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Artificial intelligence is everywhere these days. But what if it isn’t? I would guess that at least 50%, and probably closer to 70%, of the article pitches I receive these days involve AI. Most conversations I’ve had at conferences this year have at least touched on AI and its impact on the supply chain. Almost every technology company touts its AI-infused software. It seems that AI is not only mainstream, it’s Main Street.

And if you look outside the supply chain, you will see similar data points to support that theory. Statista data shows that the average global monthly web search volume for keyword AI has risen from 6.58 million searches in July 2022 to 30.45 million by March 2023. When searching Google, 11.5% of sampled websites have AI content as of May, according to Originality.ai.

But, I recently received a report from a company called Zero100, a research firm focused on integration of digital and physical supply chains. The company wanted to know how much AI has infiltrated the supply chain. It scoured earnings reports of publicly held companies, looking for mentions of AI. What it found was interesting, to say the least. While most businesses are interested in AI and are rapidly investing in AI, the majority have not moved past the pilot stage, it found.

“AI is fundamentally changing the landscape of supply chain management—and it’s happening at a faster rate than we’ve seen before,” said Kevin O’Marah, chief research officer and co-founder of Zero100. “It’s the biggest tech inflection point since the internet and, while AI experiments have been ongoing, the rise of generative AI is pushing digitization to the forefront. Boards recognize that the ability to digitize and embrace AI will be the difference between prosperity and decline over the next decade. They now need a clear path forward to capitalize on this opportunity.”

The analysis found that 88% of CEOs talked about their company’s AI vision, but only 11% said they have advanced an AI project beyond the pilot stage, and only one in four could cite the results of an AI project.

So, is AI dominating supply chain or not? I posed a version of that question on my LinkedIn page and got a response that makes some sense. “Brian, these results are surprising, and I will ‘guess’ based on the technology inflection they are keeping their GTM, results and cards close to their chest until ready to share strategy,” wrote Ann Marie Jonkman, vice president of industry strategies at Blue Yonder.

Based on industry chatter, it certainly seems there are more companies leveraging AI than Zero100’s analysis of earnings calls may suggest. Jonkman may just be right.

AI will undoubtedly be a large part of the conversation at our upcoming NextGen Supply Chain Conference at the Chicago Athletic Association hotel in downtown Chicago. Taking place Oct. 21-23, the event brings together the top leaders in supply chain from some of the biggest companies. This year, keynote addresses will be given by Johnson & Johnson, Procter & Gamble, and Walmart will be honored with our Visionary Award.

Visit our NextGen website at nextgensupplychainconference.com to learn more, register, and book your hotel stay. Special rates are in effect until Oct. 4.

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The promise of AI offers greater decision-making power, but there are some decisions that AI should not make.

By Larry Lapide

Almost four and a half years ago, I wrote my first Insights column on artificial intelligence (AI) titled: “Rely on AI to make decisions? Yes, but warily” [March/April 2020]. I had planned to do an annual update, however, the COVID-19 pandemic came along—consuming much of the oxygen for columnists like me. Now that the pandemic has subsided, and a lot is being made of OpenAI’s launch of ChatGPT in November of 2022, there appears to be renewed optimism regarding the potential for AI to change the world.

In a Wall Street Journal (WSJ, March 23, 2023) article titled “Gates Calls AI Most Revolutionary Tech in Decades,” Bill Gates is quoted as saying: “The development of AI is as fundamental as the creation of the microprocessor, the personal computer, the internet, and the mobile phone.” And “entire industries will reorient [a]round it,” as well as “businesses will distinguish themselves by how well they use it.” Gates had already put his money where his mouth is, having invested billions of dollars in OpenAI. With Microsoft planning to invest more in the future (WSJ, Jan. 24, 2023).

Other WSJ articles paint a picture of the scale of optimism as well as cautions regarding AI.

• “AI Regulation Advances in European Union” (June 15, 2023)
• “AI Is About to Be Everywhere. Skeptics Risk Being Left Behind” (Sept. 30, 2023-Oct. 1, 2023)
• “Business Schools Are Going All In on AI” (April 4, 2024)
• “Musk, Dimon Are Hyped on AI, But Not Everyone Is On Board” (April 11, 2024)
• “Amazon CEO Touts AI, Commits to Cut Costs” (April 12, 2024)

Thus, there is a lot of hubbub touting the bright future for AI: the good, the bad, and the ugly. (The latter two potentially requires governmental regulation to hinder AI’s potential for nefarious use by bad actors.) China is investing $50 billion in it, and the U.S. is likely to follow suit, maybe even upping the ante—to not fall behind in the
global AI technology race. The big question is whether it will be embraced by corporations to significantly improve business performance. Or is it “déjà vu all over again,” as the late great New York Yankee catcher Yogi Berra quipped. That is to say, I’ve seen this technology hype before and it hasn’t gotten very far yet.

Brief history of AI
I’ve been intrigued by the pursuit of creating systems that could replicate and improve upon human intelligence. I’ve long taken note of the AI research and innovation done by IBM. AI research has a long history at IBM, dating back to the 1950s. IBM sees its commercialization as one of its most important business initiatives. Its AI history has included the development of a chess-playing computer system known as Deep Blue and Watson, a question-answering computer system capable of responding in natural language. However, despite this research history, IBM has been less than successful when it comes to selling AI products and services.

In the early years, governments heavily funded AI research. Eventually, in the 1970s, disillusion set in and funding stopped. This led to the “AI Winter.” Sometime later, Japan’s AI initiatives inspired others to invest billions of dollars in AI, but by the late 1980s, investors withdrew funding. Then for the third time (think AI 3.0), AI started to boom once again at the beginning of this century. I believe this current iteration might be AI 4.0.

Despite AI’s ups and downs, it has had some incremental success. Simple thinking has been imbedded into hardware items—such as smart TVs and refrigerators, as well as the ‘intelligent’ software that supports driving a car and flying an airplane. However, I don’t believe we have yet seen any AI game-changing killer apps that have enabled significant business processes and operational improvement. For example, an article, “Retailers Say Skip Returns of Unwanted Items” (WSJ, Jan. 11, 2021), stated that: “Amazon.com, Walmart Inc. and other companies are using artificial intelligence to decide whether it makes economic sense to process a return.” I wouldn’t term this type of thinking as AI—it’s not much more thinking than a refrigerator’s to keep items in it cold and frozen.

ChatGPT could be a game-changer
ChatGPT, however, does appear to have the potential to be a game-changer for some businesses. As a Generative AI, it does have the ability to replicate human thinking as it deploys neural-net concepts, for example. My grandson and I like to play with our Amazon Alexa, asking it all sorts of weird questions. I tell him that Alexa is dumb because it only knows how to search, not think rationally. When I ask Alexa: “Who is my parent’s child?” it used to respond: “not enough information.” Recently it says: “I didn’t find any notes about parent’s child?” Of course, the simplest answer to the question is merely: “You.” It could also add: “If you have siblings, it would be them too.”

When I asked ChatGPT the same question it responded: “It seems like you’re asking about yourself. If so, then you are your parents’ child. If you’re looking for a different answer, could you please provide more context?” So, it has some capability to reason.

According to “Business Tech Is Finally Having Its Moment Thanks to AI” (WSJ, Feb. 15, 2024): “Generative AI is ideally suited for transforming large organizations by making people and processes radically more productive.” ChatGPT, for example, improves the writing and researching processes, including speeding up software coding. In “Chatbots Attempt to Figure Out Where Shipments Are” (WSJ, Aug. 31, 2023) it states that, “Logistics companies are increasingly building artificial intelligence technology into their operations.” Several freight brokers, for example, are “looking at how generative AI [such as using ChatGPT’s bot] could transform their customer-service divisions by automating tasks such as tracking shipments, booking loads, and declaring imports.

Many of the current activities in AI are being done to bolster technology companies’ iCloud service platforms. So, they are largely focused on the supply-side of AI technologies. Activities are based on the premise that “if
you build it, they will come.”

The hope is that big data analyses will eventually be used to develop the AI decision models incorporating decision variables. To analyze large data sets, businesses might buy machine-learning technologies that amass large amounts of data drawn from the internet. In addition, Nvidia’s high-resolution graphics chips are currently selling like hot cakes. Its gaming-based graphical user functionally is needed to visualize big data, as well as its ability to do simultaneous calculations. However, there is still a dearth of demand-side sales of AI applications—i.e., there are no game-changing killer apps yet. (i.e., think Excel, Word, etc.).

**AI for decision-making**

I’ve always taken the position that technology is only useful when it enables business process changes that improve operational and financial performance. Computers should be decision support systems (DSSs) and should not necessarily make all final decisions for managers. Of course, this is not to take away from the fact that many decisions can be made without managerial intervention.

For example, an ABC Pareto analysis on stocked items can help an inventory manager be more productive by determining which items should have more time spent on them. The most important A items represent the largest share of revenue, thus requiring a lot of time to support the fewest major customers that buy A items. Meanwhile, for the greater, yet less important B items, a manager relies on the computer to do much of the inventory management, intervening on an exception basis. Lastly, C items—the largest number of items—represent the smallest share of revenues, so they are on autopilot with the computer doing all the work except when a crisis arises. Automated AI inventory management technology would be most useful for C items, less useful for B, and would be least useful for A items.

**System-1 versus System-2 thinking**

In one business decision-making course I’ve taught, I used a textbook that discussed two types of cognitive thinking. It stated that “the current theory is that there are two distinctly separate cognitive systems underlying thinking and reasoning and that these different systems were developed through evolution.” These systems are often referred to as implicit and explicit, or by the more neutral System-1 and System-2, as coined by Stanovich and West [Stanovich, K.E.; West, R.F. (2000). “Individual difference in reasoning: implications for the rationality debate?” Behavioral and Brain Sciences].

System-1, the most used thinking, does not involve much thinking. As a result of this type of thinking, an untold number of routine and insignificant actions might be taken predicated on gutfeel, tried-and-true methods, and heuristics. Actions are effortless, taken quickly, and intuitively. System-2 represents rational decision-making because the actions to be taken are more critical, strategic, and impactful. Decision analysis is slow, conscious, effortful, and logical. Thus, AI will be most useful for automating System-1 decisions. However, for System-2 decisions, not so much. These decisions might not benefit from AI’s real-time decision-making & optimization capabilities, as well as its lack of humanity.

**Built-in latency is important**

I once debated an analyst on the concept of zero latency being a long-term goal for computerized systems (latency is defined as the time from receiving data that triggers a need for action until the action is taken). I took the position that zero latency is not necessarily always good for business. For example, when navigating a big ship, turning it too quickly will result in it turning over and sinking. Moreover, there is a reason that cars have shock absorbers to absorb sudden shocks from bumps in the road. All complex systems (including supply chains) need latency buffers built into them for sustainability and survival.

**Realistic optimal decisions**

Advanced planning and scheduling (APS) systems often have optimization software engines (or brains) in them, turning them from supporting managers with a what-if analysis to prescribing what is the best decision. AI will certainly improve these, and automated real-time optimization will be appealing. Automating optimal decisions might be great for System-1 decisions, however, not for System-2 decisions. Their impact is significant and
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thereby requires cross-functional collaboration among managers to develop realistic quantitative decision models.

An analyst I knew asked plant managers if they turned on their APS’s optimizer. They largely said no because they knew their plants were constrained by materials. Thus, they were only interested in learning which materials were constrained, so they could find more supply of them. Basically, why accept the system’s so-called optimal answer if you know you might improve on it by making more product?

All optimization analyses are predicated on quantitative modeling and assumptions. So-called optimums need to be vetted among managers to make sure all interests and concerns are incorporated before taking action. In short, since optimization usually involves System-2 decisions, no one should believe an automated optimal decision from a computer. Its acceptance requires an enterprise-wide collaborative vetting process.

**AI might be unjust**

A newspaper clip I once read a long time ago discussed a judge presiding at a trial in a small town. One of the lawyers put into evidence a computer printout. The judge quipped: “If the computer says it, then it must be true.” As we know years later, it is oftentimes far from the truth because computers are programmed by humans. Thus, decisions made by a computer might be susceptible to not only being wrong, but being socially unjust and inhumane, as well.

In my Insights column, “Don’t build weapons of math destruction” [March/April 2019], I discussed the book: “Weapons of Math Destruction: How Big Data Increases Inequality and Threatens Democracy” by Dr. Cathy O’Neil, a former financial quant. She wrote how she became disillusioned with mathematical models that affect society.

Her premise is that the vast amount of big data on the internet is being used in ways that are: 1) opaque; 2) unquestioned; and 3) unaccountable. In simple terms, the detailed data used is not transparent to the person affected by the decision-making it supports; the use of the data is beyond reproach in modelers’ minds; and modelers refuse to defend the model other than to say, “it is what it says” (often equating correlation with causality). She discusses a variety of applications that have “vicious, self-reinforcing feedback loops” whereby things get worse for those affected—especially minorities and the poor. I bring up this book in the context of AI because one has to remember that AI software will be developed by humans, and so it will always be subject to potential bias, corrupted behavior, and simple errors. In addition, AI will have no empathy and feeling for the people who might be adversely affected by its decision-making.

**An AI cautionary tale**

I recently attended a play—”Machine Learning,” written by playwright Francisco Mendoza—about a software developer who programmed a service bot to take care of his aging father that lived alone. He programmed it with machine learning, whereby the bot learned how to interact with his father by observing how the developer interacted with him. In the end, the developer finds his father dead from what looks like a medical problem of some sort. He discusses what happened with the bot and asks why it decided not to call 911. It said: “You wanted me to make him as comfortable as possible and I should act as you (the programmer) would have done so. Therefore, I decided that his death would be the best alternative for your father’s comfort, along with knowing that you inherently wanted him out of your life.”

In summary, I recommend that managers be wary of using AI to make System-2 decisions for them. While fast real-time planning with no latency has appeal, it should largely be used to automate operational execution, rather than planning and forecasting processes, which are more tactical and strategic in nature. For example, whenever I’ve been asked by a company how it might improve forecast and planning accuracy, I jokingly tell them to go out of business. Forecast error would be zero, and plans would be non-existent and perfect. AI might seriously give supply chain managers the same advice—that they should work toward putting their companies out of business. Not good advice. •
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How to get the most out of academic research

Understanding the process and the resources required improves the ability to meet the project goals.

By Ken Cottrill

Companies can engage with academia on various levels through educational programs and the cross-sharing of knowledge. Another channel to engagement is research—the subject of this column.

Academia can be a valuable source of innovation for companies, especially those searching for answers to specific research questions. Researchers in academia offer deep expertise, inventiveness, and, often, industry experience, and do not have an agenda to sell commercial products. However, companies must know academia’s distinguishing features to ensure project participant goals are met.

Levels of engagement
There are various ways to engage with an academic research resource. For example, companies can join existing research projects like consortia, created to focus on a particular issue or set of issues. As a member of such a group, a company exchanges ideas with other member enterprises and the academic researchers involved. Typically, the consortium has a research agenda—that corporate members help to shape—and a timetable for achieving its objectives.

Another approach is to find a researcher within an academic institution whose work you appreciate and/or with whom you have a productive relationship. Supporting research is similar to how artists received funding hundreds of years ago. A sponsor would find an artist they favored, and fund them to create works of art, sometimes with specific objectives in mind.

A researcher might propose a project to a company he or she has identified as a likely research partner. For example, MIT CTL’s last-mile logistics team wanted to be on the bleeding edge of this field and sought innovative enterprises with which to work.

Another variation is engaging with students to meet a company’s research goals. At MIT CTL, for example, supply chain master’s students must complete a capstone project before graduating. A company can propose such a project, and the students, supervised by a faculty member, carry out the work. Sometimes a capstone can inspire a more substantial research project.
Keys to success
Regardless of which route a company takes to collaborate with academic researchers, it needs to know what to expect. We draw the following pointers from our experience of research collaborations with corporate partners.

**Define the research question.** This might seem obvious, but many companies are less clear on their research objectives than they assume. Goals can differ from one department or team to the next. The problem statement must be clear and paired with a research question. A mistake we often encounter is that the statement and/or question are too general. Examples of this include asking about the availability of state-of-the-art solutions or what future developments to expect in a particular area of interest. Questions like these require assessments of trends rather than research. Companies should take time to study the issues they want to research and clarify their goals before framing problem statements and research questions.

**Define what research vehicle you are looking for.** For example, do you need a forum to bounce ideas and gain insights into how other companies are handling the challenges you have identified? A forum can also help to clarify what you don’t know.

A consortium could be an option but be aware that the sponsor organization often tries to tailor the work toward its specific needs. This is understandable given the work a sponsor devotes to the project. A consortium may be the right vehicle if you can accept this potential restriction. If your needs are more specific, maybe an in-depth, one-on-one relationship with an academic resource is the right vehicle. Perhaps you want to break new ground, find solutions that a previous research initiative failed to deliver, or build on past research.

Some companies reach out without doing much research on their own because they require a quick briefing on key emerging issues. This approach can reflect a lack of market knowledge and a sudden realization that the organization urgently needs to fill a knowledge gap. Do some initial research and consider your requirements before engaging with a researcher. Both parties should benefit from these exchanges.

**Understand the difference between work carried out with academia and consultants.** Fundamental differences between these types of relationships shape the work and expected outcomes.

Academic researchers are generally more interested in solving unique problems and publishing their discoveries than in developing commercial products or services. However, confidentiality and the commercial potential of the fruits of their research are usually foremost priorities for corporate partners.

