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SUPPLY CHAIN MANAGEMENT REVIEW

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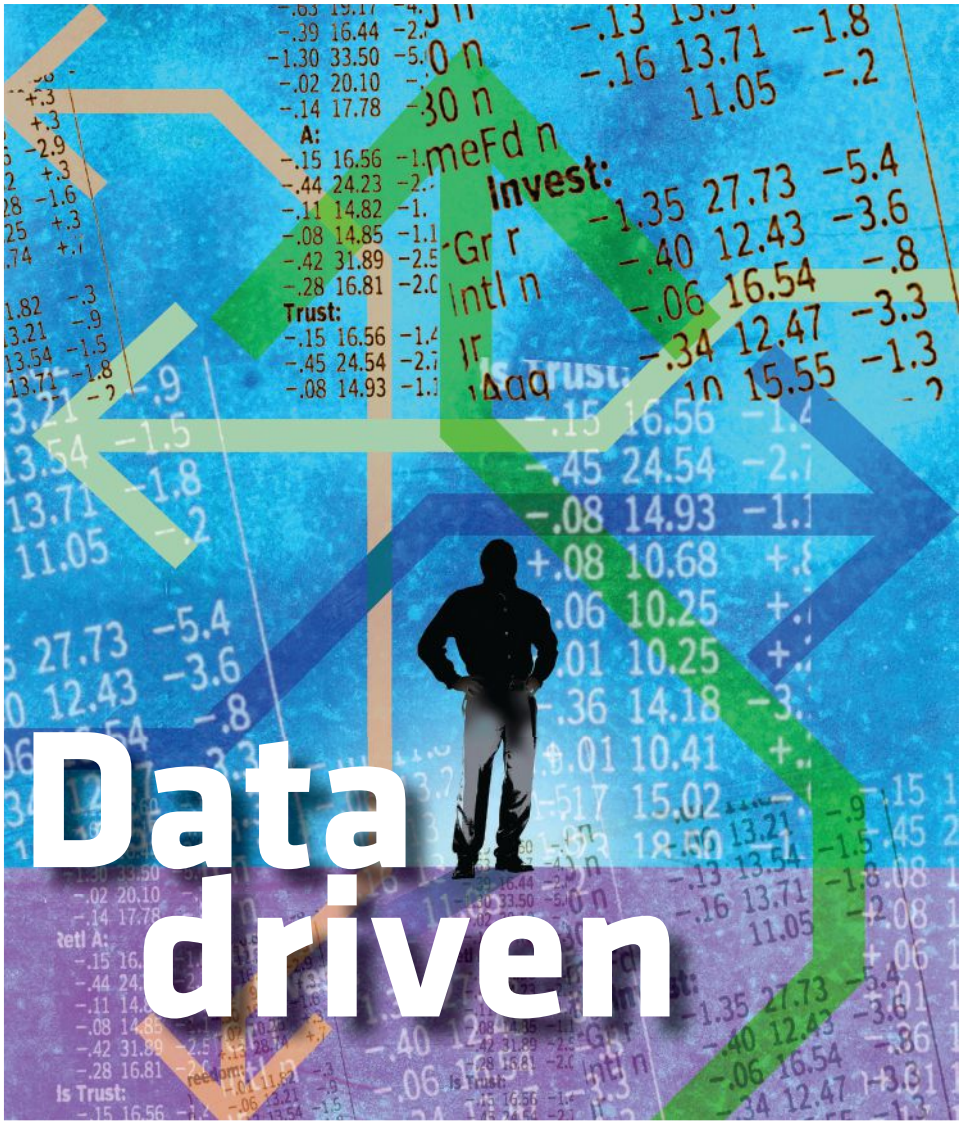

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C.H. ROBINSON

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The data-driven supply chain

When I visit my millennial-aged daughter in Chicago, I'm amazed at the number of packages dropped off by UPS, FedEx and the USPS at her three-unit building on a daily basis. It's as if she and her neighbors are single-handedly keeping Amazon in business. All those drop-offs got me to wondering: Does any of this make sense if you think about a carbon footprint? Rather than deliver millions of packages to one address at a time every day, wouldn't it be more sustainable if we all just drove to the mall to do our shopping? After all, doesn't research indicate that a significant percentage of consumers, especially millennial consumers like my daughter, consider a company's carbon footprint before making a purchase?

That's a question Anne Goodchild, Erica Wygonik and Bill Keough set out to answer when they conducted research on online deliveries in the Seattle area. Their article, "Deliver it all," provides some fascinating data, surprising answers and a framework for companies attempting to balance sustainability with the expectations of today's e-commerce customer.

Uncovering the data driving supply chains is also explored by Simon F. Jacobson and his colleagues at Gartner in "Metrics that count." The Gartner team surveyed *SCMR*'s readers to understand the way metrics are being used by today's leading manufacturers. In "Just my (re-) imagination," authors Rich Sherman from Tata Consultancy Services' Supply Chain Centre of Excellence, and Vibhavari Chauhan, a graduate research assistant at the University of Texas at Arlington, reached out to industry leaders to learn how they are taking their supply chains digital. And in "The perfect formula," Wesley S. Randall, David R. Nowicki and Shailesh Kulkarni, three researchers from the University of North Texas, introduce the science of theoretical minimums—a new approach to looking at the data in supply chains to reduce safety stock and lead times while optimizing inventory.

Bob Trebilcock, editorial director
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Last, but certainly not least, we've all watched as the slowdown in China dominates the headlines and affects everything from global production rates to the price of oil to the value of our retirement portfolios. But, have you ever considered China's ambitions to become a powerhouse in manufacturing, energy production and logistics beyond its borders? If not, be sure to read the two articles we've put together in "Globalization: China style." They make you wonder if Made In China stickers will give way to Made By China or Shipped By China stickers in the coming years.

As always, I look forward to hearing from you with comments or suggestions.

Bob Trebilcock

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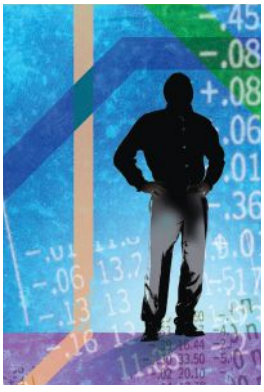

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BY LARRY LAPIDE

"First do no harm" to true demand

"First do no harm" is an important tenet of medical doctors. While supply chain management is perhaps not as noble a profession as medicine, we do have a noble goal. Our goal (and real purpose in life) is to optimally match supply and demand over time. This is what I've termed optimized demand management. Paraphrasing the medical tenet, we should "first do no harm to true customer demand."

Demand forecasts that support sales and operations planning (S&OP) processes need to represent estimates of future unconstrained demand—which reflects undistorted demand in terms of what, how much, and when customers really want their orders filled. In essence it reflects the fulfilled demand that would result if a company (unrealistically) had immediate and infinite supply available at all times. Based on unconstrained demand forecasts, the S&OP team plans supply; and once done "constrained" demand forecasts are one of the key outputs of the S&OP process.

I recall a comment made by the late Dick Clark during a discussion about the difference between constrained and unconstrained forecasts. A consummate industrial forecaster, Dick was P&G's forecasting guru for several decades before he passed away some years ago. He doubted that "true" unconstrained demand existed. Until recently, I never understood what he meant by that because I viewed unconstrained demand as demand devoid of impacts due to supply shortages (e.g., that cause stock-outs and backorders).

Supply-neutral demand is important, competitively

There are times when other supply factors, such as a surplus of supply, can also affect demand. Thus, the concept of unconstrained demand is a bit of a misnomer and insufficient. It ought to be extended to supply-neutral demand, because there are other supply factors that influence and distort true demand. Supply-neutral demand is true customer demand devoid of any impacts from all supply chain activities.

I believe this is what Dick was referring to with his comment, at least in part. Many companies condition their customers' ordering behavior to align with periods of time during which product availability is plentiful. Yet, there might be other times of the year when customers really need deliveries but product availability is scarce. Not being able to get products at a reasonable price during scarcity might foster routine customer behavior to purchase products when most available. This type of conditioning caused by supply factors is often unconscious, unplanned, and non-transparent. Promotional activities that influence demand are consciously planned out in great detail mainly because the primary job of sales and marketing organizations is to shape and create demand. Conceptually, supply-side managers should not condition customer-buying behavior because that is not their job. These factors, in concert with purposeful demand-shaping activities, lead me to believe that it is no wonder that Dick believed it is very difficult to get a good handle on true demand.

Ensuring that demand is devoid of supply impacts is important, competitively. Conditioning customers to buy product when, where, how, and in quantities that are most convenient for a supplier might suffice for a short time. However, conditioning could provide a false sense of comfort in customer loyalty. In the short run, a customer might be willing to align its demand to suit its supplier because there might not be other suppliers

Dr. Lapide has extensive experience in the industry as a practitioner, consultant, and software analyst. He is currently a lecturer at the University of Massachusetts' Boston Campus and is an MIT Research Affiliate. He received the inaugural *Lifetime Achievement in Business Forecasting & Planning Award* from the Institute of Business Forecasting & Planning. He welcomes comments on his columns at llapide@mit.edu.

that can meet its needs. However, there is a risk that a competing supplier might come along some day and steal the business away. There is no such thing as guaranteed demand in a competitive marketplace.

Supply-related demand distortion illustrations

Throughout my career I've encountered situations where supply chain activities unknowingly affected demand. (Supply shortages do not fall into this category because backorders and stock-outs are more easily identified.) Demand impacts from supply surpluses and other supply-side impacts are often inconspicuous. In "Supply-neutral versus unconstrained demand," an article I published in the Summer 2015 issue of the *Journal of Business Forecasting*, I discussed six anecdotal illustrations I've noted of these types of supply impacts. I discussed ways to adjust historical sales data for various supply-side factors in order to better estimate supply-neutral demand. Three of these illustrations are discussed below.

Supply-neutral and unconstrained demands are at times different; especially when (unbeknownst to them) supply chain managers routinely shape and create demand.

During a workshop with the S&OP process team of a tire manufacturer, the topic of constrained versus unconstrained demand forecasts came up. The team leader asked each regional process leader what type of forecast was submitted to the process. The first three leaders, representing North America, Latin America, and Europe, stated that they submitted unconstrained forecasts. The last, representing Asia-Pacific, said that they submitted a constrained demand forecast. Flabbergasted, the S&OP team leader asked why. The leader glibly answered that "we never get the supply we ask for, so we submit a forecast of what we think we can get." The Asia-Pacific leader was essentially distorting true demand, and likely hampering his region's growth by not submitting demand forecasts that were supply-neutral.

Corporate buyers for an apparel retailer sent a mix of sizes to each store based on the average national mix. However, one store was located in an Asian neighborhood where the population was somewhat smaller than the average national store. Every season the store's manager had to drastically mark down the larger sizes to dispose of them. For years the corporate buyers believed that the store's size mix forecast was accurate because every size sold out. Because the drastic markdowns were not visible to them, they continued to send the store the same mix year after year; and the store manager continued to mark down the prices of larger sizes to clear out the surplus sizes. In this case, the corporate buyers were not using true demand to allocate sizes. They were using sales that were distorted by a surplus of the larger sizes that had to be drastically marked down to sell. Obviously, while larger sizes sold in the store, there really was little supply-neutral demand for them.

The last illustration involves a grocery store chain that did business in Puerto Rico. Each week, stores ordered goods from a warehouse in Florida where the goods were loaded into a container for shipment. After all the ordered goods were loaded, there was often extra space left in the container. So, to save transportation costs, dock workers filled the extra space with (unordered) paper-goods. When a store manager got the extra paper goods, and realized that there was a surplus, he/she would conduct a paper-goods sale. Over time, the store managers were running weekly sales—that is, until it was discovered what the warehouse workers were doing. In effect, to reduce transportation costs, the workers invariably forced store managers to heavily discount paper goods and conditioned consumers to buy on promotion. The supply surpluses distorted demand, so sales did not adequately reflect supply-neutral demand.

In each of the above illustrations, shipments or sales did not reflect supply-neutral demand for reasons other than just supply shortages. These include distortions resulting from S&OP planner miscommunication, an over-reliance on shipment/sales data to forecast demand, and unauthorized distribution execution. In all cases, the supply-related distortions were not transparent to demand forecasters. In addition, it took a long time to realize that true demand was being distorted by supply.

In summary, supply-neutral and unconstrained demands are at times different; especially when (unbeknownst to them) supply chain managers routinely shape and create demand. Because this activity is not in their job description, they should identify and eliminate such activities that are affecting demand. They should also work with the corporate forecasting organization to develop methods for correcting historical shipment data to render it more reflective of "true" supply-neutral demand. S&OP planners need supply-neutral demand forecasts rather than just unconstrained ones. Over time, not doing so can be noncompetitive. It runs the risk that a customer might get tired of being conditioned by supply-related factors and switch to a competitor. So in short, just like your physician: "first do no harm" to true customer demand.

New technologies can learn from mature markets

By Daniel W. Steeneck

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What do Class 8 trucks and cell phones have in common? Their end-of-life (EOL) strategies are shaped in large part by each product's characteristics as well as current market conditions.

These factors have long been part of the reverse channel, but how relevant are they in the booming market for wearable technology devices, or wearables? Market analyst IDC estimates that 91 million wearable devices were shipped in the third quarter of 2015—an increase of almost 200% over the same period a year ago. The industry needs effective EOL strategies as it grows rapidly, and governments tighten regulations covering the handling of used electronic products.

Research underway at the MIT Center for Transportation & Logistics suggests that companies producing wearables should learn from established markets if they want to develop innovative ways to recover the value of used parts and products.

Best option

Used products are handled in a number of ways at the end of their useful lives, including landfilling, recycling, reselling, refurbishing, remanufacturing, and parts salvage. In combination these activities comprise the closed-loop supply chain (CLSC).

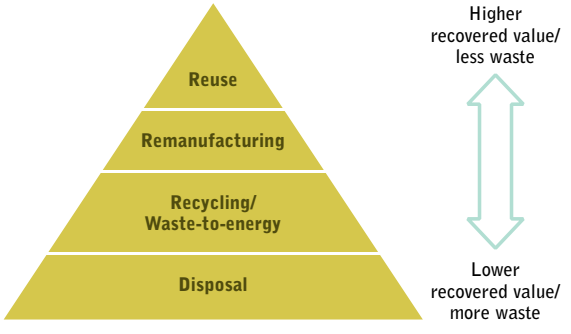
From a waste management perspective, these options are often represented as a hierarchy (see Figure 1). Options that retain the form and function of items (e.g. reuse and remanufacturing) are considered to be the best choices, while those that reclaim material and energy (e.g. recycling and waste-to-energy) are less desirable. Destroying the product (disposal) is the lowest in the pecking order of handling options.

Remanufacturing is a major activity in industries such as aftermarket automotive parts, heavy equipment, and military systems. The U.S. Trade Commission estimates that the industry grew 15% between 2009 and 2011 to at least $43 billion in the U.S., and some estimates put the remanufacturing industry's value as high as $100 billion.

Much of this growth comes from the increasing attention paid to environmental sustainability. Recovering the value of EOL products conserves resources and lowers energy consumption; remanufacturing a product requires about 25% of the energy consumed to manufacture it. This is one reason why governments in Europe are shifting the responsibility for managing EOL electric and electronic products to the producers of products.

FIGURE 1

Hierarchy of EOL options



Source: Daniel W. Steeneck, MIT Center for Transportation & Logistics

An economic argument in favor of remanufacturing is that related activities such as product disassembly create jobs for small businesses.

Complex choices

Despite these advantages, choosing an EOL strategy that includes remanufacturing is not straightforward. The optimal mix of methods varies according to the type of product and the dynamics of the market.

Consider Volvo, a major large truck and construction equipment manufacturer. Rather than remanufacturing its Class 8 trucks, Volvo's subsidiary, Dex Truck Parts, recovers used trucks from the open market and disassembles vehicles to obtain spare parts. Additionally, Volvo regularly remanufactures recovered Class 8 truck transmissions, engines, and exhaust gas recirculation valves, as well as construction equipment. The company has adopted this combination of approaches in response to market demand and the nature of the products involved.

In the cell phone recycling industry, EOL strategy has evolved over time. Historically, cell phones were recovered from consumers and then resold or the valuable metals were reclaimed. More recently, the rate of technological change, or the "clockspeed" (a term coined by Charles Fine in his book *Clockspeed: Winning Industry Control in the Age of Temporary Advantage*), of smartphones slowed, resulting in a strong market for smartphone parts that did not exist before. However, by the time cell phone recyclers realized this, falling commodity prices had rendered material reclamation unprofitable, forcing them to look for alternative recovery methods. They shifted their EOL strategy to include recovery and the sale of spare parts.

Components of EOL programs

These examples show that although the best EOL strategies are product-dependent, approaches can change in line with shifting market conditions.

The factors that determine the optimum approach to recovery fall into four broad categories.

Costs and Revenues. When considering your product's value recovery strategy, numerous costs and revenues must be determined related to the product, its parts, and the closed-loop supply chain. These include costs related to new production, product collection (includes logistics and buy-back costs), product disassembly, reassembly for remanufacturing, replacement part for remanufacturing, part salvage values (either material reclamation or part resale), and faulty part disposal cost. These costs and revenues are dynamic and can dramatically affect EOL strategy (recall how mobile phone and commodity prices affect part salvage values).

Consumer characteristics. Consumer characteristics include changing demand for new and used/remanufactured products and their parts, and the nature of product usage that includes the item's useful life and the willingness of the customer to return the unit. The clockspeed of a product is defined by these consumer characteristics. High clockspeed products have low future demand, so speed of product acquisition and resale is critical to value recovery. In many cases, this type of product should be designed for ease of disassembly and material recovery since there is relatively little demand for the product at the time of recovery. On the other hand, the demand for low clockspeed products will remain stable. These items can be excellent candidates for remanufacturing and parts salvage for the aftermarket (recall, the slower clockspeed of smartphones is creating a strong spare parts market for these devices).

When considering your product's value recovery strategy, numerous costs and revenues must be determined related to the product, its parts and the closed-loop supply chain.

Product design. The durability of each part of a product determines how many components from recovered products will be reusable—a critical factor dictating value recovery strategy. There is a durability/cost trade-off for each part that must be considered. In many cases, a part's durability will fall into three categories:

- Minimal. Parts only last as long as one warranty period, and will be replaced if the product is remanufactured.
- Remanufacturable. Parts are durable enough to allow a sufficient number of units to be recovered to meet market demand.
- Maximal. These durable parts are built to last, and every unit has sufficient value to make both remanufacturing and resale viable.

Additionally, whether or not the product has an integrated, modular, or parts-based design plays an important role in determining the ease of disassembly and re-manufacturability. Integrated designs are the least desirable from this standpoint, while modular and parts-

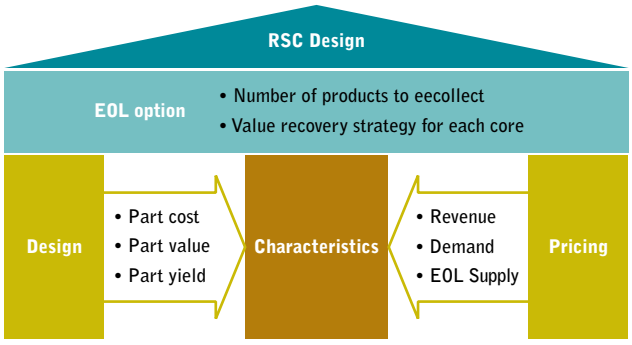
based designs are the best.

Product pricing. New products supply the markets for used and remanufactured products. Additionally, new and used/remanufactured products can compete for the same customers. The balance between expanding a market through value recovery, and cannibalizing the new product market, must be considered. This is accomplished through appropriate demand/revenue management based on product pricing.

These factors represent the pillars of the EOL strategy decision, and therefore, the overall design of the closed-loop supply chain. Figure 2 presents this relationship in terms of available EOL options, and the product's characteristics, design, and pricing. Note that these features, in turn, dictate the CLSC design.

FIGURE 2

Pillars of an EOL strategy



Source: Daniel W. Steeneck, MIT Center for Transportation & Logistics

Even without taking product design and pricing factors into consideration, the framework in Figure 2 explains why Class 8 trucks and cell phones currently exhibit similar EOL strategies. Both have a strong market for used products, and the aftermarket parts market is very strong as well. Thus, the products will be resold if possible, and the remainder disassembled and the parts resold. However, the framework can also be used prescriptively, especially for new markets such as that for wearable devices.

Given the expected proliferation of wearable products such as Fitbit and Apple Watch gadgets, what should be done with these (currently) high clockspeed products when they reach the EOL phase?

Learning the lessons

Given the expected proliferation of wearable products such as Fitbit and Apple Watch gadgets, what should be done with these (currently) high clockspeed products when they reach the EOL phase?

The more mature cell phone market offers some clues. Many consumers have drawers that are brimming with old phones. According to a 2008 survey by Nokia some 44% of used cell phones were discarded in this way; only 3% were recycled, and the rest were resold or used as hand-me-downs. A 2010 estimate by the U.S. Environmental Protection Agency puts the recycling rate for cell phones at just 10%.

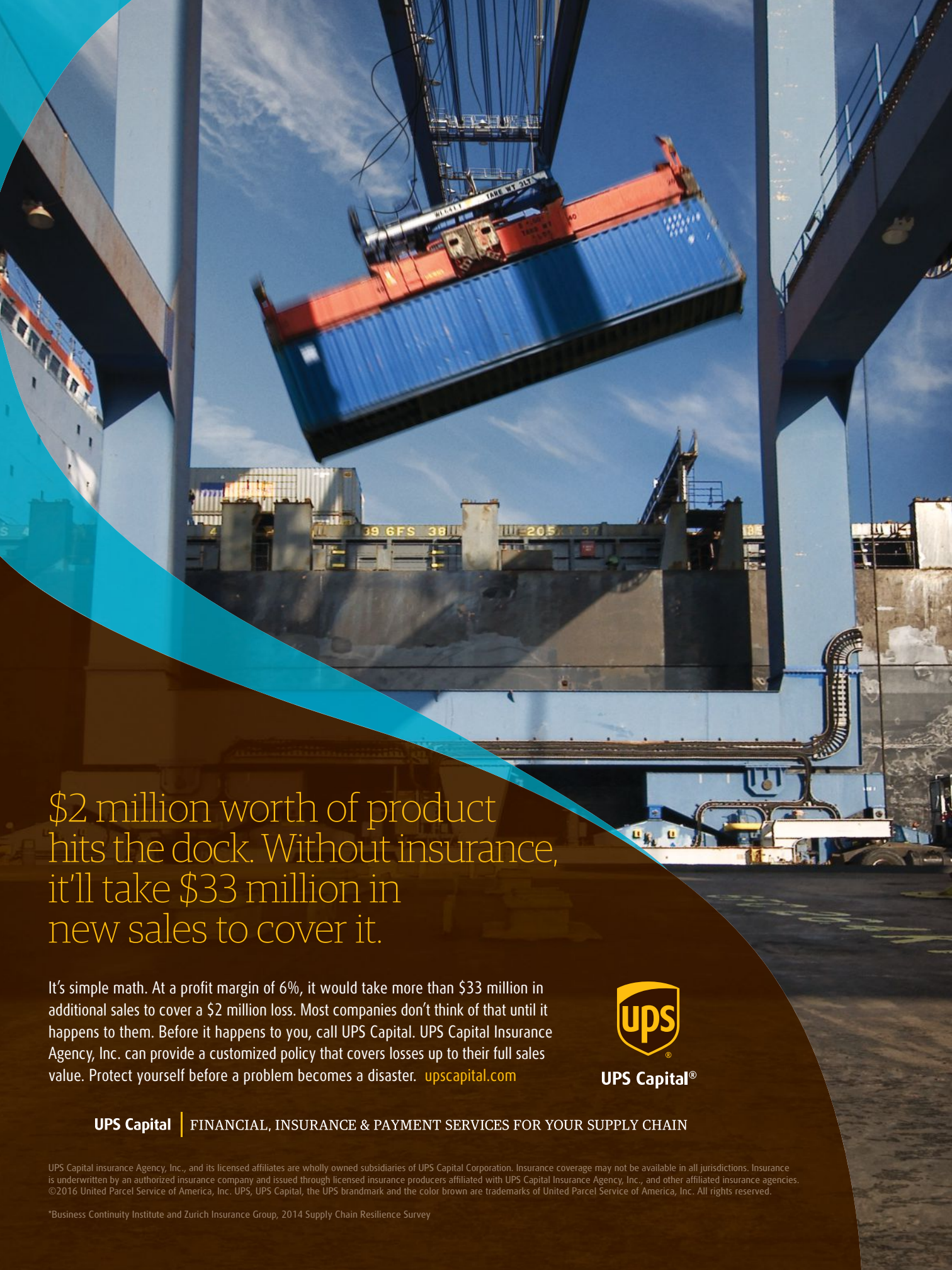
Wearables manufacturers can avoid a similar fate for their products by designing first-generation models for easy disassembly with value recovered through material reclamation (because such parts will have minimal durability). This might require more collaboration between trading partners early in the design process. And they should create collection systems designed for material reclamation and resale to secondary markets. Potential recovery channels include:

- trade-in programs offered by manufacturers or retailers;
- online recyclers offering to purchase old wearables; and
- donation of wearables as medical devices.

