater process visibility, and on automating transactions and data translations needed to smooth information flows. In addition, a number of firms are somewhat opportunistically applying technologies such as 3-D printing and robotic process automation (RPA) to reduce capital (inventory) and labor costs.

An important distinction that seemed evident in our conversations with leaders is how the company views digital transformation milestones and potential returns. Some seemed to view technology investments primarily as internal cost reduction efforts, with heavy weight placed on financials and ROI. For example, one leader expressed a primary goal as:

- “Seeking reductions in spend, reducing cost per transaction, 30%-40% headcount reductions, increase efficiency

FIGURE 3

Average technology spend per industry sector



Source: Authors

of team members to be greater value-added work.”

While these are appropriate goals, other firms tended to take a more strategic view, placing more weight on accomplishing steps according to an established roadmap designed to provide broader aims. For example:

- “Bringing silos together (make move enable), provide end-to-end visibility and link it to factories—create an end-to-end dashboard of metrics.”

One executive highlighted the difference in internal and larger perspectives in this way:

- “Internal perspective is to figure out what data I have and how to best utilize it. A larger perspective is to build partnerships to leverage respective strengths.”

Scope of application

This issue of *perspective* is an important one and is also reflected in the scope of applications of digital concepts and opportunities. Executives leading digital transformation strategies must balance the opportunity to solve problems in specific function and process areas with more integrative, strategic objectives.

Figure 4 provides an overall view of digital technology applications across six major supply chain processes.

If the popular press provides any gauge of development, one would surmise that firms are putting most of their investment and attention to improvement in planning processes, including demand management, forecasting and inventory management. The press also contains lots of stories about asset monitoring in logistics and robotics applications in manufacturing. While procurement seems to be relatively underdeveloped in analytics

applications, some see it as offering the largest potential for technological advancements.

Application areas include supplier platforms, spend analytics and supplier collaboration. In our study, a majority of leaders stated a focus on supply management transformations, and mentioned creating digital connections with suppliers, automating procurement transactions and building upstream visibility as key initiatives.

A distinctive attribute of maturity that emerged from

our conversations with leaders is an enlarged scope of transformation that includes integrated, systems-oriented, objectives and projects. They recognized that developing technology solutions in parochial supply chain functions is relatively easy, compared to larger, more integrative initiatives. Several leaders expressed desires to evolve their efforts toward larger-scoped projects, including:

- “Deploying SAP across the entire organization (multiple platforms and instances).”

- “Becoming

highly integrated with suppliers, using web based scorecards that provide real time (24 hour) performance visibility.”

- “Developing an inside out approach, starting with consolidation of internal data (e.g., cross systems, EDI, transportation system)—but this just digitizes silos, solving specific problems but not connecting nodes. The next step is to make connections, reach out to partners and get their data.”

- “Looking to gain greater access to partners’ data,

IPC/Subway leads the way in traceability

Independent Purchasing Cooperative (IPC) is the organization that provides procurement and supply chain services to the thousands of franchise owners of Subway sandwich restaurants. With growing pressures from regulators and consumers, IPC food safety and quality managers determined that traceability—the ability to quickly verify the history, location and usage of items—was the dimension of visibility most critical to the organization’s long-term success. A recent item recall event highlighted its financial importance. Managers visited over 5,700 restaurants in the search for contaminated foods, yet the items were present in only 980 locations. Traceability would have saved over \$400K in recall costs for this event alone. Equally important, IPC expects complete traceability to provide better control of expired product (through mobile alerts), a foundation for perpetual inventory systems, sustainability data for interested consumers, and overall brand and consumer safety enhancements. As a leader in the restaurant industry, IPC and its partner, FoodLogIQ, have been working with growers, distributors and restaurant operators for several years to implement the standards and systems necessary to provide 100% track and trace capability.

control flow and gather more intelligence inside partners' facilities to synch flows with factories' operations."

- "Developing one integrated system with one single database."
- "Integrating systems across all business units."
- "Centralized control tower sharing information in real time with everyone in the ecosystem."

Lack of data integration, "data silos" and "data lakes" were common themes. Most leaders understood that this is the first step in digital transformation, and that a single source of data is the most important factor to move forward.

Enablers and challenges

A final dimension of maturity uncovered in our study is the degree to which a firm has addressed key enablers and challenges of transformation. When asked about the key obstacles to change, all interviewees agreed that *organizational issues* create the greatest challenges.

Leaders stated that limitations in culture, talent and organizational structure form greater impediments to

transformation than do technological limitations. Figure 5 adds these elements to our core attributes framework, showing that organizational structures and human resources are the foundational enablers for digital supply chain transformation.

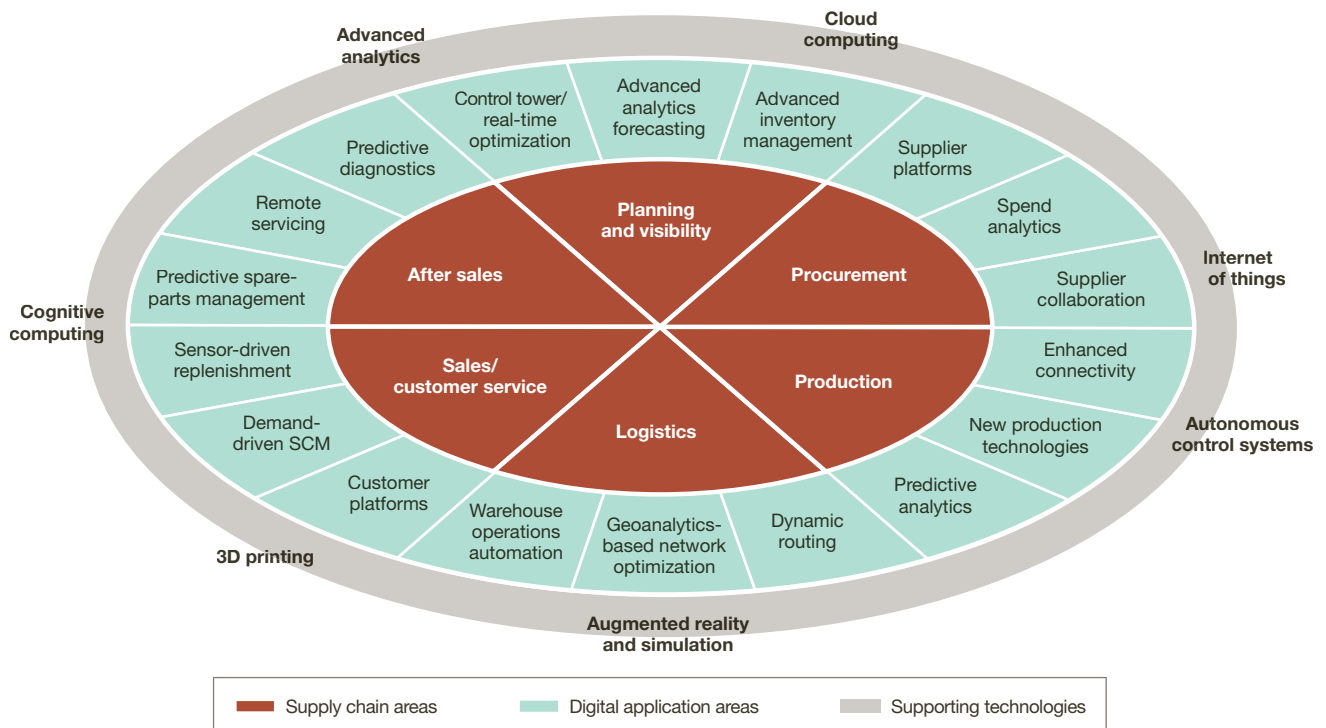
An important challenge for many firms is determining where to place transformation leadership within the organizational structure, especially structures that lack CSCO or CTO offices that offer natural homes for responsibility. In terms of intellectual capital, one leader succinctly stated the human resource challenge: "Transformation will require a different skill set for people who are asked to interact with intelligent systems."