These differences underscore the need for conversations about non-disclosure and intellectual property agreements at the outset. We find NDAs are usually only needed when the company intends to share data and/or confidential information about their practices. But even in these situations, it is often possible to set boundaries for information sharing with no formal NDAs. Of course, if the company prefers a formal agreement, that is fine. A notable difference between academic research and consultancy is that the former aims to solve problems without existing solutions, whereas the latter re-applies known solutions in different environments or with slightly different conditions. Hence, the nature of the work and the time required to complete it are quite different.

An example is a project MIT CTL completed for the sports apparel company Reebok some time ago. Details of the project are in the public domain. Reebok wanted to improve its demand forecasts for NFL jerseys after Sunday games. Our research team determined the answer was not better forecasting, but improved responsiveness and suggested a supply chain design that delivered more rapid responses. A consultant may have pursued only state-of-the-art methods for forecasting demand.
Make sure you have the right data. This requirement applies to any research initiative. It is prudent to expect a substantial data-cleaning component of the project you want to pursue. In our experience, the extra time required for collecting and cleaning data can increase a company’s time estimates for this work fourfold.

Allocate the resources needed to support the project. Again, this may seem obvious, but remember that an academic department will not have student or faculty resources standing by to meet unexpected demands like a commercial partner might offer.

Also, suppose an academic research project has a relatively low priority within your busy organization. In that case, it might not command the attention—especially from your subject matter experts—that it needs to accomplish its goals. Schedule regular status project meetings to monitor progress and resource needs.

Matching outcomes with needs
For many companies, ready access to research has become a competitive necessity as the pace of change speeds up, and they grapple with increasing supply chain complexity and market volatility. The rapid advance of innovative technologies such as artificial intelligence and the growth of automation also put a premium on new knowledge.

In this environment, innovation in and of itself is not enough. These pressures, and the importance of building on past successes, elevate the need for long-term research relationships.

One of the most important benefits academic researchers can offer is to fulfill the role of honest brokers; a source of objective, thoughtful feedback not beholden to a commercial agenda. We find companies appreciate the opportunity to refine their research goals with researchers who have deep knowledge about a particular field or application.

For their part, working with industry partners keeps academic researchers in touch with real-world problems and demands, and less prone to becoming overly focused on theory.

However, to realize these benefits, both parties need to be cognizant of their respective needs and shape research agendas accordingly.
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Supply chain network design for success

Three tactics to tell a compelling supply network design story to senior stakeholders.

By Marianna Vydrevich and Nari Viswanathan

Accurate modeling of a company’s supply chain network provides insights into optimal production, storage locations, and raw materials supply network strategy. The modeling process can last from one day to several months, and the supply network design team might run hundreds of scenarios and simulations over the course of a project. Once that work is completed, conveying the findings to senior stakeholders can become a fundamental challenge. How does one turn analytical insights into strategic directional business recommendations? In our experience, there are three fundamental tactics for effective supply chain network design storytelling.

It is impossible to move forward without the stakeholders being fully on board

Throughout business history, management commitment is the recurring ingredient for project success. Stakeholder feedback is what keeps the wheels spinning. Only by having their buy-in, engagement, and support from the beginning through the end of each modeling cycle can the supply network design team achieve success by developing compelling, actionable, and specific business recommendations.

The process of summarizing recommendations isn’t simply about minimizing costs or maximizing efficiency—it’s about uncovering value. Through data storytelling, you can address essential questions about business performance and company priorities: What’s the story behind your sales trends? How do different factors influence your lead times? Where are your opportunities for improving the bottom line?
The following three tactics will allow network design teams to more effectively engage with data storytelling to convey important messages to stakeholders.

**Tactic #1: Present pearls, not oysters**

Picture this: you have just opened a hundred oysters in search of a few precious pearls. It was a painstaking process, and now your task is to share these treasures with the team. When it’s time to communicate your analysis, think of yourself as a storyteller, narrating a grand adventure. Your story isn’t about all the oysters you opened; it’s about the discovery of the pearls.

It’s easy to fall into the trap of showing your audience the entire journey. You might feel the urge to display every piece of data you have, every oyster you cracked open as a testament to the thoroughness of your exploration. After all, you’ve spent hours analyzing and you want to demonstrate the breadth and depth of your work. But opening all those oysters can be overwhelming and time-consuming.

Instead, focus on the pearls (as described by Knafl, C.N. in the essay “Storytelling with data: a data visualization guide for business professionals,” Wiley 2015) — the critical insights that emerged from your analysis. These are the core results of your story. The goal is to transform your complex data into digestible, relatable information that senior executives can easily comprehend and appreciate.

In the process of preparing a presentation for stakeholders, focus on delivering key insights and actionable outcomes instead of overwhelming them with all the scenarios and models evaluated during the analysis. This means avoid opening the meeting with “we ran fifty different scenarios” or “we compared two hundred forecasting models.” Remember, your audience doesn’t need to open every oyster—they need the pearls.

**FIGURE 1**

**Three tactics**

PEARLS, NOT OYSTERS

Delivering **key insights** or “pearls,” rather than overwhelming the audience with the exhaustive details of the data analysis process or “oysters.”

QUANTIFY EVERY STEP

Adopting a **scientific approach** to conduct factorial design; the importance of individual factors and their combinations to the end result.

EXPLAIN THE SUBOPTIMAL

Articulating why alternative solutions are less effective to deepen stakeholders’ understanding of the problem dynamics.

Source: Authors
Tactic #2: Quantify every step

In demonstrating this approach, consider the example of a stakeholder raising the challenge to the network design team to determine the cost-benefit of a 10% production rate increase across all production plants. Assuming that the baseline scenario has already been created, this might initially appear as a straightforward task.

We can very quickly determine that the 10% rate increase across all of our plants results in $5M in savings per year. Is this the message that we want to convey? It is best practice to anticipate possible challenges to scrutinize the response and think about further challenges that could follow.

- Will this answer encourage discussions between stakeholders?
- Does this answer drive additional decision-making?
- Does this answer enhance the stakeholder’s understanding of the network’s dynamic behavior?

The responses to these queries imply that the answer will merely trigger a cascade of further inquiries which the supply network design team should have anticipated and prepared a response.

Returning to the original question of a 10% rate increase, a good answer might look like this: “The 10% rate increase across all of our plants results in $5M savings/year in a flat market, $2M from a rate increase at plant 1, and $1.5M from a rate increase at plant 5. However, even a marginal 5% drop in the industry volume would negate these savings for all plants, except for plant 5.”

Approaching this task is in many ways similar to conducting a scientific experiment. The process of evaluating individual contributors and their combinations is often seen in experimental design. In experimental design, the process of evaluating individual factors (contributors) and their interactions (combinations) is often done through factorial design. This includes methods like two-factor or multi-factor analysis, where scientists test multiple variables at once to see their individual and combined effects.

To deliver the recommendations with the reliability of a scientist, the network design team must develop a scenario for each change to assess its impact. In this case, it would be assessing the impact of increasing the production rate at each plant individually and then in combinations.

It is very common in network design practices not to get a loaded question; but, it is the ultimate practice of the team to present a loaded answer. Let’s consider another example to illustrate this: if the question on the table is to “identify the best location to produce a new product,” it is deceitfully simple to use the demand projections, find the optimal location, and finish there. However, you should always look at the full business context of cause and effect. If this new product has a very slow run rate, the outcome will cause a negative impact/consequence on the whole network. It is critical that the team not only considers the obvious intended consequences/causes, but also identifies and considers unintended consequences/effects.
The recommendation in this case should not only be about the best location but should also emphasize reassessing the assumptions about the product in question.

**Tactic #3: Explain why other solutions are suboptimal**

You are in a room full of senior stakeholders. You have just recommended a particular course of action based on your supply network design model, explaining how it would bring substantial cost savings, increased efficiency, and better customer service. But then, a question arises: “Why not do this another way? Why not adopt this alternative solution instead?”

Herein lies the challenge—and opportunity—for the network design team. Showcasing why other solutions are suboptimal is as important as demonstrating why your solution is the most favorable one. This doesn’t mean simply dismissing these alternatives as inferior. Instead, it involves demonstrating the nuances of these alternatives—the potential challenges, the higher costs, and the inefficiencies—that make them less than optimal compared to the total supply network value created by the recommended solution.

For example, consider a scenario wherein your team was instructed to find the best way to increase manufacturing output across the supply network. Your recommendation is to move the manufacturing of problematic product A from plant 1 to plant 2. An alternative solution suggests stopping the manufacturing of product A, which you, as the supply network design expert, know not to do: it will cause a drop in demand across product categories.

Your objective is to illuminate and make visible these implications to your stakeholders. It’s about painting a clear picture of the potential pitfalls and the chain of events that would follow. The result is that you not only validate your preferred solution but also enlighten your stakeholders about the intricate dynamics of supply network design and behavior.

Explaining why other solutions are suboptimal isn’t about winning an argument. It’s about fostering a deeper understanding among your stakeholders. It’s about sharing the complexities of supply network design in an engaging, relatable way that leaves your audience feeling informed, enlightened, and ready to embark on the journey ahead.

**Conclusion**

In supply chain network design, the magic lies in the narrative. As a supply network professional, your objective isn’t merely to design efficient networks. It’s to use your data to tell compelling stories that inspire, enlighten, and persuade. You are the narrator of your supply network story. You have the power to make it worth listening to. Your tale of strategy and optimization, of risk and reward, and of innovation and impact is waiting to be told. It’s time to take the stage and share your compelling supply network design story with your stakeholders. It’s time to let your story shape the future of your supply network.

**About Global Links**

Global Links appears in each issue of Supply Chain Management Review. Richard J. Sherman, retired guru of SCM, is the Global Links column editor. If you are interested in participating in the column, he can be reached at rsherman@goldanddomas.com.
Balanced supply chain management: MANAGING AT THE EDGES

By Steven A. Melnyk, Nick Little, and Lee Levy II

As supply chain management silos have broken down, most of the critical management activities today take place in areas few understand.

In this, the second of the four-set series of articles on balanced supply chain management, we will continue the exploration of what balance means and why it is important. However, the set of tensions explored in this article share a common theme—they deal with managing at the edge—focusing on interfacing with other groups or articles (either within the firm or with suppliers or customers). Driving this focus is the realization that the modern effective supply chain manager can no longer live or manage in a supply chain management silo. In today’s environment, most of the critical activities and tensions involving the supply chain manager take place at the edges. Yet, the challenges of managing at the edges are often poorly understood or even comprehended. Consequently, it makes sense to focus this article on these challenges.
Steven A. Melnyk is a member of the department of supply chain management at the Eli Broad College of Business at Michigan State University. He can be reached at melnyk@msu.edu.

Nick Little is the director of the Railway Education Center for Railway Research & Education at the Eli Broad College of Business at Michigan State University. He can be reached at littlen@msu.edu.

Lee K. Levy II is a retired Major General of the USAF, and CEO of The Levy Group, LLC. He is a doctoral candidate at Vanderbilt University and holds the Directorship Certification from the National Association of Corporate Directors. Levy can be reached at lee@thelevygroup.net.
Understanding what it means to manage at the edges?

The concept of managing at the edges was first introduced by author Steven A. Melnyk in a 2016 Supply Chain Management Review article, “The emergence of the strategic leader.” Then, it was discussed in terms of “cross-boundary, coordination.”

To better understand this notion, consider Figure 1. This figure was initially developed for a long-term corporate program developed by Michigan State University. At the heart of the figure is the supply chain manager. The SC manager must work with four groups: superiors, subordinates, upstream (suppliers), and downstream (customers). Each group is critical to the long-term success of the supply chain manager; the supply chain manager must work with each group. However, each group often has a unique perspective with views that often overlook critical issues—issues where the supply chain manager can offer important insights. Each group often has its own “language” and organizational biases (which often distort outcomes). The presence of a separate language means that the supply chain manager must be able to communicate with each group in terms that make sense to them. These communication flows are bi-directional—going from supply chain to the other groups and from the other groups to the supply chain. These issues form the foundations of this article. Before leaving Figure 1, it is important to understand the importance of the three circles found in this figure. The first circle closest to the center represents the immediate suppliers, subordinates, customers, and superiors; the second circle—the ultimate groups, and finally, the outer circle represents external elements such as technology, government, geo-political, the competition, and key stakeholders.

This outer circle is important because the changes taking place within this outer circle ultimately influence the behaviors of everyone in this diagram.

In this article, we will focus on the following “managing at the edges” tensions central to balanced supply chain management.

- Embracing complexity ↔ encouraging simplicity.
- Supply chain excellence ↔ business excellence.
- Expectations of top management ↔ needs of operational personnel.
- Focusing on costs ↔ focusing on other supply chain outcomes.

Embracing complexity ↔ encouraging simplicity

Before we begin this discussion, let’s make sure that we understand the difference between complex and complicated. Many managers and researchers treat these two terms as if they are interchangeable and they are not. As noted by Lars Magnusson, currently an ASCM board of directors member and supply chain
expert, complexity comes from the customer. It is anything that the customer wants and is willing to pay for. In contrast, complications are whatever we do to ourselves that unnecessarily increase cost and/or lead time, or adversely impact quality and innovation. From this perspective, complications form targets that we should be continuously focused on identifying and eliminating if possible. We encountered a quality problem due to parts coming in from a supplier; in response, we put in an inspection step into our current process. We resolve the problem with unacceptable quality parts. Yet, we still have an inspection—that is complexity. Once the quality problem was resolved that inspection should have been eliminated.

Yet, if the complexity comes from the customer, then why should we as supply chain managers be concerned? The answer is that we must educate the customer (and, in turn, marketing) about the true costs and strategic implications of complexity. To illustrate this point, consider the following problem facing Starbucks—a problem described in a recent BusinessWeek article (Sirtori, 2023, “Why your Starbuck’s wait is so long,” Bloomberg BusinessWeek).

Strategically, Starbucks offers its customers an affordable luxury in its coffee. What this means is that Starbucks has been willing to allow its customers to customize their coffees. Consider the café latte. Customers are offered choices in size, long shots, how the cup is lined, the type of milk/cream used, the type of sugar used, the type of syrup used, and the specific flavoring. Starbucks deals with three different types of customers: (1) in-store; (2) drive-through; and (3) digital. While each type buys the same type of café latte, what they want is very different. The in-store customer wants a cup of coffee to drive to the store and they are willing to wait for it. In contrast, the drive-through customer wants speed. Once they get in line, they want to place their order and get out as soon as possible. Finally, the digital customer wants to place an order (and pay in advance) with the assurance that it will be available at a specific time. Furthermore, all three customers are served with the same process. So, what is wrong with this situation?

Currently, Starbucks has found that it is not $7 for a grande blonde vanilla latte that is bothering customers, it is the long wait time. The time from placing an order to being served now exceeds five minutes for more than one-third of customers. Consequently, some customers are not picking up their café lattes, even though they have paid for it. If you have paid $7 for your café latte and it is not there when you expected it to be, then there is a very good chance that you may not be returning to Starbucks. The company has potentially lost a customer forever. It is in this situation that the supply chain manager can provide real insight.

They can point out the implications of allowing customers to completely customize their café lattes. For example, when all the options for a café latte are considered, a customer can order up to 383,201,280,000 different and unique versions. The implications of this breadth of choice are staggering: these options generate higher lead time variance and adversely affect service time; more inventory has to be stocked and managed (remember in many cases, we are dealing with perishable items); staff training has been made more complicated; and we have more room for error. Second, one process cannot be expected to adequately meet the needs of these three customer segments. If we want to effectively service these three customer segments, then we must invest in three separate processes—one for each customer segment.

In other words, we must carefully and completely identify the implications of complexity both operationally (inventory management) and strategically (how it affects our ability to meet or exceed the expectations for each segment).

Before leaving this segment, it is important to note that balanced supply chain management requires mutual education and learning. We, as supply chain
managers, must learn about our customers (specifically our key customers); we must educate other areas (such as marketing) about what their supply chains can and more importantly cannot do. We must understand how we compete (and how we lose customers—consider Starbucks and the long lead times) and how we differentiate ourselves in the marketplace.

**Supply chain excellence ↔ Business excellence**
This second tension flows out of the preceding discussion. This tension focuses on how we define success, and how the parent organization defines that success. Two extremes are underlying this tension. The first is being the best in terms of supply chain performance; alternatively, the focus could be on overall business excellence. At first glance, this tension can be effectively resolved simply—by focusing on business excellence. Yet, the challenge here is that business excellence is impacted by numerous factors—many of which, such as budget constraints, are outside the control of supply chain management. In contrast, supply chain excellence is under the control of the supply chain manager. However, the tension here is that sometimes the actions that the supply chain manager takes can adversely affect the ability of the firm to implement or change its strategy quickly. A good example can be found in the experiences of a large American-based farm equipment manufacturer during the 2010 farming boom.

Before this boom, the supply chain group had decided to focus its attention on becoming the leader in “lean” supply chain management. The reason for this focus—to help reduce cost. By 2010, the supply chain group had achieved this objective. Yet, 2010 was a period of rapid change for the American farmer.

Poor harvests in China, Russia, and Europe had created a sudden demand for American wheat and other grains. By March 2010, most American farmers knew that they had to increase capacity if they were to meet this sudden uptick in demand. This meant investing in farming equipment, with the expectation that this equipment would be in place by the start of the growing season.

Farmers who had long bought this company’s equipment (the company had a great reputation for brand loyalty) visited their dealers in February and March to place orders. The prices quoted for the desired products were great—the lowest in the market. The problem, however, was delivery. Most farmers found out that they could not expect delivery until late October or early November—far after the end of the farming season. When faced with this reality, many farmers decided that availability was more important than brand loyalty and they turned to products offered by competitors—products that while higher priced offered one major advantage—they were available.