However, these channels require the consumer to voluntarily return the product. A truly effective closed-loop supply chain for wearables (or any product) can only be realized if the seller or OEM retains control of the lifecycle of the product.

Again, wearables companies can learn from established markets where companies have achieved this level of control with specially designed sales programs. Examples include "power-by-the hour" programs for aircraft engines, managed print services adopted by Xerox, and, more recently, T-Mobile's Jump cell phone leasing offering.

Hopefully the wearables industry will learn from past experience, and develop innovative EOL solutions that are aligned with changing market conditions. In doing so, they will capture a huge opportunity to redefine EOL operations and derive significant value from used products.



$2 million worth of product hits the dock. Without insurance, it'll take $33 million in new sales to cover it.

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BY PATRICK BURNSON

Do faulty supply chains undermine trust?

The 2016 Edelman Trust Barometer finds global trust inequality is growing.

Patrick Burnson is executive editor at *Supply Chain Management Review*. He can be reached at pburnson@peerlessmedia.com

The 2016 Edelman Trust Barometer reveals the largest ever trust gap (12 points) between the informed public and mass population, driven by income inequality and divergent expectations of the future. Faulty supply chains are also likely to figure into the equation.

While trust levels among informed publics are the highest ever in 16 years, trust is below 50% for the mass population in over 60% of the countries surveyed, having barely moved since the Great Recession. The trust disparity has widened and is now at double-digit levels in more than half of the countries surveyed. The U.S. presents the largest divide at nearly 20 points followed by the UK (17 points), France (16 points) and India (16 points).

"We are now observing the inequality of trust around the world," observes Richard Edelman, president and CEO of Edelman. "This brings a number of potential consequences, including the rise of populist politicians, the blocking of innovation, and the onset of protectionism and nativism."

The widening gulf is directly linked to income inequality. A double-digit trust gap between high-income and low-income respondents is present in nearly two-thirds of the countries, with the U.S. (31 points), France (29 points) and Brazil (26 points) exhibiting the largest disparities. There are also diminished future expectations among the mass population. In more than two-thirds of the nations surveyed, less than half of the respondents believe they will be better off in five years.

"We must get beyond 'The Grand Illusion' that the mass will continue to follow the elites," says Edelman. "This 'Illusion' was predicated on the belief that the informed publics have access to superior information, their interests are interconnected, and that becoming 'an elite' was open to all who work hard. But the democratization of information, high-profile revelations of greed and misbehavior, coupled with rising income inequality, have squashed those beliefs. The trust of the mass population can no longer be taken for granted."

Supply chain chasm

But do faulty supply chains also contribute to this disquieting trend? Katherine Peavy, head of program management for the Center for Responsible Enterprise and Trade, thinks so. She works for a non-governmental organization dedicated to helping companies around the globe prevent piracy, counterfeiting, trade secret theft and corruption.

"China's recent downturn has not only prompted vast swings in the financial markets, but as previous downturns have shown, also is likely to send Chinese companies and factories—if they aren't well run—to ruin," she says. "In the early part of this century, every industry in China was so hot that you could just start a business and it would likely do well. Today is a different story."

To survive, Peavy maintains, forward-thinking executives are working to improve productivity and efficiency by leveraging management systems, human resource development, and process optimization. This approach can

and should also be applied to supply chain compliance efforts, which are often still only implemented at corporate headquarters.

Reversal of fortune

And it seems that global supply chain managers in China and the world over still have a chance to correct this reversal of fortune.

Despite the general population's skepticism of business, it has the best opportunity to bridge the trust chasm. Overall, respondents view business (61%) as the institution most trusted to keep pace with rapid change, far more than they do government (41%) and NGOs (55%). Business is also significantly more trusted than government in 21 of 28 countries, with large gaps in countries such as South Africa (44 points), Mexico (44 points), and the United States (12 points). And a decisive 80% believe business can both increase its profits while improving the economic and social conditions in the communities in which it operates.

Globally, business also received the largest uptick in trust (5 points to 53%) among the four institutions, while continuing to close the gap on NGOs (55%) as most trusted. This was aided by the continued recovery of the financial services sector (51%), which has seen an eight-point increase over the last five years, larger than any other sector. And for the 16th consecutive year, technology (74%) remains the most trusted industry.

The public is also responding positively to CEOs trying to realize the dual mandate of profit and societal benefit, as CEO trust has risen substantially in the past five years to 48%. But they will need the help of their employees, whose trust levels (52%) are on the rise. Respondents are more likely to trust an employee compared to a CEO for information on treatment of employees (48% versus 19%) and information on business practices and crises (30% versus 27%).

"Business can be a big part of the solution because it is apolitical, fast, and tracks its progress," says Kathryn Beiser, global practice chair of Edelman's corporate practice. "Now is the time to lead from the front with the support of their employees and passionate customers," she says. "No longer can business leaders focus on short-term goals. The new model CEOs are taking action by addressing the issues of our time, and taking a personal interest in the success of society. Stakeholders expect business to have a solid and steady focus on financial returns, but also on actions around key issues such as education, healthcare and the environment."

Other key findings from the 2016 Edelman Trust Barometer include:

- Respondents want to see a shift in CEO focus from short-term results and lobbying to job creation (49%) and positive long-term impact (57%). They want business leaders more visible in discussions of income inequality and public policy (80%).
- Despite an increase of one point to 42% globally, government remains the least trusted institution for the fifth year running.
- Trust in NGOs went up in 81% of the countries surveyed with the most dramatic jumps occurring in China (17 points) and Mexico (11 points).
- Globally, family-owned companies (66%) remain most trusted, trailed by public (52%) and state-owned (46%) businesses.
- Companies headquartered in developed markets are still more trusted than those based in developing markets. Canada, Sweden and Switzerland, all 66%, are most trusted, followed by Germany (64%).

Despite the general population's skepticism of business, it has the best opportunity to bridge the trust chasm. Overall, respondents view business (61%) as the institution most trusted to keep pace with rapid change.

And finally, some good news for *SCMR* readers. It appears that traditional media—including trade journals like ours—remain among the most trusted sources for general news and information.

Meanwhile, the Edelman survey indicates that online media jumped 8 points to 53% and is now the third most trusted source, followed by owned media, which is up 3 points to 46% and social media (44%).

Today's supply chain manager, who is wired into all these networks and resources, must now do his or her part to ensure trust remains part of the mission.

THE PERFECT FORMULA

By Wesley S. Randall, David R. Nowicki and Shailesh Kulkarni

For years, supply chain executives have asked how can they reduce inventory without affecting customer service levels or shifting cost to other supply chain partners? The answer could be a new inventory management strategy.

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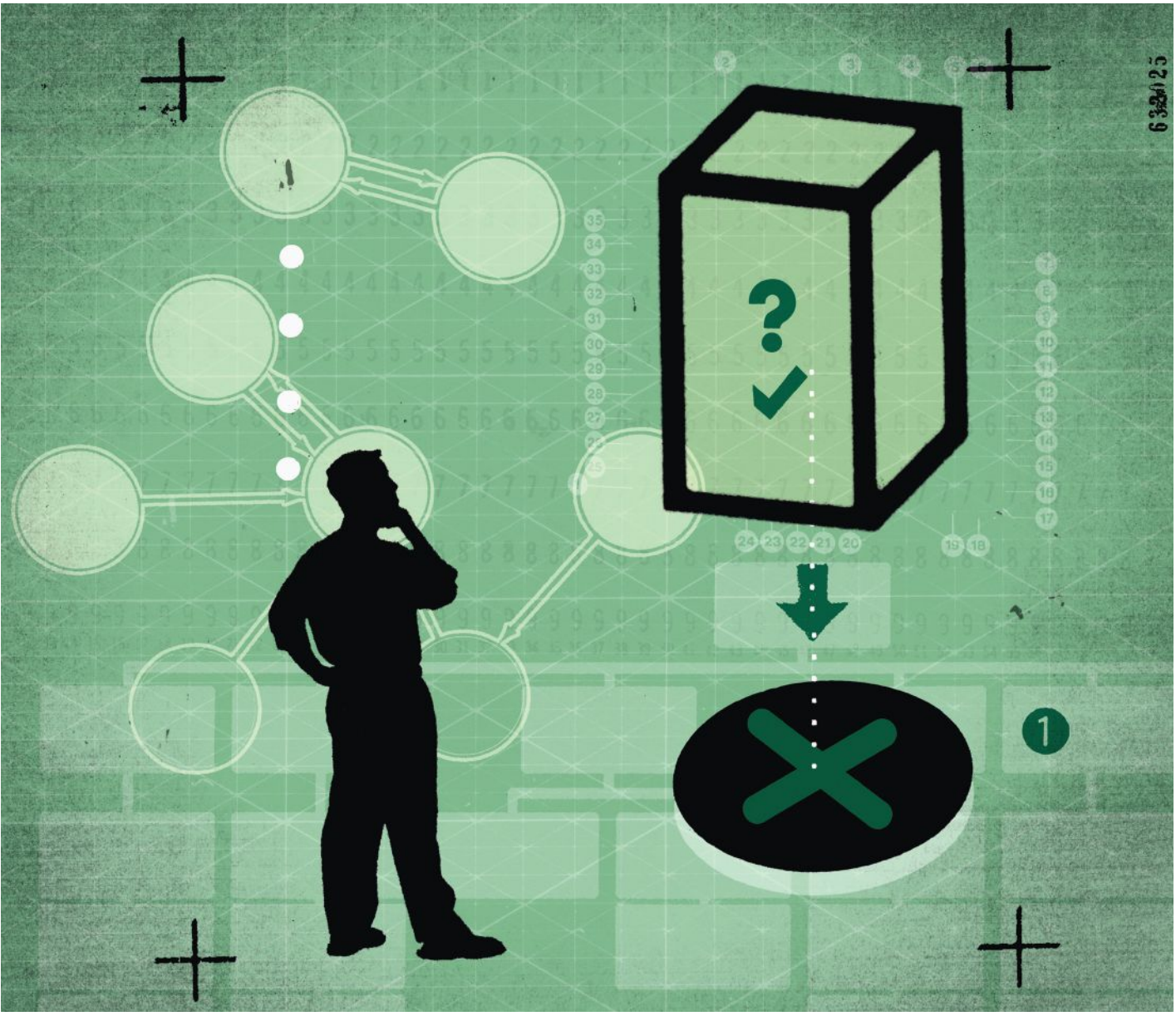
HAVING THE RIGHT AMOUNT OF INVENTORY when and where it's needed is a key element of corporate success. After all, losing control of inventory eats away at corporate profit margins and costs a firm its customers. As a result, today's CEOs are well versed in inventory strategies such as Just-in-time (JIT), collaborative planning, forecasting and replenishment, and shared point of sale data. Yet, the wrong application of the right strategy can be just as costly as no inventory control at all. Reducing the wrong inventory, for instance, often leads to a reduction in customer service levels (CSL) with little impact on cost. That affects customer satisfaction. Strategies such as JIT, on the other hand, often simply shift the cost of carrying inventory back to the vendor with little impact on the total end-to-end total supply chain cost. Eventually, those costs affect all of the players in the supply chain.

The result is that supply chain executives are often left scratching their heads and wondering: How can I manage inventory in a way that doesn't impact my customers or leave real money on the table?

Our work answers these questions using a new inventory strategy that we call the science of theoretical minimums, or STM. STM provides a simple and elegant framework to reduce cost and increase customer service levels by monetizing time delays across the extended supply chain. Unlike other strategies, managing to theoretical minimums reduces the total supply chain cost instead of simply pushing costs onto weaker suppliers. This means that STM reveals how much profit is being left on the table in the end-to-end supply chain. This monetization of delay cost provides supply chain executives with a clear picture on where to focus their efforts.



More importantly, we contend that STM is an idea whose time has come. In the last decade, the task of managing inventory flows in ways that drive out informational delay has been a sort of alchemy that has alluded the major supply chain technology companies. Our work with a major technology provider demonstrates that the dead weight of slow moving inventory can be turned into gold. Moreover, we can share real world examples where supply chain executives from very diverse industries are leveraging Cloud-based systems, common interfaces, and smart software systems to monetize the informational delays in their supply chains.

Simple and insightful

In "Competitive Strategy," Michael Porter provided business executives with a simple and insightful way to look at their businesses. A firm, he wrote, competes in two ways: It either provides what other firms do for a lower cost or it provides additional features for the same price. In hindsight, the concept of cost- and differentiation-based competition seems intuitive, but when it was first published, it was an "ah-ha" moment that had executives asking: "Why didn't I think of that?" The elegance in STM—the "ah-ha" moment—comes from a similar, simplistic two element view of the way inventory affects a firm's competitive position.

The concept is not new. In the hard sciences, theoretical minimums have been used as a bench mark for years. Information technology strategists, for instance, often discuss the theoretically achievable bandwidth of a particular configuration. That is used to understand bottle necks and the opportunities to invest to reduce those bottle necks.

Theoretical minimums have a similar value in the supply chain. Here, they provide an idea of what is possible by increasing visibility, attacking latent activities, and synchronizing supply chain processes. Attacking these latencies mitigates the negative costs associated with lead times and variability. STM accomplishes this by providing the basic logic for accounting for inventory and inventory costs in terms of physical and informational delay. This simplicity removes the ambiguity that often clouds inventory related decision-making.

STM gives insight, and thus control, into the end-to-end supply chain inventory investment and optimization.

The key to managing by theoretical minimums is to understand how to decompose lead-time into two buckets. The first bucket is based on physical constraints such as the batching of transportation, work in process, or safety stock to support demand variation—we call this physical lead time. The second bucket is based on informational delay— this bucket includes everything that is not a true physical delay. We call this informational lead-time.

We all recognize an informational delay when we see one—lack of a precise delivery window, a purchasing order process that is given four weeks but only involves four hours of true work, or a lack of insight into inventory positions at particular moment. And, yet, we often simply accept informational delay as an unavoidable cost of doing business.

As it turns out, there is actually a great deal we can do about informational delay once it is monetized. Consider how work has been done to reduce physical delays, such as pipeline projects, JIT, direct ship, mass customization, and delayed differentiation. The goal of managing to theoretical minimums is to focus not only on the added cost of unnecessary physical delays but also to monetize the cost of informational delays. This monetization, and the associated mathematical logic, puts into profit-based terms just how much money supply chain executives are leaving on the table due to informational delays. And, as we will show with results from real world projects we have worked on, the potential to convert that to profit is much greater than one might first believe. But before we delve into those, let's take a few minutes to understand the science behind the STM against the backdrop of modern supply chain management.

Supply chain management and the alchemy of inventory

For supply chain managers understanding the alchemy of turning inventory lead into supply chain gold is not nearly as interesting as the alchemy of achieving high inventory service levels at the least total cost. When supply chain management and logistics began to move to the forefront some years ago, strategies for achieving high inventory fill rates at lower and lower cost were focused at the firm level. Retailers, for example, harnessed the math behind risk pooling by shifting inventory to their distribution centers while making smaller and more frequent deliveries to their stores.

Over time, efforts aimed at increasing inventory efficiency were applied to the extended supply chain with the goal of understanding the trade-offs, hidden costs, and sources of inefficiency that could be converted into a competitive advantage. These efforts resulted in an astounding number of strategic breakthroughs. Ideas such as just-in-time, consolidation of inbound and outbound transportation, vendor managed inventory, and the rise of third-party logistics providers are just a few examples.

Yet the ability to unlock the full profit potential associated with end-to-end supply chain optimization remains elusive. Managers, and scholars, have been stymied by that key supply chain problem: "How do we take that last bit of cost out of the system when we don't even know where that cost is hidden?" What aggregate level strategy will give us the visibility needed to convert that cost into shareholder value?

STM gives insight, and thus control, into the end-to-end supply chain inventory investment and optimization. In its simplest form, STM provides a methodical approach, and accompanying governance structure, which allows managers to uncover fundamental latency and the resulting cost, which remains in even the most aggressively managed supply chains. The key to the STM strategy is the development of a method to define supply chain-

specific minimum resource requirements (time, inventory, transportation) and correlate those requirements (using an advanced algorithm based tool) to monetize potential cost avoidance. This monetization spurs strategic investment and attention. This approach provides managers with a mechanism to determine where potential wealth remains, a decision toolset to unlock that wealth, and a way to evaluate the return on investment associated with STM driven decisions.

More specifically, STM provides the following end-to-end supply network management capabilities:

- correlate lead times and inventory levels;
- distinguish between informational and physical lead times in their value networks;
- identify theoretical minimum lead times and calculate the return on investment available by moving network toward theoretical minimum lead times; and
- demonstrate how the use of real-time consumer demand to drive time-phased shipments and production through the supply network while quantifying and mitigating the effects of demand, supply and lead-time variability, can create increased profitability for all trading partners.

What is the science of theoretical minimums?

Okay, if you have stuck with us thus far, you might be asking: Just what is the Science of Theoretical Minimums? STM is a methodology that can provide guidance to supply network trading partners to move lead times toward a minimum that approaches zero. STM provides a simplified, yet accurate, conceptualization of time in the supply chain. This simplification provides managers with the ability to more clearly link actions to results. At the aggregate, physical lead times (PLTs) is a catchall term that we use to define all other delays besides informational lead-time. PLT is a surrogate metric to include such factors as procurement and transportation lead-times. Introducing the concept of informational lead times (ILTs) when decomposing lead times into its fundamental building blocks provides critical insight into the cost of latency that is typically encountered in the extended supply chain.

We define ILT as the time it takes for information to move between supply chain participants. We monetize ILT by using a novel analytical model that allows for the correlation between informational and physical lead times, along with the demand arising at each supply chain stage. The "a-ha" in STM comes from the model's ability to visualize for each trading partner the cost impact of reducing their respective lead times to a theoretical minimum of zero. While this is an abstract goal, we show that STM helps align the actions of supply chain members to identify mechanisms that bring the network closer to theoretical minimums. Further we back up this abstract strategy by sharing very real results.

The goal of managing to theoretical minimums is to focus not only on the added cost of unnecessary physical delays but also to monetize the cost of informational delays.

Quantifying ILT is accomplished by monetizing (cost, inventory, capacity) the delay that is induced while waiting on information and decisions that precede the movement between supply network participants. Involved in this quantification are the direct cost of delay and some element of indirect cost associated with delay driven degradation of information relevance and accuracy. STM provides an ability to calculate how ILT variability drives increased inventory without increased CSL. This latency is defined as non-value added time waiting for the information that is required to perform collaborative supply network planning and execution.

Managing STM involves three key steps:

- define a supply chain with zero informational lead time;
- define the physical lead time and its corresponding variability; and
- define the cost difference between ILT and PLT.

Armed with the information created by these steps, managers can make informed decisions on the cost and benefit associated with removing delays.

To understand how well STM works, let's first take a look at an example from a Major Spare Parts Manufacturer. This industry faces a number of initiatives that have bloated inventories as firms have attempted to dominate in this often overlooked, yet profitable, sector. Table 1 shows how this firm managed to leverage STM to grow profitability and shareholder value.

By managing to theoretical minimums, firms can move away from an assumption of "fixed" or "uncontrollable" lead times. Further, STM highlights the very real cost of lead

TABLE 1

Major government program

Key metrics impacting profitability	Before	After
1. Domestic freight spend	$400 Million	$320 Million
2. Dealer part availability	67%	96%
3. Inventory reduction		25%

Source: Wesley S. Randall, David R. Nowicki, and Shailesh Kulkarni

TABLE 2

Major government program

	Before	After
1. Loss/damage free shipments	96%	99.98%
2. System uptime	97%	99.9%
3. Reduction in transportation costs		23%

Source: Wesley S. Randall, David R. Nowicki, and Shailesh Kulkarni

time variability by establishing real and achievable baselines, increasing visibility, attacking latent activities, and synchronizing supply chain processes. Attacking these latencies mitigates the negative, and often exponential, costs associated with lead time, supply, and demand variability.

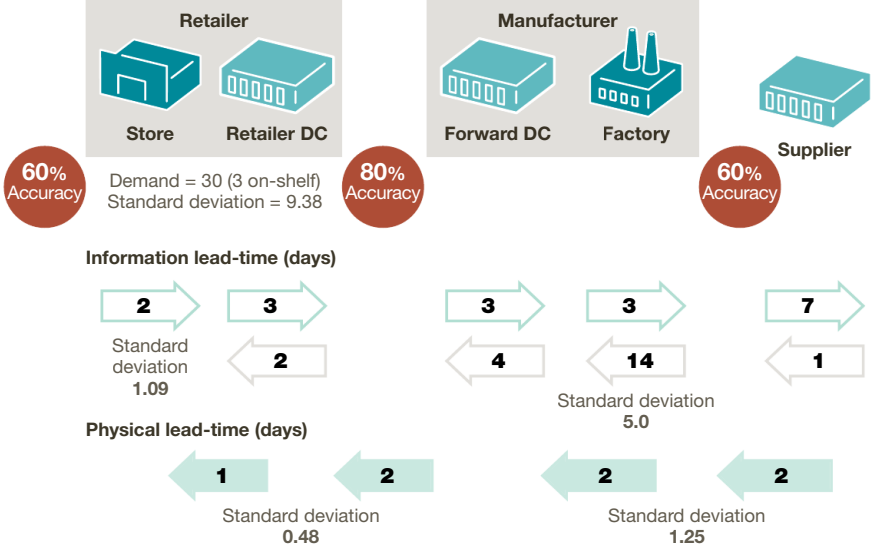
Some retailers and manufacturers have already embraced STM type strategies with excellent results. For example Walmart's new Supplier Portal Allowing Retail Coverage (SPARC) relies on real-time supply chain information to "stay in stock" with the lowest total inventory levels. The result has been improved gross margin return on inventory investment (GMROII). Del Monte Foods, meanwhile, decided to see what an STM strategy could do for them. The results were an eye opening 27% reduction in inventory level, an increase of in-store service levels to 99%, and a 20% increase in forecast accuracy. In Table 2, we show how a supply chain technology firm, working alongside a government customer, drove dramatic results for taxpayers and end users.

As a part of STM, we also study the interrelationships between customer service levels (CSLs), inventory costs, and inventory. Effective management of ILT results in improved profit margins for the supply chain with no negative impact on CSLs. This insight creates guidance for the governance mechanism (strategy) that identifies how decisions can reduce unnecessary lead times by identifying the costs of latency and the potential profit associated reducing these delays.

This highlights the second key aspect of management based on STM: The clear monetization of the cost of uncertainty. Uncertainty generally manifests itself as demand variability and lead-time variability, both of which result in increased inventory expenditures. As demand and lead-time variability increase there is a need to increase the amount of safety stock in order to achieve the desired CSLs. The safety stock acts as a necessary, but expensive, buffer to multiple sources of nervousness associated with uncertainty in a supply network. Taken together, STM monetizes the cost associated with variability in demand, lead-time, transportation, order processing, and purchasing.

FIGURE 1

Representative three stage, CPG supply chain network



Source: Wesley S. Randall, David R. Nowicki and Shailesh Kulkarni

A strong foundation for STM

Ideas at the core of STM can be seen in Toyota's efforts to reduce its lead-time problems with suppliers in the 1980s. By reducing the number of processing points and batch sizes, Toyota reduced its lead times from 15 days to one day, essentially moving toward a theoretical minimum. When the number of processing points increases, processing times increase, as does the variability of lead times, while the information delays that result from batch processing result in increased lead times.

Walmart has built a rich

competitive strategy by removing the batch processing of information that causes delayed ordering decisions. It does so by assuring that orders are communicated to upstream suppliers as soon as retailers receive orders from customers. The result increases the probability of on-time deliveries.

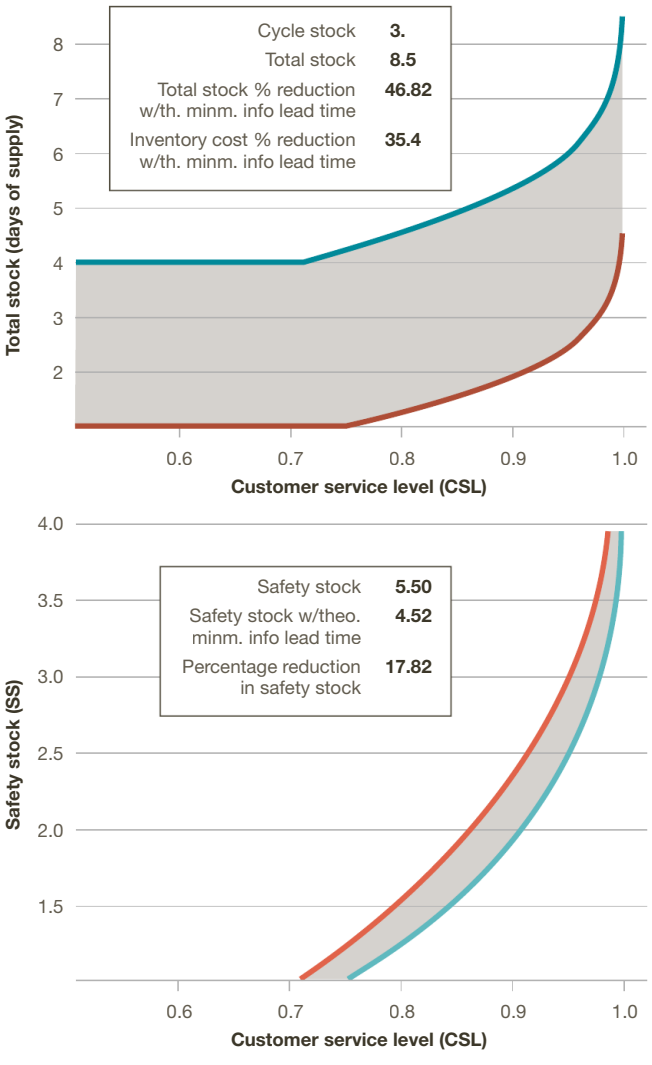
Hewlett Packard reduced lead times and improved on time deliveries by decreasing trading partner communication delays. By doing so, HP more than doubled its on-time delivery rate and reduced its inventory expenses by $9 million. HP accomplished this by identifying informational lead time delays and implementing a three stage process that included the communication to suppliers of suppliers' delivery dates, supplier's production time, and product delivery times.