Where today, data analysts are playing increasingly important roles in the development and use of analytics that make diagnoses and predictions; tomorrow's systems will require a more general set of skills, including business domain knowledge, to properly interpret and apply prescriptions made by increasingly intelligent software agents.

Other challenges mentioned by leaders include:

FIGURE 4

Areas of opportunity for digital transformation



Source: BCG analysis

- working with union contracts;
- accommodating mergers and acquisitions;
- finding properly skilled people;
- managing through regulatory constraints;
- dealing with suppliers who lack technological capabilities;
- working around siloed systems that don't talk to each other; and
- recognizing change fatigue.

Recommendation: Build capabilities

In this study, we document a reality for most companies that is different from portrayals found in the popular press. Most companies are far from realizing the benefits of fully digitized, connected, intelligent and adaptive supply chains. Nevertheless, leaders understand the potential, along with the need to develop and follow a roadmap, rather than merely acquiring technologies to solve problems. Surprisingly few firms seem to have roadmaps in place, however.

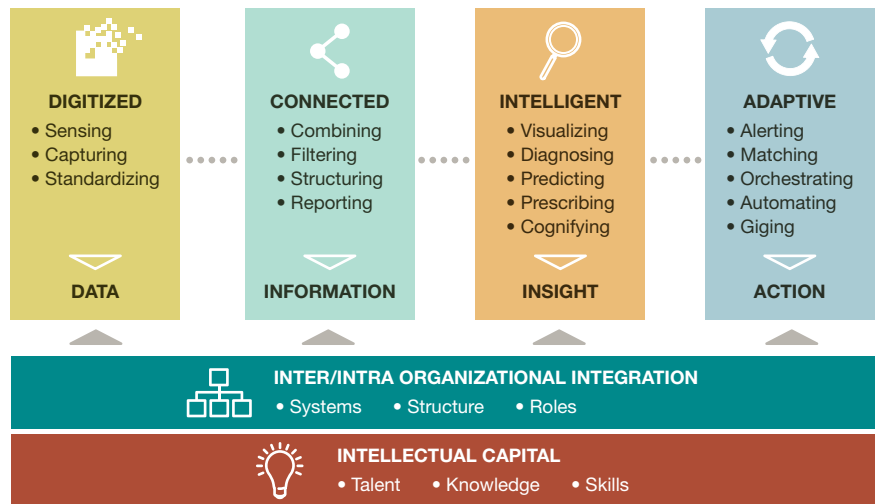
A good roadmap guides selection of projects for a transformation portfolio and is shaped by the specific strategies and competences of the firm. Each firm's roadmap will be unique, as it matches its unique circumstances. Even so, we believe it is valuable for all leaders to keep certain essential *capabilities* in sight as they work through the details of transformation plans.

Figure 6 maps these capabilities along two core dimensions of technology enablement: *automation and insight*. The supply chain technologies described in Figure 2 enable these two process transformations. Many technologies automate decisions and actions, including computations, transactions, data capture, physical transformations and movements and more. By definition, automation substitutes capital for labor in ways that improve efficiency and quality by lowering costs, speeding-up processing and transitions, improving consistency, and increasing resource

availability. Technologies that improve insight increase visibility and intelligence by connecting stakeholders, structuring and sharing information, and cognifying processes, that is, developing knowledge through analysis and learning.

Strategic leaders can combine automation and insight in ways that create tremendous opportunities for supply chain transformation, and that build capabilities leading to competitive advantages. In its most essential form, digital transformation is about developing automation and insight to radically advance visibility, intelligence, efficiency and customer experience and agility and customization.

FIGURE 5
Foundational resources of digital supply chains



Source: Authors

Below, we explain these capabilities, and provide a leading example for each.

Visibility

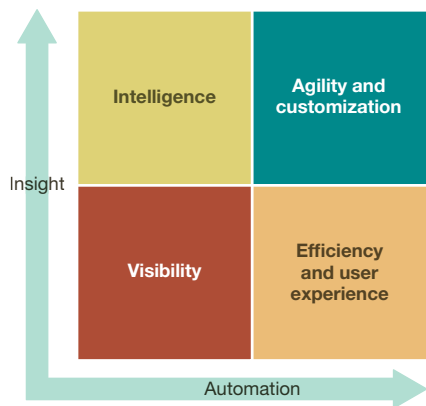
Visibility means having the information you need at the time you need it. Good information comes from data that are current, accurate, complete and usefully formatted. As we discussed at earlier, visibility requires digitization and connectivity for the processes and stakeholders involved.

The leaders we interviewed indicated that they wanted visibility in the following areas:

- “Visibility across all business processes.”
- “Perfect visibility and accuracy of products in the right place and time to support demand.”

FIGURE 6

Digital supply chain capabilities



Source: Authors

- “Better visibility into demand and supply planning, including customer important characteristics of inventory and more detail on shop floor operations.”
- “Visibility into demand and supply.”
- “Visibility into sales and movement of goods as real-time as possible.”

As an important step toward digital transformation maturity, leaders must identify the types of visibility that are crucial to competition. Typically, this means visibility that reduces or eliminates the most damaging uncertainties in the supply chain, and/or visibility that offers the greatest potential for improvement and competitive advantage. Leading firms develop visibility using these criteria, rather than exploiting types of visibility that are readily available. Almost by definition, developing visibility requires working with upstream and downstream partners to develop data standards, along with technologies for data capture and connectivity.

(See Figure 7.)

Intelligence

Visibility lays the foundation for next-level insights enabled by applying intelligent algorithms to visible data. Smart programs using machine learning and other types of artificial intelligence can provide deeper understanding of trends, anomalies and even causes of process effects. These technologies tend to be the most useful when applied to repeated processes that produce

massive amounts of data such as sales, clickstreams, asset monitoring and other transactions. Levels of intelligence include visualization, advanced analytics, prediction and prescription.

Efficiency and customer experience

Visibility and automation are mutually reinforcing. Automated data capture and processing are foundational capabilities for visibility, and, as processes become more connected and transparent, visibility fosters opportunities for automation of both physical and informational transactions.

Supply chain managers often think immediately of automation as a means to efficiency. Capital-for-labor substitution truly is an important source of efficiency and productivity gains—it has been so since the Industrial Revolution. New technological capabilities go far beyond the basic benefits of greater efficiency, however.

Lennox uses machine learning to optimize service and cost

Lennox, a leading manufacturer of HVAC equipment, has the monumental task of managing repair parts inventories for tens of thousands of items across hundreds of service locations. Repair parts are notoriously difficult to manage, as they include many slow-mover, long-tail demand items. Recently, Lennox partnered with ToolsGroup SO99+ to develop an application to optimize inventory levels for service and cost. The intelligent program uses machine learning and cluster analysis to identify more than 200 “micro-climates” within the United States, along with seasonal timing variations for each zone. Machine learning sifts through the SKU-locations to identify “clusters” with similar seasonality profiles. Using the system, Lennox improved service levels by 16%, with almost 100% next morning availability, and simultaneously increased inventory turns by 25%—quite an improvement given that at the same time they more than doubled their regional distribution centers and store locations.

Cemex automates its way to lower costs and improved customer satisfaction

Cemex is one of world's largest suppliers of cement, ready-mix concrete, and aggregate products; it supports commercial and infrastructural building projects in more than 50 countries across five continents. In order to extract its business from intense price competition, Cemex is working with IBM to consolidate fragmented databases and automate processes, designing an end-to-end user experience defined by eight connected mobile apps that cover all order-to-cash transactions, as well as pre and post sales support. The apps allow construction foremen to schedule and track deliveries, establish and change pick-up and delivery points, arrival times and make other order changes on the fly. Foremen can also manage quotations, pricing, invoices and payments, disputes and customer service, all from a smart phone. In addition to seeing dramatically improved customer satisfaction and revenue growth, Cemex has cut back office staff for AR/AP and call centers by more than 35%.