What the company had learned, through the school of hard knocks, was that lean, while excelling at reducing costs through attacks on waste and reduction of variance, was not sufficiently responsive when faced with large and sudden shifts in demand. Consequently, the definition of supply chain excellence had to change and with that change, the systems used to achieve that excellence had to also change or, at least, be modified.

This tension between supply chain excellence and business excellence can only be resolved when the supply chain manager clearly understands the corporate strategy but also is in constant contact with the customer. As changes in the environment and the expectations of the customer become evident, the supply chain manager must be willing to reassess and adjust the supply chain strategy when it is no longer consistent with the new realities.

**Expectations of top management ↔ Needs of operational personnel**
The third tension is one that most supply chain managers are familiar with. Supply chain management must realize that they have to balance the needs of these two groups, which are often not quite in synch. Top management is interested in outcomes; they want to know what has not happened, not how. They are interested in knowing how supply chain management
can affect the firm’s ability to compete. This impact can occur at the following three levels.

- **Better, faster, cheaper.** This is the lowest level of impact and the one with which most supply chain managers are familiar. It is focused on cost savings. However, it is important to understand what generates these savings. Essentially, in the past, one or more errors took place within the supply chain. These errors have now been identified and corrected. These are also the easiest types of impacts to demonstrate since they can be captured using existing cost accounting systems.

- **Cost avoidance.** One step up from better, faster, cheaper is that of cost avoidance. In other words, avoid making the investments that ultimately led to the cost savings in the first place. While potentially more attractive, these types of impacts are more difficult to measure.

- **Customer needs poorly met.** With this impact, the focus shifts from cost to revenue (from the bottom line to the top line). These types of impact are far more attractive to top management because they represent growth. Again, at the heart of this impact is an understanding of the key customer(s), their needs, the value proposition, and how the supply chain can be used to address these needs. It is here where technological changes are most effectively felt.

- **Costs needs not met.** This final impact is the home run of impacts. It is here that the supply chain can address a need that the key customer did not realize they had or that they realized they had but no one could address it.

  Success with these impacts is dependent on being customer-centric (see the prior article in this series, SCMR, May/June 2024). It also depends on recognizing that the language of supply chain management (i.e., fill rates, ppm, Cp/Cpk, TAKT time) is not the language of top management. The language of top management is dollars and cents, and it focuses on output measures. For the supply chain manager, enlisting the involvement of top management involves identifying and understanding the key measures by which top management assesses their progress and then showing changes in the supply chain can positively influence these measures. It is WIIFM (what’s in it for me) in action. The challenge for the supply chain manager is to translate operational improvements and changes into financial terms (this can be done through the Strategic Profit Model, otherwise known as the Dupont Profit Model—an example is found in Figure 2). It also means mastering the language of performance measurement.

  “Top management is interested in outcomes; they want to know what has not happened, not how. They are interested in knowing how supply chain management can affect the firm’s ability to compete.”

In contrast to top management, the operating personnel have very different requirements. They are interested in output measures (which are recorded after the fact). While somewhat informative, such measures are ultimately viewed as punitive because, since the events triggering these measures are already completed, there is nothing that the operating personnel can do to change these negative outcomes. Rather, they are interested in predictive or process-based measures. These are measures based on the processes that can be used to predict the outcomes and which can also be used to help operating personnel identify what can be done to achieve the desired results. For example, if we are interested in competing on speed and reduced lead times, then predictive measures
would focus on the following attributes.

- Number of steps in the process.
- Distance covered by the order.
- Number of people who touch the order.
- Setup times (the higher the setup times, the more likely that we are to build larger lot sizes, thus increasing lead times).
- Percentage of the steps that are operations or transformations (value, operationally defined, consists of three traits: (1) it involves an operation; (2) the customer is willing to pay for that transformation; and (3) it is done right the first time).

With these measures, operating personnel know what they must do—reduce steps, reduce the distance covered by the order, reduce the number of people who touch the order, reduce setups, and eliminate any activity that is not an operation. By the way, the important role played by performance measures is covered in greater detail in Melnyk et al. (2020, 2021).

Operating personnel are also motivated by different factors. They are driven by the four S’s—survival, surprises (eliminating any negative surprise), simplification (making existing systems and processes easier and simpler to manage and understand), and success (being part of a successful activity, department, or company).

Within this context, we see balanced supply chain management as having the manager act as a translator and as a coordinator. As a translator, that person is communicating changes taking place in the supply chain in terms that are meaningful to top management. Similarly, they are communicating top management and strategic directions to the operating personnel in terms that are clear, unambiguous, and meaningful. They are coordinating activities to ensure that what is done on the shop floor is in synch with and supportive of strategic intent.
Focusing on costs ↔ Focusing on other supply chain outcomes

Traditionally, supply chain managers have focused on cost and cost savings/reduction. There is something satisfying about this focus. Costs and cost savings are something that everyone can agree are important. Everyone can understand and appreciate the importance of costs and cost savings. Yet, the supply chain manager must understand that costs and cost savings, while important, are not enough. There are additional outcomes that customers want and are willing to pay for. These include the following.

- **Responsiveness.** The ability to respond to changes in demand (volume, mix, location) quickly and at a reasonable cost.
- **Security.** Ensuring that supplies coming through the supply chain are protected against threats to quality and that the digital assets of the firm (information technology, intellectual property, and operating technology) are protected from cyberattacks.
- **Sustainability.** Provide goods and services through a supply chain that ensures controlled and minimal resource impact both today and, in the future, and that ensures that people at all levels are appropriately treated and nurtured.
- **Resilience.** Develop a system that can identify, monitor, and reduce supply chain risk and disruptions, as well as react quickly and efficiently to these threats, thus offering its customers “peace of mind.”
- **Innovation.** Provide key customers with a stream of goods and services that not only are new but also address needs that the competition has either neglected or poorly addressed. Innovation also focuses on changes in process, business models and the supply chain.

Each outcome requires a different type of supply chain structure and supply chain practice. No one supply chain system can adequately address all of these needs simultaneously. The challenge for the supply chain manager is that of determining which outcome is most attractive to the firm’s key customers and recognizing the need to reconfigure supply chains if and when needed.

“The challenge for the supply chain manager is that of determining which outcome is most attractive to the firm’s key customers and recognizing the need to reconfigure supply chains if and when needed.”

**Conclusion: Part two**

In this second article, we have focused on the theme of managing at the edges. This skill, part of the requirements for the new supply chain leader, as set down by Melnyk in 2016, introduces its own set of tensions. We have explored only four. Yet, from this discussion, we can see an image of balanced supply chain management as being one where the supply chain management actively engages others, recognizes the importance of measures as communication, tailors the message to the audience, and attempts to balance success at the micro level (the supply chain) with success at the macro or business level. The supply chain manager is both an active learner and an active teacher. This vision requires new skills and capabilities. Yet, it can be argued that developing supply chain leaders with these skills and capabilities benefit the supply chain, benefits the firms, and it benefits the customer.

We will continue this exploration of balanced supply chain management in the next article.
In 2014, SAP Business Consulting conducted its initial study to understand companies’ visions for digital supply chain management. Based on numerous interviews with supply chain executives from different industries, these visions were exciting: many innovative technologies were emerging, a set of 120 use cases was compiled, and companies demonstrated a willingness to invest and experiment with these innovations. Companies explored interesting ideas like the 3D printing of Lego bricks, social media data for forecasting, mini-factories, super-fast bill of material explosion, and last-mile delivery by drones—many of them quite visionary at that time. Now, a decade later, we have completed a follow-up study in collaboration with Kühne Logistics University to examine the current state of digital supply chain journeys, the application of emerging technologies, and the evolution of corporate expectations on digital supply chain technologies as the hype has faded.

While often hyped, the adoption of digital technologies for supply chain management has frequently failed to meet the expected results. We examine how to successfully embark on the digital transformation journey.

What really works in the digital supply chain?

Dr. Joerg Wilke, Dr. Andre Brunner, Dr. Kai Hoberg, and Rod Franklin
Dr. Joerg Wilke is head of the SAP business consulting practice for supply chain management. He can be reached at j.wilke@sap.com.

Dr. Andre Brunner is a chief enterprise consultant at SAP in Walldorf. He can be reached at andre.brunner@sap.com.

Dr. Kai Hoberg is a professor of supply chain and operations strategy at the Kühne Logistics University. He can be reached at kai.hoberg@klu.org.

Rod Franklin, Ph.D., is a professor of logistics practice at the Kühne Logistics University. He can be reached at rod.franklin@klu.org.
After discussing with numerous supply chain executives (old and new ones) their real-life experiences, we find that companies’ perspectives have changed. Our research indicates that successful companies adopt a pragmatic approach to their digital supply chain initiatives. We observed a scaled-down and delayed implementation of digital technologies, with fewer companies adopting them than expected. This shift can be attributed to an underestimation of the complexity of use cases, a misunderstanding of the capabilities and limitations of digital technologies, and the companies’ level of technological readiness. Organizations often struggle with immature technologies, a shortage of skilled personnel, and inconsistent data management when embarking on a digitalization journey. In contrast, a few “early adopters” have found ways to leverage certain digital innovations quickly to gain competitive advantage—predominantly driven by industry clock speed and significant upfront investment in technology and skills.

Contrary to the broad digital ambitions initially envisioned, firms are now prioritizing technologies that address clearly defined problems and provide rapid returns. Companies in our interview sample focused on projects that aim to improve fulfillment reliability, minimize supply chain disruptions, or add immediate value to the customer. The changing corporate environment, characterized by heightened volatility, stronger competitive pressures, and complex operations, constrained by limited resources, had contributed to this change in ambitions.

### Examples of successful and failed SC technology project

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<thead>
<tr>
<th>Successful SC technology projects</th>
<th>Failed SC technology projects</th>
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<tr>
<td><strong>Machine learning review of customer forecasts</strong>&lt;br&gt; An automotive supplier receives regular short- and mid-term demand forecast updates from OEMs. While the short-term forecast is typically quite accurate, the quality of the mid-term data varies significantly due to the bullwhip effect, rationing and other reasons. To improve the forecast quality the company implemented machine learning algorithms to analyze deviations between recent forecasts and later call offs. This enables them to learn about the statistical accuracy of OEMs’ forecasts and provide recommendations for adjustments to internal demand planning.</td>
<td><strong>Condition-based monitoring in logistics</strong>&lt;br&gt; A chemicals company tried to implement a concept of condition-based monitoring in logistics. Special pallets were equipped with IoT sensors to provide real-time information on the location, temperature, and other conditions of goods in transit. The intention was to enable a rapid response to any abnormality or disruption. However, the company encountered major hurdles in replacing standard pallets with the new “IoT pallets” throughout the logistics process, and in convincing supply chain partners to adopt the new technology. The maturity of sensor technology was also perceived as inadequate at the time.</td>
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<td><strong>RPA for processing incoming orders</strong>&lt;br&gt; A company providing specialist chemical products and additives in the B2B sector initiated an RPA project to automatically process incoming orders from their distributor customers, and to transfer a consolidated record of them to the central ERP system. Their intention was to accelerate the order process, reduce errors, and save operational costs. Their main challenge was the need to harmonize and align data formats across all the distributors involved. However, this could be effectively achieved.</td>
<td><strong>Selling data from own logistics operations</strong>&lt;br&gt; A leading logistics service provider discontinued a project aimed at selling data derived from its own logistics operations and external sources. The target customers were financial institutions that need accurate logistics data for predicting trade patterns and correlated economic indicators. Artificial intelligence, machine learning and cloud computing were the main technologies employed. However, the failure of this project was not caused by any deficiency in the core idea or supporting technology. Rather, the plan was considered too remote from the company’s core business and entering a new market proved too difficult.</td>
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<td><strong>Track-and-trace sea freight</strong>&lt;br&gt; A leading pharmaceutical and FMCG company successfully implemented a cloud platform for tracking and tracing sea freight. The platform connected shippers, forwarders, carriers, and retailers, yielding not only global visibility of shipments, but also synergies in the procurement of transport services across multiple markets. Before the implementation, market units managed their own transportation. With this platform, the company achieved economies of scale, lower freight rates and internal operational efficiencies.</td>
<td><strong>Digital twin for supply chain</strong>&lt;br&gt; A German automotive supplier tried to build a comprehensive digital twin for simulating all kinds of scenarios in its production and supply network. Given the many different variables, decision rules, and cause-and-effect loops that had to be taken into account, this project quickly became unworkably complex. The lesson learned was to begin any future attempt with a small-scale pilot rather than an entire network.</td>
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Source: Authors
In this article we aim to provide a realistic perspective on what is needed to successfully deploy new digital technologies for better supply chain management. We take a closer look at the technologies that offer the biggest potential and outline key factors for the success of digital projects. Finally, we provide insights into the practical realities of adopting digital technologies in supply chains, underscoring the need for focused strategies, clear management support, and thorough execution.

The supply chain world has become more interesting, and more difficult

The digitalization of a supply chain cannot be done in isolation from the dynamics of the environment surrounding the supply chain. And, these dynamics have been very challenging for most companies over the past several years. External challenges resulting from the COVID-19 pandemic, geopolitical disruptions, climate change, and volatile economic conditions have forced supply chain managers to re-evaluate their global footprint, diversify risk, and shorten supply lines to create more resilient supply networks. Organizations are struggling to find qualified staff, both for new roles such as data scientists and AI specialists, and for more traditional supply chain roles such as transport drivers and warehousing personnel.

If the challenges posed by these external events weren’t enough, implementing solutions to address their impacts—such as near-shoring, increased safety stock, network redesign, and improved planning—has put yet more pressure on today’s supply chain professionals. To cope with the complexity of this new normal, supply chain managers are increasingly turning their attention to new technology. Thanks to technological advances (e.g., the maturity of cloud computing, improved algorithms, increased computing power), supply chain technology is becoming more sophisticated and capable. At the same time, budgets and resources for experimenting and implementing these technologies are often limited.

Most managers understand that aiming to revolutionize entire supply chain processes with new and potentially untested technology is extremely risky. Even use cases that seem simple can easily fail (see Table 1: Examples of successful and failed SC technology projects). A key question that managers need to answer is where to start deploying emerging digital technologies in their supply chain. Given the number of digital technologies and the different processes in the supply chain, this is certainly not an easy question to answer.

We solicited the insights of experts, asking them to suggest promising combinations of processes and technologies that could yield the greatest potential for practical use cases. With eight business processes such as design, planning, and sourcing, and 14 prominent digital technologies under consideration, we developed a total of 112 possible combinations. From the experts’ input, we constructed a heat map using a process-technology matrix to represent the use cases that companies were either exploring or considering (see Figure 1).

FIGURE 1
Process and technology heat map

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<thead>
<tr>
<th>Artificial intelligence (AI) and advanced analytics</th>
<th>Design</th>
<th>Plan</th>
<th>Source</th>
<th>Operate</th>
<th>Make</th>
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<td>Cloud and edge computing</td>
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Technologies for improving the customer experience enhance the customer journey and improve their experience of interacting with the organization. To meet the dual challenges of intensifying competition and growing customer expectations, numerous firms are investing in technologies directly affecting customer experience. Innovations such as tracking and tracing, chatbots, and customizable digital platforms are transforming how customers interact with companies. A notable initiative is a paint manufacturer’s app that lets customers virtually test paint colors at home using augmented reality, coupled with an automated production process for customized orders. This approach not only revolutionizes the customer experience but also offers significant implications for the supply chain and e-commerce models.

Automating digital operations enables an organization to streamline tasks along the supply chain by, for example, using robotic process automation for order management. Given the surge in decision-making complexity (e.g., with more granular planning on product and location level), there is a need to manage escalating supply chain workloads amidst limited human resources. By automating processes and reducing the need for manual intervention, companies can handle increasing system and product complexity more efficiently. An example is an e-commerce company that has automated inventory management to minimize reliance on manual decision-making. These innovations reflect a strategic shift toward enhancing system-driven decision-making and efficiency in supply chain management.

Four key application areas are emerging

The distribution of company interests across this matrix is decidedly uneven. For instance, while technologies like 5G garner limited attention across the board, others, such as augmented reality and computer vision or autonomous vehicles and robots, stir up more interest within a few specific processes. As anticipated, technologies such as artificial intelligence and advanced analytics attracted interest across virtually all processes. Based on the experts’ responses, we have identified a particularly intense focus on digital adoption in four key application areas. Owing to their diverse yet integral roles in supply chain management, these appear to be the frontrunners for the adoption of digital technologies in many companies.

Advanced analytics in planning and operations is leveraging big data, machine learning, and artificial intelligence to increase knowledge of—and visibility into—supply chain operations. Advanced analytics is capable of processing vast data volumes, enhancing forecasting accuracy for demand, yield, and lead times. Companies prioritizing improving demand forecasts and identifying service failure causes, find machine learning solutions particularly promising. For example, a high-tech company analyzes customers’ reactions to service failures to prioritize production plans accordingly. However, given all the potential benefits of advanced analytics, managers need to deepen their understanding of its limitations, recognizing that unpredictability remains and not all decisions can be improved through analytics.

Integrated planning with digital platforms connects demand, supply, and distribution planning within the organization and between its upstream and downstream partners. In response to the often still unpredictable nature of supply and demand, companies are increasingly adopting digital technologies to enhance planning agility. Utilizing digital platforms and digital twins facilitates a unified data source, enabling more responsive adjustments to market shifts. For example, a leading semiconductor manufacturer has developed a digital twin of its entire supply chain that allows it to simulate and finetune operations end-to-end. This move, from isolated to integrated planning, supported by real-time supply chain status data, exemplifies modern strategies for overcoming volatility.