Various academics efforts have provided insight into inventory problems that demonstrate the ideas at the core of STM. For example, researchers have shown that linking lead times between various production systems can lead to reduced variability in the total lead time of the system. Others have shown how a reduction in lead times in certain conditions reduces reorder levels. At Stanford, renowned supply chain scholar Hau Lee and his colleagues identified four major causes that influence bull whip effects: demand signal processing, rationing game, order batching, and price variations. All of these elements are addressed within STM.

The science of theoretical minimums is distinct from these earlier efforts in a number of ways. First, STM assumes that informational and physical lead times are correlated. This assumption is true in most practical instances. For example, when information is not communicated quickly across supply networks, production and shipment functions are delayed which results in longer lead times and loss of sales. This may also lead to unneeded inventories when there is no demand for products. Second, it assumes that demand and overall lead times are correlated. The wealth of supply chain research, coupled with the ideas embedded in STM, allows us to derive formulae for reorder levels, safety stocks, and total costs when informational lead times are greater than zero, and total costs when informational lead time is zero. Thus, the theoretical goal of supply chain management is quantified as the theoretical minimum, which is defined as that point where informational lead time is zero. STM provides a theoretically grounded foundation for this goal, and does so in a way that is actionable for supply executives.

FIGURE 2

TMM illustration of the retailer stock



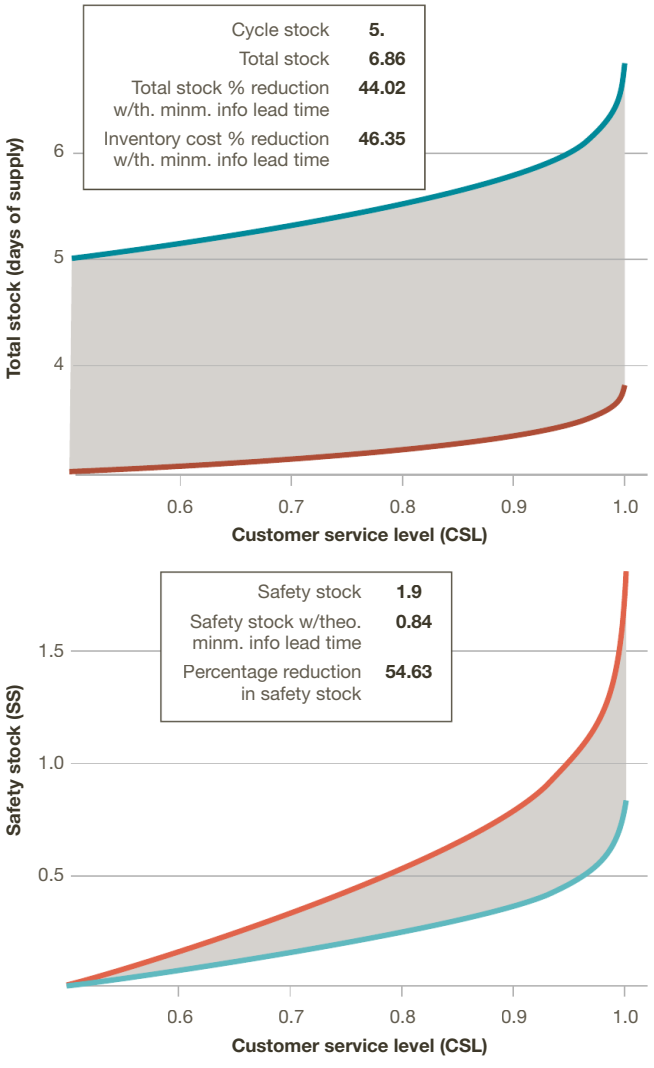
Source: Wesley S. Randall, David R. Nowicki and Shailesh Kulkarni

How to make STM work: A tool for achieving theoretical minimums

The idea of theoretical minimums is only as good as the practical tools available to managers to affect decision-making based upon those ideas. We have operationalized STM by developing an analytical tool, called Theoretical Minimum Modeling (TMM), to demonstrate how end-to-end supply network performance is influenced by key supply chain levers. TMM is structured to capture the dynamic interactions among these key supply chain levers. These levers include demand, demand variability, informational lead times, informational lead time variability,

FIGURE 3

TMM illustration of the manufacturer stock



Source: Wesley S. Randall, David R. Nowicki and Shailesh Kulkarni

physical lead times, and physical lead time variability. The tool also captures dependencies among demand, informational lead times, and physical lead times. It allows users to study the impact of decomposing total supply network times into information and physical lead times. Upon changing lead times and associated variability for a given consumer demand, users can see the impacts on cycle stocks, total stocks and associated inventory carrying costs.

To understand this example, think about the typical supply chain models, policies, and processes that define decisions. It is not unusual for a supplier to have a standard purchase order response time of four weeks. This kind of "policy" is often taken for granted. STM highlights the amount of time such a purchase order really takes to process and then assigns all of the other time to ILT. ILT is then monetized to show the true cost of delay, and as we will show in our next example, that delay can be significant.

Thus STM redefines models, policies, and process by quantifying the potential profit left on the table (PLT minus ILT). This calculation also accounts for the impact on variability informational lead-times, leading to shorter physical lead-times. The net-net of STM based management is that supply chain inventory levels are reduced, customer service is increased, and shareholder value is improved. Considerable opportunity exists to improve profitability by leveraging STM to harvest unrealized profit.

To illustrate this, Figure 1 (pg. 16) shows a realistic but hypothetical Consumer Package Goods (CPG) supply chain network with typical informational and physical lead times. The average daily demand at the retailer is 30 units. The retailer experiences 60% forecast accuracy. This accuracy translates to a standard deviation of daily demand equal to 9.38 units. That means that the total lead-time in this CPG supply chain is 46 from order execution at the retail store to order fulfillment through the retailer distribution centers (DC), manufacturer forward DC, the factory, and the suppliers providing raw materials to the factory for its manufacturing operations. A savvy supply chain executive, given the right tools, can recognize that in reality there is only 7 days of physical lead time. The remaining 39 days of latency arise from informational delays that pose a very real cost.

We can then decompose that 39 days of informational lead time to show that there are 7 days of delay residing with the retailer, and that delay has a standard deviation of 1.09 days. Remember that variance, in this case standard deviation, translates to very real cost. We also see 32 days of informational delay with the manufacturer with a standard deviation of 5 days. The average retailer's physical lead time is 3 days with a standard deviation of 0.48 days and the average manufacturer's lead time is 4 days with a standard deviation of 1.25 days.

In the Figures 2 and 3 (pg. 17 and pg. 18) we will show how the Theoretical Minimum Model (TMM) captures the three-stage CPG supply chain network described in Figure 1. In Figure 2, we see the retailer's

TABLE 3

Major consumer product goods manufacturer

	Before	After
1. Weeks of inventory supply across the supply chain	8	4
2. Case fill rates	95%	99%
3. Days of inventory on average in the distribution center	13	6
4. Average sales forecast accuracy	60%	81%
5. In store in stock	96%	99%
6. Distribution center inventory reduction		27%

Source: Wesley S. Randall, David R. Nowicki, and Shailesh Kulkarni

stock to include cycle stock and safety stock. The top graph shows the potential cycle stock that could be removed from the retailer if managed to theoretical minimums. The bottom graph shows the percentage reduction in cycle stock if managed to theoretical minimums. At the same time we show how these calculations impact customer service levels. These numbers can easily be converted into dollars within the TMM. Thus a supply chain executive could use this to calculate how much inventory investment would be freed up if we reduced informational delay by 30%—the monetization of informational delay.

In Figure 3, we see the manufacturer's stock. And here we can draw the same conclusions as we did with the retailer.

The graphs display the results based upon firm specific context with regard to the key variables. These graphs dynamically update as one or more of the sliding bars are adjusted to reflect new values. As a consequence, insights through what-if and sensitivity analyses are rapidly obtained.

The grey shaded area represents the opportunity available to the supply network if it focuses on achieving Theoretical Minimums. The two green graphs on the left pertain to the retailer and the two pink graphs on the right relate to the manufacturer. Figures 2 and 3 show the relationships between total stocks, measured in days of supply, and customer service levels.

In this example, achieving a theoretical minimum (informational lead time is non-existent) results in a total stock reduction of 85% for both the retailer and the manufacturer. The underlying algorithms derive the specific cost savings associated with a reduction in lead time and the corresponding reduction in cycle stock and its associated inventory carrying cost. Financially this translates into a 53% and 83% reduction in inventory costs for the retailer and manufacturer respectively. The TMM also monetizes how the positive consequence of achieving the theoretical minimum lead time has on variability reduction. This is reflected in the two safety stock vs. CSL graphs shown on the bottom of Figure 3.

In the example, we show that if it is possible for the manufacturer to reduce its information lead time by a week from 32 to 25 days, and the standard deviation of information drops from 5 days to 4 days, the cycle stock at the manufacturer drops from 36 days to 29 days, and safety stock for the manufacturer drops from 15.06 days to 12.4 days.

While we are the first to conduct an academic study aimed at defining STM in terms of the monetization of informational and physical lead times, we are certainly not the first to benefit. In Table 3 we show the results of how a major consumer products goods manufacturer used STM to understand where the profit was left on the table.

A leap forward

By now, we hope we have demonstrated how supply chain technology thought leaders working alongside academics and innovative customers have managed to harness the science of theoretical minimums to shatter the glass ceiling of inventory reduction. The results are real—leading firms are turning inventory lead into supply chain gold, with very little profit left on the table.

Our results convince us that STM is a leap forward in the way extended supply chain partners visualize the cost of information delay and represents a new and efficient frontier for extended supply chain inventory management. Our initial research using STM also indicates there are still significant savings to be gained.

These strategies are already providing a competitive edge to firms like Walmart and Del Monte. The fact is that if you do not understand the concepts involved in STM, one of your competitors will. Then it will be their actions that define your competitive position, not a comfortable conversation to have with your shareholders.

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Readers interested in the underlying mathematical model used to compute cycle stocks, safety stocks and their associated inventory carrying costs can e-mail Wesley.randall@unt.edu for the authors' working paper on this topic.

DELIVER IT All

In an age of expanding online commerce, is home delivery greener than sending full truckloads of goods to stores and then customers driving to them? A detailed regional study finds compelling answers.

By Anne Goodchild, Erica Wygonik and Bill Keough

READERS who were teenagers in the 1980s may remember driving to a Sam Goody store to buy music. You probably also remember your disappointment when sometimes the tape or CD wasn't in stock when you arrived. Perhaps you returned to your car and headed for Tower Records to try your luck there.

Your kids would probably find this story inconceivable today. The advent of the Internet has profoundly altered consumer expectations. Immediate gratification is getting closer by the day; you can now obtain your favorite song in seconds, and order and receive physical goods in as little as a few hours in some urban areas.

Today's ninth-grader expects to find any product she wants in seconds and order it right away on her smartphone. What's more, she expects that the order will be accurate, complete, well-packed, and easy to return if desired.

But rapid delivery and outstanding customer service are not the limit of consumers' expectations today. Adults and children alike are presented with news about global warming and other environmental concerns. Young people in particular are highly sensitized to ecological issues. Increasingly, they make choices about products and services based on their impact on the environment.

So what does that mean to supply chain or logistics professionals? It is one thing to develop and establish inventory planning and logistics strategies that deliver on-time and in full. But doing so while simultaneously reducing your environmental impact? Isn't that a tall order? Supply chain leaders could be forgiven for

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thinking it's a zero-sum game: You can provide fast, free shipping across a variety of sales channels or less-timely green delivery to address the rising environmental concerns of consumers.

But is that really true? Does it have to be a trade-off, or can service, cost and sustainability needs be met at the same time? In this article we will demonstrate that, with careful analysis of consumer demographics and the service levels they expect, it often is possible to do both. Just one snapshot: In many instances, according to our research, home deliveries to multiple consumers in one truck generate less total carbon dioxide (CO_2) than the alternative of many individual vehicles traveling to local stores—especially, if in our original example, the product a consumer wants isn't in stock and they drive to other retail locations before returning home.

The extent to which delivery services can provide emissions advantages over personal travel is a function of both population and transportation network density.

The unstoppable expansion of e-commerce

Retail sales via the Internet have more than quadrupled over the past decade, according to the US Census Bureau. The explosion of growth will continue: By 2018, Forrester Research Inc. predicts that internet sales are expected to increase to $414 billion or 11% of total retail sales, up from 8% ($263 billion) in 2013.

The growth comes from multiple directions. Traditional retailers have been moving aggressively into e-commerce. For instance, Macy's saw faster growth online than in its stores, and launched a highly successful omni-channel sales strategy that delivers a seamless shopping experience whether customers order online, on the phone, or in a physical store. Macy's online sales have increased 40% per year since 2010 and now account for 11% of the retailer's total revenue.

At the same time, e-commerce leaders are further pushing the boundaries of responsive home delivery service. In September 2015, Amazon launched a new service called Amazon Prime Now, which enables shoppers to use a mobile app to select from tens of thousands of items that will be delivered within a one- to two-hour window. Prime Now was trumpeted in the local Seattle news when Seattle Seahawks star Richard Sherman personally made one-hour home deliveries of Seahawks merchandise directly to astonished fans.

Volvo has taken this idea further with its Roam Delivery service, in which the delivery address isn't fixed. To maximize customer convenience and solve the problem of missed deliveries, Roam Delivery enables online orders to be delivered directly to the trunk of the shopper's parked car, as was reported by CNET. The delivery person receives the current GPS coordinates of the vehicle, an app generates a one-time key to open the trunk, the delivery is made, and the car is safely locked again. The customer then gets a text confirming that their delivery has been completed.

Appealing to consumers every which way

Let there be no doubt that retailers and consumer goods companies have been working hard to improve their service levels and lower their operating costs. Over the past 10 years, big-box stores such as Home Depot and Walmart have reworked their transportation strategies. Individual stores that used to be served daily by numerous LTL (less-than-truckload) deliveries now receive most of that merchandise aggregated into one truckload delivery. Where retailers once selected sites for their distribution centers in areas with low real estate and labor costs, they are now building DCs that are far closer to the population centers they serve, offering operating efficiencies that include more responsive deliveries, both to their retail stores and directly to their customers who order online.

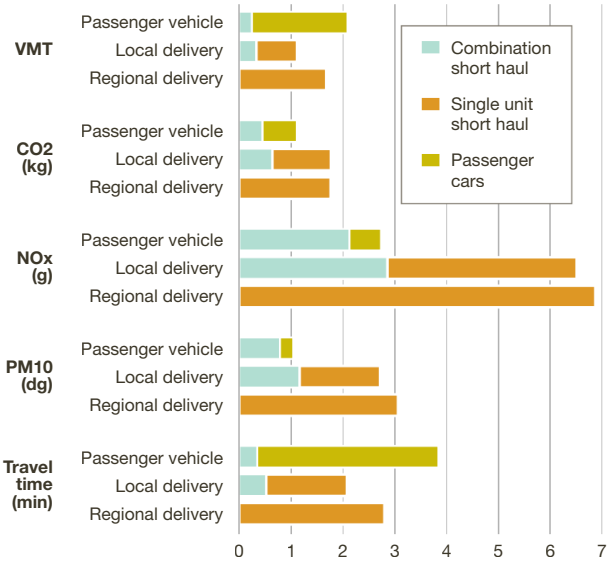
The push for superior service is very real—and it affects much more than the physical transportation and distribution assets. Retailers can no longer measure themselves simply on the fulfillment of perfect orders for customers (right product, on time, undamaged, with correct paperwork). Delivery speed is a crucial factor for consumers when comparing online retailers; UPS's Pulse of the Online Shopper research demonstrates that 50% of shoppers abandoned a cart due to lengthy delivery times or when no delivery date was provided. And low cost remains a priority. According to the UPS report, 80% of consumers feel that free shipping is an important factor when making online purchases.

And then there is the environmental impact. Research from Dotcom Distribution shows that 55% of online shoppers consider a company's carbon footprint when making purchasing decisions. Another recent study from G&S Business Communications found that 75% of consumers would be more likely to buy products or services from providers that they learned were making great efforts to adopt environmentally-conscious practices. Millennials—the next wave of consumers with an estimated $170 billion in purchasing power—will raise the importance of this last factor. They are twice as likely as Baby Boomers to own a hybrid car and seven times more likely to own an electric car.

In short, this new generation of consumers expects that the retailers they buy from will likewise prioritize sustainability.

FIGURE 1

Urban delivery only: cars are cleaner but trucks travel less



Source: University of Washington

A study of e-commerce greenness

So is it fair to say that e-commerce is green by default because there should be fewer passenger car miles required to visit stores? It's not as straightforward as that.

As e-commerce explodes, the number of trucks handling direct-to-consumer deliveries has increased dramatically. The downside there is that trucks create more greenhouse gases and particulate matter per mile than do cars. Heavy vehicles produce nearly 50% of the nitrous oxides (NOx) and particulate matter (PM-10) generated by transportation, but account for only 9% of the vehicle miles, based on modeling from the U.S. Environmental Protection Agency Motor Vehicle Emission Simulator (MOVES), described by the EPA as "a state-of-the-science emission modeling system." The EPA has also found that a combination short-haul truck at 45 mph produces about six times as much CO2 per mile as a car. It is now well-known that compared to cars, trucks contribute disproportionately more per mile to air pollution, resulting in climate change, poor air quality, and negative health consequences, particularly in urban areas.

That said, it is not clear whether the increase in truck deliveries will have a positive or net negative impact on the environment, and how the impact may be affected by the pressure to deliver faster and faster. Can supply chain managers realistically expect to develop transportation approaches that simultaneously meet customers' service expectations, keep delivery costs low, and minimize the company's carbon footprint? Is it realistic to think that the many variables involved can be managed simultaneously?

To answer those questions, authors Anne Goodchild and Erica Wygonik from the University of Washington built a simulation tool to compare various logistical strategies for last-mile retail delivery. Specifically, the team so far has examined three strategies for delivery of online groceries in the Seattle area: passenger vehicle only; local depot delivery; and regional warehouse delivery (direct from the warehouse to the customer's home). Using ArcGIS mapping software, the tool optimized routing and calculated emissions based on emissions factors obtained from the EPA's MOVE system. In doing so, the team has been able to compare and contrast delivery scenarios, estimating the net impact on vehicle miles traveled (VMT), CO2, NOx, and PM-10.

Besides factoring in three grocery delivery models, the research team also designed the study to take account of other real-world variables such as customer density and delivery window. Specifically, the team compared deliveries in Seattle metro, a dense urban area, as well as in suburban Sammamish and in Black Diamond, a largely rural area to the southeast of Seattle.

Examining deliveries only in and around Seattle itself, it quickly became apparent that the lowest VMT numbers come from a local depot delivery strategy, where individual car trips are replaced with a delivery sourced from a local warehouse. (See Figure 1.) But VMT numbers are by no means the sole proxy for greenness. Looking at emissions levels rather than VMT, the details of location and business structure become drivers of the outcome. In fact, the passenger vehicle strategy provides the lowest total figures for CO2, NOX, and for PM-10 in urban areas.

Delivery from local depots or regional warehouses generate higher CO2 emissions where population densities are high since they replace relatively short trips by personal vehicles. Of particular concern in dense living areas are the elevated NOx and particulate levels produced by trucks.

Factoring in urban form

So how would less dense environments compare? The term "urban form" describes a region's physical infrastructure and settlement patterns; key elements are population density and the available transportation network (what roads are available to connect which locations).

The University of Washington studies do demonstrate the significance of operational decisions in sustainability outcomes, and the potential for delivery services to be a sustainability asset.

The research demonstrated that the extent to which delivery services can provide emissions advantages over personal travel is a function of both population and transportation network density. It's not a big surprise that VMT figures and cost per delivery outside the metro area are higher than in cities.

In more rural areas, where passenger vehicle trips are longer and delivery service areas more closely resemble the retail store's market area, truck deliveries reduced total VMT between 70% and 85% compared to cars. (Compare that to Seattle, where the reduction was just about 20%.) In contrast to the result for Seattle, in the suburban and rural contexts, delivery can provide a CO2 benefit (See Figure 2.)

FIGURE 2

Emissions levels favor trucks in the suburbs and rural areas

		VMT	CO2 (kg)	NOx (g)	PM10 (g)	Travel time (min)
Lowest	Seattle	1.1	1.1	2.7	0.10	2.1
	Black Diamond	1.4	1.7	3.8	0.13	2.6
	Sammamish	1.6	2.4	5.2	0.17	3.3
Highest	Seattle	2.1	1.8	6.9	0.30	3.8
	Black Diamond	8.4	3.0	8.0	0.34	13.8
	Sammamish	8.6	3.3	10.3	0.46	14.0

Passenger vehicles · Local depot delivery · Regional warehouse delivery

Source: University of Washington

Taking delivery windows into account

The University of Washington team also tested to see whether better customer service on delivery—narrow delivery windows selected by customers—would affect the overall environment impact, and if so how.

The study demonstrated that when serving the same set of customers, trucks must travel further to meet narrow delivery windows. (See Figure 3.) Alongside the higher VMT figures come increased cost and more emissions. At the same time, the research shows it costs more to deliver to rural areas whether windows are wide or narrow. (See Figure 4.)

These findings raise important questions about customer preferences and how they can be accommodated. Consumers' expectations of service vary: If we order an Amazon Prime Now delivery, we expect it to arrive within the two-hour window and we know we will pay for the privilege. But we have far lower expectations of trades-people who come to service a furnace or refrigerator or cable TV set-up: The workman may commit only to arriving between 8 a.m. and 2 p.m. say—and even then, he may not turn up within that window.

So aside from determining whether the delivery window is wide—eight hours, or as narrow as 30 minutes—supply chain managers should also know whether customers are permitted to specify their desired delivery window or whether that window is determined by the service or product provider.

So, what next?

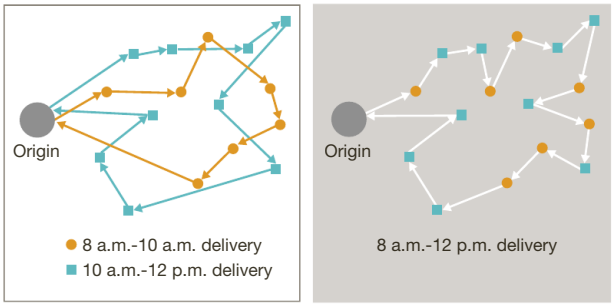
The University of Washington study has generated important insights about the true total costs of last-mile e-commerce—insights that matter to consumers who are growing increasingly aware of the environmental impact of their purchases.

The primary value of the study may not be in the specific findings that it has produced thus far—the preliminary conclusions about emissions levels segmented by delivery region or vehicle or delivery window, for example. There are few absolutes surrounding the question of the net environmental effects of commercial delivery services versus personal travel. That said, the studies do demonstrate the significance of operational decisions in sustainability outcomes, and the potential for delivery services to be a sustainability asset.

Another key outcome of the research is to give supply chain leaders new ideas with which to engage others in their companies who can help shape appropriate responses for ecologically conscious consumers. Here are five suggestions to get those conversations started:

FIGURE 3

Trucks travel further when delivery windows are narrow



Source: University of Washington

1 Study your company's customer demographics. If you are an upscale retailer, your customers may be environmentally attuned and willing to pay extra for green deliveries. On the other hand, if you are a discount chain, your customer base may not be willing to pay anything extra for such a service. Research published in the *Journal of Environmental and Resource*

Economics at Colby (JEREC) in the spring of 2014 shows that sustainability matters more to customers with higher levels of education and income, and to younger consumers.

2 Figure out the distribution of that customer base. Within what urban forms do your customers live? Working with the sales and marketing teams, identify how many sales outlets you have and where they are located. (They could be retail stores, DCs from which you fill channel partner orders, etc.) Obtain sales data by customer by zip code for each outlet (treat Internet sales as a separate outlet). Analyze your sales data by urban form and document the revenues and sales volume associated with each.

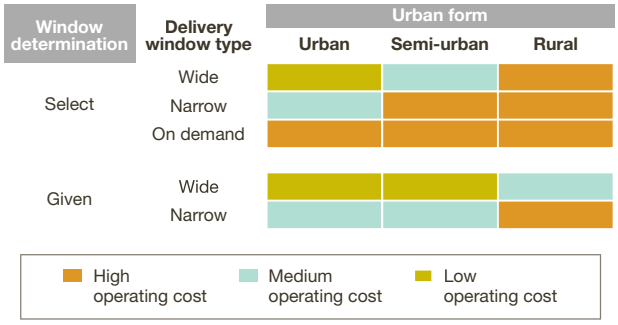
3 Meet with the customer service team. As the front-line interface with customers, the customer service reps generally know more about delivery expectations than someone in the supply chain organization. What type of delivery window will meet your customers' expectations? Do they demand near-instant gratification, like Amazon Prime Now customers, or are they willing to accept an eight-hour delivery window, or longer? The required delivery service level is a key determinant in crafting a sustainable transportation strategy that maximizes revenue while creating happy customers.