Automation now means better speed, quality and improved user interactions. In manufacturing, emerging examples illustrate the super-productivity of robots and humans working side-by-side—known as cobots—arrangements that are more productive than either robots or humans working alone. In services, automation is improving interactions between service providers and customers, as well as between supply chain partners. Leaders will do well to ask for more than efficiency gains alone from investments in automation.

Agility and customization

The holy grail of digital supply chain transformation is agility—the ability to quickly and

efficiently adapt supply chain capacity and resources to meet changing conditions. Though most supply chain leaders are focusing on efficiency, a few that we spoke with are developing visions of agility and customization.

- “Seamless end-to-end demand-supply matching and adjustments.”
- “Quickly answer questions from our customers like: ‘can you give us 50,000 more units?’”

At the highest levels of maturity, firms will apply automation and insight to develop systems that both predict and adapt to changes, including shifts in demand and supply, disruptions, environmental and regulatory changes, and competitors’ maneuvers.

Many monikers are used to describe this capability, including on-demand, uberized, mass-customized and responsive. Essentially, this means breaking constraints and unfixing capacities in the supply chain, moving to variable cost structures and building flexibilities that enable rapid scalability, supply-demand matching, seamless transitions and changeovers, increased operating range, optimal re-routing and dynamic sourcing.

Call to action

This article synthesizes the insights garnered from our conversations with supply chain executives in more than a dozen firms, spanning a wide range of industries. We trust that the frameworks and findings offered here will stimulate ideas and foster new ways of visualizing possibilities for digital supply chain transformation.

Few firms appear to be far down the path toward maturity, but the stories and examples we uncovered

FIGURE 7

Visibility dimensions



Source: Authors

Nike speeds up its supply chain

Nike is embarking on a massive overhaul of its supply chain to build speed and adaptability into its operations. For new products in the pipeline, managers are focusing the demand chain on e-commerce, tighter distribution through retail partners (including Amazon), and developing a multiplicity of delivery options. These moves improve the currency and accuracy of demand signals while giving partners options for optimizing customer service. On the supply side, Nike is increasing near-shore production to serve North America, using automation to keep labor costs down and make products quickly. This includes using 3-D printing to manufacture highly customized shoes directly for consumers. Nike is partnering with Flex, a global manufacturer, to produce more than 25% of shoes using a responsive model that reduces manufacturing-to-market time from 60 days to 10 days or less. The emphasis on speed isn't limited to near-shore factories. Nike has also installed more than 1,200 new automated machines at Asian suppliers' factories to speed processes and reduce labor content.

promise an exciting future for supply chain management. On the other hand, national productivity metrics and other indicators suggest that many firms are slow to embark on the transformation journey. Many are sitting on hoards of cash, having made relatively low capital expenditures over the past decade. It is likely that, given the massive turbulence in technologies, geopolitics and economics over this period, many executives are wary of making big investments; they are waiting for the uncertainties in these areas to resolve. While prudence makes sense, there is also a large opportunity cost here.

The new normal is an operating environment full of unresolved and continuing uncertainty. Accordingly, the future will belong to firms who develop digitized, connected, intelligent, adaptive supply chains, following well thought out and flexible roadmaps for digital transformation.

The authors gratefully acknowledge the funding and support of the American Production and Inventory Control Society (APICS) for this study. ∞

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THE RETAIL SUPPLY CHAIN HITS THE BRICKS (FOR CLICKS)

In an era of shrinking bricks-and-mortar footprints, offline retailers can find a new use for their real estate by bringing e-commerce fulfillment to their retail stores.

BY BRIDGET McCREA



Bridget McCrea is a contributing editor to Supply Chain Management Review.



80%

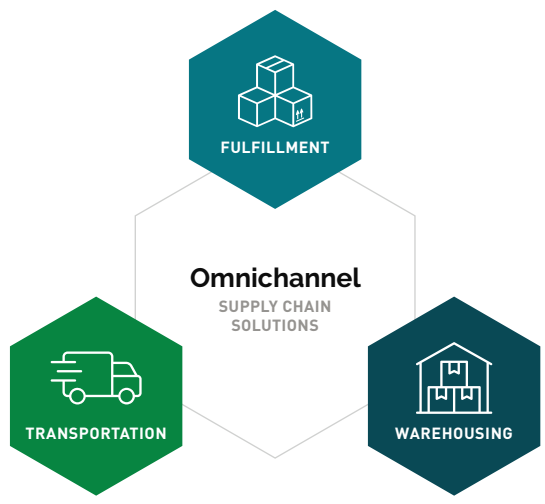
of retailers need to improve cross-channel inventory visibility.

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*Source: Boston Retail Partners Report

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There's a lot of extra retail store space in the United States right now that no one knows what to do with. In fact, A.T. Kearney estimates that there's 24 square feet of commercial retail space for every American, compared to five per person in the U.K., three in China, and two in South Korea. Calling the United States "dramatically over-stored" compared to nations such as the U.K., where urban planners limit the ratio of real estate to people, the consulting firm gives the situation a positive spin in its recent report on "The Future of Shopping Centers."

"Our study suggests the industry can have a robust future provided it evolves and successfully harnesses three change drivers: the human element, technology and commercial considerations," A.T. Kearney predicts. "We see yesterday's shopping centers and malls morphing into consumer engagement spaces (CESs)—transformed mixed-use commercial offerings designed to meet the needs of new and future generations of shoppers."

Chris Shaw, director of product marketing at Manhattan Associates, has another idea. With so much extra space lying around—and with the bricks-and-mortar shops continuing to give way to e-commerce—which American consumers spent \$453.46 billion on in 2017—why not use a portion of that valuable real estate for order fulfillment?

"The United States has 40% more shopping space per person than Canada and 10 times more than Germany; we have too much space," says Shaw. "Retailers have a compelling reason to use some of that space to fulfill orders and/or put products closer to their customers. The question is, exactly what products should retailers put where and exactly what type of fulfillment strategy should they use?"

For customers who buy online and then pick up in the physical store, for example, retailers must consider how to enable that capability, which products consumers will be apt to order online and pick up in person, and then which items they'd rather have shipped directly to their homes.

The answer will depend on the size of the product, its space requirements and cost.

"A lot of people may want to order bicycles online and then pick them up," says Shaw, "but bicycles also take up a lot of space, so retailers need to keep that in mind when developing an e-commerce fulfillment strategy at the store level."

The new retail

For more than a century, retailers have filled their stores by shipping goods to those locations from one of their distribution centers (DCs). Customers either purchased store inventory in person or placed orders that were fulfilled by the same DCs. "It pretty much stayed that way until about 10 years ago," says Shaw. E-commerce would turn that model on end and force retailers to rethink the way they fulfill customer orders—a trend that would become known as omni-channel.

"Once retailers started fulfilling online orders, it unlocked all kinds of complexities that they didn't really consider before," Shaw explains. It also opened the window of opportunity for retailers who found themselves saddled with extra real estate just as store footprints began to shrink. And while the concept of store-based e-commerce fulfillment is still in its infancy, Shaw says retailers can't afford to ignore the trend.

"We've seen a massive shift over the last three years to five years in terms of how consumers expect to interact with brands and retailers. They hold the power and they have the tools and technology to become the 'alpha' in the relationship," Shaw notes. "They can literally take down entire brands on social media and/or instantly switch from one brand or retailer to the next."

This new consumer is driving a modern-day retail environment that's based on the complete integration of online, offline, logistics and technology to create a single value chain, says Michael Zakkour, vice president at Tompkins International. "In the 'new retail,' the trick is to bring the product to the customer," he says. "Doing that effectively is all about moving the inventory and the

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product as close to the consumer as possible. One way to do that is by putting inventory in the store for delivery anyway, anywhere and anytime the customer wants it.”