Viability and feasibility of technologies

To deepen our understanding of the various technologies’ potential, we invited the participating supply chain experts to share their experiences with the technologies they have implemented. We asked them to characterize each implementation in two dimensions: viability and feasibility. The results are shown in Figure 2. Viability (on the x-axis) refers to the expected value of a technology implementation in terms of costs and benefits. Feasibility (on the y-axis) refers to the perceived ease of implementation.

We find that autonomous vehicles and robotics technologies have demonstrated high value and feasibility. Companies are effectively leveraging AGVs, robots, cobots, and autonomous forklifts...
realizing substantial benefits in shop floor and logistics operations, showcasing the maturity and practical applicability of these solutions. While AI and advanced analytics are viewed as highly promising, their application has yielded mixed results. High expectations are often met with challenges in implementation, primarily due to the need for skilled experts like data scientists for developing and training models. This situation has resulted in a split between the anticipated value and actual feasibility, highlighting the complexities involved in harnessing these technologies successfully. On the other end of the spectrum are technologies such as blockchain and digital twins: They have considerable challenges in terms of feasibility and practical application. Blockchain projects often lack a clear business case, and digital twins have struggled with the complexities of modeling and simulation, making these technologies less viable in the current landscape.

**Pragmatic vs. strategic technology adoption**

Most companies we talked to have elected to follow a pragmatic approach toward technology adoption that is driven by the necessity of a clear business case and a short-term return on investment. Despite the initial enthusiasm for new technologies, as in the early days of RFID, the current trend emphasizes technologies with clear and immediate business benefits. The unanimous sentiment across different sectors and roles is the need for new technologies to solve specific business problems and ensure a rapid ROI, underscoring a shift from technology-driven to need-driven implementations.

This pragmatic, results-oriented focus (see Figure 3) is critical for organizations aiming to navigate the hype and genuinely benefit from digital transformations. With all the media hype surrounding

![Portfolio of implemented use cases](image)

**FIGURE 2**

<table>
<thead>
<tr>
<th>Applied technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Artificial intelligence (AI) and advanced analytics</td>
</tr>
<tr>
<td>Internet of Things (IoT)</td>
</tr>
<tr>
<td>Individual and intelligent products</td>
</tr>
<tr>
<td>Conversational systems</td>
</tr>
<tr>
<td>Unmanned vehicles and robotics</td>
</tr>
<tr>
<td>Digital platforms and business networks</td>
</tr>
<tr>
<td>5G</td>
</tr>
<tr>
<td>Cloud and edge computing</td>
</tr>
<tr>
<td>Blockchain</td>
</tr>
<tr>
<td>Augmented reality and computer vision</td>
</tr>
<tr>
<td>Wearables</td>
</tr>
<tr>
<td>Digital twin</td>
</tr>
<tr>
<td>3D printing and scanning</td>
</tr>
<tr>
<td>Robotic process automation (RPA)</td>
</tr>
<tr>
<td>Others</td>
</tr>
</tbody>
</table>

Source: Authors

new digital technologies, one could be forgiven for assuming that organizations that do not immediately implement these cutting-edge technologies would be left behind. The reality is that organizations that follow a pragmatic approach to testing various digital technologies in their operations will be clearly aware of the opportunities and challenges. They are more realistic in where they might apply digital technologies and what benefits they might yield from an economic and operational perspective. As the supply chain manager of an agrifoods company states, it is the business need that drives technology implementation, not technology hype.

In sharp contrast, long-term investments in technology are mostly confined to a few industry pacemakers with advanced capabilities which are...
often categorized as strategic research rather than immediate operational problem-solving. The drive toward technological superiority is not just about keeping pace with competitors but about fundamentally altering the competitive landscape. These organizations, operating in sectors where technology directly influences market standing, are more inclined to invest in and experiment with cutting-edge digital solutions like AI, digital twins, sensors, and blockchain, even if these technologies do not promise immediate payback for the selected use cases.

Barriers and factors for success

While the promise of new digital supply chain technologies is large, many implementation projects fail due to some common barriers that are often underestimated. First, often immature technologies are hyped as being ready for prime time when they are at best in the beta testing stage. Frequently, a technology fails to meet the performance standards necessary for the harsh realities of day-to-day operations (e.g., augmented reality in picking).

Second, projects often struggle due to a lack of skilled personnel for the implementation and rollout. New technologies often require new skill sets and new talents (e.g., data scientists for ML, simulation experts for digital twins) that are frequently unavailable internally and in high demand externally. Finally, poor data quality, lack of data and fragmented IT systems often drive tremendous implementation effort. Whenever advanced analytics is involved, the data foundation is key. This requires a high degree of data harmonization, which is difficult to achieve when IT systems are highly fragmented and data harmonization is still an unsolved problem.

Some companies that have been successful in supply chain technology projects credit their success to up-to-date and integrated IT systems and a strong global IT team—or even a separate department that drives the digitalization of the company. While not every company has the benefit of these luxuries, we identified multiple success factors that significantly increased the chances for success. First, companies require clear commitment from management and partners as setting strategic directions with

FIGURE 3

Strategies for use case selection

Challenges
With so many different technologies and solutions available to support the different business processes, the challenge is to decide where to invest, in which technology, and how many projects to initiate (especially if investment funding and talent is limited).

Strategies
Even for mature companies, creating supply chain use cases is complex, so strategic visions and roadmaps are important. For less mature companies, the selection process is easier as they align projects pragmatically with specific business needs, such as solving a problem like poor planning or low visibility. Of course, in both cases, management support, investment budgets and change management must be available.

Benefits
By selecting and implementing the right uses case, companies can gain multiple advantages, including:

• improving performance, better customer experience, or freed-up resources (direct impact);
• developing further use cases more easily based on technical experience gained;
• achieving buy-in from top management; and
• increasing team motivation.

Source: Authors
Digital supply chain: A decade on

As our insights highlight, there has been a significant shift in the focus of supply chain executives toward technology since our original 2014 study. Initially, emerging technologies presented exciting yet uncharted opportunities for supply chain improvements, fostering an atmosphere of optimism regarding their capabilities and potential applications. However, a decade later, influenced by hands-on experimentation and evolving market dynamics, supply chain leaders now adopt a much more pragmatic stance, focusing on technologies that offer tangible benefits.

We find that digital technology implementations in supply chains have occurred, predominantly for use cases that solve ongoing problems and provide payback quickly. Many pilots were abandoned due to complexities, technological immaturity, or lack of data. Despite these challenges, the interest in adopting digital solutions remains strong, particularly for advanced analytics, integrated planning, improving customer experiences, and automating operations. This ongoing interest is tempered by a requirement for clear business benefits and measurable outcomes.

Our findings should not come as a surprise to anyone. Businesses are, to paraphrase Milton Friedman, in the business of making a profit. The operational function of a business is to produce goods or services that it can sell. Without a clear contribution to the business’s ability to produce its output with greater efficiency, reliability, timeliness, and/or quality, a technological experiment is an extravagance that few organizations can afford today. Pragmatic decision-making based on a clear analysis of potential is what is required to ensure that the “business of business” remains the focus of the organization.

Summing up our findings, in contrast to the initial enthusiasm for digital technologies, organizations now pursue these innovations with a blend of practicality and strategic focus, reflecting both the altered market conditions and a deeper understanding of how digital technologies can effectively support business goals. This pragmatic approach underlines the evolution of digital technology adoption in supply chains over the past decade.

achievable and consensus-driven goals is crucial for the successful completion of digitalization projects. Garnering support from internal business stakeholders and external partners is equally important. This often goes along with a clearly defined business need. If the business has identified a problem that can be realistically addressed with digital technology, the project definition becomes more straightforward and drives buy-in. Projects initiated in this way are more successful than those driven top-down or that are only technology-focused.

While implementation costs are often difficult to forecast, a strong business case with a solid benefit-to-cost ratio is more likely to be supported by people in various lines of business as they become convinced that their time will be well spent. Finally, digitalization projects need to be supported with professional change management, spanning not just IT but also the whole organization and its business processes. For example, new tools for forecasting and planning are often black boxes and it is difficult to build trust into recommendations as explanations get lost for the users. Here, it is critical to train users, start small, and increase the portfolio of SKUs managed over time as buy-in increases.
Green transportation and logistics:

STRATEGIES FOR SUSTAINABLE SUPPLY CHAINS

By Sudhir Makkar

By understanding the challenges and opportunities in transitioning to a sustainable future, supply chain industry stakeholders can map a path forward.

The transportation and logistics industries are a cornerstone of economic growth and global trade, facilitating the movement of goods and services across borders and continents. However, this vital sector’s reliance on fossil fuels and outdated practices has inadvertently contributed to many environmental challenges.

Sudhir Makkar is a senior manager at Accenture with 20-plus years of experience in North America supply chain and operations. He has worked on 10 full life cycle implementations in SAP transformation programs in the retail, beverage, agriculture, aerospace, life science, pharma, and food and beverage verticals. Makkar has functional and technical experience leading SCM digital transformation strategies and programs for mid and large-scale clients. He can be reached at Sudhir.makkar@accenture.com
From air pollution choking urban centers to the escalation of greenhouse gas emissions exacerbating climate change, the environmental toll of traditional transportation and logistics operations is undeniable. Furthermore, the industry’s unsustainable practices have also taken a toll on natural resources, leading to resource depletion and ecological degradation. The call for sustainability has become increasingly pronounced as governments, businesses, and society grapple with the consequences of environmental degradation and climate change.

Green transportation and logistics represent a paradigm shift in conceptualizing and operationalizing supply chain management. Green transportation and logistics hold the promise of delivering tangible environmental benefits while safeguarding the long-term viability of supply chain operations. This article explores the multifaceted dimensions of green transportation and logistics, exploring the strategies, technologies, and best practices underpinning this transformative approach. By examining the challenges and opportunities inherent in transitioning toward sustainable transportation and logistics, this article seeks to provide insights and actionable recommendations for industry stakeholders.

**Literature review**

In recent years, the concept of green transportation and logistics (GTL) has gained significant momentum as industries strive to address environmental concerns and meet sustainability goals within their supply chain operations. This literature review aims to provide a detailed examination of GTL strategies, focusing on their role in fostering sustainability within supply chains.

Studies have extensively documented the adverse effects of these practices, including air pollution, greenhouse gas emissions, and resource depletion (Sarkis, 2013; Seuring & Müller, 2008). For example, research by Banomyong and Supatn (2019) highlights the significant carbon footprint associated with traditional freight transport, emphasizing the urgent need for sustainable alternatives.

Various conceptual frameworks have been proposed to guide the implementation of GTL strategies within supply chain management. These frameworks emphasize the integration of environmental considerations into transportation and logistics decision-making processes, emphasizing eco-efficiency, multimodal transportation, and collaboration among supply chain stakeholders (Klassen & Vereecke, 2012; Zhu & Sarkis, 2006).

These strategies include the adoption of alternative fuels (e.g., electric, hydrogen), route optimization, modal shift to more sustainable modes of transport (e.g., rail, water), and the implementation of green logistics practices such as consolidation and reverse logistics (Browning & Rees, 2016; Carter & Rogers, 2008). Additionally, advancements in technology, such as telematics, enable real-time driver status for tracking shipment and delivery status, offer opportunities to enhance the efficiency and sustainability of transportation and logistics operations.

Collaboration among supply chain partners is essential for successfully implementing GTL initiatives. The research underscores the importance of fostering partnerships and stakeholder engagement to overcome barriers and drive collective action toward sustainability goals (Ntow-Gyamfi et al., 2020). Collaborative initiatives, such as green freight programs and industry alliances, enable knowledge sharing, resource pooling, and the development of innovative solutions to sustainability challenges.

Studies have examined the effectiveness of regulatory frameworks, such as emissions standards, carbon pricing mechanisms, and incentives for green technologies, in incentivizing businesses to adopt sustainable transportation and logistics practices (UNCTAD, 2021). Moreover, international agreements, such as the Paris Agreement and Sustainable Development Goals, provide a framework for global cooperation and action on climate change and sustainability.

**Methodology**

The methodology adopts a systematic review approach to explore GTL strategies for sustainable supply chains through a rigorous and structured analysis of existing literature, providing valuable insights into current practices, future trends, challenges in decarbonization, and net zero goals for sustainability. Data from selected studies will be synthesized and analyzed using thematic analysis techniques. For instance, the EY research team surveyed 525 executives and found that eight in 10 supply chain executives are increasing their efforts toward sustainable transportation operations. Executives are working toward efficient use of natural resources, decarbonization, ethical sourcing, and fair trade as part of their larger focus on ESG initiatives. This paper aims to provide a comprehensive analysis of GTL strategies for sustainable supply chains, contributing valuable insights to academia, industry practitioners, and policymakers.

**Environmental impacts of traditional transportation and logistics**

Over decades, conventional logistics processes and practices have had significant impacts on the environment and planet which degraded human life due to increased pollution, loss of natural resources, and global warming to name a few.
Some of the notorious areas are as follows.

**Air pollution.** Excessive reliance on fossil fuels such as gasoline and diesel, emit pollutants (such as carbon monoxide, nitrogen oxides, sulfur dioxide, and particulate matter) that contribute to poor air quality [Dockery, D. W., & Pope, C. A], respiratory illnesses, and smog formation, leading to adverse health effects for humans and ecosystem degradation.

**Greenhouse gas emissions (GHG).** The combustion of fossil fuels in transportation activities led to a rampant increase in greenhouse gases (GHGs) such as carbon dioxide (CO₂), methane (CH₄), and nitrous oxide (N₂O) [Intergovernmental Panel on Climate Change (IPCC) (2014)]. These gases trap heat in the atmosphere, leading to global warming and climate change. The transportation sector is a significant contributor to GHG emissions, accounting for a substantial portion of total emissions worldwide.

**Habitat fragmentation and land use.** Infrastructure development (construction of roads, ports, railways, and highways) requires extensive land use which leads to the disruption of the ecosystem and loss of biodiversity [Forman, R. T., & Alexander, L. E. (1998)]. Moreover, the expansion of transportation infrastructure worsens urban sprawl by encroaching on natural areas, building concrete jungles, reducing green space, and altering wildlife populations.

**Noise pollution.** Excessive noise levels from transportation infrastructure and operations can negatively impact local communities, wildlife habitats, and sensitive ecosystems, leading to stress, hearing loss, and disturbance of natural rhythms [European Environment Agency (EEA) (2021) Noise Pollution].

Overall, the environmental impacts of traditional transportation and logistics underscore the urgent need for sustainable alternatives and the adoption of greener practices to mitigate climate change, reduce pollution, and preserve natural resources.

### Frameworks of green transportation and logistics

A framework for green transportation and logistics serves as a structured approach to guide the integration of sustainable practices into transportation and logistics operations. For example, the EU has pledged to reduce emissions by 55% by 2030 compared to 1990 levels and has also agreed to have a fleet average target of 0 gCO₂ per mile by 2035. Multiple components hold significance in formulating policies for the robust framework.

**Sustainability goals.** The framework typically begins with defining sustainability goals aligned with environmental, social, and governance (ESG) objectives. This involves establishing targets for reducing carbon emissions [Paris Accord, Seuring, S., & Müller, M. (2008)], minimizing resource consumption, enhancing social equity, and improving economic viability within transportation and logistics activities. Organizations can orient their GTL strategies toward achieving tangible environmental and social outcomes by setting clear sustainability objectives. For instance, by adopting the GTL framework, Caterpillar (A North American large mining truck facility) consolidated their shipping operations based on weight, packaging, routing, and scheduling to reduce overall carbon emissions by 340-730 tons of CO₂ per annum.

![FIGURE 1](image)

**Buy green, save green**

One-year SAVINGS FROM SWITCHING from a 25 miles-per-gallon (MPG) car or truck to a more fuel-efficient one

<table>
<thead>
<tr>
<th>MPG</th>
<th>Daily Savings</th>
<th>Monthly Savings</th>
<th>Yearly Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>$0</td>
<td>$350</td>
<td>$1,050</td>
</tr>
<tr>
<td>30</td>
<td>$350</td>
<td>$788</td>
<td>$2,668</td>
</tr>
<tr>
<td>35</td>
<td>$600</td>
<td>$1,050</td>
<td>$3,575</td>
</tr>
<tr>
<td>40</td>
<td>$788</td>
<td>$1,584</td>
<td>$5,192</td>
</tr>
<tr>
<td>45</td>
<td>$993</td>
<td>$2,226</td>
<td>$6,978</td>
</tr>
<tr>
<td>50</td>
<td>$1,050</td>
<td>$4,300</td>
<td>$13,300</td>
</tr>
</tbody>
</table>

SAVINGS FROM SWITCHING from a 25 to 50 MPG vehicle equals…

- **DAILY** 1 cup of coffee
- **MONTHLY** 3 trips to the movies with a friend and popcorn
- **YEARLY** More than $1,000

Source: EPA

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*scmreview.com*
Multimodal transportation strategies. The framework emphasizes the importance of adopting multimodal transportation strategies to reduce reliance on carbon-intensive modes such as crowded road transport [Taniguchi, E., Thompson, R. G., & Yamada, T. (2001)]. This may involve promoting the use of rail, waterways, and intermodal freight transport to optimize cargo movement while minimizing greenhouse gas emissions. By diversifying transportation modes and leveraging synergies between different modal options, organizations can achieve greater and cost-effective environmental sustainability and resilience in supply chain operations. For example, the Ocean Spray organization leveraged distribution network design and intermodal shift from road to rail which led to a 20% reduction in CO₂ emissions across the transportation network.