4 Review the transportation team's metrics. Does your company currently capture emissions or other sustainability data on your transportation operations? Meet with the leadership of the company's transportation team and review their metrics dashboard/scorecard for sustainability. Ask them what approach they take to iteratively improve their results. If the team doesn't have a scorecard, work with them to define meaningful metrics, determine how and at what frequency they will be tracked, and figure out how you will improve your results over time.

5 Start experimenting with various delivery models. Are all of the above considerations compatible with your cost model? Your rural customers might appreciate two-hour deliveries, but they probably are unwilling to pay for that service in a manner that

FIGURE 4

Tight delivery windows in rural areas are the most costly



Source: University of Washington

makes it cost-effective. Based on your findings from the considerations above, brainstorm with your team to create several models, using the urban form of your customers as the only fixed variable. Then try offering wider or tighter delivery windows and vary the extent to which customers can dictate that window. With your customer base uppermost in mind, shortlist the most feasible options and then devise delivery strategies that minimize VMT and thus CO2. Finally, assess each of those options based on transportation and other costs and determine how this will affect profitability.

How you decide to collectively manage these variables should map closely to your company's current business strategy. If the company is rapidly losing ground to an Internet-based competitor, say, you might decide that investments in more responsive delivery and lower emissions will help you maintain or even increase market share. If the company is focused more on near-term financial results, you will probably decide on a different balance across these variables.

The bottom line is this: environmental factors are rapidly becoming another form of serving customers well. E-commerce providers that truly understand that—and are ready to act on what they have learned—are poised to open up a lead on their competitors.

* The figures in this article were originally published in 2012 by Erica Wygonik and Anne Goodchild in "Evaluating the Efficacy of Shared-use Vehicles for Reducing Greenhouse Gas Emissions: A U.S. Case Study of Grocery Delivery" in the *Journal of the Transportation Research Forum*.

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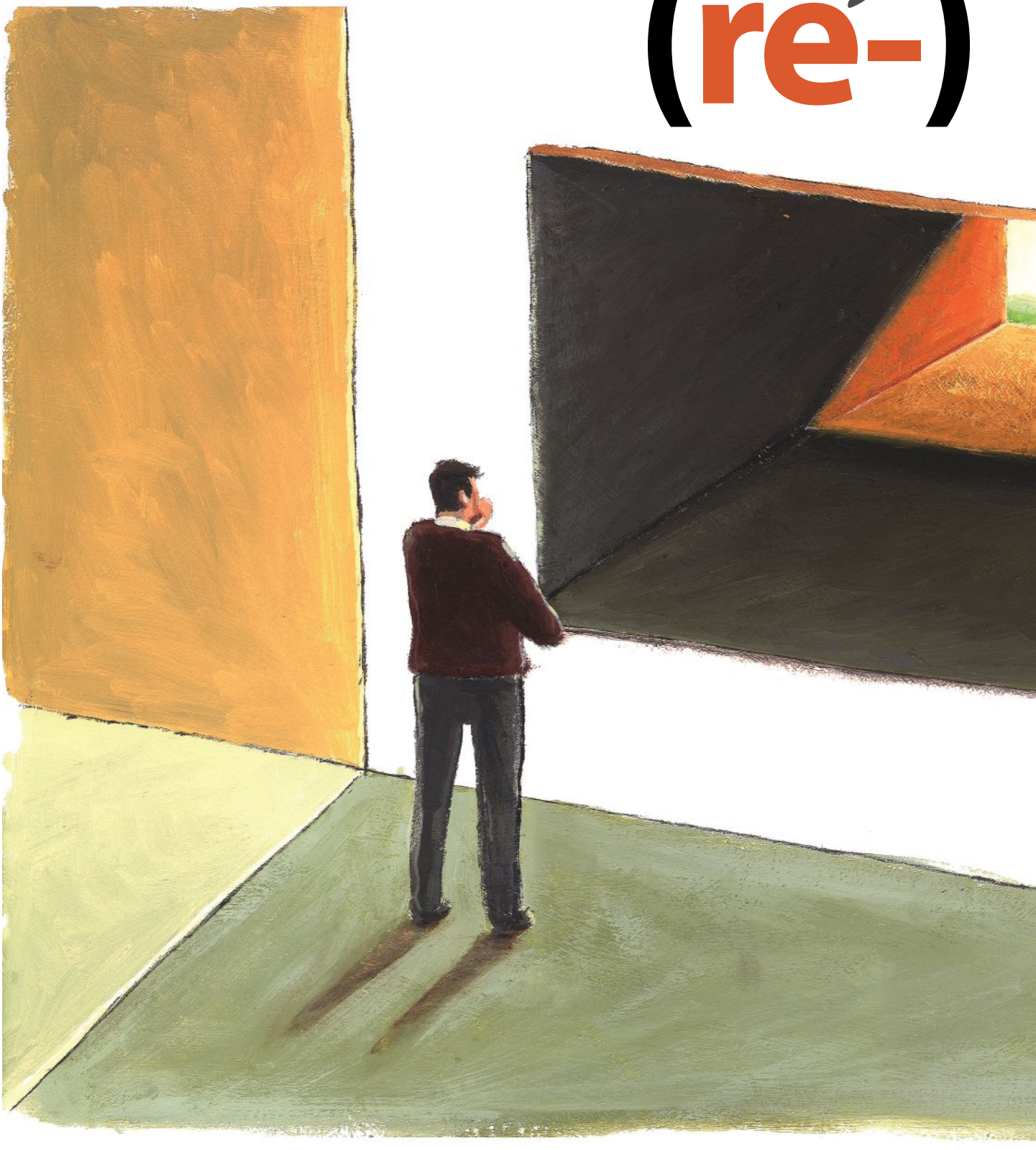
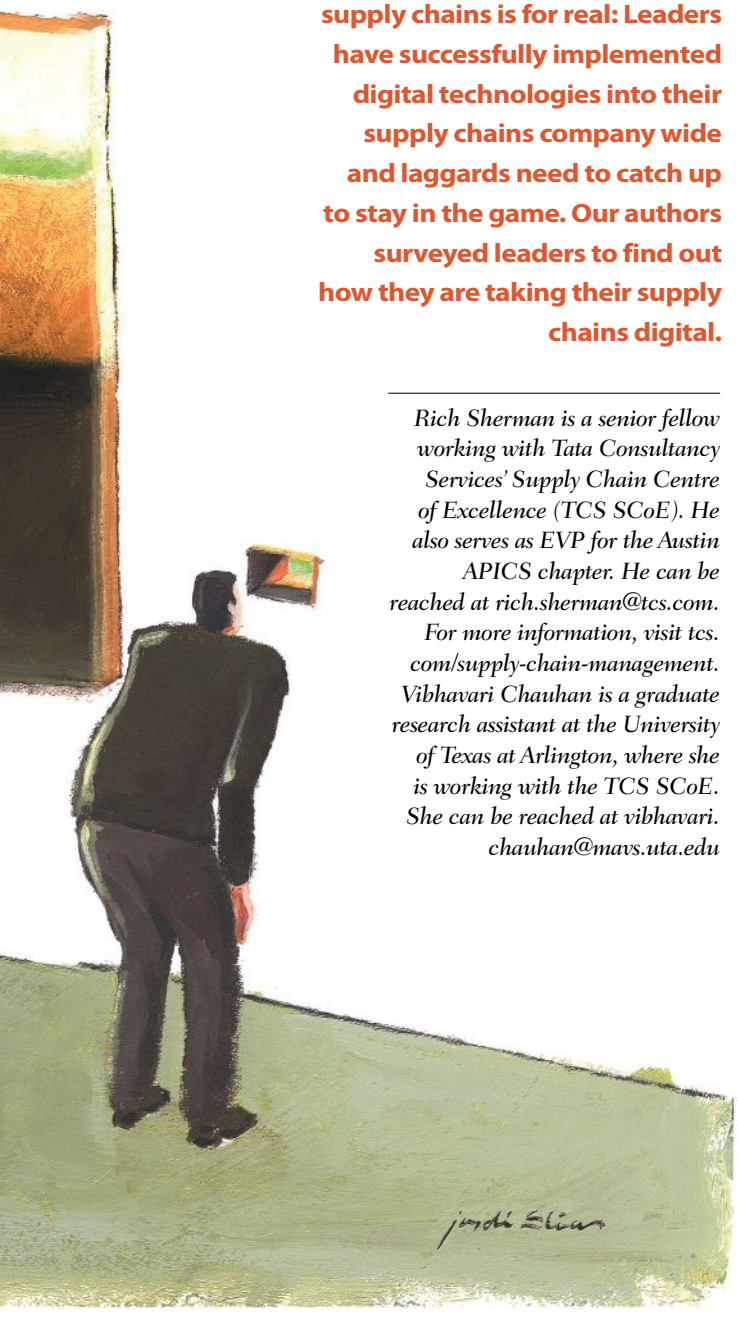


imagination

The digital re-imagination of supply chains is for real: Leaders have successfully implemented digital technologies into their supply chains company wide and laggards need to catch up to stay in the game. Our authors surveyed leaders to find out how they are taking their supply chains digital.



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By Rich Sherman and Vibhavari Chauhan

Change is powerful. But, the pain associated with change is one reason companies often move slowly to embrace new ways of doing business. There are times, however, when change is so sweeping it can't be ignored: In his book, "The Third Wave," Alvin Toffler wrote about three societal waves of change. The first was the settled agricultural wave, the second was the industrial wave, and the third was the post-industrial wave, or as he also called it "the information age." We believe we are entering into a fourth wave of change, a "connected wave" that is based on the evolution of the information age into a digital age as exemplified by this quote:

"The 20th century was about dozens of markets of millions of consumers. The 21st century is about millions of markets of dozens of consumers,"

—Joe Kraus, Google Ventures, BBC News Magazine

The digitization of markets is transforming the competitive landscape across industries to omni-channel marketing, sales and fulfillment. E-commerce is becoming "connected commerce," with everything from consumer goods to building materials to specialty chemicals being marketed, bought, and sold on line by customers who are "connected" to markets and suppliers. Competition can come from anyone, anywhere and anytime. Companies find themselves simultaneously as competitors, customers, partners, and suppliers with one another. The digital technologies that are driving this wave of transformation are:

- the Internet of Things (IoT) and mobile devices (including GPS);
- the Cloud and pervasive computing;
- Big Data and analytics (business intelligence); and
- social media.

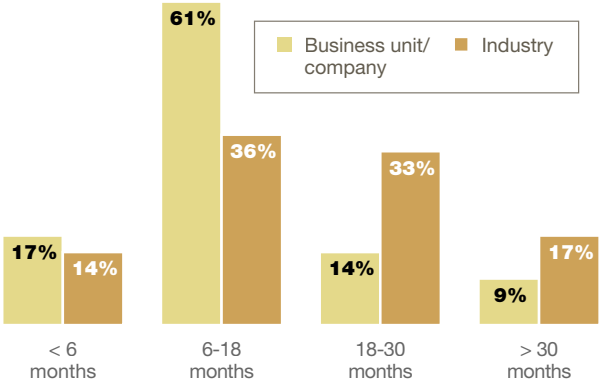
Going digital

What does it mean to go digital? Companies must understand and leverage these digital technologies to compete in the digital markets of the 21st century. They must analyze the unique characteristics of their customers and prospective customers to develop personalized, segmented market and channel strategies. The proliferation of different market segment service requirements, products, and demand are driving new supply fulfillment and network design requirements.

In digital markets and supply, traditional re-engineering and transformation approaches simply don't work. They are inflexible, slow, and fail to take advantage of the wealth of knowledge offered by existing and new sources of data. Traditional supply chain models are sequential and linear, a model that creates time delays and amplifies demand and supply signals—what we call the bullwhip effect. The emerging digital supply chain, on the other hand, is a nonlinear complex supply network comprised of connected customers, suppliers, competitors and third-party providers that comprise a network not a chain. New technology enabling omni-directional communication in real time requires new approaches and methodologies. Rather than re-engineer insufficient supply chain designs, competing in the 21st century is about re-imagining the digital supply network for the future as a customer-centric supply network, enabled by real time visibility, end-to-end data, and advanced analytics.

FIGURE 1

How quickly do you believe digital technologies will reshape your business unit or company and your industry's supply chain?



Source: Rich Sherman and Vibhavari Chauhan

The question is whether companies have started down that path and, if so, how far have they traveled? To assess the maturity, pace and progress with which companies are transforming to digital, we surveyed supply chain professionals in early 2015 about their perceptions of the emerging digital supply chain and how they see the impact of the emerging digital technologies on their companies and industries (see About our research).

The evolving supply chain

Supply chain management is simultaneously being compelled to go digital technologically and to comply with the emergence of new industry track-and-trace regulations. Traditional supply chain structures, strategies, design, processes and execution cannot meet the personalization, speed and connectivity required by digital markets. Management silos have long been bemoaned as a major constraint to planning. In our experience, you can't break down silos. Consider your organization as a demand management structure with the functional silos vertically aligned by three structures: demand creation (for example, engineering/design, marketing, sales), demand fulfillment (for example, procurement, manufacturing, distribution), and demand performance (for example, executive governance, finance, information technology, human resources). Now, consider three horizontal processes within these structures as create, market/sell (demand creation); source, make, deliver (demand fulfillment); and invest, control/measure, return on investment (demand performance). Process demand planning can be performed cross functionally while execution of the activities is managed vertically. The key is to leverage technology to improve the collaboration across functions.

As the supply chain gets closer to the consumer and behavior becomes more transparent, the value for demand driven supply network data becomes more bona fide. A scientific approach that is data driven from the consumer/customer backward is required to re-imagine traditional models. With the flexibility and adaptability to respond to variability as it happens, companies can improve the top line, liberate working capital, and reduce overall cost while providing service that delights individual customers within target segments. By adopting a cross-functional demand management framework, companies can use digitalization to stimulate and support collaboration in their organizations to improve

demand accuracy and responsiveness to variation.

In short, crafting the digital supply network of the 21st century requires a break from the past and re-imagining the future. In fact, the next generation of supply chains will not only be digital, but advanced analytics are also providing the intelligence for smart digital supply network management.

Leveraging digitalization

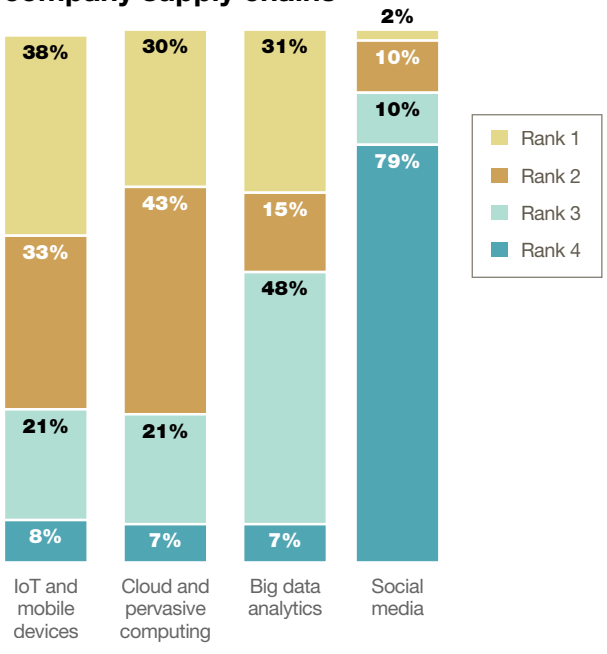
Most companies believe they will use digital technologies to reshape their businesses faster than the industry will. It is evident from the TCS SCoE survey responses (see Figure 1) that some companies clearly believe they are at the forefront, leading supply chain digitalization in their industry. Many companies feel that their path-breaking business initiatives will alter industry performance. About 80% of the respondents are of the opinion that digital technologies will reshape their company's business in less than one and a half years. Adoption, according to the survey respondents, indicates that while the leaders are adopting the new technologies, most are still at a low level of digital maturity. It is also noteworthy that many professionals are convinced that the promise of digital technology and initiatives offer almost instant returns.

In our opinion, some companies are lagging behind due to a lack of understanding of what digital is, lack of capital for investment, industry complexity, a lack of trust in information sharing, and low confidence in the capabilities offered by cutting-edge tools. Leaders, as our survey respondents imply, envision themselves to be one and a half to two and a half years ahead of the laggards. This notion is driven by the assumption that leaders not only adopt new technology faster, but are also involved in creating innovative solutions to stay ahead of the competition. In our experience, companies that stay abreast of new and emerging technologies encourage and nurture a continuous improvement culture. Those that segment and design their operations backward from the voice of the customer are more likely to adopt new technologies, adapt processes to changes in the market, innovate in their operations, and lead in the markets in which they compete.

When we look at some of the technologies preferred by these leaders, several surface as the top digital technologies in supply chain transformation, including the Internet of Things (IoT) and mobile devices, Cloud and pervasive computing, and Big Data analytics (see Figure 2). The preference is somewhat equally divided among these technologies, indicating that companies recognize that they offer the most obvious gain and actually complement each other.

FIGURE 2

Digital technologies most critical for reshaping business unit and company supply chains



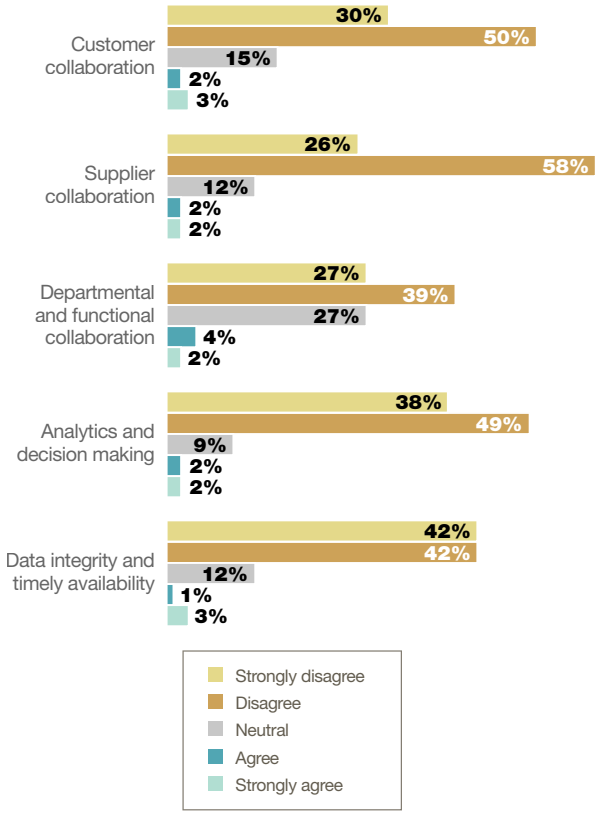
Source: Rich Sherman and Vibhavari Chauhan

At the top of the list, 40% of the respondents believe that IoT and mobile devices are most critical in business re-imagination. The IoT and mobile devices expand the sources of data beyond the boundaries of the organization, and they provide the "digital thread" that connects the nodes in the network. By adding in location-based data, companies can connect directly to their customers and consumers to capture "point of demand" as well as behavioral data by individual and by location (demand sensing). Instead of starting with "point of sale" data, companies can "sense" and identify when and where customers are considering placing demand for a product.

Companies can actually incentivize the customer to consider their product in advance of the sale and use the data to improve their response when the actual sale is made (demand shaping). Further, companies can track

FIGURE 3

What do the IoT and mobile devices enable?



Source: Rich Sherman and Vibhavari Chauhan

how, where, when, and by whom the customer demand is fulfilled. IoT devices can be placed throughout the supply network to automatically collect data about the flow of demand and supply as orders and materials flow through the network. Cash can be collected and transferred in moments. The real-time, end-to-end, and transparent smart digital supply network is enabled by the IoT and mobile devices.

Of course, 45% treat Cloud and pervasive computing as the second priority. All of those IoT and mobile devices need to be connected to generate more abundant data about the demand generating behavior of their customers and the flow of goods through the network to meet the new demand. Accessing and managing that data requires Cloud-based application deployment and pervasive computing to manage the complexity and connectivity of the information network supporting 21st century markets and supply networks. Data must be accessible and on demand to support 21st century decisions.

Following that logic, 50% of the companies believe that Big Data analytics is the third critical technology for business transformation. Note that IoT and mobile devices, and Cloud and pervasive computing lead current activity because most companies understand that implementing these technologies first is required to generate the Big Data. Of course, Big Data collected is not relevant information. Emerging analytics based on cognitive, artificial and neural advanced techniques are becoming more affordable and available due to the Cloud and pervasive computing. New advanced analytics challenge the status quo of spreadsheets and tribal knowledge. Operations must re-imagine their decision-making processes to capture the promise that predictive and prescriptive analytics offer. Old notions of variability and lead time change as visibility to demand and consumption in real time eliminate the time delay and amplification that linear supply chain information and its associated bull whip effect create. It will not be sufficient for companies to re-engineer these inefficient processes—they must be re-imagined.

It comes as no surprise, then, that the advantages of social media have not yet outweighed those offered by other digital technologies. In fact, this lack of understanding may define the talent evolution as millennials come into the workforce. Most supply chain executives today haven't grown up in the connected wave. For them it's change, but for the millennial, it is their ecosystem. Among supply chain professionals, there is an inherent discomfort with the notion of being always on and always connected. Coupled with a lack of understanding of how social media can be implemented within supply chain functions, it is the least preferred technology in supply chain transformation across all industries.

Unfortunately for the laggards, social media is at the point of intersection of marketing and operations. The most important data for immediate response to uncertainty in the supply network is to capture the data causing a variant from demand at the time it occurs: at the point of consumer/customer demand. Data collected and monitored via social media and mobile devices is hyper local and hyper personal. Collectively it can be used to enable companies to serve the millions of market segments of dozens of customers. We are finding that smart companies are using social media for internal as well as external collaboration and identifying demand variants well in advance of current

methods. They are also using it to identify and blow out the matches before they start a fire.

For example, in the consumer products market, food and beverage brands are tracking social media to identify regional and local trends, events, the response to text-based promotions, and other triggers to guide their marketing and fulfillment strategies and plans.

Technology-led transformation

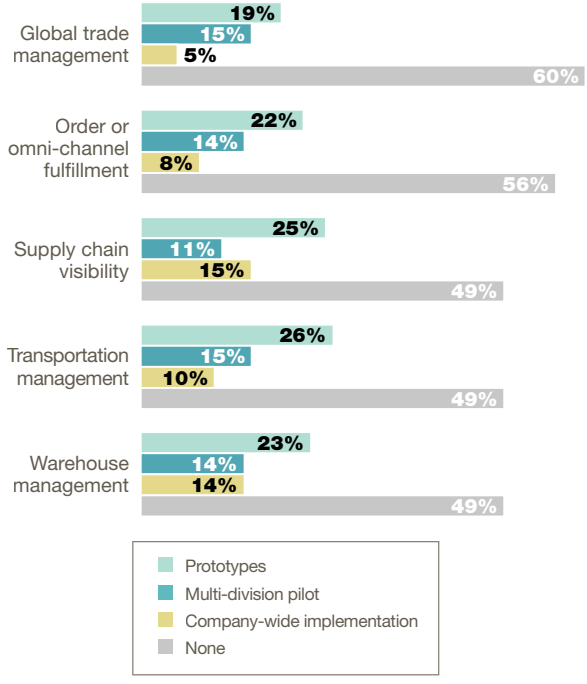
Most companies agree that the IoT and mobile devices enable customer, supplier and departmental collaboration; accelerate decision making; and uphold data integrity and its timely availability (see Figure 3). However, they are clearly struggling with applying and implementing the digital technologies in their environment. Fewer than 15% of companies are using digital technology company wide. Companies are generally looking at digital technology to support both supply chain planning and execution; however, nearly half of the respondents report no usage in their companies. In our opinion, companies have been slow to adopt these technologies due to the investments they have already made in transactional systems, and the transformational cost and magnitude of adapting existing enterprise applications to new data sources and analytics. We believe adoption will increase going forward, as more Cloud-deployed applications, Software as a Service (SaaS) solutions, and managed service offerings connect and modernize enterprise applications.

As one would expect, the IoT and mobile devices, Cloud and pervasive computing are believed to enable customer, supplier, departmental, and functional collaboration; enhance decision making; and uphold data integrity and its timely availability. As the priorities of implementation follow the logical sequence of implementation, usage also follows. In the absence of data collection sources, the computing and network infrastructure is less of a priority for implementation. Interesting, however, is that this technology is perceived to have a higher percentage of enablement for supply chain execution processes. We believe this is largely due to more transportation management systems being offered via the Cloud and that more and more warehousing operations are being provided by third-party logistics (3PL) services using the Cloud for deployment, integration and visibility.

Its usage in inventory management is surprising and alarming simultaneously, as digital technology offers the promise of taming the bull whip effect. It is also surprising that global trade management is low compared to other supply chain planning and execution processes. Global trade management requires significant regulatory compliance and risk management that extends well beyond organizational boundaries that would benefit from digital technology.