Zakkour says store-based e-commerce fulfillment makes sense because the closer the product is to the customer, the more cost-effective the fulfillment and delivery process is for the retailer. It also helps to blur the lines between online and offline sales, the latter of which have been declining while the former continues to thrive.

Pointing to Amazon, Target and Alibaba, Zakkour says these large companies prefer to operate as “giant ecosystems,” instead of dissecting their operations into various online and offline channels. “Retail is undergoing a metamorphosis, and supply chain managers are having to meet the demands of those customers who want different portfolio packages of inventory shipped to different parts of their ecosystems,” says Zakkour. “Ultimately, it’s about getting products as close to the customer as possible; that’s not going to change anytime soon.”

Creating a unified experience

As she surveys the retail environment, Karen Bomber, director, vertical marketing at Honeywell, sees an industry that’s focused on creating a “unified experience” for shoppers. So, whether a consumer goes into a store, orders online or places an order from 30,000 feet in the air, he or she expects the same experience every time. This is different than the industry-centric omni-channel term, Bomber points out, in that it applies not to the fulfillment/distribution operation, but rather to the way consumers interact with the retail industry.

“The average shopper doesn’t know what omni-channel is, nor do they care,” says Bomber. “Knowing this, retailers are looking at how to connect the dots between the need for a unified experience, the need for a positive shopper experience and then how to use technology to bridge that gap.” For example, she says stores are turning to technology

to help “fill in” where traditional retail employees (e.g., front-end cashiers without warehousing or fulfillment experience) leave off.

“You can’t just flip a switch and use your retail bricks-and-mortar as a fulfillment center because you’re going to miss out on two things,” says Bomber, “and they are the ability to increase a shopper’s basket size (on the sales side) and the reverse logistics needed to be able to put inventory back into the supply chain (on the distribution side).”

Going forward, Bomber expects a blending of fulfillment activities across the traditional DC and the physical store. She also predicts more store-to-store supply chain activity, including the transfer of goods from one retail store to another as a way to fulfill e-commerce orders. Retailers will also have to tackle the reverse logistics challenge—or, how to get that millions of dollars’ worth of returned goods back into the supply chain. “Especially critical for expensive goods that need to be sold at full value,” says Bomber, “this is something that retailers are just starting to get a grasp on.”

Also on retailers’ to-do lists right now is figuring out where the next point of customer interaction will come from, says Softeon CMO Dan Gilmore. In fact, this is one of the biggest challenges facing retailers on the fulfillment front right now. Put simply, when we get to the point where consumers can just click on their TV sets to place an order, what will retailers have to change to be able to fulfill the order quickly and efficiently? Will it flow through to a store for delivery or pick up the next day, or will it be shipped from a DC?

Gilmore sees distributed order management (DOM) as one solution that will help retailers figure out this puzzle, and then address it with their traditional or store-based fulfillment operations. “We’re still early in the game on this,” says Gilmore, “but as we go forward, we’re definitely going to start to see even more, different order points for retailers to address. There’s no end in sight.”

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Tech's role in the retail renaissance

As Bomber pointed out, you can't just flip a switch and turn a retail store into a fulfillment center overnight. However, you can use a blend of technology and human labor to transform at least a portion of that expensive real estate into some type of e-commerce fulfillment operation. "We're no longer in the days of batch-pick-store for e-commerce fulfillment, but we're still in the early stages of this transformation," says Mike Khodl, Dematic Corp.'s vice president, Global Solutions Management. "Retailers' dynamic order fulfillment processing is having a major impact on how orders are managed and processed inside the facility."

Dynamic order fulfillment also changes order management and the software associated with it, Khodl says, as well as the packaging process. "The trend is to reduce packaging as much as possible, and that's driving the use of more polybags and envelopes on the outbound side of the DC,

including micro-fulfillment from the retail store to the end customer. This, in turn, changes the type of automation needed to fulfill orders," says Khodl. It also changes retailers' labor and order conveyance requirements, both of which need to be retooled when fulfillment operations are pushed out to the retail store.

"More retailers are looking at doing micro-fulfillment in smaller stores to take the burden off the large DC and put the product closer to the consumer," says Khodl, whose team has worked on several automation projects using modular, plug-and-play systems designed to fit small-scale buildings.

Going forward, Khodl expects more retailers to explore similar options in their quest to streamline and speed up the e-commerce fulfillment process. "Companies need to look at how they are going to manage the dynamics—and the continued change in the dynamics of those orders," he says, "and how to process those orders in their facilities." ☞☞

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Optimizing a maintenance turnaround

Maintenance tasks can be tricky—especially when some equipment can't be repaired while the plant is running. TurnaroundDs can be mitigated by a strategic approach that uses detailed scenario planning and risk-based assessments to identify problems and responses ahead of time.

By Arun Kochar



Every business can appreciate the value of keeping equipment maintained. But maintenance tasks can be tricky—especially in process manufacturing industries such as chemicals, oil and gas, agribusiness, or food manufacturing. For example, a chemical plant might have 4,000 pieces of equipment, some of which can't be maintained, repaired, replaced or even inspected while the plant is running. Such plants require a turnaround—a complete cessation of all plant activities to perform necessary maintenance.

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Because a turnaround involves lost production, an overrun in turnaround downtime can have severe consequences. At a sold-out plant, one where market demand exceeds demonstrated capacity, an inability to meet that demand can lead to millions of dollars in lost potential revenues. But companies sometimes feel powerless in the face of unplanned events, such as the discovery of unexpected damage to a piece of critical equipment. Is there any way to mitigate the risks associated with maintenance turnarounds?

Yes. Turnarounds can benefit from sound strategy and planning. In one recent project, a global chemical company reduced turnaround schedule slippage in a sold-out plant by 97% (100-plus days). It increased asset utilization by 5% and reduced turnaround costs by 10% to 20%. This article explains how.

Reducing turnaround losses

The problem with many turnarounds is that inspections and repair processes often discover additional work. The turnaround scope widens and its schedule becomes endangered. Problems can be made worse by poor management of add-on jobs, leading to scope creep along with poor training, communication and documentation—leading to gaps in operating discipline. In addition to schedule slippage,

there can be cost overruns: Discovery work often leads to overtime wages for skilled labor and last-minute ordering of expensive specialty parts. A time crunch and lack of oversight can also cause environment, health and safety (EH&S) issues.

All of these problems can be mitigated by a strategic approach that uses detailed scenario planning and risk-based assessments to identify potential problems—and potential responses to those problems—ahead of time (see Figure 1). In our project with the global chemical company, the first two steps of the approach, strategy and planning generated 70% of the value.

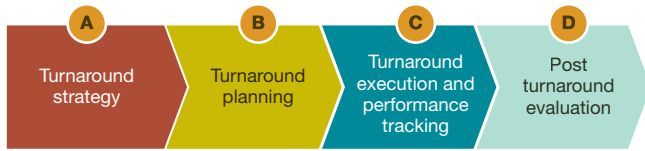
1. Turnaround strategy

Optimizing a turnaround starts with assessing strategy. What's the scope of the job and how long will it take? Essential to this task is an assessment of equipment conditions. Which pieces of equipment are due for repair or scheduled maintenance? What are the symptoms of failure for each, and the cost impact?

Many companies suffer from poor data on equipment conditions. Data may exist in multiple places and be poorly maintained. If it's never used, staff may not see the point of keeping it up-to-date. Thus resetting your turnaround strategy can be painful—but if done well, it will

FIGURE 1

Approach: Maintenance turnaround optimization



Source: A.T. Kearney

spark a long-term shift in attitudes to ensure that subsequent efforts go more smoothly.