Adoption of green technologies. The adoption of green technology in the transportation sector is a crucial component of the GTL framework. This entails making investments in fuel-efficient engines, electric and hybrid cars, biofuels, hydrogen, and renewable energy sources to power warehouses and transportation fleets [Banomyong, R., & Supatn, N. (2019)]. Organizations may lower carbon emissions, increase energy efficiency, and make the switch to low-carbon transportation systems by adopting technological advancements.

Environmental considerations. Organizations need to systematically assess and integrate environmental considerations into their decision-making and financial results to ensure sustainable strategies for transportation are instituted. One critical approach [Sarkis (2013), titled “A boundaries and flows perspective of green supply chain management”] is leveraging lifecycle assessment (LCA) to evaluate end-to-end environmental impacts throughout the supply chain, spanning from procurement of raw materials to end-of-life disposal. This will help businesses identify hotspots around the evaluation of emissions, vehicle technologies, fuel choices for transportation, and alternatives available.

Strategies for green transportation
Sustainable transport is key to tackling the climate crisis and emerging technologies are reshaping transportation management globally and offering innovative solutions to improve logistical efficiency, economies of scale, alternate fuels with less emissions, and sustainability. Supply chain sustainability strategies that are driven by short-term thinking are susceptible to many different types of disruptions, from government regulations and economic conditions to other global influences.

Some of the pathbreaking key trends are as follows.

Modernization in vehicles (autonomous, electric).
Vehicle modernization has the potential to revolutionize transportation fleets. Newer vehicles use advanced sensors and artificial intelligence algorithms to navigate routes and paths safely and responsibly, thereby improving operations and vehicle utilization and reducing carbon emissions. Similarly, advancements in battery technology and infrastructure for charging electric vehicles will significantly reduce carbon emissions, thereby providing a sustainable operative for logistic service providers and fleet operators. Transitioning to electric vehicles powered by renewable energy sources can significantly reduce greenhouse gas emissions and air pollution associated with traditional gasoline and diesel vehicles [Nikas, A., & Xydis, G. (2020)].

Sustainable planning for cities and communities.
Architecting and designing cities and communities with compact and accessible amenities can reduce reliance on motorized vehicles and promote physical activity thereby mitigating environmental impacts due to transportation [Newman, P., & Kenworthy, J. R. (2015)]. Local and municipal bodies need to further encourage physical activities in communities via the use of digital apps such as Virgin Pulse and many others. Furthermore, carpooling and ridesharing programs can help optimize vehicle occupancy rates, reduce traffic congestion, and lower carbon emissions per passenger mile [Chen, P., Lu, L., Zhai, Y., & Tang, J. (2017)].

Investment in sustainable infrastructure.
Governments and local authorities need to plan and allocate funds for the development, and maintenance of transport infrastructure with emphasis on environmental sustainability, social equity, and economic viability.

Futuristic mode of transportation (Maglev and Hyperloop).
Technologies such as Hyperloop and Magnetic levitation offer high-speed solutions as futuristic modes of transportation. Concepts such as bullet trains will reduce travel time, reduce carbon emissions, and provide greener avenues for communities. Alternative fuels such as biodiesel, ethanol, hydrogen, propane, and natural gas
further help conserve resources and reduce emissions.

**Stakeholder engagement and regulatory measures**

The decarbonization and transformation of the transport sector remains essential for achieving the Paris targets, as transport still accounts for 24% of global CO₂ emissions from fuel combustion [IEA 2020]. The challenge of decarbonization massively increases the need for intercompany carbon data exchange [Forbes, 2022 study]. Transparency and powerful collaboration capabilities are key for sharing data up and down the supply chain. Successful companies on the sustainability front are using open networks that connect multiple partners for inter-company collaboration and insight.

Stakeholder participation, collaboration, and engagement are imperative for the adoption of sustainable practices, fostering transparency and accountability in the supply chain. Shared goals, priorities, and challenges need to be identified and discussed amongst all parties including transportation authorities (department of transportation), governmental agencies, manufacturers, retailers, environmental bodies, and regulatory agencies [Ntow-Gyamfi, M., Yang, Y., & Damoah, I. S. (2020)].

Conducting stakeholder-focused group discussions and workshops to solicit inputs on sustainability, establishing advisory committees on sustainable transportation, and working groups to facilitate dialogue, is a must. Solutions need to be co-created and social media platforms can be leveraged to disseminate and provide information transparently to the public. This will help build trust and incorporate inclusivity and equity amongst diverse stakeholder groups.

Similarly, the regulatory framework comprising environmental laws and regulations on emission standards, pollution control, and natural resource conversation needs to be revamped to promote green technologies for environmental sustainability. Governments can provide grants, subsidies, and tax credits to support research in the green transportation domain.

Regulatory frameworks can support environmentally friendly logistics techniques including cutting down on empty kilometers, increasing cargo efficiency, and optimizing freight routes. Regulations about freight consolidation, vehicle routing, and environmentally friendly packing materials may be implemented to reduce environmental effects and improve the sustainability of the supply chain. As demand for action continues to grow for recycling plastic and sustainable packaging, effective implementation of transportation policies to promote alternative modes of transportation to reduce reliance on fossil fuels needs to be enforced across developing nations.

Aviation and shipping sectors contribute large amounts of greenhouse gas emissions, which can be tampered with by regulatory action. This could entail carrying out international agreements and rules, such as the International Civil Aviation Organization’s (ICAO) Carbon Offsetting and Reduction Scheme for International Aviation and the International Maritime Organization’s (IMO) emissions limits for ships (CORSIA). All countries and organizations need to disclose environmental, social, and governance (ESG) performance metrics, and conduct quarterly audits to enhance accountability in reporting the state of the supply chain [United Nations Environment Program (UNEP). (2011)].

**Conclusion**

Sustainability simply means keeping things going—but the conundrum is that keeping things going exactly as they are right now is unsustainable. Fortunately, one thing sustainability doesn’t mean is poor business performance. Many sustainability initiatives in the logistics domain are designed to increase efficiency and drive down costs.

Stakeholder engagement initiatives, policy interventions, and the use of cutting-edge technologies have all contributed to the notable advancement of sustainable supply chains and greener transportation. Reducing carbon emissions, improving air quality, and increasing resource efficiency have all been shown to be tangibly benefited by initiatives like investing in sustainable infrastructure, encouraging the use of electric vehicles, promoting public transportation, and putting supply chain transparency measures in place. This includes support for renewable energy technologies, smart transportation systems, circular economy practices, and resilient supply chain networks.

The paradigm shift toward more environmentally friendly smart transportation and sustainable supply chains needs to be led by the values of inclusivity, social justice, and fairness. Prioritizing the needs and voices of disadvantaged communities, vulnerable populations, and future generations is crucial in promoting sustainability and ensuring that the benefits of sustainable development are distributed fairly throughout society. By fostering collaboration, innovation, and shared responsibility, we can build a more sustainable, equitable, and resilient future for all. •
Salary and satisfaction up

Our latest Peerless Research Group (PRG) survey reveals current salary trends, career satisfaction rates, and shifting job priorities for individuals working in logistics and supply chain management. Here are all of the findings—and a few surprises.

BY BRIDGET McCREA, CONTRIBUTING EDITOR

As global supply chains continue to transform, use more technology and address new challenges, the professionals who run these networks play a critical role in shepherding goods from the point of raw material and right out to the end consumer. As the conductors of this complex orchestra, supply chain and logistics specialists streamline the flow of goods, reduce costs, improve customer satisfaction, manage risk, and help their organizations gain strategic advantage.

Salary by age

<table>
<thead>
<tr>
<th>Age Range</th>
<th>Average Salary</th>
<th>Median Salary</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 35</td>
<td>$68,000</td>
<td>$61,950</td>
</tr>
<tr>
<td>35 to 44</td>
<td>$85,000</td>
<td>$87,300</td>
</tr>
<tr>
<td>45 to 54</td>
<td>$108,000</td>
<td>$107,100</td>
</tr>
<tr>
<td>55 to 64</td>
<td>$119,480</td>
<td>$114,000</td>
</tr>
<tr>
<td>65+</td>
<td>$115,550</td>
<td>$82,000</td>
</tr>
</tbody>
</table>

Source: Peerless Research Group (PRG)
The complex supply chain environment demands a skilled and dedicated workforce that, of course, deserves fair compensation for its efforts. To learn more about the key salary trends, job challenges, and career satisfaction shifts in the industry, Peerless Research Group (PRG) and Logistics Management recently conducted their 2024 Salary Survey. More than 240 respondents shared their insights for the survey, which revealed several interesting trends currently taking place in the supply chain and logistics field.

To get their expert input on the survey results and feedback on the career-related industry trends, we spoke with Abe Eshkenazi, CEO at the Association for Supply Chain Management (ASCM), and Tom Derry, CEO at the Institute for Supply Management (ISM). Both contributed their feedback on the report and explained some of the surprises that emerged in this year’s survey.

### What is your current total annual salary for 2023?

(Includes bonuses and commissions, etc.)

<table>
<thead>
<tr>
<th>Salary Range</th>
<th>2023</th>
<th>2024</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than $40,000</td>
<td>5%</td>
<td>2%</td>
</tr>
<tr>
<td>$40,000 to $49,999</td>
<td>4%</td>
<td>3%</td>
</tr>
<tr>
<td>$50,000 to $59,999</td>
<td>5%</td>
<td>2%</td>
</tr>
<tr>
<td>$60,000 to $69,999</td>
<td>5%</td>
<td>6%</td>
</tr>
<tr>
<td>$70,000 to $79,999</td>
<td>8%</td>
<td>9%</td>
</tr>
<tr>
<td>$80,000 to $89,999</td>
<td>8%</td>
<td>9%</td>
</tr>
<tr>
<td>$90,000 to $99,999</td>
<td>8%</td>
<td>16%</td>
</tr>
<tr>
<td>$100,000 to $119,999</td>
<td>9%</td>
<td>11%</td>
</tr>
<tr>
<td>$120,000 to $149,999</td>
<td>14%</td>
<td>18%</td>
</tr>
<tr>
<td>$150,000 to $249,999</td>
<td>22%</td>
<td>25%</td>
</tr>
<tr>
<td>$250,000 or more</td>
<td>5%</td>
<td>7%</td>
</tr>
</tbody>
</table>

In the past year, has your salary level...

- Increased: 58%
- Decreased: 9%
- Stayed the same/No change: 33%

By what percent did your salary level change?

- Increased by: Average 5%, Median 3%
- Decreased by: Average 8%, Median 3%

Source: Peerless Research Group (PRG)

Survey says...

Most of this year’s survey respondents work in the manufacturing industry (44%), including food, beverage, and tobacco (18%), automotive and transportation equipment manufacturing (11%), and industrial machinery manufacturing (10%). Others work for third-party logistics providers (12%), distributors (10%), retail trade (9%), and wholesale trade (9%).

Twenty percent of this year’s survey respondents work for companies with less than $50 million in revenues, 15% for organizations with $50 million to $99.9 million in revenues, and 14% for companies in the $100-million to $249.9-million range. Seventeen percent of respondents work for organizations with $2.5 billion in revenues and 9% for companies in the $1-billion to $2.49-billion range.

Supply chain and logistics professionals working in the manufacturing sector earn the highest average annual salary of $123,450, while those working for 3PLs earn $107,900, distributors $107,500, and consulting firms $102,200. On average, supply chain and logistics professionals expect to earn $121,150 annually in 2024, with the median salary being $100,000. These salary levels are both consistent with 2023’s survey results.

This year, 25% of supply chain professionals will earn between $150,000 and $249,999 annually, while 18% will...
earn $120,000 and $149,999, 11% earn between $100,000 and $119,999 and 9% say their annual salaries will land somewhere between $80,000 and $89,999.

Average salaries remained consistent from 2023 to 2024, but over the past year, 58% of professionals say their salary level has increased (compared to 67% last year). Also, 33% say that their salary level has stayed the same, and only 9% say it has decreased. When asked by what percent their salary has changed, the average increase was 5% and the average decrease was 8%.

Reflecting on the average reported salary of $126,475 (and median salary of $105,000) from 2020’s survey,
Derry says the extreme impacts of the pandemic may have boosted salaries during that timeframe.

“It’s interesting that total cash compensation has declined since 2020; but 2020 was one of the most challenging years in logistics in recent history,” says Derry. "We had a shortage of ocean containers, a shortage of drivers in the United States, and massive congestion at U.S. ports. I would assume logistics professionals earned significant bonuses in 2020 as an appropriate reward for successfully negotiating those incredibly difficult conditions.”

How demographics affect salary
This year’s survey group was 86% male and 14% female, with the former continuing to earn more than their female counterparts. However, women’s salaries are increasing: Men earn an average of $145,200 annually (up from $121,310 in 2023) and women earn $101,700 (compared to $88,275 in 2023).

Professionals located in New England continue to earn the highest wages at $120,100, followed by Canadian professionals at $108,300 and the Midwest at $106,950 annually.

Respondents’ salaries clearly increase with age, according to the survey results. Respondents aged 55 to 64 report the highest annual salaries at $147,200 (compared to $119,470 in 2023), while those aged 45 to 54 report an average salary of $132,200 (compared to $108,000 in 2023) and professionals aged 35 to 44 earn $110,600 (compared to $68,000 in 2023).

Salary increases by job title
This year, 20% of survey respondents...
are logistics managers or directors, 12% are operations managers or directors, and 7% are VPs or general managers. Other positions include supply chain managers or directors, transportation managers or directors, distribution managers or directors, and purchasing managers or directors.

On average, VPs and general managers come out on top with an average annual salary of $263,750 in 2024 (compared to $209,750 in 2023), followed by operations managers and corporate/divisional managers at $172,500. Supply chain directors and managers earn $162,950 on average and sales professionals report annual average salaries of $148,600. With the exception of corporate/divisional managers, every job role has seen a salary increase over last year’s numbers.

Individuals involved with supply chain management reported the highest average of $167,700, followed by distribution and logistics ($141,050); warehousing ($134,750); procurement ($131,900); and traffic and transportation ($128,900). Individuals across all job functions are now earning more than they did in 2023.

Earning more and doing more
Over the last two years to three years, most respondents (67%) say the number of functions they perform on the job has been increasing. Meanwhile, 27% say their job responsibilities have stayed the same and just 6% say they’re now handling

![Level of satisfaction with career in supply chain/logistics](image1)

![Salary by level of satisfaction with career](image2)

What type of logistics/supply chain management education have you completed?

![Education types](image3)
fewer functions.

When asked how many years they’ve been in their current position, 26% of respondents say that they have held their position for more than 10 years, while another 26% have been in their position for between three years and five years.

Individuals who have held their positions for 10 years earn $131,300 on average (compared to $117,880 in 2023), while those in the six-to-10 year range earn $117,350.

Eshkenazi says the number of respondents with under three years of experience versus those with 20+ years is a clear indication of a looming talent shortage in logistics. “Companies need to act on this now before it’s too late,” he says. “The salary by different employers is a unique perspective. It’s interesting that salaries increase as one has more employers, but drops off at 10 or more.”

Asked to rate their levels of understanding of e-commerce and e-fulfillment processes within their organizations, 39% of professionals consider themselves “highly knowledgeable,” while 51% are “somewhat knowledgeable,” and 10% say they’re “not very/not at all knowledgeable.”

These results concern Eshkenazi, who sees them as yet one more indicator of a talent gap in the supply chain and logistics sector. “For the past five years, ASCM’s Innovation and Sensing Committee has foreseen a major digital transformation in supply chains that’s now underway,” Eshkenazi says. “This skills gap needs to be addressed for companies to stay competitive.”

Seeking out new opportunities
This year, 41% of respondents say they’re open to better job opportunities, 28% are happy where they are, 19% are passively looking, and 12% are actively looking (compared to only 3% last year).

Salary plays a role in these job pursuits. Respondents who are happy at their current employers earn $129,100 annually, while those passively looking earn $129,900 on average. Those actively looking earn $113,400 on average, while those who are always looking earn the least at $112,700.

More than half (51%) of respondents say that they are very satisfied with their careers in supply chain and logistics, while 43% are somewhat satisfied, 5% are somewhat dissatisfied and only 1% say that they’re “very dissatisfied.”

Education and industry involvement
Thirty-eight percent of this year’s respondents hold a bachelor’s degree, while 20% hold an MBA degree, 15% have completed some college, and 12% earned an associate’s degree.

To advance their careers, 54% of respondents use personal or social networking, 24% earn industry certifications, and 22% take classes or earn a degree in business or another related field.
Specific to logistics and supply chain management education, 68% of respondents have completed job-related training; 42% attend industry conferences, seminars or workshops; and 24% earned professional certifications such as AST+L or APICS.

Only 8% of professionals have completed an undergraduate degree in logistics or supply chain management, and 9% say they hold a graduate degree in logistics or supply chain management. These percentages are consistent with the 2023 survey.

Eighteen percent of respondents say “joining an industry or professional association” has helped them advance their careers. This year, 30% of respondents say they are planning to take continuing education programs or classes during the next 12 months, compared to 44% in 2023.

When negotiating salaries, nearly all respondents (70%) view involvement with professional associations as being critical or somewhat important to the process. “It’s both interesting and gratifying that such a high percentage of respondents say involvement with a professional association is very important to extremely important in negotiating salaries,” says Derry. “For supply chain professionals, career opportunities, and upward mobility are both recognized as critical enablers of business success.”