FIGURE 4

The degree of usage of IoT and mobile devices in supply chain planning processes



Source: Rich Sherman and Vibhavari Chauhan

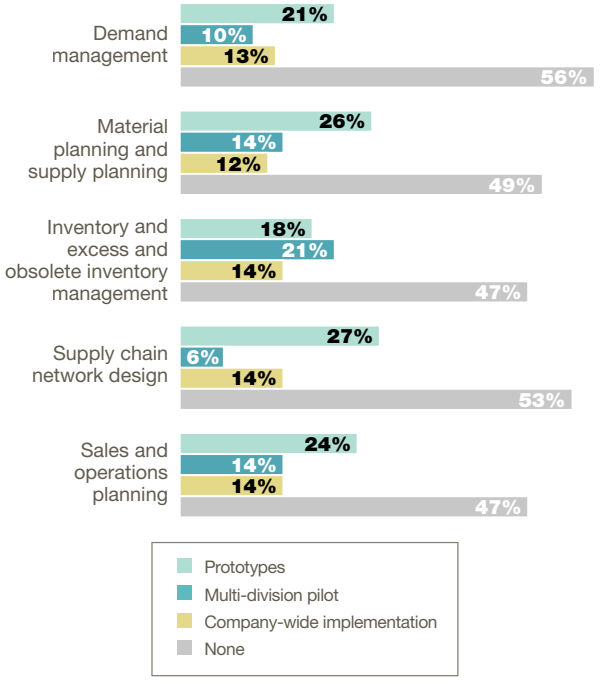
As you might expect, almost all companies strongly believe in the advantages of implementing Big Data analytics, not just in the areas of data integrity and decision making, but also in customer, supplier, and departmental collaboration efforts. It has witnessed increased usage in all supply chain planning processes (see Figure 4), but especially in sales and operations planning (S&OP). No other digital technology has been more widely demonstrated and written about. It is also increasingly being tested for its application in transportation management and other supply chain execution processes, as compared to other digital technologies.

In our experience, the lack of data quality and consistency

across functions and companies is deterring the widespread adoption of advanced analytics. In fact, at a conference where we recently conducted workshops for several dozen supply chain executives, the comment was made that master data management (MDM) used to be an IT conversation; today it is a business conversation

FIGURE 5

The degree of usage of IoT and mobile devices in supply chain execution processes



Source: Rich Sherman and Vibhavari Chauhan

and a necessity. The transformation of supply chain management to smart digital supply network management will largely be driven by the insights unlocked from artificial and business intelligence, increased cognitive and neural analytics, and the adoption of a scientific approach to the analysis and delivery of the information.

Data scientists are among the most sought after supply chain and IT professionals in the market. Data driven analytics and diagnostics are supplanting traditional transformation methodologies as they are faster to implement and can be used to prioritize initiatives based on fact and performance. As supply chains become more connected and collaborative, predictive and prescriptive analytics will become more pervasive. This will be driven largely through more shared and managed services as companies operate more like a network rather than a chain.

As we said earlier, companies have generally not placed much emphasis on social media; however, according to our survey, respondents are beginning to test social media prototypes in supply chain execution processes. Although, these initiatives are still in the early stage (see Figure 5), we believe that they are largely being driven by driver and third-party service provider communications, commercial vehicle telematics, and mobile Auto ID and data collection device integrations. Many organizations are still thinking within 20th century paradigms, as opposed to embracing the emerging connected network structure of the millennial generation and systems thinking. This is impeding the adoption of social media as a key supply chain enabler.

Assessing survey results

Overall, we can infer that while digital technology adoption in supply chain planning and execution is incipient, it is also inevitable. While the percentage of companies testing prototypes are few, combined with the few that have invested in multi-divisional pilot projects, and the few more that have implemented digital technologies company wide, the business and industry tipping points will emerge more quickly than most emerging technology adoption curves.

And, while the majority have still not implemented digital technologies in either supply chain planning or execution processes (even though they realize the benefits) once digital adoption based on the speed of Cloud implementation occurs, the tipping point will again be more rapid. Sure enough, digital technology is being adopted in certain functions, and solutions are being approached more at a functional level. We believe that as SaaS and managed service solutions become more pervasive, the traditional barriers to holistic implementation, capital and culture, will be more easily overcome.

To reap the maximum benefits from digital technologies, companies must consider organization-wide adoption of technologies across functions. This will promote collaboration, improve visibility, and create flexibility. More than two-thirds of the companies surveyed believe digital transformation improves supply chain segmentation, flexibility within supply chains, and visibility and predictability of operations.

Given the lower capital cost that SaaS and Managed Services bring to market, and the speed to benefit they offer, companies will increase adoption of connected

commerce applications and digitalize supply networks. Companies' perceived benefits of decreasing working capital along with improved bottom line from investments in digitalization are indicative of this belief.

Leadership buy-in

Industry experts have long harbored the notion that supply chain transformation is a senior leadership priority. However, this survey shows that at a majority of companies, the business primarily drives supply chain transformation, which is followed by senior leadership driven transformations. In a continuously improving supply network, any delay in acting upon transformation by senior leaders can adversely affect businesses.

Why are some companies leading this foray into digital? What is stopping other companies from adopting technologies? Managers are pressed to make a business case to adopt digital technologies, and the leadership team needs assurance of quick returns. Most companies believe return on investments (ROI) in digital technologies are aligned with expected supply chain transformation timeframes. Two-thirds of the companies expect ROI within one and a half years, unlike investments in other areas. They are gravitating toward quick hits and smaller bites. By leveraging agile techniques, systems thinking, and a scientific approach driven by data analytics, they are re-imagining their supply chains.

Looking ahead

Digital re-imagination of supply chains is for real. Leaders have successfully implemented digital technologies in their company-wide supply chains. GE Power & Water speaks publicly about their "Brilliant Factory and Digital Thread." Procter & Gamble has presented how it is leveraging IoT-based supply chain analytics to more quickly modify production schedules to daily demand variations.

The leaders are continuously looking for new paths to blaze and laggards will need to catch up quickly if they want to stay in the game. Digital markets are rapidly emerging, and inevitably they will continue to grow as more millennials enter the workforce. To remain competitive—even viable—companies must invest in digitalizing their supply chains and transforming them to smart digital supply networks. The threat of extinction to companies that are slow to adopt digital technologies is real. In today's world, the speed at which change to markets occurs can exceed the time the laggards have to catch up.

Big Data analytics emerges as the front-runner among technologies that have been adopted to drive the digital transformation of supply chains. The leaders are implementing digital technologies and using them to operate more predictable and responsive operations. They are using digital technologies to re-calculate forecasts and make operational adjustments to actual variants from plan on a daily—sometimes twice daily—basis. They are using advanced analytics to eliminate spreadsheets and reliance upon tribal knowledge. The financial results enable them to maintain the competitive advantage they enjoy and to capture an increase in market share. Although it may not be a top priority for the laggards yet, transforming to a smart digital supply network is the competitive mandate to compete in the 21st century.

To reap the maximum benefits from digital technologies, companies must consider organization-wide adoption of technologies across functions.

About our research

We surveyed several thousand supply chain professionals with responses mostly evenly divided across industries. For this survey, of the total sample set, 58% was valid and retained for further analysis. The representative sample comprises companies who are planning to re-imagine supply chains digitally as well as those who have already modernized their supply chains. And, 37% of the respondents are from companies with annual revenues over $5 billion, 25% respondents represent companies with annual revenues of $1 billion–$5 billion, and the remaining 38% respondents represent companies with annual revenues below $1 billion.

Supply chain planning, inventory management, sales and operations planning, supply chain visibility, and demand planning represent the top five scopes of responsibilities of respondents. And, 60% of the survey respondents represent senior leadership positions (either vice presidents, senior directors, chairman, CEOs, or presidents) while 40% represent managers, internal consultants, and other junior staff members.

A Gartner survey of supply chain professionals on manufacturing metrics reveals big expectations for the value that improved usage of manufacturing metrics is expected to bring in the next two years. This research offers supply chain and manufacturing leaders insight into the current state of manufacturing metrics.

METRICS

By John Johnson, Simon F. Jacobson and Debra J. Hofman

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OVER THE YEARS, measuring manufacturing performance has been an ongoing challenge for companies. Plants have operated in isolation, disconnected from the supply chain, or have employed metrics that are diametrically opposed to the end goals of the business, such as choosing to focus on efficiency and uptime when flexibility is required.

Isolation and disconnection is no longer acceptable in today's global economy. The growth in product portfolios and the expansion of supply networks to reach more markets puts a strong focus on the need to have reliable and integrated manufacturing processes and measure them as part of the end-to-end supply chain. The question is: What are the metrics and alignment best practices that are driving manufacturing excellence today?

In 2015, Gartner conducted a survey in conjunction with *Supply Chain Management Review* (*SCMR*) to address that question and to gain a better understanding of how manufacturing metrics are characterized, developed, and used to link manufacturing and supply chain performance.

Our most important takeaway: The survey reveals that manufacturers have big expectations for the value that improved usage of manufacturing metrics can bring over the next two years. The results also offer supply chain and manufacturing

C S THAT C O U N T

leaders insight into the current state of manufacturing metrics.

Adding value today, and an ambitious future ahead

Today's manufacturing operations must deal with complex product portfolios and even more complex supply networks. They must also cope with differences in manufacturing styles and strategies. This raises the need for identifying and deploying a common set of metrics to track manufacturing's performance. Figure 1 shows that improved responsiveness, quality and schedule adherence as well as capacity utilization are where supply chain professionals are most likely to expect to drive value from the use of manufacturing metrics today. Although improved supplier quality and/or asset reliability are not as commonly used, they are nonetheless still crucial to measuring manufacturing performance.

Improving the responsiveness and speed at which manufacturing can meet demand is top of mind for all respondents. However, survey data suggests that different supply chain roles surveyed have varying perceptions of the value that manufacturing metrics can drive.

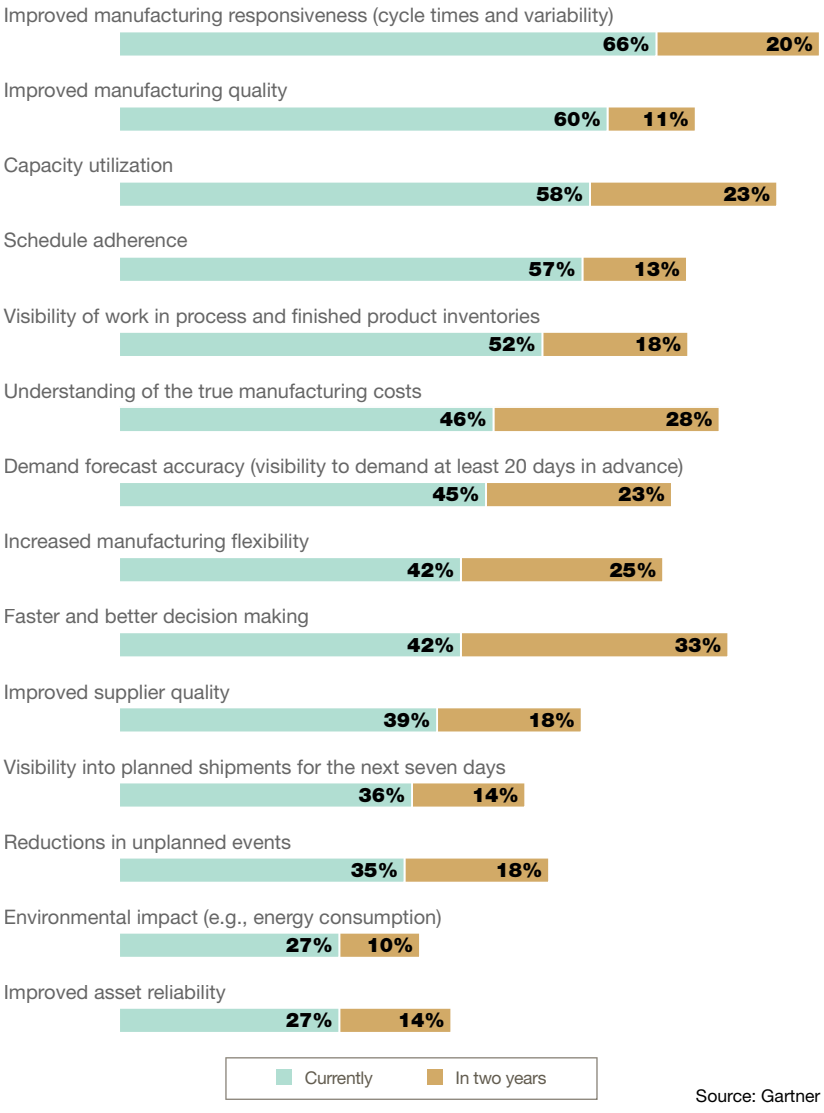
Manufacturing respondents place the highest focus on responsiveness, quality and flexibility—the latter two, while designed into the supply chain, often fall on manufacturing to execute.

Supply chain strategy roles focus on capacity utilization and manufacturing responsiveness.

FIGURE 1

Where manufacturing metrics drive value today and over the next two years

In which areas is your organization planning to drive business value from the use of manufacturing metrics currently and over the next two years? (percentage of respondents)



Source: Gartner

In a research study across *Supply Chain Management Review* readers, Gartner asked manufacturers just what metrics they are using to manage and transform their manufacturing operations.

Other functional supply chain roles (e.g., plan, source, deliver) see value in those metrics that help them to better understand how manufacturing processes and performance will affect their own performance. These metrics include visibility of work in process (WIP) and finished goods inventories, schedule adherence and demand forecast accuracy.

Although one-third of respondents aspire to use manufacturing metrics to drive value through faster and better decision making in two years, Figure 2 shows which individual manufacturing metrics are expected to deliver top value in two years—and paints a slightly different picture.

The equal importance of cost and responsiveness (service levels) highlights the same trade-off that many manufacturers grapple with today. Also, while flexibility is important—either as an enabler of responsiveness or of cost reduction—it's the high reliability on demand forecast accuracy, ahead of quality or asset reliability, that matters. The changes in demand at the supply chain level can have a ripple effect down to granular, unit-operations levels and affect individual cycle times and quality levels.

Demand forecast accuracy affects the allocation, planning and forecasting of available capacity and resources (e.g., material and human) and only 5% of the manufacturing respondents view it as a top metric, choosing cost, flexibility and responsiveness instead.

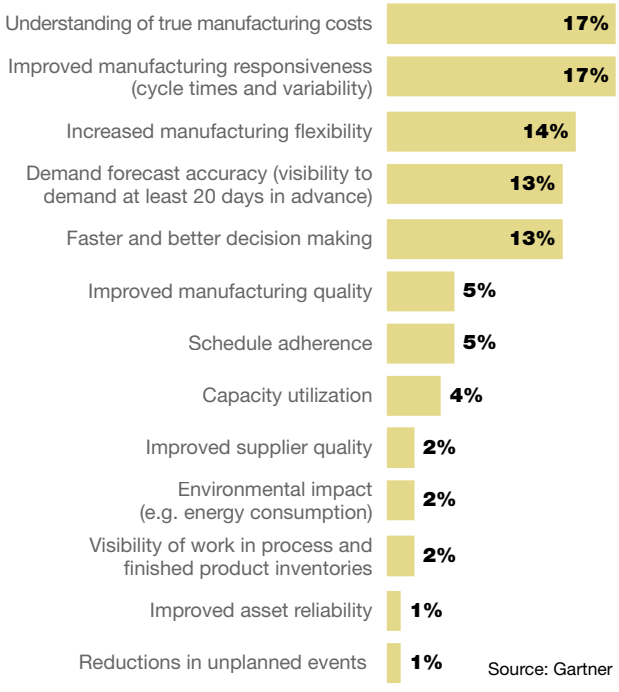
Take-away: Gartner believes that, despite the ambition to improve how manufacturing performance is measured, most manufacturers are not prepared to benefit from the expected gains two years from now.

Indeed, 59% of respondents reported

FIGURE 2

Which manufacturing metrics will deliver top value in two years

Which of these do you believe will drive the greatest business value from the use of manufacturing metrics over the next two years? (percentage of respondents)



Source: Gartner

FIGURE 3

Measuring manufacturing's performance today

To what extent do you agree with the the following relating to the measurement of manufacturing performance within your organization? (Average mean rating using a scale where **1 means strongly disagree** and **7 means strongly agree**).

Source: Gartner

that their manufacturing operations are not directly under their supply chain organization's scope of control. Yet, to derive the most value from using manufacturing metrics, an understanding of manufacturing's touchpoints with those metrics used to measure the overall health of the supply chain is needed. This is why the 41% of respondents that reported their manufacturing operations falling directly under the supply chain organization's scope of control are able to prioritize faster and better decision making above all other options.

Manufacturing operations are more closely tied to demand-facing activities. By the nature of this integration, not only are any improvements in responsiveness, cost improvement and flexibility in manufacturing operations made in a timely fashion—but they are done so in a way that doesn't negatively affect overall supply chain performance.

About our research

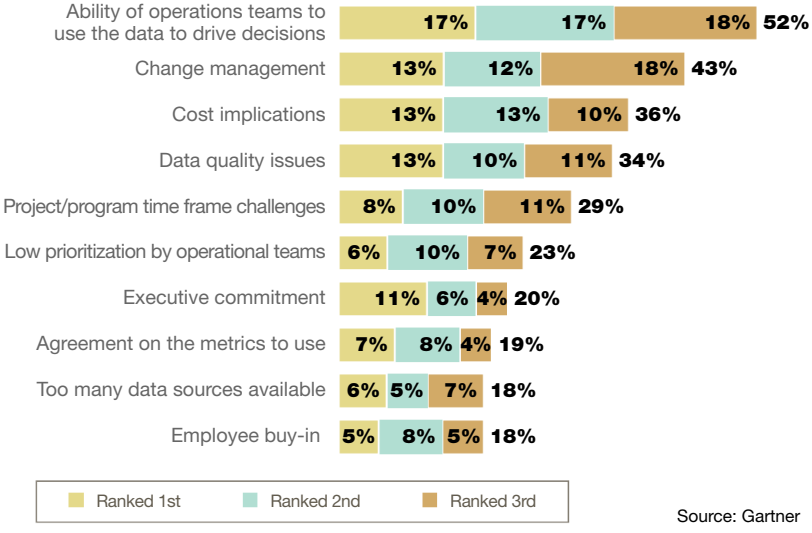
This article was based on a survey of 83 qualified supply chain professionals at manufacturing organizations conducted between April 27 and May 21, 2015. The survey sought to gain an understanding of what organizations measure at three levels: the design of the supply chain, the development and orchestration of manufacturing strategy, and the execution of metrics locally at the factory. The goal was to uncover the metrics and alignment best practices that drive manufacturing excellence.

The survey was developed collaboratively by a team of Gartner analysts who follow these IT markets and was reviewed, tested and administered by Gartner's Research Data and Analytics team. Interviews were conducted online with the readership of *Supply Chain Management Review*. Qualified participants hold positions or job roles tied to manufacturing operations and supply chain activities (e.g., planning, sourcing, logistics, customer service and strategy).

FIGURE 4

Top challenges to using manufacturing metrics

What are the top three challenges your organization faces in the use of manufacturing performance metrics to drive operational decisions? (percentage of respondents)



Source: Gartner

Value is in the data

The most critical enabler to success with manufacturing metrics will be the ability to make faster and improved decisions, which requires improving information access and availability. Throughout the survey, respondents showed concerns about the ability to access and use granular, operational data and improve performance using manufacturing metrics.

The trends displayed in Figure 3, which shows the extent to which respondents agree with their organization's usage of manufacturing metrics, acknowledge the improvement and usage of manufacturing metrics in the past five years. Respondents report that metrics initiatives are highly prioritized and that visibility into manufacturing performance is acknowledged as critical to measuring manufacturing contribution to supply chain performance.

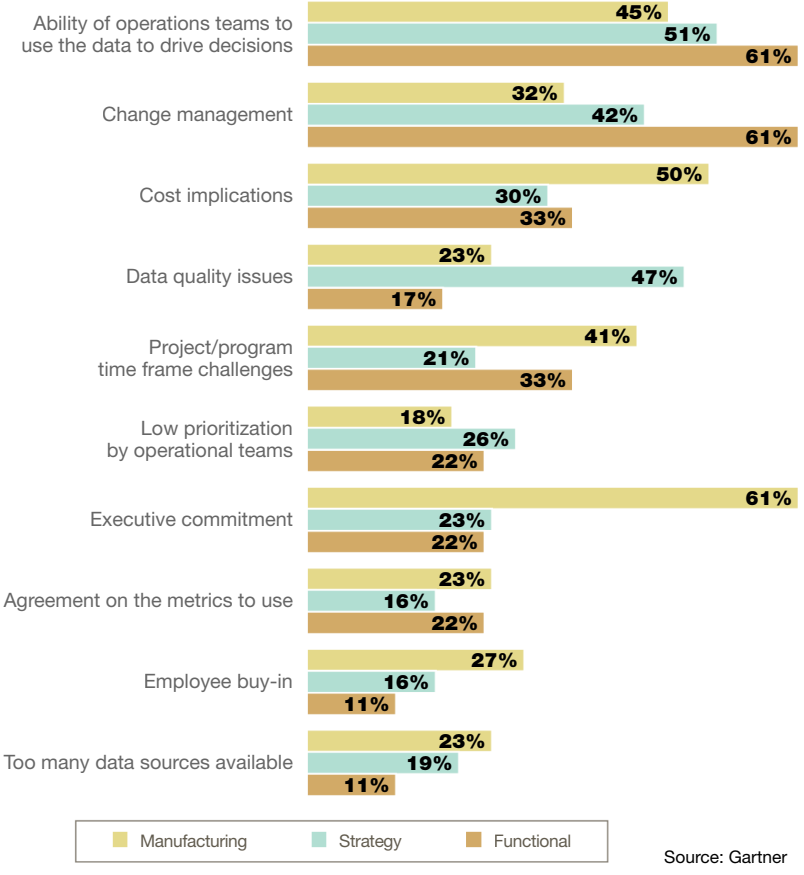
Figure 3 also shows uncertainty (and potential distrust) of whether or not manufacturing data is timely and used to its full potential—something that can impede the long-term value that improving the use of manufacturing metrics offers. A large percentage of plant-level data goes unused, and several Gartner clients are refining their technology roadmaps to improve how factory data is captured and leveraged—assuming that the portfolio of manufacturing metrics is agreed upon and defined. Even when the data and information is available, questions about the ability of operations teams to use data to drive decisions remain. Figure 4 shows the challenges in using manufacturing metrics.

While change management is a constant concern of all respondents,

FIGURE 5

Top three challenges to using manufacturing metrics by role

What are the top three challenges your organization faces in the use of manufacturing performance metrics to drive operational decisions? (percentage of respondents)



Source: Gartner

the different challenges by role, which are shown in Figure 5, illustrate potentially misaligned priorities around manufacturing metrics.

Supply chain strategy-oriented roles are more concerned about data quality and whether the data will be used to make improved (or informed) decisions than how much these initiatives can cost. Manufacturing respondents reported concerns on data usage too—in addition to challenges of cost, time frame and change management that accompany any manufacturing-specific, improvement-oriented initiative.

There is no shortage of manufacturing data, but a lack of context and accessibility must be overcome to improve the access and usage of manufacturing data.

Not to be overlooked are how these challenges are viewed by supply chain functions that were most concerned with change management and data usage. This is reflective of how manufacturing processes can affect other supply chain functions' ability to successfully execute. Aside from asking about the right metrics to use and how to drive agreement and alignment on those measures, the relatively low prioritization of employee engagement is another concern revealed in the survey and reinforced by what we hear from clients. If metrics are to enable faster and better decisions, engaging front line employees is critical.

Take-away: The major challenge when it comes to refining manufacturing strategies is the identification, deployment and analysis of common metrics that will drive end-to-end performance. A second is providing all stakeholders the information they need to make informed decisions.

There is no shortage of manufacturing data, but a lack of context and accessibility must be overcome to improve the access and usage of manufacturing data. More tactically, they must be overcome to address change management barriers, and develop joint ownership between IT, OT, and lines of business to define and broaden the use of analytics in the manufacturing network. This will ease the change management burden.

Going forward, all of this will require a common vision and understanding of the business goals and process capabilities necessary to balance global supply chain orchestration with local execution and plant operating strategies.

Findings and recommendations

The Gartner survey revealed several key findings and recommendations for manufacturers focused on improving their metrics and performance.

Key findings

In the next two years, manufacturers vow to improve the usage of manufacturing metrics. They strive to better understand manufacturing costs, improve responsiveness and flexibility, and make better and faster decisions.

Measuring manufacturing performance is a key priority, but there are concerns about what is measured, data accuracy and whether the data on hand is used to its full potential.

The primary challenges to improving operational decisions with manufacturing performance metrics is the ability of operations teams to use metrics data to drive decisions and ongoing change management issues.

Recommendations

Identify which manufacturing metrics will be foundational to driving significant improvement in manufacturing's performance and outcomes over the next two years. Use Gartner's Hierarchy of Manufacturing Metrics as a starting point.

Avoid measuring manufacturing's performance in isolation by analyzing the interdependencies and touchpoints with those metrics used to measure the overall health of the supply chain. This will drive a deeper understanding of costs and fuel the intended gains in responsiveness and flexibility.

Improve how data is used to drive decisions by identifying the necessary data sources for manufacturing metrics to be calculated from. Apply analytics to calculate the metrics and present them in role-specific context so the right actions are taken.