One common reason that turnarounds under-perform: responsibility is distributed. Who owns turnaround performance? Strategy-setting can create the parameters under which site-based plant operation teams (responsible for prepping and cleaning the plant for maintenance) and specialty maintenance/repair teams share accountability.

When the teams are working together effectively, they can assess equipment, capacity, plant operability and resource availability to identify levers for improving turnaround efficiency. For example, the chemical company used this strategic planning step to reduce the complexity of turnaround activities, consolidate associated jobs and align turnarounds with supplier outages, utility outages or product changeovers. The company developed a strategy with four interlocking components—budget, asset and operation, resource management and job scope and inventory—and a three- to five-year time horizon.

2. Turnaround planning

Rigorous analysis and planning is the key to improving the reliability of a turnaround optimization effort. The first step is to understand what specifically is involved: a job inventory list, with maintenance jobs segmented into corrective/routine/predictive and work orders classified into repair/inspection/replacement/testing/cleaning. A typical turnaround may involve 100 such jobs and segmenting helps you best sequence them.

Then you can start thinking about what might go wrong and how to plan ahead to address such issues. Of course, it would not be feasible to do a full analysis for 100 jobs. Thus you develop a risk-based prioritization strategy to identify complex jobs that will have the highest impact on the turnaround's success.

For example, our client mapped a historical analysis of unplanned events against a critical analysis of consequences, such as impacts on production, cost, quality or safety. The resulting risk score identified priority jobs that required particular attention (see Figure 2).

For these critical jobs, the company conducted cross-functional scenario planning workshops. Multi-disciplinary teams asked what could go differently than expected, and thus developed best-case, likely-case and worst-case scenarios. The teams then developed contingency action plans and workarounds that would minimize the impact of a worst-case situation.

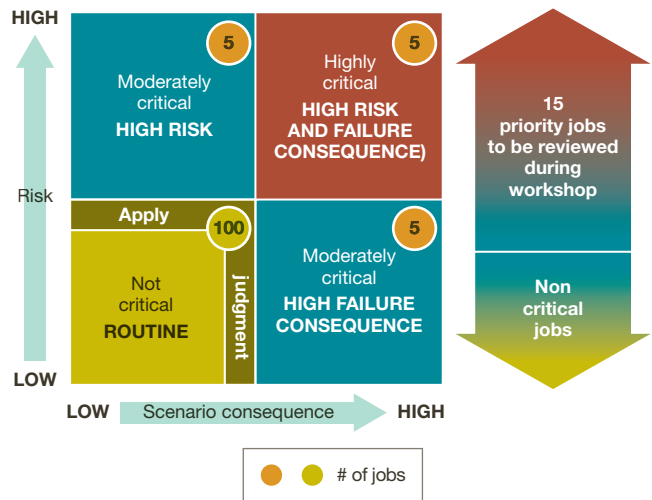
Assembling these analyses, our client developed a master turnaround schedule—a detailed, comprehensive project plan including step-by-step tasks per job, expected job duration and expected resources, tools and costs (see Figure 3).

3. Turnaround execution

Armed with the comprehensive schedule, a company can monitor daily performance during the execution of the turnaround plan. New and enhanced key performance indicators (KPIs) track scheduling quality, planned versus add-

FIGURE 2

Mapping risk and consequences to identify priority jobs



Source: A.T. Kearney

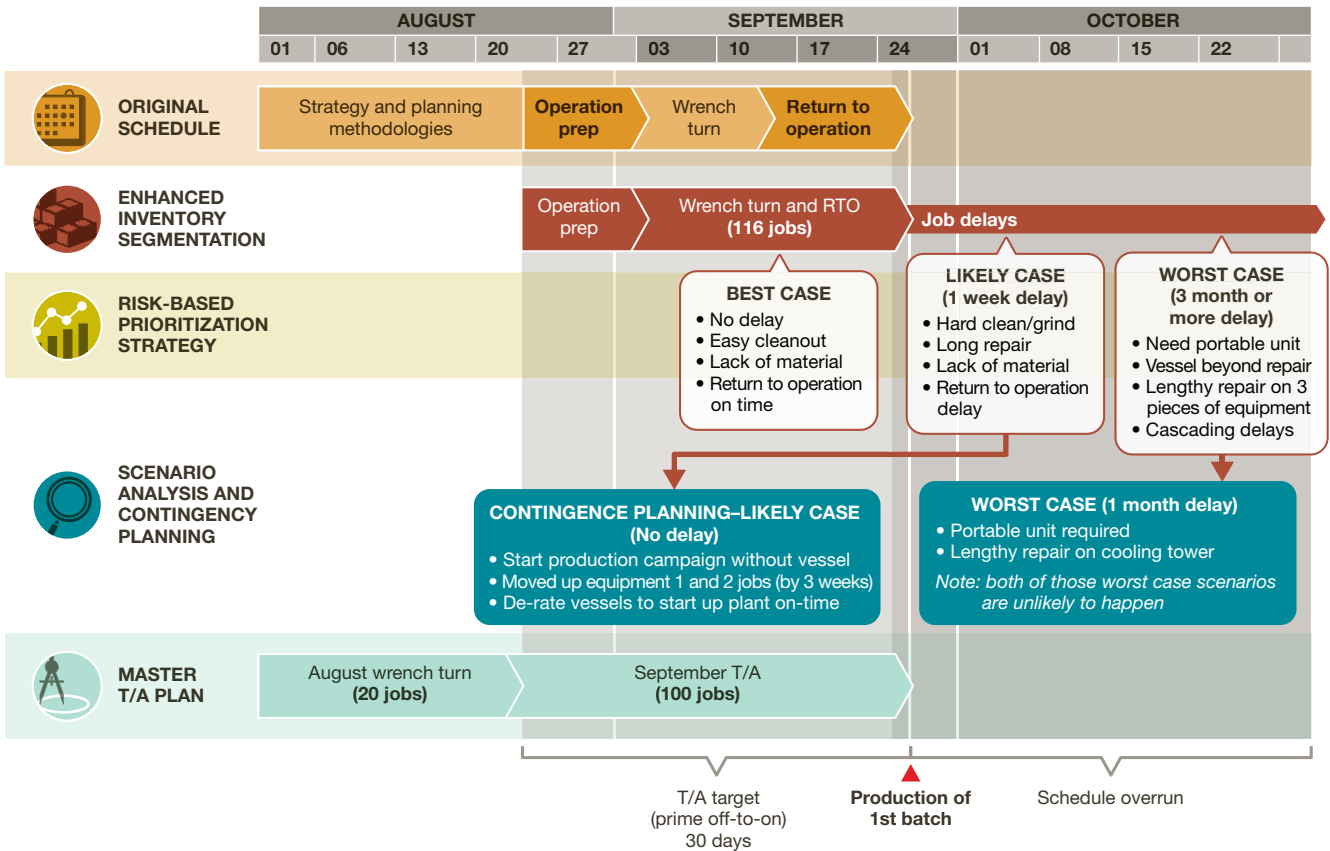
on jobs, planned versus discovered work and schedule and cost compliance.

4. Post-turnaround evaluation

A subsequent survey and workshop assess overall turnaround performance, identifying opportunities for continuous improvement. Where were tasks short-staffed? Were buffers for unplanned work appropriate? In this phase, turnaround and plant management teams continue their collaboration to look at “what went well” (WWW) and “even better if” (EBI).

FIGURE 3

Master turnaround plan



Source: A.T. Kearney

The results

The chemical company was particularly pleased that this approach cut in half the slippage in its turnaround schedule at one particular plant. Because the plant was sold out, reducing downtime by more than 100 days led to vastly improved revenues.

In general, the initiative also lowered equipment failure rates by 3%, which increased asset utilization by 5%. The initiative also reduced turnaround and maintenance costs by 10% to 20%: It simplified the scope of work, reduced parts costs by increasing the time horizon of planning and reduced labor costs by grouping similar jobs with shared resources.