Finally, the majority of survey respondents (79%) would recommend the logistics or supply chain management field to their son, daughter, or friend, while 21% wouldn’t make this recommendation. Similarly, 80% say they are either seeing or expect to see younger managers enter the logistics and supply chain workforce, while 20% say they’re not seeing this trend taking shape yet.

### Estimated 2023 company revenues

<table>
<thead>
<tr>
<th>Revenue Range</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than $50M</td>
<td>20%</td>
</tr>
<tr>
<td>$50M to $99.9M</td>
<td>15%</td>
</tr>
<tr>
<td>$100M to $249.9M</td>
<td>14%</td>
</tr>
<tr>
<td>$250M to $499.9M</td>
<td>7%</td>
</tr>
<tr>
<td>$500M to $999.9M</td>
<td>6%</td>
</tr>
<tr>
<td>$1B to $2.49B</td>
<td>9%</td>
</tr>
<tr>
<td>$2.5B or more</td>
<td>17%</td>
</tr>
<tr>
<td>Cannot disclose</td>
<td>13%</td>
</tr>
</tbody>
</table>

### Salary by company revenues

<table>
<thead>
<tr>
<th>Revenue Range</th>
<th>2023 Average</th>
<th>2023 Median</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than $50M or less</td>
<td>$95,220</td>
<td>$87,000</td>
</tr>
<tr>
<td>$50M to $99.9M</td>
<td>$95,250</td>
<td>$91,000</td>
</tr>
<tr>
<td>$100M to $249.9M</td>
<td>$103,575</td>
<td>$98,000</td>
</tr>
<tr>
<td>$250M to $499.9M</td>
<td>$114,625</td>
<td>$96,000</td>
</tr>
<tr>
<td>$500M to $999.9M</td>
<td>$120,510</td>
<td>$115,000</td>
</tr>
<tr>
<td>$1B to $2.49B</td>
<td>$119,100</td>
<td>$105,000</td>
</tr>
<tr>
<td>$2.5B or more</td>
<td>$127,650</td>
<td>$121,000</td>
</tr>
</tbody>
</table>

Source: Peerless Research Group (PRG)
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One door closes, a better one opens

Four years of supply chain chaos have left C-suites tired of playing defense. Armed with lessons learned from the COVID pandemic, leading companies envision a new, AI-enabled supply chain not just rewired for resilience but regenerated for long-term growth, performance, and sustainability.

The sense of resolve out there seems at first counterintuitive, given the holding pattern of weak demand and continued uncertainty, even after COVID. Inflation, China de-risking, the brutality of Ukraine and Gaza, attacks on Suez shipping, Panama Canal drought, hacked data and ransomware demands—another day, another headline scare.

That said, many of the broad market indicators driving demand and supply chain growth are positive: the roiling supply-demand dislocation from lockdowns and climate events has eased; interest rates appear to be stabilizing at around 3%-5% across OECD countries with inflation moderating, unemployment holding steady around 4%-6% and global GDP growth forecast in the 3% range for 2024-2025. On the supply side, investments in digital optimization, automation and process improvements have also made supply chains more resilient; end-to-end visibility enables faster, more agile response to disruption and sharper decision-making to boost performance, manage risk and control costs.

Despite a temptation to preserve capital and wait for some catalyst to provide greater market clarity, businesses are also wary of waiting too long; volatility may also prove resilient. And in the meantime, supply chain complexity is straining conventional business-to-business (B2B) models run on manual processes, spreadsheets and legacy software. Customers are demanding on-time/in-full reliability; compliance requirements around trade and sustainability are expanding. Wage,
input and logistics cost pressures must be managed. Companies sense opportunity during this period of relatively weak demand and slower orders. Now may be just the time to shift focus from defensive resilience to building a more proactive set of capabilities with the same tools, to work with the market environment they have, not the one they wish they had. The greater risk may lie with inaction.

Create your own future
The buoyant mood reflected in last year’s Kearney Supply Chain Institute/Amazon Web Services survey of chief operating officers has moderated somewhat in the 2024 survey just released. Given recent macroeconomic, trade and geopolitical uncertainties, the share of respondents forecasting robust revenue growth for their companies—in the 10%-20% range—for the coming 12 months slipped from 63% to a still significant 38%, nearly half of those forecasting growth higher than 15%. In 2024 COOs are prioritizing investments in digital, automation and AI, mainly in warehouse automation, AI/ML, Internet of Things (IoT) visibility and risk monitoring; resilience is a top priority for 56% of respondents, with 85% of those actively recalibrating their firms’ manufacturing footprints, in many cases involving nearshoring or reshoring to manage risk, and re-evaluating supplier relationships in the interest of resilience and/or sustainability.

COOs are allocating significant resources to attracting new customers and developing new channels via innovation, operational efficiencies and new products. At the same time, they are clear-eyed in their assessment of market headwinds. They see geopolitical instability as the greatest external supply chain risk and rank slow organizational decision-making as the biggest internal obstacle.

Underlying all strategic and investment decision-making, cost considerations loom large. COOs are prioritizing initiatives generating the quickest return on investment (ROI) through cost savings, such as equipment, maintenance and logistics costs. Top-of-mind initiatives include reducing reactive maintenance costs; improving statistical forecasting focused on key drivers; and optimizing the organization’s distribution strategy. Some priorities, like changing the manufacturing footprint, require complex analysis and difficult trade-offs among labor, energy, tax, and other cost impacts.

Resilience remains an organizational imperative. The product-at-all-costs mindset that saw many organizations overpaying to reduce supply chain risk and maintain stocking levels has given way to single-sourcing agreements and lean inventory arrangements. And while COOs are still open to keeping or moving manufacturing operations and transportation onshore to optimize quality control or delivery service performance, cost is receiving a heavier weight relative to risk management this year.

It’s time to rewire
Conventional supply chain models tend to reflect the times in which they’re developed and the supporting technologies then available. Most originated in the 1990s, as globalization was on the rise, and were designed for reliability, low cost and a predictable operating environment. Most goods trade entailed predictable, high-volume business-to-business (B2B) shipments driven by longstanding supplier, vendor and customer relationships. Demand fluctuated
within relatively narrow ranges. Merchandise was pushed out to large regional distribution centers for incremental sales into primary and secondary markets. Shipment track and trace was based on completed EDI transaction steps in the order process.

The model has steadily broken down over the past two decades as global sourcing patterns, just-in-time manufacturing and omnichannel e-commerce have steadily extended supply chain length and complexity. Then came the severe supply-demand disruption from COVID, compounded by climate. Environmental and sustainability measurement and reporting compliance objectives—in particular tracking and reporting of scope 3 supplier and vendor emissions—now promise further end-to-end challenges.

Companies have benefited from lessons learned as the pandemic severely stress-tested supply chains and accelerated the development of modular, software-based freight technology solutions. Resulting efficiencies from optimization and automation now demand accelerated, even dynamic, implementation through connectivity and collaboration among partners.

**Technology comes to the rescue**

Global proliferation of data centers and increased processing power from advanced chipsets have brought big data, AI, and machine learning capability to more businesses, more quickly, at lower cost, than ever before. Fully integrated real-time, end-to-end, actionable visibility is suddenly within reach, as:

- AI and ML deliver instant, continuously updated data, analysis, predictive insights, prescriptive recommendations and control tower visualizations in near-real time;

- mathematical optimization simplifies, prioritizes and automates workflow at the strategic, tactical, and operational levels; and

- distributed ledger technologies such as blockchain securely track goods, documents and payments, report and verify SKU-level provenance, and automate fulfillment/payment under smart contracts.

Suddenly it becomes easier to envision new end-to-end possibilities, building on the same capabilities put in place earlier during COVID to add resilience. The added processing and analytic capacity provide a foundation for altogether new, growth-focused supply chain configurations.

Why not, for example, embed sustainability objectives within the procurement and logistics functions, where suppliers and logistics vendors are evaluated and selected? Or embed cybersecurity response within the supply chain where some of the most serious threats reside, alongside the most effective system monitoring and onboarding safeguards? Or build product redesign into a nearshoring strategy that simplifies portfolios, bypasses scarce materials and questionable suppliers and eliminates costly assembly steps customers may not even need or want?

Some examples of digital operations initiatives Kearney has undertaken with global clients to regenerate their supply chains for performance and long-term growth include the following.

**Telecommunications.** Minimum viable product models helped a global telco improve its demand forecasting by 23%; more efficient allocation of smartphone and accessory supply among retail outlets and distribution centers reduced on-hand inventory by 5% and annual fulfillment costs by nearly a third.

**Grocery/department store retail.** Cost-to-serve models applied to real-time data provided a major food retailer and supermarket/department store operator with continuous live tracking of freight operations, freight analytics to reduce empty miles and CO₂ emissions, and dynamic optimization of freight terms trade-offs. Service performance improved by 5%-10%, saving $50 million in working capital expenditures; cost of goods sold (COGS) and
CO₂ emissions fell by 1%-2% each.

- **Household/personal care products.** Adding digital twin modeling to a large household consumer products brand’s scenario planning enabled the firm to confidently incorporate a natural cosmetics line into its product portfolio over a 10-year planning horizon. The digital twin model is now used to assess future scenarios and responses, stress-test network resilience and predict direct, indirect, opportunity, and other concept costs.

**What are the next practices?**
Ubiquitous, affordable AI adds a new layer of future supply chain capability—proactive, dynamic end-to-end visibility. With near-zero latency partners can “see” all operations and processes at work in real-time to monitor performance, spot potential disruption as or before it happens and respond dynamically, in accordance with predefined business rules and contractual arrangements. Generative AI, still in the early development stages, will go a step further, building an infinitely scalable army of specialist AI bots, or agents, to perform specific functions in real-time. These agents can operate as a single, always-on, connected force, performing their functions automatically subject to predefined business rules, and escalating where necessary to human intervention, responding to queries and direction in natural language.

In the process, the current linear supply chain model will evolve into a more dynamically configured, networked system of capabilities delivering customer, societal and business value. End-to-end data will become more accessible, contextual and correlated in real-time, enabling more sophisticated optimization and contractual collaboration among partners on strategic, sustainability or other initiatives.

As data sets build over time, they will become more predictive—and prescriptive—in identifying operational improvements to boost resilience, performance, margins and customer satisfaction. AI will monitor the end-to-end network and draw from millions of complex internal and external data points in seconds, incorporating customer, partner and market signals to make routine adjustments while escalating to human intelligence and intervention to resolve more complex trade-off decisions. Analytics will test and rank complex probability scenarios for more accurate, detailed demand forecasting, supplier or carrier selection and negotiations, carbon emissions reduction and more.

Standardization and digital integration of business platforms across the organization dramatically increase the speed and granularity with which supply chains can be configured both internally and externally. Companies will be able to stand up temporary networked value chains, drawn from specialized, global partner and talent ecosystems, to seize short-term opportunities, or manage a sudden disruptive event.

**Leaders are seizing the initiative**
Forward-looking companies are retaking control of their futures post-COVID, recognizing that a pandemic-driven “product-at-all-costs” strategy was always unsustainable and that, rather than trying to predict an uncertain future, it’s more useful to be prepared for anything. They should instead prepare for any eventuality and assess the likeliest probabilities.

Businesses need to build an end-to-end, real-time, actionable window into their supply chains, to view and plan for the full range of risks and opportunities open to them, rank the probability of each in the moment and over time, and begin to move forward.

The same data processing, connectivity and analytic capabilities providing visibility to manage volatility can also optimize a manufacturer’s global footprint, boost on-time, in-full performance and build a brand image around sustainability to reach new markets and customers.

Waiting to act in hope that a different future arrives is counterproductive. Businesses can’t control externalities like conflict, climate, pandemic or inflation, but they can control how they adapt and respond. The future belongs to those ready and willing to open the door and walk through.
Building resilience in manufacturing

Adopt a phased approach and leverage technology to build flexibility and transparency.

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

Manufacturing remains a critical area of investment for many business leaders. In APQC’s 2024 Supply Chain Priorities and Challenges research, 72% of organizations named manufacturing as a priority for the year with regard to investing resources, innovation, and hiring.

This critical function is under increased pressure. Challenges related to geopolitical tensions, climate change, labor shortages, and cyberattacks continue to result in supply chain disruptions that affect manufacturing capabilities. In addition, supply chains experience risk on a smaller scale, such as disruptions for a particular supplier or a particular distribution channel.

With all these factors affecting the supply chain, it is important for manufacturing organizations to remain resilient so that they can both anticipate and mitigate the impact of disruptions.

According to APQC’s research, organizations recognize disruptions as an area to focus on for manufacturing. However, the results are mixed regarding how organizations are building resilience in the face of potential disruptions.

**FIGURE 1**

Top focus areas in manufacturing

<table>
<thead>
<tr>
<th>Focus Area</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manage supply chain disruptions</td>
<td>51%</td>
</tr>
<tr>
<td>Production management</td>
<td>36%</td>
</tr>
<tr>
<td>Automation and robotics</td>
<td>29%</td>
</tr>
<tr>
<td>Lean</td>
<td>28%</td>
</tr>
<tr>
<td>Sustainability</td>
<td>24%</td>
</tr>
<tr>
<td>Advanced analytics</td>
<td>21%</td>
</tr>
<tr>
<td>Talent acquisition and retention</td>
<td>11%</td>
</tr>
</tbody>
</table>

*Note: The values above do not add up to 100 percent because it was a “select top two” question.*

Source: APQC
An area of focus
APQC’s Supply Chain Priorities and Challenges research shows that managing disruptions is the top focus area for manufacturing in 2024 (Figure 1). Adaptability is key to this effort; organizations must build contingency plans for their production and shipping capabilities.

The second focus area for manufacturing is production management. This is an enabler of adaptability, as it requires solid processes and the ability to identify areas for change. It also requires data management that supports risk identification and mitigation.

The third area of focus identified in APQC’s research is automation and robotics. The adoption of technology can facilitate an organization’s preparedness for disruptions and boost its resiliency. This rapidly changing area of supply chain requires careful consideration to ensure the organization adopts technology that will best support its processes and business needs.

Key components of resilience
APQC also conducted research in collaboration with BCG to evaluate the range of supply chain resilience capabilities organizations need to thrive. The project involved surveying 185 companies, with quantitative data collected as well as information on practices related to establishing visibility and assessing risk.

One area examined in the research is organizations’ flexibility and transparency in manufacturing. The project defined flexibility to include the extent of network redundancy and whether an organization has a robust stockpile strategy. It defined transparency to include the visibility of an organization’s inventories, capacity, and supply forecasts.

Flexibility. Manufacturing flexibility has room for improvement within organizations. At the median, non-retail/wholesale organizations have only 25% of their revenue coming from products that could be manufactured at more than one plant. Similarly, at the median only 26% of retail and wholesale organizations’ total contract manufacturing spend comes from products that could be manufactured at a different facility.

These results indicate a large amount of risk assumed by these organizations. Should a trade route become inaccessible due to a natural disaster or political conflict, it may be difficult to get products out of a given facility. This can in turn lead to stockouts for products that cannot be manufactured at any other location, making a significant impact on an organization’s revenue, customer satisfaction, and reputation.

Industry plays a role when it comes to having a robust stockpile strategy for inventory. At the median, non-retail/wholesale organizations have 35% of their revenue come from raw materials or make-to-stock finished goods inventory with a robust stockpile strategy in place. Retail and wholesale organizations have a median of 50% of their revenue coming from inventory with a robust stockpile strategy.

The non-retail organizations are again putting themselves at risk by lacking a robust stockpile strategy. If a disruption leads to manufacturing delays, these organizations may have limited inventory on hand to fulfill orders. In an extended disruption, this again can lead to decreased revenue and a negative effect on reputation.

Transparency. Transparency has two components: visibility, or the ability to collect accurate information from all parts of the supply chain, and disclosure, or the ability to communicate this information both internally and externally.

Visibility. Transparency of capacity, inventories, and forecasts throughout the value chain is key to building resilience. As shown in Figure 2, most respondents among non-retail/wholesale organizations have at least some transparency for all of these items.

Two benefits of supply chain transparency are
directly related to resilience: positive reputation and the ability to meet legal requirements. Reputation impacts an organization’s relationship with both its customers and its partners. Transparency can provide customers as well as regulators with visibility into the sourcing of parts and other materials that ultimately end up in a product. This provides peace of mind that the organization is able to ensure a consistent supply of materials without any legal issues.

For business partners, transparency can support their risk management. They can gain insight into the value chain, thus ensuring stability for their customers and partners. This is a shift in how supply chains have been run, as many companies have feared that revealing too much about their operations would undermine their advantage in their respective markets.

Another valuable aspect of transparency is the ability to meet legal requirements. Organizations face increased regulations regarding the source of materials for products and the ability to plan for potential disruptions. Having the ability to collect and disclose this information enables organizations to meet the requirements of these regulations.

**How technology supports resilience**

Many organizations have access to technology that supports transparency, as more supply chains embrace digitization. Although this technology implementation is not uniform across or even within organizations, it supports mature decision making as well as the adoption of specific automation systems in manufacturing.

**Real-time manufacturing data.** Gaining access to real-time production data enables a company to connect partners from across the supply chain to the manufacturing process. According to APQC’s data, 48% of respondents have access to real-time manufacturing data at specific facilities, and 8% have real-time data accessible throughout the enterprise.