It's fair to say that no country has had as much impact on global supply chain management over the last 30 years as China has. As Larry Lapide wrote in the January 2016 issue of *SCMR*, low fuel prices in the 1980s helped create a "long supply chain" that stretched from Long Beach to Asia. "Companies altered their networks to embrace the integration and globalization of supply chains, leveraging cheap oil to minimize costs and inventories…Speeding up supply chains was the mantra followed to maintain customer response."

China's impact on global business continues to be felt today. While there is some talk of moving manufacturing closer to the point of demand, large manufacturing companies have identified supply management, and the need to continue to reduce the cost of parts, components and commodities, as a priority. That bodes well for low-cost countries with a developed manufacturing infrastructure like China. At the same time, we have all watched the stock market—and our 401(k)s—drop in value in recent months over concerns that China's growth, along with its demand for commodities and raw materials, is on the wane.

Less noticed is the investments China is making to sustain its growth in emerging markets such as Africa, India, and Latin America—and its attempts to acquire industry leaders in the United States and Europe. Just last month, China National Chemical Corp. bid $43 billion to acquire Syngenta AG, the Swiss pesticide and seed giant.

What does it all mean? That's the question posed in the following two essays.

—Bob Trebilcock, editorial director

GLOBALIZATION: China style

By Todd Taylor and Thomas Choi

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The world has turned to China for low-cost labor, ample production and cheap goods for the last three decades. Now, the world's second largest economy is looking to the world for sustained growth.

For years, globalization was synonymous with doing business in China. Foreign companies set up shop to take advantage of low-cost supply and manufacturing and to gain access to the China market. As globalization reached China, we witnessed the birth of China Inc.

Now, there are early signs that the tables are turning. We predict that in the coming years, globalization will be defined by Chinese businesses reaching out to the rest of the world and moving their manufacturing might beyond China's borders. "Made in China" will give way to "Made by China," as much of the value adding work will be done in global market places, closer to its customers.

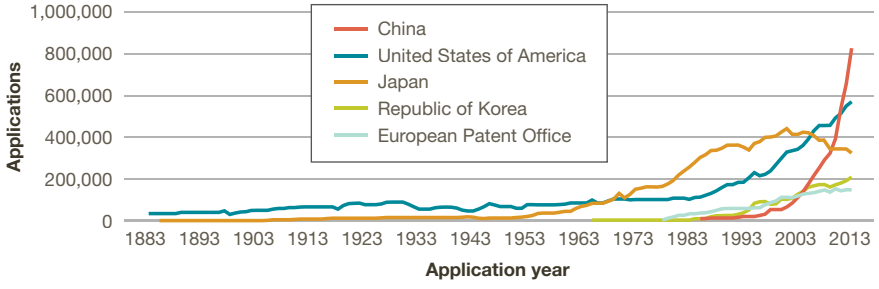
A perfect storm is brewing in the convergence of President Xi's market-driven economic approach, China's history of entrepreneurialism and innovation, and a shrinking Chinese economy. As a result, we believe that global supply chains will also undergo dramatic changes.

China's continued move to a market-driven economy

President Xi and Premier Li are pushing China toward a market-driven economy following Deng Xiaoping's philosophy. That position was reaffirmed in March 2015 and again at the World Economic Forum in Dalian in September.

FIGURE 1

Trends in patent applications



Source: IP Watch

But there is tension between those who support a market-driven economy and the traditional Communist party, especially among party members whose fringe benefits stem from their government posts. To that end, President Xi has launched an aggressive anti-corruption campaign.

Those tensions were highlighted on the heels of the World Economic Forum, when China unveiled its plans to restructure its State Owned Enterprises (SOEs). Many executives of these SOEs gained their posts because of their position in the party or through their relationships. This announcement put these party representatives and managers on notice that their world could be changing. And, it began to level the economic playing field and re-ignite a spirit of innovation and entrepreneurialism.

Chinese entrepreneurial roots and real innovation

In fact, given that China has been manufacturing other companies' designs, it's easy to forget that China has a long history of innovation. Consider that paper, printing, gunpowder and the compass were all invented in China. Or, as author Robert Temple wrote: "Possibly more than half of the basic inventions and discoveries upon which the 'modern world' rests come from China."

Although, the Cultural Revolution snuffed out much of this spirit, President Xi and Premier Li are fanning the entrepreneurial flames and furthering Deng Xiaoping's moves to a market-driven economy. Today, the people of China's cities and rural hinterlands crave opportunities to start and run their own businesses.

These new entrepreneurs are still often dissuaded by lingering red tape, politicking and the lack of a fair playing field. But if Preside Xi can maintain his popularity through continued economic adjustments and corrections that coincide with a market economy, innovation and entrepreneurialism will flourish again.

In fact, many Chinese are already innovating at a higher rate than companies from other countries, even as they lose some of their past cost of labor advantage. As Figure 1 indicates, China's percentage increase in patent applications is leading the world. Moreover, despite a reputation for shoddy work, Chinese businesses are producing products with increasingly better quality and are gaining more market share than their competitors.

Driving these moves is growth, or, the lack thereof. From 1989 until 2015, China's GDP growth averaged 10.88%. That 25 years of incredible economic expansion included the 3rd quarter of 1995, when GDP growth was 105%.

The story is very different today. Growth is slower than 7% (Figure 2). These "unchartered waters" are cause for concern amongst even the older and most resilient Chinese citizens. It is also cause for political anxiety for President Xi, Premier Li and their associates.

This shrinking economy will cause Chinese businesses to move even more aggressively to overseas markets. As Figure 3 indicates, international investment from Chinese multi-national corporations is expected to set new records and reach $110 billion for 2015.

Impacts on the global supply chain landscape

With the accelerated international growth of Chinese companies, we will see many changes to the global supply chain landscape. For instance, Chinese businesses are already creating major hubs to serve foreign customers.

Enter DragonMart, a nearly 2 million square foot complex in Dubai, and PhoenixMart, a 1.5 million square foot complex scheduled to open in late 2016 in Arizona. Both are combining their physical presences with online marketplaces to facilitate configuration, pricing, quoting, and ordering of materials, components, and products from Chinese manufacturers.

These hubs are a prime example of Chinese companies moving closer and closer to their customers. We expect to see sourcing, manufacturing, configuration, assembly, service and support moving from centralized locations in China to global locations that are closer to demand around the world.

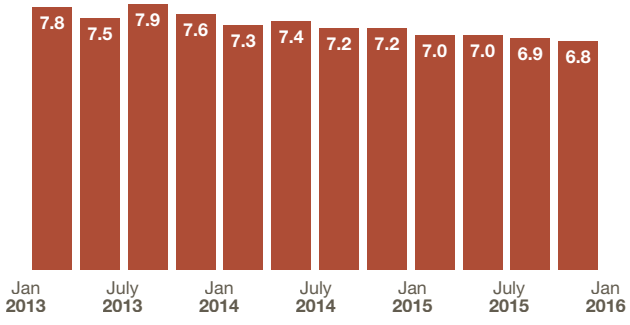
Also of note is the growing awareness among savvy Chinese business executives that operational excellence is required if they are going to compete and win in global markets. Operations executives working in these corporations understand the profit leverage effect that comes from reducing the amount of inventory in the supply chain, and conceptually know the value of operational efficiency. They realize that the centralized, Made in China model encouraged for so many years by the Communist party will not provide the responsiveness and efficiency needed to compete in a global marketplace. More importantly, they realize the quality of their product is paramount. They face some Communist party inhibitors, but they are advancing toward globally optimized networks, safety stock, sourcing, manufacturing, product portfolios and risk profiles. They are evaluating and using the latest in modeling and analytics tools to achieve efficiencies and they know they have to continue to move their capabilities closer to their customers in foreign countries.

Some companies should be excited, as the growth of these Chinese businesses represents a great opportunity. Still others around the world should be shaking in fear. On the plus side of the ledger, China's global expansion will be a boon for some local materials suppliers and contract manufacturers who have sourcing, manufacturing, and assembly capacity close to China's areas of demand. Job seekers will benefit as these Chinese businesses hire more and more local talent, especially those who have some familiarity with Mandarin.

At the same time, competitors in industries targeted by China will lose market share to the Chinese multinational corporations. This will be especially challenging for publicly traded companies that have difficulty thinking beyond a given quarter, while their new Chinese competitors think, and methodically act, upon three-to-five year plans and five-to-10 year plans.

FIGURE 2

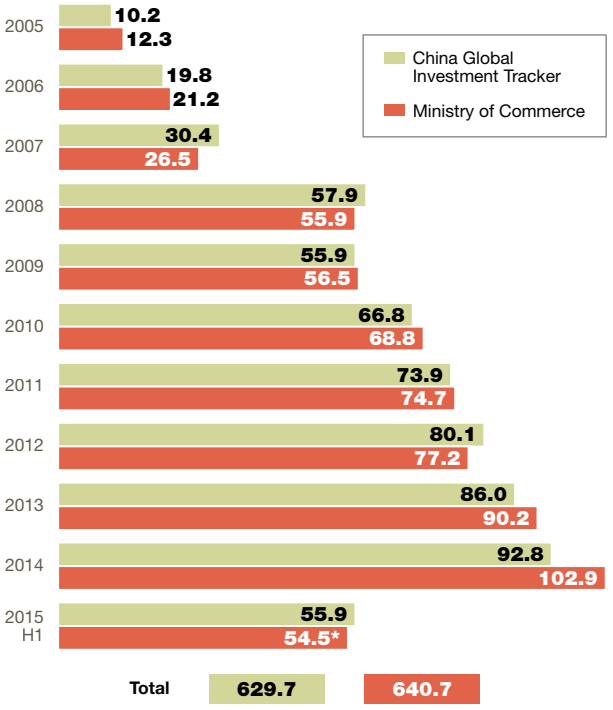
China GDP annual growth rates



Source: tradingeconomics.com, National Bureau of Statistics of China

FIGURE 3

China global investment



Note: *Extrapolated from official figure for January-May

Source: American Enterprise Institute and Heritage Foundation, China Global Investment Tracker, July 2015

A perfect storm

President Xi's ability to further level the playing field rather than provide a sanctuary for the Chinese political elite will be a key to the success of these Chinese businesses and

China's economy in general. Indeed, by all indications, the field is leveling, but President Xi's enemies in the party, SOEs (state owned enterprises), and regional governments are still able to exploit favoritism and manipulate the system to their benefit. Further enhancements to the legal system are the primary ingredient needed to continue this progress.

For now, all signs point to the Chinese government continuing on its current path to this more open economy. And, as long as Chinese businesses continue their path of entrepreneurialism, real innovation, and operational excellence, they will surprise the rest of the world—again.

China's passage to prosperity

To understand China's global ambitions, look no further than the proposed Grand Canal in Nicaragua and what it may mean for global shipping.

By V.G.Venkatesh and Ved Srinivas

Known as the Middle Kingdom because it sits in the middle of the world, surrounded by natural barriers such as the Himalayas, the Gobi Desert, and the Pacific Ocean, China has always been somewhat isolated from the rest of the world. A scan of today's headlines demonstrates how that is changing. From a $50 billion investment to overhaul Brazil's aging infrastructure to an agreement to expand trade with Iran by $600 billion over the next 10 years, to a plan to invest $47 billion over five years in the chip industry, China Inc. clearly intends to take a role on the world stage—especially in emerging and developing economies.

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Those ambitions aren't limited to infrastructure, trade, and a focus on specific verticals like the chip industry. With a $50 billion deal between Hong Kong Nicaragua Canal Development (HKND) and the government of Nicaragua to build the Grand Canal, China Inc. is looking to make its mark on global logistics. The competitive advantage of the new 173-mile canal (when—and if—it becomes operational) will be its ability to accommodate ships of up to 23,000 twenty-foot equivalent units (TEU), far larger than the 13,000 TEU ships that can be handled by the expanded Panama Canal. What's more, the new canal could count on goods produced by China Inc. as one of its leading customers. While the proposed start date for construction has been pushed back to late 2016, HKND has stated that it will complete the project in 2019.

Without question the project has skeptics and critics. Many logistics professionals question the feasibility of the project as well as whether there is enough demand to support the operation of the canal if it ever becomes a reality. However, the establishment of a new shipping route that will cut as much as 7,000 miles off of the trip from Asia to ports on the East Coast of the United States could have a significant impact on the transit time of vessels and logistics costs. After all, global shipping has been affected in the past by the closure of the Suez Canal for eight years during the Arab-Israeli conflicts, technical glitches faced by Panama Canal locks in the early 1990s, and the temporary closure of the Kiel Canal in 2013. Each had significant impacts on global transportation.

For reasons such as those, countries with advantageous marine routes are attempting to establish or modify existing marine shipping routes to boost their economies. Along with the Nicaraguan Canal, the proposed Kra Canal project in Thailand, which also involves China, would connect the Indian Ocean and the South China Sea and allow shipping traffic to bypass the Strait of Malacca.

Before any of these projects will see the light of day, they will have to overcome local opposition and environmental concerns, and they will require heavy investments. While

construction of the Grand Canal from Nicaragua is anything but assured, if it goes forward, it could have strategic, socio-economic, and geo-political implications for China, Nicaragua and the community of shippers. What follows is our analysis of the potential implications of a new canal, based on available information.

A new strategy

Governments and private enterprise have proposed building a canal across Nicaragua since the 19th century. The country not only sits between the Pacific and Atlantic Oceans, it has the natural advantage of a large freshwater lake and river between the two oceans, Lake Nicaragua and the San Juan River. Had a canal been built in Nicaragua rather than Panama, the fortunes of both countries might be very different today.

While the concept lay dormant for decades following the construction of the Panama Canal, interest in the Grand Canal was reignited at the beginning of the 21st century, with HKND winning the bid to develop and operate the canal. Among other things, the deal gives HKND the right to operate the canal for 50 years, renewable for another 50 years, utilizing a Build, Operate and Transfer (BOT) model. Nicaragua will reportedly receive a 1% stake in the project after year one, plus a 10% increase in ownership each decade. Additionally, Nicaragua will receive $100 million in 10 annual payments.

The canal's biggest competitive advantage is that it is designed to handle ships with 23,000 TEU capacity, like the Triple E ships from Maersk. While experts question whether there is enough traffic to support the project, the trend in the marine industry is to increase the size of cargo ships to gain economies of scale. That trend shows no signs of abating. While the United States has been largely silent on the project, the new route could increase the reliability of east-west shipments. For now, most logistics professionals have adopted a wait-and-see approach to new canal development projects, until they understand how well the new routes are received by shippers as well as the toll structures associated with these projects in comparison to alternatives.

For instance, the expected tolls in Nicaragua could be higher than the Panama Canal given the heavy investment costs, which poses a question of viability. Some observers have argued that the Chinese government will have a vested interest in supporting HKND to increase its long-term influence in Central America rather than to just focus on returns on investment from one quarter to the next.

- **Length:** 173 miles long
- **Depth:** Between 88 feet and 98 feet deep
- **Width:** Between 754 feel and 1,706 feet wide
- **Miles saved:** Between 5,000 miles and 7,000 miles from Asia to ports on the East Coast of the U.S.

Source: scientificamerican.com/La Voz SandInista

A new passageway

Nicaragua is located in Central America just north of Costa Rica, with which it also shares the San Juan River, and south of Honduras, which shares the Northern Border throughout—leaving it open entirely to the Pacific Ocean on the West and Atlantic Ocean and Caribbean Sea on its Eastern shore. The proposed canal would link the two seas, with the Brito Lock on the Pacific and the Camilo Lock near Punta Gorda on the Atlantic side. As it traverses the country, it will pass through Lake Nicaragua, one of two lakes located in the region.

Business activity generated by the canal would certainly be an indirect benefit for the economy of Nicaragua. Indeed, the waterway has the potential to transform Nicaragua into a major shipping hub, illustrated by HKND's plans to develop the ports at both entrance points and support the development of Free Trade Zones (FTZs) along the canal's path. Those developments would surely improve the standing of a country aiming to extend its influence in the region.

Socio-economic development

Without question, the successful launch of the Grand Canal should lead to other socio-economic benefits for Nicaragua, and by extension to China. Income from fees for using the canal could be used by the government to invest in schools, healthcare facilities, and other projects that improve the overall standard of living for the average citizen. The construction and ongoing operation of the canal will create jobs in local communities, and wealth that can be invested to improve the country's manufacturing sector—something China Inc. should also be interested in supporting as it continues to invest in the "Made by China" strategy described earlier by Taylor and Choi.

A project as massive as the Grand Canal will affect migration patterns in the area. For one, the country can expect the arrival of talent from around the globe that can provide the expertise required to build something on this scale and to serve the burgeoning economy. That, in turn, will lead to a more cosmopolitan landscape. We have already seen that happen in other fast-growing, emerging economies such as the United Arab Emirates, which has benefited greatly from an expatriate population that moved to the region to support development. Just as important, the establishment of the canal will bring the culture of Nicaragua to the world stage. We note that, in our opinion, that did not happen in Panama. If the Chinese government is smart, it will allow Nicaragua to stake its own claim to fame in this project.

There are, of course, potential downsides from this kind of development. There will be vested interests that view immigration and new influences as a serious threat to Nicaragua's traditions. Similarly, environmentalists have already expressed concerns about the impact of the canal on Lake Nicaragua, the largest source of freshwater in the country. In our analysis, these concerns are overstated. The design of the locks offers a level of protection to prevent the fresh water lake from becoming overly brackish. Moreover, Lake Nicaragua is already threatened by the discharge of effluents by surrounding cities and Lake Managua, which is located near Nicaragua's capital city and is the most polluted lake in the region. We note that Lake Managua already sends effluents to Lake Nicaragua via the San Juan River. Still, environmental concerns present a significant hurdle.

China's geopolitical ambition

What about China? Without question, the canal represents a big gamble. However, it is a calculated gamble that can go a long way to further China's strategic interest in gaining a foothold in Central America. Moreover, a successful project could bode well for China Inc.'s goal of becoming a supplier of finished goods manufactured closer to markets in North, South and Central America. The Grand Canal would allow China to transport raw materials from Asia and Africa (where it has already set up shop) to new manufacturing facilities in Nicaragua, and North and South America. In turn, local manufacturing aids the economic development of Nicaragua and provides gainful employment to its citizens as the country becomes a major contributor of mass production meant for the trade and consumption for "pole to pole" American markets.

What then does this all mean? China's new found confidence is vital if the world's largest populated country is to sustain its economy. While its foray into interoceanic canal building may seem new, China has already proved its mettle by tackling high-speed rail, highway, and other infrastructure projects throughout the globe, including Africa.

The new world order emerging from projects such as this could very well lead to a transformed geopolitical reality. If successful and combined with the Panama Canal, Central America could transform its image from that of a collection of third world counties to one of dominance in global shipping.

This new equation will help China forge a strategic alliance with the Central American region that gives rise to the vision for the 21st century envisaged by Chinese planners. With it, the Middle Kingdom may truly overcome its natural barriers and find a passage to prosperity.

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A formidable competitor

Chinese manufacturers are evolving, not fading. Western competitors have no time to waste.

Patrick Van den Bossche

China rose from an underdeveloped backwater to an industrial juggernaut on the strength of its vast pool of low-wage workers. Labor cost advantages enabled Chinese manufacturers to take over industries ranging from consumer electronics to machine tools. But cracks have begun to appear in this model. China's official manufacturing purchasing-managers index (PMI) fell to a three-year low last summer, dropping into contraction territory for the first time in six months. The stock market tumble earlier this year seemed to indicate further disarray.

Behind the numbers are indeed signs that China's cost advantages are starting to slip. While wages in China remain well below those of western countries, manufacturers find far lower labor costs in Vietnam, Myanmar, Indonesia, Bangladesh, and even India. At the same time, high staff turnover undermines productivity in Chinese factories. In high-tech for example, many original device manufacturers (ODMs) suffer turnover rates of 15% to 20% per month. High turnover reflects a tightening labor supply in a country where demographics favored employers for the past several decades. That is changing, with the number of available workers expected to fall from a peak of 915 million today to 890 million in 2025.

Bloated cost structures and inefficient manufacturing processes take another bite out of productivity. Chinese manufacturers are up to 70% less efficient than Western counterparts in indirect functions such as materials handling and quality assurance. Raw materials conversion rates also lag global norms: A Chinese steelmaker uses three times as much water and twice as much energy to produce a ton of steel than more efficient manufacturers in Germany.

Together, these cost headwinds have pushed China's Producer Price Index up nearly threefold since 2000, a faster rise than Western countries have seen, and a sign that most Chinese companies have not been able to raise productivity enough to cover cost increases.

Moving beyond low-end manufacturing

While these cost headwinds have hurt some Chinese manufacturers—particularly state-owned enterprises in commoditized industries—they do not spell defeat for the country's manufacturing sector as a whole. Private Chinese companies retain significant advantages, not least of which are the resiliency and competitive spirit of their people. China benefits from an established industrial ecosystem comprising myriad integrated supplier networks, supported by strong education in science and technology. Lower-wage countries generally lack these attributes, putting them at a disadvantage to China in many manufacturing sectors. So, for the foreseeable future, China will continue to produce most of the world's shoes, mobile phones, and hair dryers. Even as it loses share in low-value categories such as apparel, China is gaining ground in many export segments.

Although some manufacturers have been shifting low value production to countries such as Vietnam, Myanmar and Bangladesh, a closer look at this "flight from China" phenomenon shows that it is more limited than it appears. Some manufacturers are building new factories elsewhere, but they're not shuttering Chinese plants in bunches. Only a few, usually in low-value sectors, have been reduced to "zombie" status.

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Most factories in China have at least 20 years of useful life left, and many are increasingly being upgraded with new technology and equipment.

Far more significant than the so-called flight from China is China's flight forward away from low-end manufacturing, where low costs are critical to profitability. Chinese manufacturers are moving up into segments where profits flow from high-value product features that command higher selling prices.

Chinese manufacturers move west

As Chinese manufacturers target higher-value, higher-margin products, they need advanced technical skills and innovation capabilities that are more abundant in western markets. That's one reason why many are setting up shop abroad, particularly in the United States. Local authorities often help offset higher U.S. wages by offering generous subsidies to manufacturers.

Yarn manufacturers from China and other Asian countries, for example, have opened highly automated plants in the United States that require far less labor than traditional yarn factories. The U.S. operations produce high-quality fabric that's shipped back to Asia for the labor-intensive steps of cutting and sewing cloth into apparel. Some Asian apparel makers perform the latter operations in Mexico, so they can ship finished goods back into the United States without paying the costly duties levied on Asian imports. Chinese companies in a range of industries are making similar moves to tap American engineering skills and manufacturing know-how while expanding in U.S. markets.

In the future, any U.S. manufacturer operating in an industry where access to American technology, talent and markets creates a competitive advantage should expect a Chinese-owned factory to appear in the neighborhood. Of course, moving to the United States is not without risks. Tax credits and subsidies go only so far in offsetting the costs of operating in the country, which are growing even higher as the dollar strengthens. But Chinese manufacturers can always pack up and head home—taking along the strategic and technical skills they've acquired in the United States.

Competing with the new Chinese manufacturer

China's efforts to improve productivity and move beyond a fading position of strength in low-end production make clear its intention to become an even greater force in global manufacturing. However, western companies have levers to pull, too. Three critical steps will prepare them to compete.

Create a flexible footprint. With global currencies, labor rates, and energy costs gyrating, it's time for manufacturers to reassess their own footprints, as well as those of their suppliers. These reviews should ensure that products with high labor or energy content are made in areas where those factor costs are lowest. Even within China, costs can vary significantly from region to region, a fact not lost on Chinese manufacturers. More important, however, is building in the flexibility to adjust your footprint in response to future global movements and cost fluctuations. In addition to traditional network optimization techniques, this requires strategic scenario planning that tests the proposed footprint under various cost and currency scenarios, and under different timelines to identify potential tipping points.

Upgrade Chinese plants. If your Chinese plants are not merely low-cost manufacturing hubs, but strategic assets that serve the domestic or regional market, they'll need an operational upgrade through Lean methods, smart automation or both. Turning factories accustomed to relying on cheap labor into highly productive operations requires a major cultural shift involving significant time and investment. Chinese plant managers will need more than a manual on how things are done elsewhere in the world. They'll need focused training, curriculum upgrades, and the assistance of experts from other parts of the world. To maximize efficiency throughout the supply chain, leading companies are not only addressing their own China plants, but also helping their strategic suppliers make the leap.

Keep innovating aggressively. Despite their reputation for low-cost manufacturing of products pioneered elsewhere, Chinese companies across a variety of industries are showing innovative flair. From now on, western manufacturers will have to work harder to stay on the cutting edge. Especially in high-end markets, rapid product development will be essential to meet the rising Chinese challenge. Understand that Chinese manufacturers are no longer content to make "the cheap stuff," and objectively assess the areas where you can maintain an advantage. A "ruthless competitor" assessment will provide valuable perspective on what a new Chinese rival could do starting from scratch in your industry.

China manufacturing 2.0

Western manufacturers should resist the temptation to write off Chinese competitors buffeted by temporary headwinds. Chinese manufacturers are evolving, not fading. Even as they lose ground in low-end sectors, they're moving up the value chain, and moving beyond domestic markets. China has a plan to close the productivity gap, centered on a better-educated work force, high-tech manufacturing, and a worldwide search for advanced know-how. As their capabilities grow, Chinese manufacturers will challenge western rivals in new ways. Competitors who make the right adjustments and investments can meet the challenge of China Manufacturing 2.0.