The turnaround initiative was part of a larger effort by the company to reduce downtime. The company also needed to improve equipment reliability and reset its operating discipline. Although separate initiatives addressed those issues, the process improvements of the turnaround initiative helped in that overall picture as well. Operators gained improved expertise to manage unplanned events and discovery. Updated procedures and clarified roles helped improve communication and timely escalation of issues. Coordination among maintenance and operations teams provided transparency to daily tasks and job interdependencies. The overall result was improved forecasting accuracy and risk mitigation across multi-year turnaround planning.

Why it works

Any planning effort is an opportunity to set priorities. One distinguishing factor in turnaround strategy planning is the plant’s operational capacity status: For a sold-out plant, the priority is schedule. The goal is to start the plant back up on time, while avoiding EH&S issues. For a non-sold out plant, with idle production capacity, schedule issues take a back seat to cost. A turnaround strategy will allow a company to set different priorities for plants of different capacity status.

A turnaround strategy initiative also helps a company shift priorities to focus on planning as much as execution. Many maintenance specialists are admirably focused on the question of “how do I fix this well?” The novelty of this optimization approach is to ask them and to also think about that effort ahead of time; developing the scenario analyses and contingency planning in order to minimize risks.

The tasks involved in optimizing maintenance turnarounds are not difficult. Such initiatives take advantage of tools and perspectives well-tested in other contexts—and the approach is applicable in a variety of manufacturing settings. But such initiatives do involve a shift in culture that often has to be experienced to be fully appreciated. ∞∞

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Special Report: Virtual Summit Roundup

Transportation Management 2018:

Navigating the new realities

Our latest Virtual Summit tackles the most serious transportation issues facing shippers and explains what companies can do to operate smarter and more efficiently in the tightest freight environment in more than a generation.

The national economy is booming, e-commerce sales are going through the roof, and shippers across all industries are busier than ever. While all positive of course, these factors have converged to create a challenging transportation, fulfillment and labor environment for logistics and supply chain organizations. Today, nearly all U.S. shippers are grappling with rising freight bills, a dearth of skilled labor, driver shortages, new federal regulations and capacity crunches.

To help shippers tackle these pressing issues, *Logistics Management* and *Supply Chain Management Review* assembled an expert line-up of analysts and thought leaders for this year's Virtual Summit. Focused on transportation management, the event offers new concepts and solutions for creating connected, streamlined operations that enable flexibility while also sharing new levels of transportation management excellence.

Here's a quick synopsis this year's Virtual Summit.



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2018 KEYNOTE

The New Transportation Management Realities

When you're running a supply chain or logistics operation, putting out daily—or even hourly—fires can consume most of your time. This leaves little opportunity to put the current state of freight transportation into perspective, assess the market drivers that are moving that market and predict what's coming around the next corner.

In his Virtual Summit Keynote, Nick Vyas, executive director of USC's Center for Global Supply Chain Management, addresses all of these key points while also offering practical advice that shippers can use to improve their own logistics approaches.

Vyas takes participants through globalization, technology's impact on transportation management, and ends with the current trends and realities in transportation. He kicks off his keynote by discussing how the growing consumer class and the growth of mega cities are all working together to drive globalization.

"These factors will all contribute to the future transportation network," says Vyas. "Every region is growing at a different pace, and Asia is growing the fastest with the largest population growth rate." At

the same time, the consumer is evolving and buying more via e-commerce, and these trends are changing the middle mile- and last-mile delivery strategy. "Speed and transparency are no longer value adds," says Vyas, "it's now a requirement."



Vyas also talks about the influx of disruptive technology in the transportation sector, noting that technology that used to take decades or even centuries to develop is now being discovered and commercialized within a year. "Disruptive technology will continue to evolve," Vyas says, "and we really have to embrace it and be ready for it."

SESSION 1

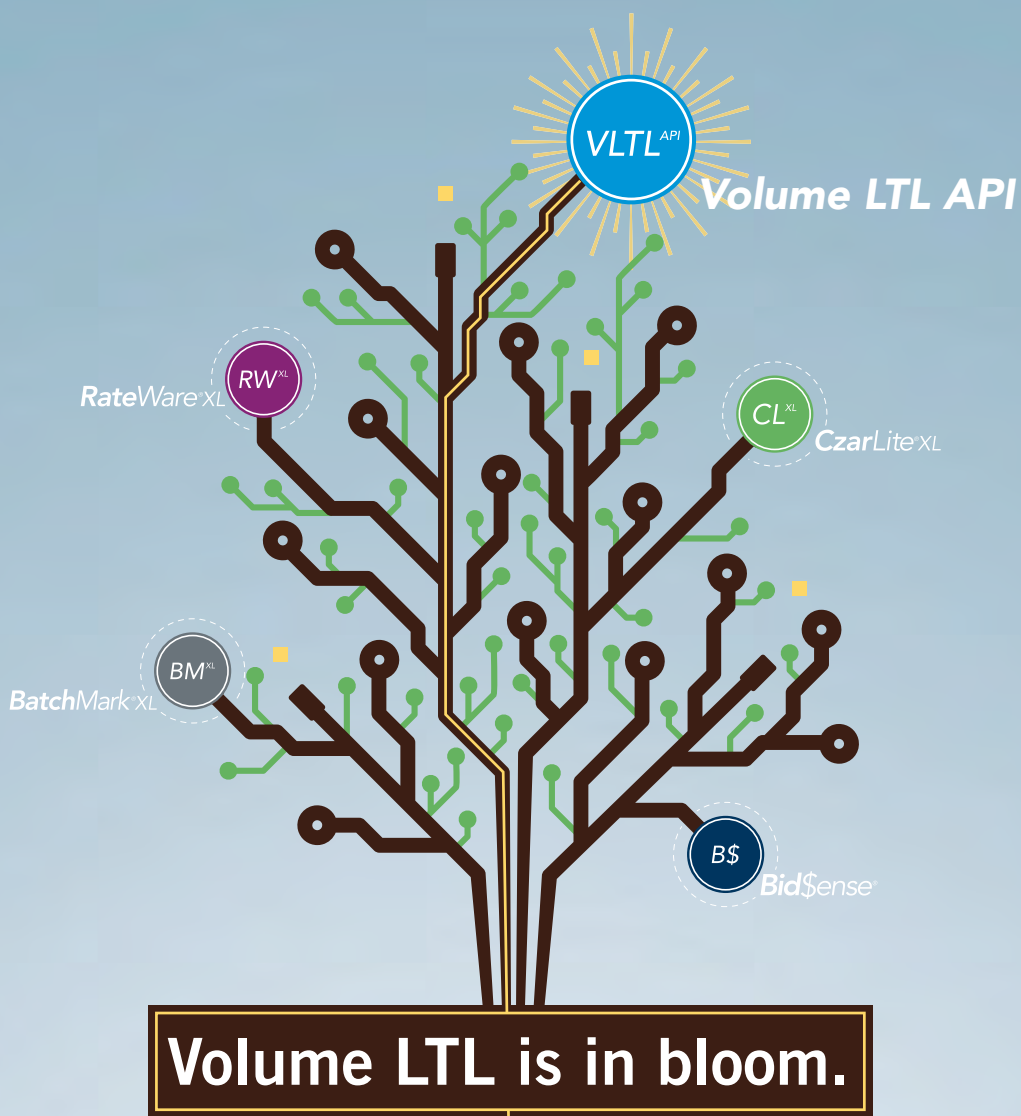
2018 Logistics and Transportation Trends Survey: Will new tools fix our old problems?

Today's shippers are assessing new technologies to better manage and streamline operations, but the results of *Logistics Management's* "27th Annual Study on Trends and Issues in Logistics & Transportation Survey" suggest that these new tools alone will not solve the age-old prob-

lems that logistics and supply chain professionals are still facing.