**Decision-making maturity.** The decision-making maturity of an organization depends on the type and amount of data and analytics it possesses. Access to real-time manufacturing data enables an organization to make data-driven decisions, thus bolstering its resiliency. According to APQC’s research, only 42% of organizations are making decisions based on advanced analytics and predictive algorithms, the most mature capability an organization can have.

**Automation systems.** Figure 3 presents the most commonly implemented automation systems for organizations’ manufacturing. Each provides a benefit to an organization’s resilience. However, the fact that the most commonly implemented system has been adopted by only 57% of organizations indicates that many companies have room for growth.

The top two systems, predictive maintenance and autonomous machining, streamline manufacturing tasks and reduce the need for human intervention. Predictive maintenance allows organizations to optimize maintenance tasks in real time,
accomplishing two goals of extending the life of equipment while minimizing disruptions to operations. Autonomous machining ensures that the manufacturing process occurs with minimal human involvement. It also supports real-time data analysis and decision-making, leading to increased efficiency in manufacturing and increased accuracy of supply chain data.

The next two systems, advanced planning and scheduling and advanced control and optimization, track and schedule production. Advanced planning and scheduling systems use algorithms to optimize demand, capacity, and production schedules. This not only results in more efficient production, but also more resilient production that can quickly adapt to unexpected changes. Advanced control and optimization uses software that tracks and regulates production stages. These tools yield higher productivity and cost savings for manufacturing.

Production-line simulation enables organizations to identify the potential effects of changes to their manufacturing systems, including production lines. They can model different scenarios with their manufacturing processes and use the results to make better informed decisions about how to address changes to production. Conducting these tests can bolster organizations’ resilience as it enables them to understand how mitigation steps can affect their production overall.

FIGURE 3
Most commonly implemented automation systems

<table>
<thead>
<tr>
<th>Automation System</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Predictive maintenance</td>
<td>57%</td>
</tr>
<tr>
<td>Autonomous machining</td>
<td>43%</td>
</tr>
<tr>
<td>Advanced planning and scheduling</td>
<td>34%</td>
</tr>
<tr>
<td>Advanced control and optimization</td>
<td>32%</td>
</tr>
<tr>
<td>Product-line simulation</td>
<td>29%</td>
</tr>
</tbody>
</table>

Source: APQC

To build resiliency against disruptions, organizations must incorporate flexibility and transparency into their supply chain operations. So far, organizations’ ability to build these traits has been mixed.

APQC recommends that organizations support their resilience by making real-time manufacturing data accessible throughout the enterprise, leveraging analytics and predictive algorithms when making decisions, and implementing a variety of automation systems in their manufacturing. They can accomplish all of these tasks through a phased approach.

The first step is to assess current capabilities and perform a risk assessment to identify potential threats. Based on the risk assessment, the next step is to develop a strategy that prioritizes the biggest risks and includes risk mitigation plans for each. The third step is to take action by addressing risks and building capabilities that create visibility into the end-to-end supply chain.

Although organizations can identify many points to address in their efforts to build resiliency, they do not need to act on all of them at once to gain a competitive advantage. They can continue to take a phased approach that addresses key risks and other potential weaknesses in the supply chain as they arise.

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Q&A with Abe Eshkenazi, CSCP, CPA, CAE, Chief Executive Officer
Association for Supply Chain Management (ASCM)

Q: What trends are you seeing as the biggest differentiators when it comes to attracting and retaining talent?
A: Digital technologies including AI, ML, big data and analytics—which are all among ASCM’s 2024 Top 10 Supply Chain Trends—make supply chain even more exciting and rewarding. More supply chain organizations are transforming their networks into connected, intelligent, scalable, customizable and nimble digital ecosystems. Automation that reduces repetitive tasks and cognitive fatigue allow employees to focus on areas where humans perform better than machines.

Q: What changes have been most successful in terms of employee engagement?
A: Providing an inclusive, equitable and diverse (IED) workplace is key to employee engagement. Our recent report we did with SHRM showed that IED translates into a competitive advantage in three main ways: enhanced performance, improved talent acquisition, and greater employee engagement and retention. When leaders are actively involved in setting goals, tracking metrics, and engaging in IED planning, the chances of success increase significantly.

Q: What steps need to be taken to ensure employees are successfully trained to use and engage with supply chain technologies like automation and artificial intelligence?
A: Finding professionals experienced with emerging supply chain technologies is challenging because they are just that—emerging. The better strategy is to grow this type of talent internally by reskilling current employees or training new ones and keeping them educated about the latest developments. Best-in-class organizations turn to professional associations for training. For example, the ASCM Supply Chain Technology Certificate teaches automation and artificial intelligence, as well as other cutting-edge topics including 3D printing, blockchain, cybersecurity, IoT, and more.

Q: Are you still seeing talent shortages in the supply chain, and what steps need to be taken to help mitigate and/or avoid continued shortages?
A: The labor shortage is evident nearly everywhere. A key step is communicating just how rewarding supply chain careers truly are. ASCM’s recent Salary and Career Report shows job satisfaction continues to be sky-high, with 81% of professionals planning to stay in the field for at least five years. Further, on a 1-10 scale, 60% of respondents rate career satisfaction an 8 or higher. Perhaps most importantly, supply chain professionals enjoy excellent job security, work-life balance and impressive opportunities for growth.
Q: How do you perceive the current state of talent in your own organization, and more broadly, in your industry?
A: The supply chain industry is currently at a critical juncture when it comes to talent. From our view as executive education providers for technology organizations, we see a mix of seasoned professionals and emerging talents who are eager to drive innovation. It’s exploding. However, the broader industry faces significant challenges due to rapid technological advancements and evolving skill requirements. There’s a pressing need for continuous upskilling and reskilling to keep pace with these changes. Overall, while there is immense potential, the supply chain industry must invest heavily in developing a robust talent pipeline to sustain its growth and innovation. The last few years has been about dealing with uncertainty. Now it’s using AI and machine learning.

Q: What challenges are most pressing when it comes to attracting and retaining talent in the industry?
A: Attracting and retaining talent in technology-driven supply chain organizations hinges on a few key factors. The highly competitive market demands compelling value propositions. There’s also a skill gap, especially in AI, data analytics, and digital engineering, necessitating targeted training. Fostering a culture of continuous learning and career development is crucial. For instance, RTX (Raytheon, Collins, Pratt & Whitney) offers frictionless access to higher education, significantly enhancing their supply chain teams’ growth and retention. This approach can serve as a model for others.

Q: What steps does your industry need to take in blending technologies like artificial intelligence with human talent to develop a more productive workforce of the future?
A: Blending AI with human talent requires a strategic approach focused on collaboration. The industry must invest in comprehensive training programs that equip employees to work alongside advanced technologies. This includes hands-on, project-based learning. We’ve added ChatGPT functionality to our client training programs, with models trained on company-specific processes and information. This supports learning and management decision-making. By fostering a mindset of continuous improvement and innovation, and empowering employees to experiment with AI tools, organizations can enhance productivity and drive significant advancements in supply chain management.

Q: What initiatives or programs have you implemented, or would you consider implementing, to improve employee engagement and improve retention?
A: Improving employee engagement and retention starts with understanding the unique needs and motivations of your workforce. Through our programs, we’ve worked with leaders to implement initiatives like executive education and professional development tailored to develop both technical and soft skills. Additionally, we’ve integrated AI/ML into our training, offering personalized learning experiences based on company-specific processes. Clear career progression paths, opportunities for cross-functional collaboration, and a culture of recognition are also critical. Moving forward, enhancing mentorship programs and investing in wellness initiatives will ensure a holistic approach to employee satisfaction.
Q: **How big of a concern is cybersecurity to shippers today?**

**A:** A recent industry study we conducted revealed that cybersecurity is the number one concern among shippers today, surpassing other important considerations like fuel prices and the overall state of the economy. This shift in priorities indicates that despite its slowness in technological adaptation, logistics continues to digitalize.

Q: **How can shippers combat cybersecurity threats?**

**A:** While digitalization comes with new opportunities, this pronounced concern about cybersecurity shows the unique and novel risks that it also brings—risks that many professionals may not feel adequately prepared to manage, despite their commitment to managing new vulnerabilities.

It’s been said that every company nowadays is a tech company. Logistics leaders are not exempt from this principle. We need to invest in tech—secure supply chains require mature technology to support them.

Over the past year, we have been laser-focused on integrating our legacy businesses’ tech stacks, deploying a best-in-class cybersecurity tech stack, and creating a culture of security awareness across our 2,000+ employees globally.

Tech strategy should focus on best-fit solutions, not just the ‘best’ tech.

To that end, Odyssey has adopted a five-part roadmap for AI-readiness and technological resilience designed to develop proactive strategies for company-wide tech stewardship. To make this strategy work, we’re focused in the following areas, all equally important: risk reduction, mitigating tech debt, improving productivity, streamlining the customer experience and unified data governance.

Logistics organizations need workable strategies that will make tech-stewardship a company-wide responsibility. Our purpose-built plan is designed for mitigating risk, maximizing productivity, and delivering superior experiences to our customers.

Q: **Rapid technological developments, including AI, pose great opportunities, but even greater risks. What advice would you give to an organization evaluating its approach to technology?**

**A:** Logistics cyberattacks are a rising threat, forcing professionals to treat cybercrime as a strategic priority.
Navigating Talent Challenges in the Supply Chain

Q&A with Christina Fletcher, Senior Vice President of Human Resources
Penske Logistics

Q: How do you perceive the current state of talent in your own organization, and more broadly, in your industry?
A: The market for talent for all roles in the logistics space continues to be extremely competitive for truck drivers, warehouse workers, supply chain engineers and all levels of leadership. At Penske Logistics, we are focused on building talent internally through training and development programs to invest in elevating the skills of our employees while remaining focused on providing competitive pay and benefits to attract top-tier external talent.

Q: What challenges are most pressing when it comes to attracting and retaining talent in the industry?
A: Constant evaluation for market competitive pay is also paramount to retention of existing talent, along with ensuring that we are offering a positive and engaging work environment, compelling learning and development opportunities and growth into a variety of different roles. We want our employees to understand that they can grow within our company and do not need to leave it to have career development opportunities – and we need to focus heavily on that messaging and communication.

Q: What steps does your industry need to take in blending technologies like artificial intelligence with human talent to develop a more productive workforce of the future?
A: The logistics industry has been a consistent leader in the innovation and technology space, driving advancements like AI to augment the productivity and efficiency of our workforce. We are excited about the potential of machine learning, automation and AI – when coupled with human expertise – to provide more powerful and optimized logistics solutions. Exploring the possibilities of what these new technologies can do to make our workforce more effective and efficient is a powerful investment across the logistics industry as we seek enhanced data, analytics and intelligence to optimize supply chain performance.

Q: What initiatives or programs have you implemented, or would you consider implementing, to improve employee engagement and improve retention?
A: Retention of talent is an intentional focus at Penske Logistics. Our HR teams have spent a great deal of time developing engagement programs focused on associate satisfaction and retention, from welcome kits for new associates to role-based training programs to appreciation week events. We want our workforce to understand that we value our associates and their safety and recognize they are, collectively, the team that allows us to successfully serve our customers. We also utilize advanced analytics that enables us to better understand retention trends within our workforce and how to improve employee engagement to reduce turnover.
Q&A with Mike Slomke, Retired Fortune 100 Chief Procurement Officer (CPO) RED BEAR Negotiation

Q: How do you perceive the current state of talent in your own organization, and more broadly, in your industry?
A: The need to attract, retain, and develop talent has always been and will always be a top priority for procurement leadership. Today, procurement organizations face increasingly complex supplier negotiations and the demand for highly skilled negotiators is intensifying. Developing your team into world-class negotiators is more important than ever.

The benefits of this approach include:
1. Better negotiators deliver improved business results
2. Demonstrating your commitment to the development and long-term success of your team
3. Keeping your talent engaged
4. Expanding your team’s skills to better face today’s procurement challenges.

Q: What challenges are most pressing when it comes to attracting and retaining talent in the industry?
A: The most pressing challenges in attracting and retaining procurement talent include fierce competition for skilled negotiators, providing a clear and meaningful procurement strategy and metrics, and the frequently unfulfilled need for continuous professional development. Leading organizations must foster a supportive work culture and provide opportunities for career growth by developing and deploying the advanced processes, skills, and tools required for today’s procurement top-performers to succeed. Addressing these challenges ensures that talented professionals are attracted to and remain committed to delivering impactful business results.

Q: What steps does your industry need to take in blending technologies like artificial intelligence with human talent to develop a more productive workforce of the future?
A: Leading organizations prioritize process excellence before applying technology. Technology is highly effective at retaining, recalling, searching, and transmitting large volumes of data quickly. But technology’s role is to supplement, not supplant, the underlying business process to deliver value by improving the speed, accuracy, and throughput of that process. If technology is applied to a poor process, it will only accelerate the delivery of poor results.

Negotiation is Procurement’s most critical business process to deliver value to the business. An advanced negotiation process combined with cutting-edge negotiation skills are required before enhancing the negotiation process with technology tools.

Q: What initiatives or programs have you implemented, or would you consider implementing, to improve employee engagement and improve retention?
A: In my 17 years in Chief Procurement Officer roles, the single most impactful thing I did to dramatically improve business results and attract and retain top talent was to deploy a world-class negotiation training program, process, and skills to create a team of world-class negotiators. This approach leveled the playing field between my procurement professionals and the highly trained and highly skilled sales professionals they negotiate with daily. It equipped them to win!

To learn more, visit: redbearnegotiation.com/scmr
What are Universities Doing to Fill the Early Supply Chain Talent Pipeline?

Q&A with Stephanie Thomas, PhD, Associate Professor of Practice
Department of Supply Chain Management, University of Arkansas

Q: How do you perceive the current state of talent in your own organization, and more broadly, in your industry?
A: Interest in a supply chain degree and ultimately career is at an all-time high. Coming out of COVID, increased awareness of the important role of supply chains has attracted more students. Prior to COVID, most undergraduate students discovered supply chain because of a class or professor. We are not having to “recruit” as many students to the field. Many of the best and brightest business students are choosing SCM. Universities are filling the talent pipeline more than ever before.

Q: What challenges are most pressing when it comes to attracting and retaining talent in the industry?
A: From the university perspective, we are constantly trying to create awareness of supply chain opportunities for students. It’s a strong degree with a lot of career potential. I have noticed that the first job out of college is vital for retention in the industry. If that initial role is a bad fit, those young professionals often leave the field and may never return. Educating students on evaluating options and knowing themselves can help them stay in the industry.

Q: What steps does your industry need to take in blending technologies like artificial intelligence with human talent to develop a more productive workforce of the future?
A: As an educator, I work closely with industry to see how technologies like AI can be incorporated into our curriculum so that the emerging supply chain professionals are prepared to use these technologies to be more productive. That requires professors to build and maintain close ties with supply chain professionals to remain current on the technologies being used. Classroom conversations also center around the dynamic nature of the industry, and the need to be a lifelong learner as the field evolves.

Q: What initiatives or programs have you implemented, or would you consider implementing, to improve employee engagement and improve retention?
A: At the University of Arkansas, we require all supply chain majors to complete a supply chain internship as part of their degree. We believe this experience has a lot of benefits. A key benefit is helping the student and organization they are interning with to learn more about each other than a 30-minute interview can show. This helps both sides determine the fit and future, which can lead to more engagement and higher retention. Managers can also positively affect retention.
In the constantly evolving world of supply chain management, the executive quest for new knowledge, qualifications, and skills never really ends. With new challenges, opportunities, and technologies emerging all the time, keeping up requires a continuous learning approach that includes—but isn’t limited to—higher education, hands-on training, certifications, well-rounded skills, and excellent problem-solving capabilities.

Figuring out which of these ranks high on an employer’s “must have” list isn’t always easy. Many universities offer supply chain management degrees that help individuals lay down a strong foundation for success. Online courses, roundtables, conferences, boot camps, micro-credentials and on-demand learning opportunities help fill in the gaps for executives in need of targeted skill development.

Executives have a lot of learning opportunities at their avail. Here’s how certifications fit into the picture.

By Bridget McCrea
The question then becomes, which of these learning opportunities are most valued by employers? And, are they seeking out acronyms like CSCP, CPSM and SCPro when recruiting new executives or promoting existing ones? The answers to those questions really depend on whom you ask. In her recent Acceleration Economy podcast, Joanna Martinez of Supply Chain Advisors, LLC, discusses whether supply chain certifications are still valued by employers.

“Unfortunately, some supply chain certification programs are woefully behind the times. One research foundation found that just 18% of certifications issued through career and tech education programs are actually sought by employers,” says Martinez, who adds that “leaders who embrace transformation” are needed at every level.
“We also need certifications in whatever technologies our companies have chosen to use so we can take the utmost advantage of that technology,” she adds. “We have a responsibility to understand how the certifications we’re pursuing will add value and result in a real payback.”

We asked Mark Baxa, president and CEO at CSCMP, whether employers value and seek out supply chain certifications at this stage of the game. He says it varies by business and industry, as well as what the company wants to accomplish. “Certification has its place, but it’s not the first thing that employers talk about or have an interest in,” Baxa says. “That’s just what’s happening today.”

High-level supply chain executives—CSOs and EVPs of supply chain, for example—are looking for help upskilling their workforces. They’re interested in “raising the tides” of their organizations, Baxa says, but that doesn’t always include the intensive, well-developed learning process associated with formal certifications. For example, CSCMP’s SCPro certification encompasses eight core building blocks, each of which includes an exam. Students then sit for a final exam in order to obtain their certification. The process takes an average of 10 months to 12 months to complete and is generally most suitable for career professionals who want to enhance their knowledge and problem-solving skills. Instead, CSCMP has experienced more than 30,000 new supply chain course enrollments in the past 12 months through courses like the SCPro Fundamentals Certificate Program and others.