U.S. Ports Update:

A matter of scale

While the expanded Panama Canal will be able to handle larger vessels, the next generation of mega-ships must be deployed on all-water routes. However, the nation's premier ports will still have to compete by providing customized service—no matter how much volume steams in.

The era of the "mega-vessel" was ushered in last month for U.S. shippers as the world's largest carriers called on deep-water West Coast ports. The San Pedro Bay gateways of Los Angeles and Long Beach will attract most of the initial calls, but the Port of Oakland is also a key destination. Meanwhile, The Northwest Seaport Alliance—comprising Tacoma and Seattle—are moving toward "big-ship readiness."

Some East Coast and Gulf ports are capable of handling these vessels as well, but most are anticipating a surge of traffic through the expanded Panama Canal this spring. So, with everything getting

A SPECIAL SUPPLEMENT TO:
SUPPLY CHAIN MANAGEMENT REVIEW

By Patrick Burnson, Executive Editor

bigger, will economies of scale cease to matter? Experts we spoke with contend that ports can still compete by offering enhanced service and velocity regardless of size.

"The rapid emergence of mega-ships unhinged the ocean side of maritime supply chains from the land-side infrastructure," explains Jock O'Connell, international trade advisor at Beacon Economics. "The Panamanians failed to anticipate just how huge the newest generation of vessels would be. As a result, the Canal can handle carriers loaded with 5,000 containers to 8,000 containers, but many of the East Coast and Gulf Coast ports might be swamped by the sudden shift in deployments."

Compounding the impact of larger ships at West Coast ports were other moves by the shipping lines, O'Connell says. One involved how containers are loaded onto vessels at Asian ports. "Before, containers were sorted by final destination and then stowed aboard the ship," he says. "Now, loading has become more random, in effect shifting the responsibility for sorting containers to congested U.S. ports."

Solving that problem will require major alterations in port infrastructure and to the transportation systems serving the ports, maintains O'Connell. "It will also necessitate an unprecedented level of cooperation between public and private stakeholders with varying agendas, conflicting interests, and little history of harmonious relations," he adds.

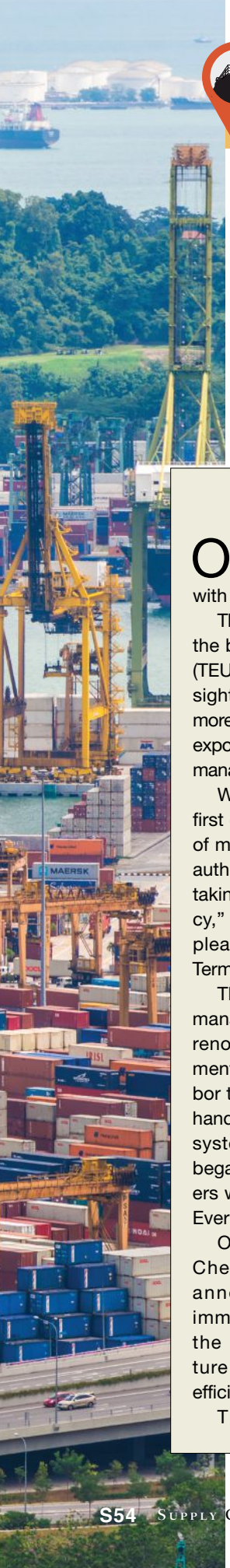
Christopher Koch, who just retired from a 15-year tenure as president and CEO of the World Shipping Council, agrees that last year's West Coast labor disruptions unquestionably gave the industry a black mark in the eyes of American exporters, importers and foreign buyers of American goods. The healing may have begun, he says, but the bruises linger.

"Shippers have asked Congress for legislation to mandate greater transparency in port operational metrics," says Koch. "They will want even more from the government if the employer/longshore labor collective bargaining process cannot figure out a way to address its issues without disrupting the American economy."

According to Koch, some shipper representatives have suggested that the Federal Maritime Commission (FMC) consider "doing something proactively," although there are few practical specific suggestions.

Furthermore, the FMC would face enormous challenges trying to tell industry participants how to sort out the cost implications of port operations and congestion.

"Improving port efficiency and throughput will require changes and investment," says Koch. "Systems engineering can identify how to improve cargo flows. It's not that the issues to improve throughput can't be identified or



addressed."

Koch adds that blaming big ships is too simple and does little to alter market dynamics. More importantly, it fails to recognize that America's supply chains are a string of interdependencies—all of which must be more closely examined.

Panama Canal update

The expansion of the Panama Canal will be the headline event in shipping in 2016. The $5 billion project promises to reorient the landscape of the logistics industry and alter the decision-making calculus of the shippers that the canal serves.

Three ports building for the future

Ocean cargo gateways on West, Gulf and East coasts are addressing infrastructure needs with customized solutions.

The Port of Oakland, which last month welcomed the behemoth 18,000 twenty-foot equivalent unit (TEU) mega-carrier Benjamin Franklin, has not lost sight of the need to improve its infrastructure for more conventional-sized vessels serving the region's exporters—nor have the independent operators who manage its terminals

When the Ben E. Nutter Terminal received its first container ship this year following two months of modernization to improve cargo handling, port authorities were quick to praise the move. "We're taking steps to improve performance and efficiency," says maritime director John Driscoll. "We're pleased that the management of Ben E. Nutter Terminal shares our desire to upgrade operations.

The Nutter terminal in Oakland's Outer Harbor is managed by Everport Terminal Services. It began renovations in November to complete improvements that include rebuilt entrance gates for harbor truckers; more than 100 new pieces of cargo-handling equipment; and a new terminal operating system. The terminal re-opened last month and began receiving export cargo and empty containers with the inbound call of the 1,100 TEU vessel Ever Liberal.

On the East Coast, Ports America Chesapeake and CSX Intermodal Terminals announced a new agreement designed to immediately enhance the competitiveness of the Port of Baltimore and position it to capture additional freight business through more efficient service.

The new agreement transfers operational responsibility for the intermodal container service at the port from CSX Intermodal Terminals to Ports America Chesapeake, consolidating management of the operation and enhancing service through Ports America's on-dock handling and operational expertise.

"With the expansion of the Panama Canal, we see tremendous growth opportunities at the Port of Baltimore," says Michael Hassing, president and CEO of Ports America. "Having direct on-dock access to rail service is a significant competitive differentiator for the Port of Baltimore, enhancing its attractiveness as one of only three East Coast ports equipped to handle super-post-Panamax ships."

In the Gulf, the Port of Houston Authority, which operates the Barbours Cut Container Terminal and Bayport Container Terminal (BCT), successfully completed its implementation of the Navis N4 terminal operating system.

These terminals handle about 67% of all containerized cargo in the Gulf, representing approximately two million TEUs annually between the two terminals. As part of a master-planned redevelopment, the port authority redeveloped more than 20 acres at Barbours Cut for container stacking and is currently in the process of commissioning four new "super" cranes on a newly renovated 1,300-foot segment of dock.

The expansion of the Panama Canal is expected to bring an influx of larger ships to the Gulf as well. In anticipation of the expansion, BCT is working to invest in the modernization of its terminal infrastructure to prepare for the expected increase in demand.

—Patrick Burnson, executive editor

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The expansion of the Panama Canal, which began in 2007 and was originally scheduled for completion in late 2014, is now expected to be finished "around the month of May," says Juan Carlos Varela, the president of Panama. Meanwhile, he is urging contractors and the Panama Canal Authority (ACP) to put aside their legal disputes for the time being in order to keep the project on schedule.

The president's message comes after an adjudication board ruled the ACP should pay Grupo Unidos por el Canal (GUPC), the construction consortium responsible for the project, $17 million to cover budget overruns and extra labor costs. The canal's widening to accommodate post-Panamax containerships with up to 13,000-TEUs of capacity, was initially expected to cost $5.3 billion, but reports suggest the actual budget for the project has far exceeded that figure.

Jorge Quijano, the chief executive officer and administrator of the ACP, says that the authority expects to conduct transit trial tests in April and inaugurate the expanded canal in the second quarter of 2016. The official commercial opening of the Panama Canal would follow shortly thereafter.

Volume shift

According to research conducted jointly by The Boston Consulting Group (BCG) and third-party logistics provider C.H. Robinson, as much as 10% of container traffic between East Asia and the United States could shift from West Coast ports to East Coast ports by the year 2020.

The report "Redrawing the Logistics Map" maintains that small percentages translate into big numbers in container traffic on high-volume lanes between East Asia and the United States.

This trade represents more than 40% of containers flowing into the United States. Rerouting 10% of that volume, therefore, is equivalent to building a new port roughly double the size of the ports in Savannah and Charleston.

Dustin Burke, partner and managing director for BCG in Chicago, says that this shift will have profound effects. "The larger ports on the West Coast will experience lower growth rates, altering the competitive balance between West Coast ports and East Coast ports," he says.

With global container flows rising, West Coast ports will still handle more containers than they do today, adds Burke. It will also shape the investment and routing decisions of rail and truck carriers, magnify the trade-offs that shippers make between the cost and the speed of transportation, and potentially alter the location of distribution centers.

"West Coast ports currently receive two-thirds of container flows from East Asia, with much of that cargo moving by rail and truck as far east as the Ohio River Valley, about three-quarters of the way across the United States," says Burke. "But once the big, efficient 'post-Panamax' container ships begin passing through the wider, deeper canal, the shipping dynamics will change."

For shipping to many destinations, using West Coast ports will still be the fastest option—but it won't necessarily be the cheapest. For price-sensitive cargo that is relatively expensive to move, routing shipments through East Coast ports to inland destinations will become more cost competitive and increasingly attractive.

"The most startling aspect of our study was the fact that there was so little consensus," says Burke. "Shippers still have questions about the gate charges that will be imposed by the Panama Canal Authority, and they also don't know how frequently the really big ships are going to be used in the trans-Pacific."

Those two big issues will have to be addressed before peak season preparations are made in late spring, add analysts at Datamyne (formerly Zepol), a global trade and intelligence provider. As the latest statistics clearly indicate, the volume through leading ocean cargo load centers in the United States is down significantly year-to-date, giving these mega-ports something they may not have planned for: mega-headaches.

—Patrick Burnson is executive editor of Supply Chain Management Review

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Innovative financing solutions for companies that want to pay the bills and stay cash flow positive in today's improving business environment

By Bridget McCrea, contributing editor

Creative Supplier Financing 101

NO ORGANIZATION likes to find itself in a tight spot, especially when the situation was created by a large customer order on one side and a substantial invoice from a supplier on the other. With the former demanding 90-day payment terms and the latter wanting to be paid within 30 days for the materials it supplied, it's the "middleman" that winds up feeling the squeeze.

"Suppliers want to get paid as soon as possible and buyers would rather wait and pay later," says Erik Wanberg, Wells Fargo Capital Finance's managing director. "There's kind of an ongoing conflict that starts once the goods change hands and the invoices are submitted for payment."

Options like accounts receivable factoring—where a company sells its accounts receivable to a third party (the "factor") at a discount—have been around for ages, but there are also some newer financing opportunities available. Strategies can

help companies fill financial gaps and maintain a positive cash flow without alienating customers or suppliers. In this article, we explore a few of the more popular choices, show how they are being used, discuss the role customers can play in the process, and explain the benefits of leveraging these financing opportunities.

Everyone is passing the buck

During a recent "Cash Flow for the Business: Understanding Payment Terms for the Good, the Bad, and the Ugly" workshop, Robert Handfield, a professor of supply chain management at North Carolina State University, discussed the problems associated with supplier payments. Using the example of a new, small supplier in the pharmaceutical industry, Handfield says many encounter working capital management issues in their eagerness to fill their order pipelines.

"When they see the lead time on most big pharma supplier payments, which span 90 days to 120 days, they are astonished," Handfield says. "However, they often don't want to disclose their challenges in managing working capital under these conditions, because they are afraid of losing face and thus losing the business." On the other side of the equation, customers are often unaware that there is a cash flow challenge associated with these long payment lead times.

"What many of these smaller suppliers don't realize is that their larger customers are dealing with their own payment delays with their own buyers," Handfield points out. "It's a vicious cycle. Everyone is passing the buck."

Improving the supply chain conveyor belt

There are solutions to mitigate the impact of that cycle. Over the last 10 to 15 years, companies have been improving the efficiency of their operations and optimizing the physical movement of goods. Using just-in-time inventory strategies, for example, shippers have tightened up the time it takes to receive, handle, and turnaround orders to their own customers. And while the efficiencies created by such actions are undeniable, this ongoing improvement of the "supply chain conveyor belt" can create problems on the financial front, says Wanberg.

"Within the realm of supply chain finance, there are always going to be hidden or embedded costs," he explains. "For example, buyers want to pay on timelines that align with their own inventory cycles. If a company has a 90-day inventory cycle, and is asked to pay invoices within 30 days, then it must be able to cover the resultant 59-day (give or take) gap. In most cases, companies have to use their own capital to fund that gap."

There are other alternatives. Wells Fargo Capital Finance, for one, offers funding based on the creditworthiness of the end buyer. By filling the role of paying agent, the institution pays suppliers on behalf of their customers, but within a shorter timeframe than stated on the original contract terms. Here's how it works: Once the customer receives the goods—and provided that customer's credit has been approved by the bank—Wells Fargo Capital Finance pays the invoice within a short timeframe (i.e., as quickly as a day or two, versus, say, 90 days) for a small fee.

An option like this puts cash in the company's bank account faster while also helping the firm more accurately anticipate its receivables. In other words, even 90-day terms don't always ensure that the customer will pay exactly within that timeframe, or the amount of the remittance (e.g., will discounts be applied? Were there any credit notes? Will the invoice be paid in full?). "Because we're the paying agent," says Wanberg, "we know to the penny exactly what the customer is going to pay."

Supporting expanded global footprints

Mark Robinson, vice president of global operations at UPS Capital in Atlanta, offers programs to UPS customers that are facing financial challenges within their own supply chains. Knowing that more and more of its customers source products globally, for example, the Capital Cargo Finance program from UPS extends credit lines of $300,000 to $1 million, and with terms of up to 75 days. Robinson says the program is especially useful for U.S.-based firms whose overseas operations *aren't* eligible for domestic financing or credit.

"It's very difficult to get reliable, affordable financing in countries like China," says Robinson, noting that U.S. firms are prohibited from using foreign collateral for bank

loans. With the UPS program, companies use the containers turned over to the transportation provider in Asia, for example, as collateral against the loans that they're applying for. In other words, UPS Capital issues a negotiable bill of lading once the inventory is loaded into an ocean or airfreight container.

So, if a shipper brings in 10 containers of goods per month from Asia and then stores the goods in its U.S.-based warehouse (for fulfillment at a later time), once those containers arrive on U.S. soil, the shipper can borrow against that inventory and begin selling it and shipping it to customers. This, in turn, shrinks the amount of time that the shipper has to finance the inventory on its own. "This allows companies to hold more inventory and fulfill more orders," says Robinson, "without having to use their own equity to do that."

The fact that supplier financing can be handled "behind the scenes" is particularly important in today's business environment, where many large organizations are still licking their wounds after the financial crisis of the late-2000s.

Helping your own suppliers

Having served as an outside supply chain consultant for various companies, Cathy A. Martin, president at Atlanta-based Martin Solutions, pinpoints access to capital as one of the biggest requirements—and challenging points—for small to mid-sized businesses. Larger shippers that rely on a broad network of suppliers to keep their own operations running should bear this in mind, says Martin, particularly in today's volatile business environment.

And while shortening payment terms from 180 days to a svelte 10 days may not be in the cards, there are other steps that buyers can take to make sure their valued suppliers stay viable and liquid. "Perhaps your company has an interest in helping smaller suppliers working for prime contractors get paid sooner rather than later so they too can continue to perform," explains Martin, who works with NOW Corp., a company that offers access to capital to both small- and medium-sized businesses. By pointing their own vendors to these types of programs, shippers can help their smaller suppliers cover the gaps between their own accounts payable and receivable.

A small supplier that's providing goods to a Tier 1 supplier, which, in turn, works for a prime contractor, may negotiate 30-day terms with that Tier 1 supplier. And while a month may sound like a workable payment timeframe in theory, that Tier 1 supplier winds up paying the bills within 45 to 60 days. Unable to ride out these unpredictable financial ebbs and flows, the small vendor can't pay its employees or its own bills on time.

By using supplier financing, the latter can get paid within two to three days, pay its obligations, and show a strong balance sheet even if its largest customers demand longer payment terms. "The best part is that it's transparent to the large customer (in this case, the prime contractor)," says Martin. "If you decide that a Tier 2 supplier could use [assistance] in this area, your prime contractor will have no idea about the financing support."

The fact that supplier financing can be handled "behind the scenes" is particularly important in today's business environment, where many large organizations are still licking their wounds after the financial crisis of the late-2000s. "Suppliers don't want their customers to know that they're having financial challenges at the risk of the buyer taking its business elsewhere," says Handfield. Using supplier financing like the program described by Wanberg earlier in this article, the smaller company can essentially "ride the coattails" of its larger (and in most cases, more credit-worthy) customers *without* having to go through the rigors of a credit check, financial analysis, or other fact-finding exercise. "The company basically gets a line of credit using the larger firm's credit rating," says Handfield, "and the supplier gains from working with an expanded population of smaller, more diverse vendors."

Pay attention to the signs

To companies interested in supplier financing, there are a few clear signs that the opportunity would be a good fit. For example, a supplier that's struggling with working capital issues (i.e., calling regularly to see when its invoices are going to be paid, or asking for cash on delivery) or one that's having a difficult time filling orders due to rapid expansion, could be a good candidate for this type of gap financing.

"When you start to see signs like this, it can be a good indicator that you're dealing with a vendor that has cash flow problems," says Handfield. "Supplier financing could be one way of helping them out."

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Global Procurement Trends

Q&A with **Chris O'Brien**, chief commercial officer, C.H. Robinson

Q: What key trends are we seeing in global procurement and outsourcing in 2016?

A: Right now, we're seeing more diverse services being bundled globally than we've ever seen in the past. Certain companies are taking advantage of a more global approach to procurement. They feel like they've removed a lot of expense from their systems and shaved costs from their transportation rates, but there's something they could be doing better. A global company that doesn't procure its truckload or less-than-truckload freight on a global basis, for example, may not have even been aware of the opportunity to do so. The bottom line is that there are a lot of best practices and trends out there that companies which are operating globally should be thinking about.

Q: Why are companies missing out on these opportunities?

A: Part of it is because they're focused on certain regions, and part of it is due to organizational limitations. Put simply, sometimes no one is really accountable for looking at global service opportunities, so no one is doing it. Also, the technology that's in use at some organizations just doesn't provide the right level of visibility for getting this done. Every company is in

a different stage or focus point from growth to efficiency, but the longer term trend in a slow growth economy like today's seems to be towards efficiency and opportunities are out there if you have global visibility

Q: What's a better approach?

A: Smart shippers are outsourcing some or all of their transportation management. This isn't a new trend, but the fact that the marketplace is focused on efficiency versus rapid expansion is giving outsourcing a tailwind. C.H. Robinson's Collaborative Outsourcing Division, for example, focuses on partnering with customers – and the fact that we're better "together" than we are on our own. We see this philosophy trending across the marketplace, where more freight is going through the hands of intermediaries or transportation experts.

Q: What's ahead in this realm?

A: The drive towards efficiency is guiding growth in the global procurement of services. Historically, for example, ocean, air, and parcel were purchased on a global basis. Now, we're seeing truckload and less-than-truckload being purchased globally across North America, Europe, and Asia. Few companies today can see everything, everywhere in their supply chain and distribution channels but it is possible. In fact, I think our industry is focusing on the right things and getting better at leveraging technology more globally. We're taking what we learn in one market and applying it even more efficiently in other markets. Overall, it's a pretty exciting time to see our industry catching up with where it should be from a global basis. This, in turn, will create even more opportunities for shippers that require procurement and transportation support around the globe.

Overcoming Market Unpredictability Through Effective IT Integration

Q&A with **Shan Muthuvelu**, president, ITOrizon Inc.

Q: Why are technology implementations, upgrades, and replacements becoming more complicated?

A: Different systems have different directions, applications, and purposes. We have clients who are using 200 different systems and working with 40 different software vendors to try to keep up with the ever-changing needs of this global, omni-channel business world. Plus, what you're using now as your integration architecture will be out of date in a year, which means you're not working on the same 5-year technology timelines that you once did.

Q: How does the increasingly global business climate impact this?

A: Companies are working with an increasingly global base of business partners that needs to get up, running, and enabled very quickly. Every second counts during this process, and every few months companies are merging with new businesses, and adding new business and supply chain partners to their lineups. The problem is that each of those merging companies and partners brings its own enterprise resource planning (ERP), supply chain management (SCM), and master data management (MDM) platform to the table.

Q: What can companies do to overcome these challenges?

A: Work with a single integration partner who can effectively manage multiple software platforms. Last year, for example, a top luxury retailer we worked with had a complex strategic systems integration program with four versions of Manhattan Associates' warehouse management system (WMS) running across multiple facilities in the U.S. and Canada. On top of that, it also had various completely distinct operating flows within each version of the WMS. We designed and developed solutions, integrating all facilities to reduce redundant work across facilities, and also keep the flexibility to let processes happen at any facility. We helped the retailer roll out new business integrations with zero or minimal changes to its WMS or other package solutions like Retail Merchandising System (RMS), Order Management System (OMS), and MDM.

Q: Is there more IT/integration complexity in the future?

A: Over the next few years, we're going to see more companies leveraging IT as a competitive advantage. The obstacles to achieving this goal are threefold: Package applications tend to work in silos, technology changes every six months, and there's an ongoing need for security and scalability. Everyone's dream is to come up with one solution, one platform, and/or one piece of technology that will do everything for the company. But that's not going to happen – and if you try to do it yourself it'll take 20 years. For answers, companies are

increasingly turning to best-of-breed software packages that can work on a modular level and be integrated in-house without requiring too much time or cost of ownership. But even leading companies are struggling to achieve this goal, based on the unpredictability of the market. This, in turn, creates even more complexities and challenges.

Transportation Optimization

Q&A with **Monica Wooden**, CEO and co-founder, MercuryGate International, Inc.

Q: Why should companies be thinking about transportation optimization right now?

A: The ultimate goal of transportation optimization is to take empty miles out of the supply chain. So the more trucks that are going down the road full, the more filled containers that you're moving, or the more full private or contracted fleets that are moving, the better. These filled vehicles or containers represent the best possible cost scenarios and are also very good for the environment. These are the principles that transportation optimization focuses on, and they solve some very important issues for today's shippers.

Q: Has transportation optimization become more critical in recent years?

A: As transportation maturity models have progressed and developed, optimization has also evolved and expanded. Much like you would progress through math by taking algebra, geometry, trigonometry, and calculus—in that order—companies start by automating processes and then move up to optimization. Distributors, for example, focus on creating routes that optimize the capacity of the truck or the container. As the use of optimization has grown, we've seen more companies upgrading the models of their

transportation systems. Other firms are using transportation planning but not really maximizing the execution side of the equation. They put together nice plans, but those plans never come full circle and are not truly executed in a way that optimizes transportation.

Q: Why is this difficult for companies to achieve on their own?

A: The accounting side of optimization, and how companies can allocate costs back, is the most difficult challenge to overcome. This is especially true for the company that has multiple business units, locations, and/or customers. To accommodate these different facets, companies need to have the backend accounting systems in place that help them understand their costs and profits (i.e., for logistics providers). Also, companies tend to decentralize their planning and look only at one facility or location. For optimization to be most effective, you have to be able to change your processes a bit and "go up" a layer to gain more access to information. For example, if you have two business units with multiple locations that are servicing the same customers, you have to be able to plan effectively across those locations. Achieving this goal requires centralization, a good view across both business units, and in some cases, change management.

Q: What benefits do companies see when they optimize transportation?

A: In general, companies are saving anywhere from 1 percent to 30 percent in transportation costs, but it really depends on how their businesses are set up. For example, a company that uses a combination of partial-truckload and less-than-truckload with few distribution points/manufacturing plans will see very big wins from their optimization efforts. Regardless of how the business is structured, optimization can lead to increased operational efficiency and greater awareness of the many options available for managing the company's existing and future transportation needs.

Innovations in Supply Chain Optimization

Q&A with **Victor Allis**, co-founder & chief puzzle solver, Quintiq

Q: What top innovations do you see in the supply chain optimization space in 2016?

A: We're seeing potential in three different areas: robust supply chain optimization, continuous optimization, and Optimization as a Service (OaaS). These three developments can have a profound impact on the way shippers manage their supply chain optimization strategies in today's same-day/next-day/omni-channel business environment.

Q: What is robust supply chain optimization and how is it being applied?

A: Robust optimization takes into account the uncertainty of the real world. Over the years, companies have been collecting data on everything from due dates to road networks to vehicle speeds in an effort to create optimized delivery models. But these models don't always factor in the uncertainties of the world – as in, what could happen, what disruptions may occur, and so forth. When a truck leaves at 11 a.m. with a delivery that a customer needs by 4 p.m. that day, the decision to have it at the customer location by 3:59 p.m. has largely been binary (i.e., it's either late or it's not late; there are no in-betweens). Robust optimization factors in scenarios like weighing the risks between moving the delivery time from 3:59 p.m. to 3:00 p.m. and thus greatly reducing the chance of the delivery being late to somewhere in between. The challenge is the cost benefit. How much "insurance premium" are you willing to take. Using robust optimization, companies not only create optimized models but they can also determine optimal solutions that factor in real-time variabilities and anticipate what might happen.