For example, companies across all industries are struggling to find the capacity they need while managing escalating costs. In their Virtual Summit session, professors Mary C. Holcomb, Ph.D., and Karl B. Manrodt, Ph.D., discuss the survey, which included 240 respondents across 15 industry sectors.





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In assessing which technologies will have the most impact on logistics over the next two years, Holcomb says that many shippers will be focused on analytics. “Predictive analytics is really going to extend beyond the reports,” Holcomb points out. “We are going to be using statistical methods and perhaps machine learning techniques to really identify the likelihood of future outcomes and we’re going to use that historical data to get there.”

And if companies can get information faster, Holcomb points out, they’ll be able to improve service

performance and leverage the digital supply chain data and information to increase supply chain capabilities.

The speakers also discussed where investments are being made in the digital space, what barriers are keeping companies from going digital, and why digital transformation is important. “When it comes to digitalization in transportation, some people are on their way and others will be left in the dust,” says Manrodt. “It’s a journey and a process, and people will get left behind if they are laggards.”

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SESSION 2

Reinventing Transportation Management: A call to action

The North American freight procurement process hasn’t evolved much over the last two decades, with many shippers and carriers using the same methods, technologies, and contractual arrangements that they used back in the 1990s. That’s about to change, thanks to the advent of new technologies, increased data fluency, and the digitization of more transportation-related processes.

In this session, Chris Caplice, MIT Center for Transportation & Logistics’ executive director, delves into the current state of transportation procurement and how “dominant design” is being challenged by the rise of new technologies, availability of detailed data, and the adoption of advanced methodologies.

In order to understand the future of transportation management, Caplice discusses how freight transportation is procured today, what dominant design is (and why we should care about it), and puts out a call to action for third-party logistics (3PL) providers, shippers and carriers.

“A lot of things are changing,



and those changes aren’t just due to the capacity crisis of the last 18 months,” Caplice points out. “Markets, information, and the appetite of both shippers and carriers to manage uncertainty are all changing. For example, running an auction to find the market rate doesn’t make sense anymore.”

According to Caplice, there’s no longer a “one-size-fits-all” transportation or freight solution that works for every organization. “Today, there’s a totally new portfolio of options out there that shippers need to consider,” Caplice says. “Because of this, transportation management isn’t as simple as it was a couple of decades ago.”

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SESSION 3

Harnessing e-fulfillment and final-mile management

As companies race to come up with the best approaches to e-fulfillment and last-mile delivery, the growth of residential in-home deliveries continues to go through the roof. With companies now expected to deliver packages containing a single item as small as a tube of Chapstick within a day or two (or sometimes less), the pressure on the fulfillment process isn't going to let up anytime soon.

In this Virtual Summit session, Victoria Brown, IDC Manufacturing Insights' research manager, Global Supply Chain Execution, discusses the key change drivers that all shippers are dealing with and delves into the strategic supply chain priorities, digital transformation, future supply chain investments, and the steps organizations and shippers should be taking now.

Throughout her presentation, Brown highlights a recent IDC survey focused on key supply chain pain points and drivers. Thanks to the e-commerce

boom, for example, companies have to become more efficient with "re-commerce," Brown says, when goods come back to the warehouse and must be redirected to a new consumer or other source.



"The reality is that we need to be thinking about fulfillment as an enabler," Brown points out. "The more we do to balance fulfillment and its relationship with last-mile delivery, the better our business outcomes will be and the happier our customers will be."

SESSION 4

State of Brokerage: Putting innovation to work

For trucking companies, market conditions just may be the best that they've ever been. What's more, the truckload brokerage market continues to see rapid gains in technology adoption, putting it squarely on a smooth road to profitability

while also reaping the benefits of current market conditions.

But how long can these good times last for brokers and the overall trucking market? In this Virtual Summit session, Robert W. Baird & Co. senior research analyst Ben Hartford offers shippers a deep dive into the dynamic freight brokerage market; discusses the factors driving the sector's rapid growth; and shares insight into the



massive investment and technological innovations driving this sector forward.

Hartford takes the audience through a journey of the past, present and future of freight brokerage, noting that the capacity crunch and supply constraints are two major trends in the freight industry right now. “The year 2018 was one for the record books,” says Hartford, “with events like the 2017 hurricane activity and the electronic logging device (ELD) implementation

drastically shaping supply and demand.”

Hartford also discusses the continued evolution of “Logistics 2.0,” and points to supply chain visibility and automation as its two most important characteristics. He also discusses emerging themes and potential models for the future of freight. “The opportunity is there for both brokers and carriers,” Hartford says. “It just comes down to a question of who chooses to be proactive and innovate.”

SESSION 5

Leveraging TMS: Simplify growing complexity


A critical link in the supply chain, transportation is costly, time-consuming and sometimes difficult to manage. It’s not going to get any easier as trucking capacity tightens and as rates continue to rise in 2019. Done right, however, transportation management can help shippers create efficiencies, improve productivity, save money and provide premium levels of customer service.

Bob Hood, Capgemini’s principal analyst and lead of its Move Domain practice, puts the state of the transportation management systems (TMS) market into perspective, examines current adoption trends, and shares the evolution of TMS functionality and delivery methods. Hood also shows shippers how to fully leverage the power of these solutions to help gain the capacity they need (and at the price that won’t break the bank).

Hood kicks off this Virtual Summit session by discussing top transportation challenges, including cost, flexibility, and speed. “These are the three factors that are inhibiting transportation today,” says Hood. “We’re in an environment today where client expectations continue to grow. With the Amazon effect, the expectation of



immediate gratification in terms of being able to place an order and have your product be delivered, if not in two days, in many cases in the same day.”

That expectation is putting tremendous pressure on shippers to provide flawless product delivery, and on an accelerated basis. Hood sees the modern-day TMS as the right tool for overcoming this and other transportation-related problems. “TMS solutions have evolved over the years,” says Hood, “and continue to get more capable in terms of what they deliver, from a feature and function perspective.” 

Technology benefits sales and operations planning

Technology can take S&OP to the next level, but only if it supports a robust process.

By Becky Partida, APQC

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



The sales and operations planning (S&OP) process enables synchronization in supply chain management by integrating an organization's supply, demand and new product plans. Once the process is implemented, organizations have one operating plan to allocate resources such as time, money and employees. This enables leaders to ensure that the plans of the involved business functions are consistent and support overall corporate objectives. It also enables organizations to better respond to both supply chain and operational challenges.

With the availability of greater amounts of data from functions involved in S&OP, organizations are increasingly turning to technology to support the S&OP process. These technologies enable the sharing of real-time data across functions and lead to more accurate and detailed planning. APQC recently surveyed S&OP professionals on how their organizations conduct the S&OP process. It also conducted cross-industry research on how organizations can leverage technology to improve S&OP.

In its research, APQC found that organizations plan to invest more in technology to support the S&OP process. However, many organizations are just now expanding their use of technology beyond spreadsheets, with the most popular tool being Cloud computing. A truly robust S&OP effort needs both technology to support data integration as well as a process supported by internal stakeholders.

Technology adoption and application

Nearly 70% of the respondents in APQC's survey of S&OP professionals consider technology to be an extremely critical or very critical part of their

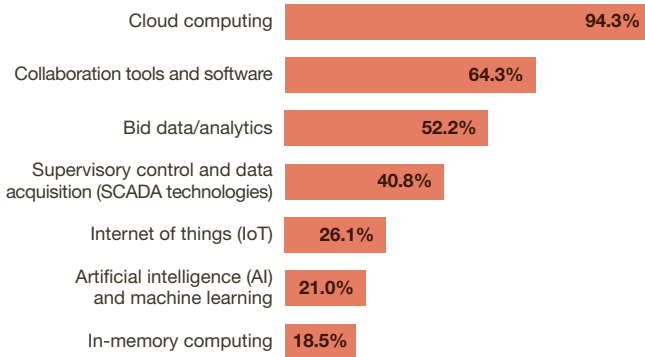
organization's S&OP process. This is reflected in organizational plans for the future: Over two-thirds of the respondents say that their organization intends to spend more on S&OP tools and technologies in the coming years than they have in the previous year.

However, about 37% of respondents state that their organization is just starting to use S&OP tools other than spreadsheets—an indicator that many companies have a lot of ground to cover in terms of technology. For these organizations, spending more on tools and technologies for the S&OP process is a necessity. Any technology upgrade will require an investment. Those organizations that have embraced more advanced technology show that there are plenty of options available.

APQC's research shows that Cloud computing is the most widely used, followed by collaboration tools and software (Figure 1). To a lesser extent, organizations have adopted the use of Big Data and analytics and supervisory control and data acquisition (SCADA technologies). Fewer organizations are making use of the Internet of things (IoT), artificial intelligence (AI) or in-memory computing.

FIGURE 1

Technologies used in the S&OP process



Source: APQC

As shown in Figure 2, each type of technology has its own applications, as well as its own benefits to offer an organization. Cloud computing, the most widely adopted technology, enables companies to connect data sets from their various business functions. This gives a collaborative view of processes across the enterprise, while enabling organizations to create meaningful action plans.

Although currently adopted by fewer organizations, the use of Big Data and analytics has much to offer the S&OP process. Organizations must handle an ever increasing amount and variety of data from internal sources, plus data from partners and customers. Accounting for these different data sets requires organizations to have greater processing power and tools to analyze the data and facilitate decision making. Advantages of analytics tools include the ability for organizations to create hypothetical scenarios, as well as the ability to understand supply and demand trade-offs and the financial implications of data from both internal and external sources.

AI, IoT and SCADA technologies are business intelligence

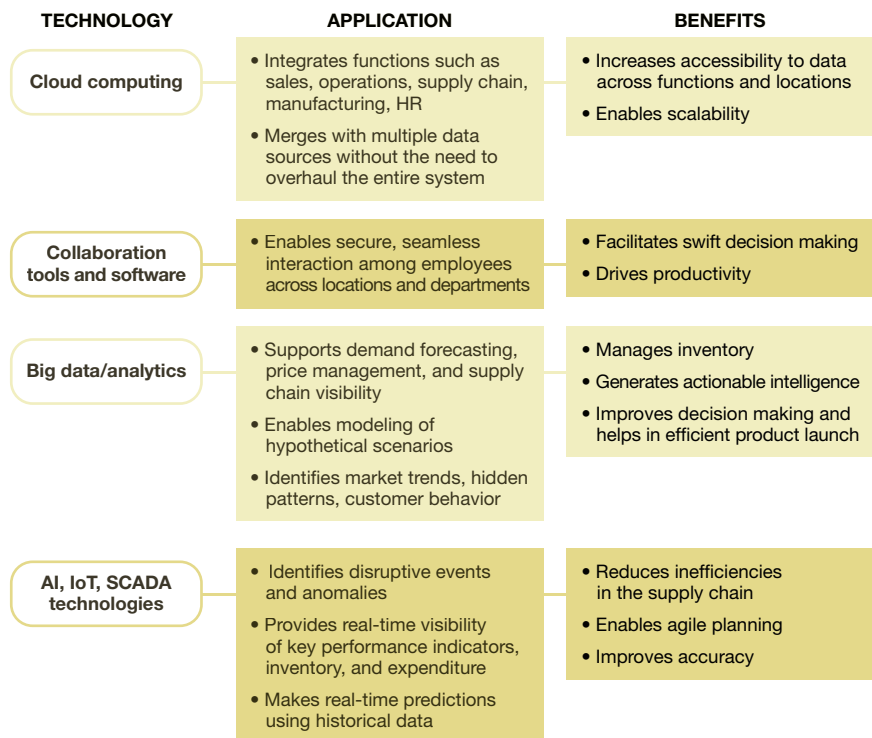
and blockchain tools. AI in particular is able to address data from various internal and external sources and decode signals from both the structured and unstructured data available. This technology can then incorporate the data into projections, resulting in improved accuracy and decreased variance in S&OP processes. Business intelligence tools give functions the ability to view information in a format that aligns with the organization’s S&OP reporting requirements. These technologies provide drill-down analysis, which supports more accurate decision making. They can also evaluate specific metrics such as forecast volatility and accuracy, demand consumption, supply chain liabilities, inventory management and expenditures.

Technology criteria and barriers

Although each of the technologies included in APQC’s survey can benefit the S&OP process, organizations consider various factors when determining which technology they adopt. As shown in Figure 3, the top criteria organizations use when selecting tools is reliability, followed by security and ease of implementation.

FIGURE 2

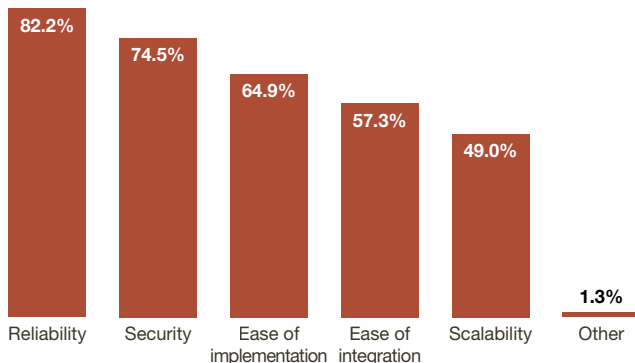
Application and benefits of top S&OP technologies



Source: APQC

FIGURE 3

Criteria used for selection of S&OP tools and technologies



Source: APQC

These results align with the need for technology to perform consistently as well as detect inconsistencies in data. To keep costs down and minimize disruption to internal processes, organizations need technology that can integrate with existing tools and avoid the need for replacing entire systems. Organizations also need technology that is consistent across interfaces and prevents the unauthorized access of data. To ensure broad and proper use, technologies and tools must be easy enough to adopt that end users have the chance to grow accustomed to the new tools.

However, organizations face real barriers to implementing new technology for S&OP. APQC's survey of S&OP professionals revealed that over 37% consider budget constraints and a lack of consensus to be the two largest barriers to adopting new S&OP tools. Budget constraints are often mentioned when it comes to the possibility of investing in new technology. What this often means is the technology is seen as not worth the investment. Organizations can create consensus for a new tool by considering its reliability, security and ease of implementation, as well as its potential benefit for the S&OP process. The organization can then revisit the budget to determine whether it can accommodate the tool.

Technology supports a robust process

Organizations vary in the degree to which they have adopted technology to support S&OP. APQC's research

indicates that some are just moving beyond the use of spreadsheets, while others have adopted the use of Cloud computing, big data and analytics, among others. These organizations can benefit from integrating technology into an S&OP process, but the key is to first establish the robust process.

Some organizations are moving beyond basic S&OP to adopt integrated business planning (IBP), or advanced S&OP, which extends internal coordination in creating business plans. These organizations get data from functions across the enterprise, such as marketing, operations, supply chain, research and development, finance, HR and IT. The broader data collection enables them to better manage risk and quickly respond to change, all while maintaining efficient business processes. According to APQC's research, about 15% of organizations currently use IBP across the enterprise. The use of data from across so many divisions necessitates sophisticated technology to support decision making, but the first step for these organizations was the decision to adopt more in-depth S&OP processes.

Organizations should investigate the use of technology to support S&OP, but they will get the most benefit with input from different functions. Without buy-in and participation from across the enterprise, the organization will not be able to make the best business decisions that consider all relevant data. Those companies only just moving past spreadsheets can begin the adoption of technology as they gain consensus and adjust budgets. They can then scale up the process as they improve their capabilities. ∞

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