Q: How about continuous optimization? What is it and how does it work?

A: With customers demanding tighter and faster delivery windows, shippers want to know that there's a high probability of shipments getting to their destinations on time. This is where the retail battle will be waged over the next few years, and winning it will require continuous optimization. So where companies once had "next-day" processes for scheduling deliveries—with exceptions made only for emergency or last minute orders—continuous optimization removes the human element from the equation. Using automation, shippers can glean information from the real world, process it in real time, and create the plans that take into account everything that's happening at any given point.

Q: What is Optimization as a Service (OaaS) and how can that be leveraged in supply chain?

A: Companies want to apply more computing power to their processes. Because this power is fairly inexpensive at this point and the hardware is readily available from hosting service providers, the idea of creating a hybrid optimization model is more feasible now than ever before. Instead of doing a completely on-site software implementations, companies can keep some of their information on their own network and/or behind a firewall, yet still gain the benefit of cloud-based applications and off-site IT support. We have one customer who is currently moving to this model and excited about the prospect of improving optimization by 30 percent to 50 percent. It's a pretty compelling proposition.

Integrating Invoice Data: The Latest Trend in Freight Audit and Payment

Q&A with **Shannon Vaillancourt**, president, RateLinx

Q: What's new regarding the use of freight audit and payment?

A: What we see in the market for traditional freight audit and payment is that nothing is really new. Unfortunately, most of the processes are still manual and the providers are processing hard copy invoices. Because of these manual processes, it takes days or weeks for the data to be visible, which makes it no longer relevant to the shipper.

Q: What issues are you seeing for shippers who rely on traditional freight audit and payment providers?

A: The main issues are speed and accuracy. These two words don't go together when you're talking about freight audit and payment, and that's because of manual processes. Often, shippers are receiving their KPIs via a PDF attached to an email from their freight audit provider. A shipper has to wait until the end of the month to have visibility into its freight. It can spend the next month trying to figure out what caused the discrepancy because you can't drill-down into the details of the PDF's KPIs.

Q: What are most shippers seeking when they move away from traditional freight audit and payment providers?

A: Shippers are now much more sophisticated. They're looking for data that will give them valuable information. In order to get this, they need speed, accuracy, and details. Shippers want real-time information that will allow them to see what happened yesterday, as well as what is happening today. The data has to accurately show the health of the shipper's freight network, and if there are any issues, the details must exist that will allow the shipper to immediately fix the issues. The days of measuring the freight audit provider based on adjustments made to invoices is coming to an end. An adjustment is not cost savings; it is really cost avoidance.

Q: What is the trending thought on capturing freight invoice data to guide strategy?

A: It's now about integrating freight invoice data with the rest of the pieces of the supply chain to create one integrated dataset. By integrating the freight invoice with order information, item information, and track & trace, the shipper now has the proper context to create a strategy that can be executed. How many times have you heard from a shipper: "We made this change because it was supposed to save us 15 percent on freight, and after six months we looked at the results and we saved nothing!" If you're making strategies based on inaccurate, out-of-date information with no details, what else would you expect?

EXECUTIVE INSIGHTS

Addressing Key Supply Chain Disruptors

Q&A with **Todd Skiles**, senior VP of sales and marketing for supply chain solutions, Ryder System, Inc.

Q: Supply chains are more vulnerable to disruptions than ever. What are the major disruptors that Ryder is tracking right now?

A: At Ryder, we are always tracking numerous major trends. Among those are four macro trends in particular that are leading to supply chain disruption – economic, regulatory, people, and technology. We have seen steady growth in the U.S. economy since 2013, as well as increased consumer demand. That has led to what we are calling the "now" economy. Regulations continue to change and make it tough for supply chain managers to keep pace with compliance, while meeting consumer demand. Thirdly, we have a severe talent shortage in the industry, from truck drivers to warehouse employees. In fact, demand for supply chain talent is outpacing supply by a ratio of 6 to 1. Lastly, technology continues to change how businesses operate and deliver their products and services. These disruptors are putting a premium on high-performance transportation and logistics functions that operate with a level of speed, reliability, and efficiency. Well-managed supply chains have never been more important to the success of businesses.

Q: How would outsourcing operations help a company maintain continuity, if the disruptor is still present?

A: For many companies, supply chain operation is not a core competency. These disruptors are something we deal with on a daily basis. By outsourcing, 3PLs such as Ryder can help companies overcome the disruption. These companies are looking for a partner with the experience and expertise to address the talent shortages; manage regulations; assess and integrate new technologies; and drive efficiency and innovation in the supply chains.

Q: Do 3PLs do consultations for a company if they are apprehensive about fully outsourcing their operations?

A: Yes, at Ryder we offer consultations to companies. It allows us to look at the supply chain as a whole and offer our expertise in meeting the needs of their customers. It gives companies the chance to have someone else observe their supply chains and suggest new ways to operate that may improve their processes.

Q: Does a company have to outsource its entire operation? If not, what would you suggest is the first step?

A: A company does not have to outsource its entire supply chain. What it outsources depends on its operation. There is not one specific place to start; it normally is centered on where the pain in the supply chain is. Most companies start with transforming their supply chains to increase efficiency. This allows the company to increase visibility, speed up order processing time, and cut costs.

Customer Service's Impact on the Modern Supply Chain

Q&A with **Ray Ramu**, chief customer officer, Saia LTL Freight

Q: What's new and different about customer service in today's supply chain?

A: The Internet has put a tremendous amount of information in customers' hands, and those customers are demanding real-time visibility to the transportation supply chain. Everyone wants to know when they're going to get their shipments. This is particularly true in the less-than-truckload (LTL) industry, where carriers are pretty close to final delivery on the consumer side (next to the parcel industry). If there's a delay or a defect in service, they want to know about it beforehand – not after the fact. Once they know, they can address it and figure out a proactive strategy for working with their own customers.

Q: What hurdles do companies face in this realm?

A: People—or, a lack thereof—are the biggest challenge. Most companies are operating leaner than they did prior to the Great Recession. They're doing more work with fewer resources. At the same time, customers are demanding more and expecting deliveries to be handled same day and next day. Effectively working through these issues requires good communication with customers. If, for example, your airline flight from Atlanta to Los Angeles changes gates—and you have to trek back to the train to get to another gate—you're going to be confused and frustrated. But if the airline sends out a short text about the switch while you're still in motion, you can quickly re-route and get to where you need to be; and you feel better about it. The same principles apply in the modern supply chain.

Q: How can companies improve customer service?

A: One of the best steps is to partner with your carrier instead of always shopping around for the low-cost option. While lower costs may be attractive on the front end, over time it's the strong relationships that you have with your carriers that produce the highest returns. This is particularly true in times of driver shortages and capacity crunches—both of which can take their toll on a shipper's ability to deliver good customer service. By forming strong partnerships with carriers, and then allowing those carriers a look at your business and truly support it, you can be more proactive about your own customer service. Without this critical piece of the puzzle, delivering good visibility, alerts, and reporting to your customers can be very difficult.

Q: What do shippers get in return for these partnerships?

A: They get value, consistency, and a high level of customer service. They also benefit from the rate stability made possible by long-term contracts with their carriers. Finally, they get to look good in front of their customers – a very important advantage in today's competitive business environment.

EXECUTIVE INSIGHTS

Recognizing and Mitigating Risk in Global Supply Chains

Q&A with **Dave Zamsky**, vice president of marketing, UPS Capital

Q: Why is supply chain risk a prevalent and pressing issue for companies?

A: The globalization of commerce is the biggest reason. Supply chains are getting much longer and much more complex. As suppliers and buyers expand and grow their businesses, they invariably reach out beyond domestic sourcing options and begin working with global vendors. When this happens, the risk grows. On top of that, supply chains have become more complex. Companies are now dealing with multiple regulatory and compliance issues, both of which also introduce more risk into the supply chain.

Q: What are the most difficult aspects of managing this new level of risk?

A: Companies haven't given much thought to global supply chain risk in the past, and they're not prepared for it. We recently conducted research with the University of Tennessee and found that 66 percent of firms described their own supply chain risk management effectiveness as "low" or "I don't know." We discovered that

76 percent of businesses had at least one supply chain incident within the previous 12-month period. Finally, fewer than 25 percent of companies are actually assessing and addressing risk within their supply chains. When you add up all of these numbers, it's clear that companies aren't prepared for supply chain disruptions – yet, it's not a matter of "if" something will happen, it's a matter of "when" and "how big."

Q: How does this hurt organizations?

A: Even if there is no long-term impact on market share or brand equity, a surprising amount of product needs to be sold to offset and write-off the loss, and that could very easily amount to a 15:1 ratio. For example, let's assume a company makes a 6 percent profit margin on its goods and lost $233,000 in a recent cargo theft, which is the average value of cargo theft in the U.S. It would take $3.8 million in new sales to recover the cost of those goods. Replacing that much lost revenue may be a huge problem for some firms, especially small to medium-sized companies.

Q: What can companies do about it?

A: You should identify the potential risks in your supply chain, prioritize those risks, and then begin looking for opportunities to mitigate the risks. If you can't do it on your own, get some help with this process. Seek out advice, use insurance to cover your assets, and stay aware of the potential problems that are lurking out there. Be aware that it's not just about buying insurance coverage; it's also about utilizing the expertise of the companies that actually provide risk mitigation strategies. At UPS Capital, for example, we focus on analyzing risk in companies' supply chains and looking for ways to mitigate that risk. We don't want companies to have losses if we can help it.

The need for STEM skills in the supply chain

Organizations can close skills gaps by offering development opportunities to both new and existing employees.

By Becky Partida, senior research specialist – supply chain management, APQC

The complexity of modern supply chains and the advancement of technology in the field have led organizations to place greater importance on the need for supply chain employees to possess STEM (science, technology, engineering and math) skills. APQC has found that a slight majority of organizations look for STEM skills in their new hires for supply chain positions. The most highly sought after of these skills are engineering and operations research, or the use of analytics to optimize transportation networks.

As in many fields, STEM skills are not widely available or fully developed among supply chain professionals. APQC has found that some organizations are tackling this problem by creating development programs for new professionals.

However, lasting solutions provide development of STEM skills among both new and more tenured employees. Some organizations have found this balance and seen positive results for the business.

STEM gap among supply chain professionals

There is a gap in STEM skills within the supply chain management field, which is no surprise given the gap experienced across industries. In a survey conducted by APQC, the largest group of organizations find supply chain job candidates to be only somewhat well prepared with regard to data/analytics capabilities, industrial engineering, and technology solutions (Figure 1).

With the increased use of data in nearly all organizations, regardless of industry, it is no surprise that new supply chain job candidates are somewhat better prepared with regard to data or analytics capabilities. Yet there is clearly room for supply chain job candidates to further develop their skills.

Organizations also have difficulty retaining supply chain professionals in STEM-focused roles such as data analysts, industrial engineers, and supply chain network designers. As shown in Figure 2, the largest groups of organizations surveyed by APQC rate retaining staff in these positions as somewhat difficult or difficult. A small group of organizations encounter no difficulty keeping individuals in these positions. This data indicates employees with STEM skills can easily find more desirable employment elsewhere if they are not motivated to stay at an organization.

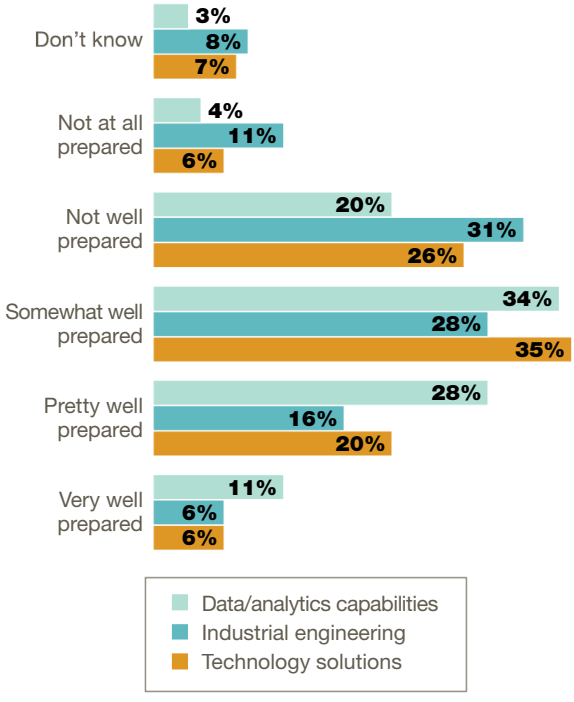
Emphasis on new employees over mid-career employees

APQC has also found that organizations that want to address the gap in STEM skills often focus employee development efforts on "newcomer" employees, or those with less than seven years of experience. As shown in Figure 3, the largest group of organizations surveyed by APQC does not make a consistent effort to develop mid-career employees. The story is different when it comes to developing employees with fewer years of experience. The largest group of organizations devotes significant effort to increasing learning activities for these employees and has obtained some leadership support for this effort.

This data highlights the need for organizations

FIGURE 1

Preparedness of previously interviewed supply chain job candidates



Source: APQC

to develop the STEM skills of all levels of employees, not just new ones. To thoroughly address the loss of skills and knowledge caused by the impending retirement of supply chain professionals, as well as the more broad lack of STEM skills among employees, organizations need to take a focused approach to employee development. Of organizations surveyed by APQC, 92% train and develop employees in STEM skills using in-person or virtual training courses. This is followed closely by the use of technical conferences and forums (90% of organizations). Slightly less (89% of organizations) have adopted mentoring or apprenticeship programs, and about two-thirds of organizations have adopted programs that identify and develop high-potential employees.

A majority of organizations find their mentoring/apprenticeship programs and training courses to be effective or very effective. Interestingly, only 47% of organizations consider technical conferences or forums to be very effective or effective at developing employee STEM skills. This highlights the need for organizations to adopt focused yet tactical training on STEM-related topics. Conferences can provide broad knowledge and introduce employees to the latest developments in their field, but for day-to-day knowledge that employees can apply long-term they need more focused programs.

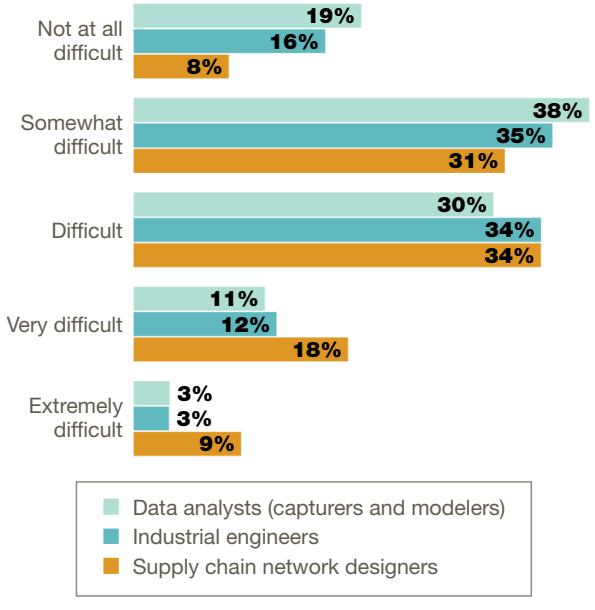
How organizations do it

There are organizations that have created opportunities to develop the technical skills of their employees without interrupting the important and time-sensitive work of the supply chain. Newmont Mining Corporation and Becton, Dickinson and Company (BD) have adopted a variety of programs for developing both new and mid-career employees that complement the supply chain function and have led to benefits to the business. Let's look at both.

Newmont Mining. Newmont Mining recruits new supply chain employees from a broad pool of individuals with various backgrounds, including technical fields such as engineering. However, the organization considers it more important for individuals to be well balanced and have the ability to transition between the supply chain, technical, and commercial aspects of a role. All of the new hires for its supply chain function go through an induction program that exposes them to the basic aspects of what their jobs will entail. They then move on to individual development programs tailored to their experience, competencies and levels of expertise.

FIGURE 2

Difficulty retaining professionals in supply chain positions



Source: APQC

Newmont sets development goals and targets for all of its supply chain employees. It provides access to online, classroom, and hands-on training and offers key competency refresher courses in a classroom setting. To supplement individual development efforts, it offers a series of online videos that can help individuals overcome knowledge gaps.

Newmont designs development goals to prepare

employees to take on more responsibilities, which not only lead to individual growth but also make an employee eligible for promotions. Supply chain employees are also prepared for higher roles through development assignments, training and executive coaching, and informal mentoring with more senior employees.

Due to this multifaceted approach to employee training and development, Newmont has increased the competencies of its supply chain staff. This has enabled the organization to promote employees to higher positions rather than have to find external candidates.

BD. To ensure that its new supply chain employees have skills needed by the organization, BD has created a supply chain development program for its entry-level employees. This two-year, structured rotational program provides leadership development and hands-on work experience. The program exposes participants to different areas within BD's global integrated supply chain function and gives individuals the opportunity to identify which tracks they would like to pursue. It also gives BD's leadership the opportunity to assess participants' skill sets and performance across a range of supply chain processes to determine which roles they should fill.

The organization has created BD University to give its existing employees access to a variety of courses designed to enhance leadership and behavioral skills. Mid-career employees are assigned leadership mentors so that they can broaden their experience and capabilities. BD also identifies high-potential employees and offers them the ability to take assignments in other regions. It also conducts annual reviews for all supply chain employees that include a comparison of the individual's skills against the skills needed for their position. Should the review identify any competency gaps, BD creates a development plan to help the individual close those gaps.

Giving high performers the opportunity to move to other regions has allowed the organization to improve operations in those area.

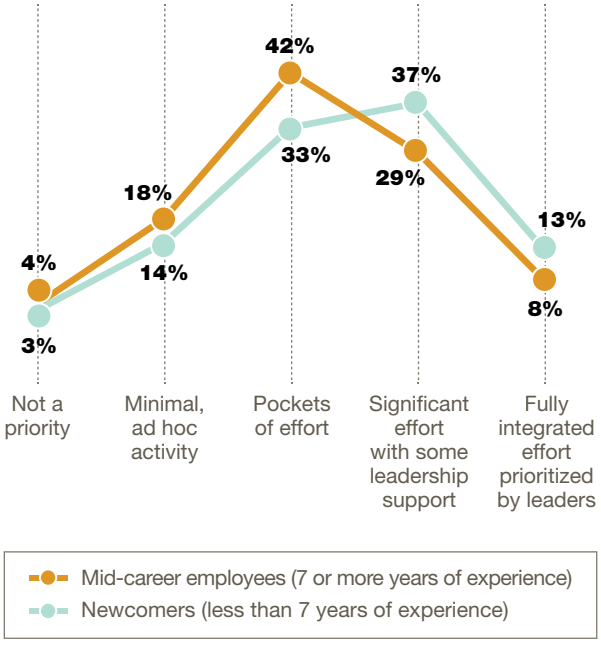
BD's development efforts have improved the capabilities of its supply chain employees. Giving high performers the opportunity to move to other regions has allowed the organization to improve operations in those areas. BD has also seen improvement in its supply chain cost since implementing its talent development efforts.

The need to go broad

With STEM skills still lacking among candidates for supply chain positions, organizations have to get creative to develop these skills among their new and existing employees. It may be tempting to focus development efforts solely on entry-level professionals because they represent an easier and faster route for bringing needed skills to an organization. However, mid-career employees have the organizational experience and on-the-job knowledge of supply chains that new employees do not. By creating a balance of development efforts that build on new employees' skills and offer more tenured employees the opportunity to be mentored and to accept stretch assignments, organizations can grow STEM skills in-house. This can help organizations prevent the loss of skills and knowledge from retiring professionals. Growth opportunities can also set apart an organization as a desirable employer and make mid-career professionals with STEM skills more likely to stay.

FIGURE 3

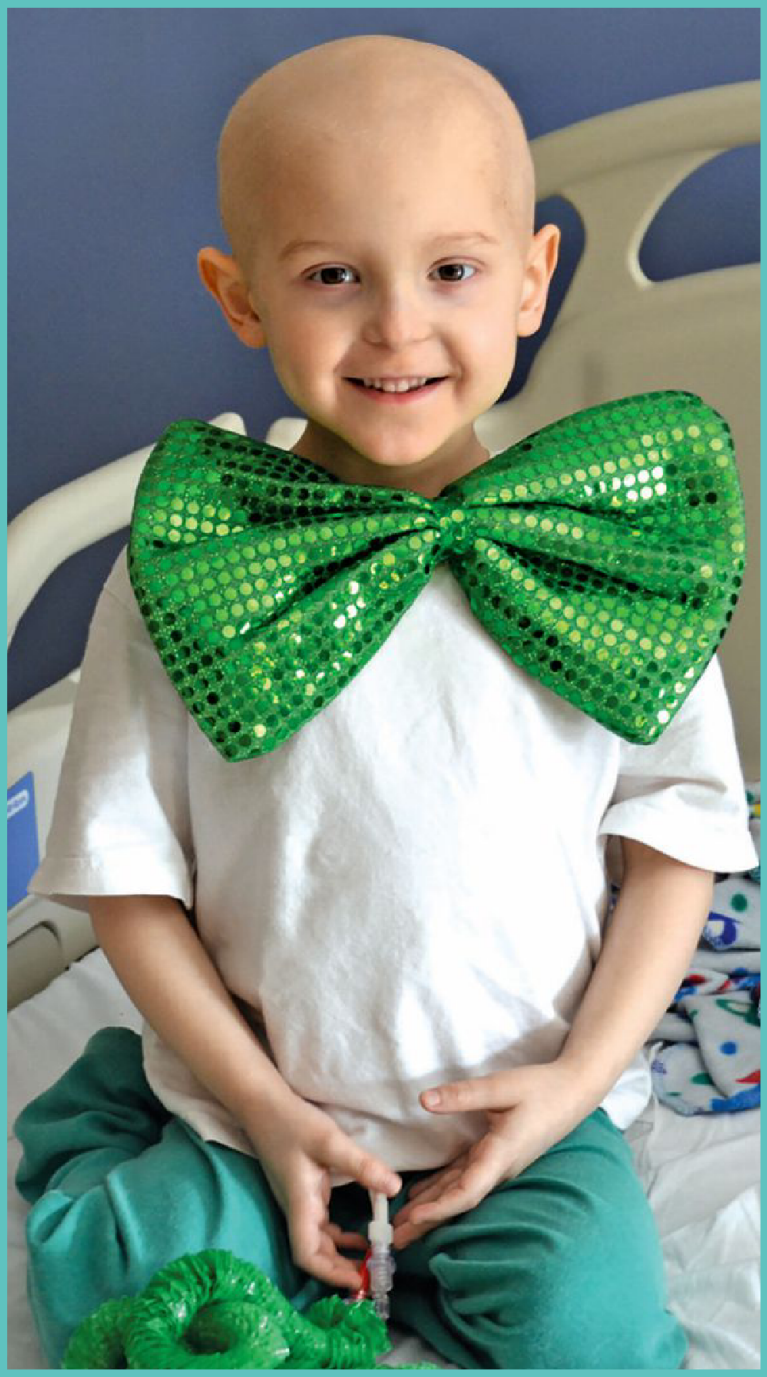
Effort to accelerate the rate of learning for employees



Source: APQC

About APQC

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



Jake, five years old, stage 3 neuroblastoma.

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Since our inception six years ago, Peerless Media has been a proud supporter of The Beauty Foundation for Cancer Care.

The Beauty Foundation for Cancer Care is a nationwide 501(c)(3) organization that recognizes the beauty in all the families that have been stricken by cancer.

Every day, despite the anguish of having to fight cancer while also shouldering the emotional toll it takes on them, these families forge ahead with dignity and unwavering determination.

The Beauty Foundation financially and emotionally supports these families and their fight against cancer.

For more information on The Beauty Foundation for Cancer Care, please visit **www.beautyfoundationnj.com**

Peerless MEDIA, LLC | Logistics MANAGEMENT | MODERN MATERIALS HANDLING | SUPPLY CHAIN MANAGEMENT REVIEW | DE Desktop Engineering

Freight Audit is obsolete.

Today there's a smarter way.

Dialing zeros when the world moves in gigabits per second is obsolete. And so is traditional freight audit. It's slow, and the information is outdated when finally collected and reviewed.

RateLinx Intelligent Invoice Management℠ is completely different.

Unlike traditional Freight Audit, we look forward not backwards. We work with your carriers before they ship so they will comply with your business rules and avoid errors. Our dynamic invoice payment system then collects invoice data directly from the carriers in real-time.

Within 24 hours, you're viewing the invoice in a valuable standardized data set on the RateLinx Dashboard. With complete visibility to what's happening in your supply chain, problems can be fixed immediately. Strategy and execution can be fine-tuned before costly errors add up.

We don't collect invoice data to make adjustments. We collect invoice data for the real-time intelligence it brings your shipping planning and execution. We plug the profit leaks and close the loop on shipping.

We help you decide. Am I using the right rules? Am I using the right carriers? Is the billing right? RateLinx Intelligent Invoice Management not only shows you where you are going but how to get there faster and cheaper. This is the smarter way.

Learn how RateLinx can put you in the fast lane. **ratelinx.com/iim**

RateLinx 24
Intelligent
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