Practical skills and knowledge continue to be highly valued by employers who need executives who understand what’s happening in the marketplace and how those trends impact the supply chains they’re running. This less formalized “education” goes a long way in today’s evolving business environment, where a focus on best practices and industry happenings can help executives separate themselves from the rest of the pack.

To help in this area, CSCMP offers digitized self-paced learning and face-to-face group learning that’s focused on specific subject areas. “This is all part of a learning ecosystem that professionals at any level must participate in to have really sharp, top-performing supply chains,” says Baxa, who sees on-the-job performance and delivering on business expectations (e.g., cost optimization, delivery performance, etc.) as top priorities for employers right now.

Getting there requires good leadership and a commitment to continuous education, regardless of the specific format or how that learning is delivered. “Leaders develop good leaders,” says Baxa. “It’s incumbent upon the executive supply chain leadership to recognize that investing in their people delivers not only better retention, but also better competency.

A double-edged sword
Certifications can be somewhat of a double-edged sword for employers who may find themselves paying larger salaries to highly credentialed individuals. This can force companies to choose between “clean slates” that need more on-the-job training and those who bring more experience and knowledge to the table, but who command higher salaries.

For example, Douglas Kent, EVP of corporate and strategic alliances at ASCM, says the executive who combines a baccalaureate supply chain degree with one or more certifications earns an average of 30% more than their peers. “That’s great for the executive, who is probably happier, progressing in their career faster and sticking around longer,” says Kent. “However, from the employer perspective, it may cost more.”

The reality of having to shell out higher salaries to credentialed executives is probably easier to digest in the current labor market, where finding and retaining employees is tough and where 11,200 Baby Boomers will reach retirement age in the United States every week between now and 2027. “Replacing valued associates is expensive, and those costs will increase if the white-collar worker shortage persists,” says Kent, who advises employers to consider the return on education or “ROE” when deciding on which credentials to prioritize and/or invest in.
“The question employers have to ask themselves is, if I make this spend will I see improvements in critical metrics like attrition rate, employee satisfaction and even supply chain-specific metrics?” Kent says. “The ROE becomes very important to ensure that those investments have a true payoff, and particularly when budgets are tight, at which point training and development are often cut back first.”

Formally upskilling workforces with certification

The university perspective on the value of certifications in employers’ eyes differs a bit from that of the larger industry groups. At MIT’s Center for Transportation & Logistics, for example, Director of Online Education Eva Ponce, Ph.D., says she’s noticed that more employers are emphasizing certifications as a way to “formally upskill their workforces.”

“More companies are reaching out to us to develop custom courses and programs in supply chain management to upskill and reskill their employees. This is becoming a crucial part of their talent development strategies,” says Ponce. “Other companies are interested in individual certificates, including programs with core and advanced courses, while others are interested in more comprehensive programs.”

Ponce says the specific preference varies based on the depth of content exposure required and the amount of effort and commitment available for employee development. For example, the MITx MM in SCM comprises five courses and requires about eight hours of effort per week, per course. The completion of this program provides a credential in SCM, equivalent to six months of graduate-level coursework at MIT.

There’s also more demand for MIT’s custom online certification programs, whereby a company chooses the topics that are covered and the amount of effort required. Right now, organizations are particularly interested in certifications that equip executives with advanced supply chain management skills. They also like programs that enhance day-to-day operational capabilities and introduce advanced analytics tools and techniques.

Specialized webinars that feature subject matter experts who discuss specific topics are also in high demand because they help executives absorb information about new trends, current challenges and future supply chain shifts. Looking ahead, Ponce expects the future of executive supply chain education to focus on more personalized learning experiences.

“There’s going to be a bigger emphasis on ‘crafting your own educational pathway,’” she says, “and with more emphasis on lifelong learning.”

Assessing the landscape

As he surveys the current executive education landscape, Steve Tracey, professor of practice and executive director of the Center for Supply Chain Research at Penn State University, says the many different acronyms that certified professionals can place after their names serve a purpose in the business world. For starters, they introduce a body of knowledge that not all students may be aware of or up to speed on. They also provide structure and knowledge based on theory and practice, although Tracey says the knowledge itself may not always be able to keep up with rapid changes in technology.

Take basic inventory calculations, for example. Historically, students learned economic order quantity (EOQ) to determine desired inventory-carrying quantities. This basic math equation is a discrete calculation that applies to a specific piece of inventory at a single location—something that may not be applicable for every organization anymore. “Now, with tools like multiple echelon inventory optimization, that calculation takes on a whole different light,” says Tracey.

Ultimately, Tracey says “no education is bad” and that certifications are one of many different educational opportunities that supply chain executives have at their avail. “As long as you remember what you learned and can apply it in practice, the education will deliver a return,” he points out. “However, if you’re getting the education simply to get the credential, and if your current or future employer doesn’t value it, then it is literally just a number of letters after your name.”

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Top 50 3PLs: Not out of the woods

Most global and domestic 3PLs faced huge challenges last year as shippers adjusted to ongoing issues related to inventory optimization and geopolitical risk. To keep pace, the top 3PLs are now amping up their collaboration with carrier partners and implementing as much cutting-edge automation as they can to improve customer service—but will it be enough?

BY KAREN E. THUERMER, CONTRIBUTING EDITOR

Last year proved to be challenging for third-party logistics (3PLs) providers. Transportation rates plummeted, fuel prices skyrocketed, retaining and attracting talent became difficult, warehouse space tightened, rules and regulations increased, competition surged, and the supply chain faced frequent disruptions. Meanwhile, shippers focused heavily on right-sizing bloated inventories and reducing logistics costs.
# Armstrong & Associates Top 50 U.S. 3PLs

(Largest U.S. 3PLs Ranked by 2023 Logistics Gross Revenue/Turnover)

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<td>49</td>
<td>Kerry Logistics (Americas)</td>
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*Revenues cover all four 3PL Segments (DTM, ITM, DCC and VAWD), are company reported or A&A estimates, and have been converted to US$ using the annual average exchange rate. **Revenue shown is that of Amazon’s Third-Party Seller Services business segment, which includes its 3PL operations as well as commissions and any related fulfillment and shipping fees, and other third-party seller services. Based on its 3PL warehousing footprint and e-commerce fulfillment focus, Armstrong & Associates estimates most of this segment’s revenue is from 3PL services. Copyright © 2024 Armstrong & Associates, Inc.
London-based Transport Intelligence Ltd.’s (Ti) State of Logistics Survey 2024 shows that the three most important challenges currently affecting the 3PL industry are the economic downturn, increased costs, and increasing competition.

“This marks somewhat of a difference compared to when we ran this survey last year, where increased costs were voted the most important challenge for the 3PL market at the time,” says Nia Hudson, Ti research analyst. “Concerns surrounding the economy and its effect on the 3PL market have clearly grown in the past year amid a very challenging economic environment.”

The leading U.S. 3PL consultancy, Armstrong & Armstrong (A&A), points to the rise in central bank policy rates to fight inflation as continuing to weigh on 3PLs and pressure margins.

Meanwhile, the Transportation Intermediaries Association (TIA) reports that 3PLs saw a 4.7% decline in shipments during the fourth quarter of 2023, a 4.3% decrease in invoice amount per shipment, and an 8.8% drop in total revenue compared to third quarter of 2023. “Average gross margin percentage during the fourth quarter stood at 15.6%, up slightly on a quarter-to-quarter basis, but still well below year-ago levels,” say TIA analysts.

Meanwhile, the influx of new players in the e-commerce fulfillment space has triggered a race to the bottom in pricing. “As a result, 3PLs are compelled to offer competitive rates to attract and retain clients,” says Sai Kiran Balaji, lead analyst of logistics research at Mordor Intelligence. “For instance, Amazon’s transparent fee structure empowers sellers to estimate their costs and potential profits accurately.”

Additionally, Amazon’s multi-channel fulfillment allows sellers to fulfill orders from various sales channels using their inventory stored in Amazon’s centers. “To keep up, 3PLs must invest more in meeting these demands while safeguarding their customer base,” says Balaji. “They must also explore innovative pricing strategies and value-added services to differentiate themselves from the competition.”

**Revenue/turnover ranked**

The 3PL gross revenue/turnover figures, compiled by A&A in its list of Top Global 3PLs, indicate just how hard hit the industry was in 2023. In fact, Amazon now leads the pack by a wide margin. A&A list ranks Amazon as the highest earning 3PL, with 2023 global gross revenues at over $140.053 billion, an enormous amount over No. 2 ranked DHL Supply Chain & Global Forwarding, which came in with $33.869 billion ($45.6 billion in 2022).

In third, Kuehne + Nagel (K+N) with $31.659 billion ($46.864 billion in 2022), fourth is DSV with $22,316 ($34.883 billion in 2022), fifth is DB Schenker with $22.257 billion ($30.392 billion in 2022), and sixth is C.H. Robinson with $16.746 billion ($23.874 billion in 2022).

On the U.S. side, the top four 3PLs in terms of gross revenues were Amazon, C.H. Robinson, J.B Hunt, and UPS Supply Chain Solutions. Globally, C.H. Robinson is ranked No. 6, J.B. Hunt, No. 11, and UPS Supply Chain Solutions, No. 13.

This was the first year A&A included Amazon on its list. “Based on its 3PL warehousing footprint and e-commerce fulfillment focus, we could no longer exclude Amazon,” says Evan Armstrong, president, A&A. “Although the revenue shown is that of Amazon’s Third-Party Seller Services business segment, which includes its 3PL operations as well as commissions and related fulfillment and shipping fees, and other third-party seller services, we estimate most of this segment’s revenue is from 3PL services.”

With an estimated 255 million square feet of 3PL warehousing space in 411 warehouses just within North America and 360 million square feet of 3PL warehousing space in 710 facilities globally, excluding its Prime Now hubs, airport hubs, sortation centers, delivery stations, and data centers, Amazon is also the largest
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### Armstrong & Associates Top 50 Global 3PLs

(Largest U.S. 3PLs Ranked by 2023 Logistics Gross Revenue/Turnover)

<table>
<thead>
<tr>
<th>2023 Rank</th>
<th>Third-party Logistics Provider (3PL)</th>
<th>2023 Gross Logistics Revenue (USD Millions)*</th>
</tr>
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<tr>
<td>1</td>
<td>Amazon**</td>
<td>140,053</td>
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<tr>
<td>2</td>
<td>DHL Supply Chain &amp; Global Forwarding</td>
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<td>3</td>
<td>Kuehne + Nagel</td>
<td>31,659</td>
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value-added warehousing and distribution (VAWD) 3PL in both categories.

A&A's last warehousing market study determined that Fulfillment by Amazon (FBA) controls 60% of the U.S. e-commerce 3PL market. A&A also notes how Amazon has dramatically affected warehouse employee wages and lease rates in key distribution areas such as Plainfield, Indiana and California’s Inland Empire.

Ti notes, however, that last year Amazon faced issues with overcapacity—the result of its aggressive warehousing network expansion.

**Warehouse costs**

Ti’s State of Logistics Survey 2024 showed that when compared with pre-pandemic data, warehouse operational costs are significantly higher.

More than 90% of respondents reported some sort of cost increase when compared with pre-pandemic numbers, and only 6% reported no change or lower costs in comparison. Over 40% of respondents saw operational costs increase by 1% to 15%, while 44% saw costs increase by 15% to 40%.

“Rising costs are still prevalent when compared with 2023, but less so than pre-pandemic, indicating a slower rate of warehouse cost growth as the global economy continues its shaky recovery path following the pandemic,” says Hudson.

Ti’s warehouse cost index also shows a similar pattern—although costs are elevated, cost growth is slowing. "One of the key factors influencing warehousing costs is the imbalance of supply and demand," says Hudson. "We're still seeing a situation, particularly in the West, where warehouse vacancy rates are very low when compared with historic levels, which is in turn pushing up warehouse rental costs.”

**Influencing factors**

While 3PLs were affected by their customers’ reactions to ongoing issues related to the pandemic and geopolitical risks, Armstrong points out that many realized supply chains need to be more flexible and able to source products and components from multiple countries rather than being reliant on only one.

“A bright spot for 3PLs has been cross-border trade with Mexico, now the largest trading partner with the United States, as companies look to nearshore manufacturing from Asia," Armstrong says. "This has created opportunities for 3PLs such as Ryder, C.H. Robinson, and ProTrans with strong cross-border offerings.”

Ti notes how 3PLs have, overall, been doing a very good job of mitigating inflationary issues by operating contracts where costs are transparent, and increases can be passed on to clients directly.

“Wincanton, for example, published data that showed that open book warehousing and transport contracts drove its revenue growth in the last few years,” says Hudson. "Hence, with price increases pushed down to customers, 3PL providers have largely been able to maintain the top line in what is a difficult economic environment.”

In fact, Ti’s contract logistics market sizing data shows an expected growth in contract logistics activity of 3.7% year-over-year in 2024, the highest growth rate since 2021, signaling a return to a more normalized, pre-pandemic state of growth. “However, while there’s relatively higher growth in emerging economies, advanced economies are expected to drag down the overall growth rate into this year,” says Hudson.

**Segment activity**

A&A figures indicate that international transportation management (ITM) 3PLs saw rapid declines in air and ocean demand and rates in 2023.

“ITM has moderately bounced back from the first half of 2023 and has seen some rate benefit from shipping uncertainty in the Red Sea and reduced ocean traffic through the Suez Canal,” says Armstrong.

Armstrong also points out that domestic transportation management (DTM) 3PLs became “hyper-focused” on contractual transportation management business and managed transportation versus spot-market freight brokerage as truckload demand waned and rates declined to under the five-year average causing a freight recession.

“The impact was widespread, and even included last-mile delivery providers which benefited from strong e-commerce demand during the pandemic shutdowns,” says Armstrong. Further, dedicated contract carriage (DCC) 3PLs hung in there due to the contractual nature of its transportation agreements. "However, pricing pressure persists,” he says.

A&A research determines that for VAWD 3PLs, inventories have stabilized, and some space has freed up even with higher interest rates keeping a lid on new warehouse development. "There’s been increased focus on fine-tuning warehouse pricing and improved bid performance,” says Armstrong. “Shippers see this as a good time to put out RFPs and work to mutualize some of the one-sided agreements entered into during the post-shutdown demand surge.”

But meanwhile, the rise of e-commerce fulfillment and customer expectations have soared. “They now demand multi-channel
fulfillment, often expecting free and swift deliveries, even on the same day,” says Balaji.

McKinsey and Co. reports that 25% of customers are willing to pay a premium price for same-day delivery. “But fulfilling these expectations necessitates further investments in technology and operational efficiency, further affecting margins,” says Balaji.

Third-party providers must also focus on enhancing their customer service capabilities, ensuring transparency in tracking and delivery, and providing flexible return policies to meet and exceed these heightened expectations.

Consequently, to stay competitive and maintain market hold against huge competitors like Amazon and Walmart, Balaji points out that 3PLs are implementing strategies such as: collaborating with shipping carriers and other 3PL providers; implementing digital automation for agile inventory management; engaging streamlined omni-channel fulfillment; and offering exceptional customer support.

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**E-COMMERCE: THE GROWTH DRIVER**

E-commerce remains a strong growth driver across all 3PL segments, particularly with 3PLs grappling with shrinking margins, primarily due to the intensifying competition in e-commerce fulfillment.

To stay competitive against e-commerce fulfillment giants, 3PLs find that they must ramp up investments in technology, infrastructure, and expertise. “Investing in technology is probably the most prominent example of 3PLs attempting to distinguish themselves from the competition,” says Nia Hudson, research analyst for Transport Intelligence (Ti).

However, Sai Kiran Balaji, lead analyst for logistics research at Mordor Intelligence, emphasizes that if not managed effectively, investments in technology, infrastructure, and expertise can strain their margins.

“The need for advanced warehouse management systems, automated sorting and picking technologies, and enhanced data analytics capabilities is becoming increasingly critical for 3PLs to operate efficiently and provide the level of service that customers now expect,” says Balaji says. “Balancing these investments with the need to maintain profitability is a delicate task that requires strategic planning and execution.”

Amazon is driving significant interest from value-added warehousing and distribution (VAWD) 3PLs to automate warehouses with autonomous robotic solutions.

“Many 3PLs invested in robotics last year to improve efficiency, accuracy, and speed of picking,” says Evan Armstrong, president of Armstrong & Armstrong (A&A). “By accessing real-time data and analytics from the cloud, robots can optimize their routes, reduce idle time, reduce human transport/travel time, and prioritize tasks based on demand.”

Ti finds that 3PLs are under increasing pressure to compete with not only Amazon’s fulfillment process, but also a dearth of newer tech-focused fulfillment providers that promise to deliver the same quick fulfillment standards as Amazon.

Ti’s State of Logistics Survey 2024 shows that the top three warehouse technologies in which 3PLs are planning to invest are AI and machine learning, warehouse management systems and automated storage and retrieval systems.

If merger and acquisition activity picks up into 2024 and 2025, we may be entering a period of intense consolidation in the e-fulfillment landscape,” adds Hudson.
Michael Irwin

Michael experiences the potential and pitfalls of AI on a daily basis. As the Chief Information Security Officer, he is at the cutting edge of enhancing operational procedures and counteracting emerging sophisticated threats. Michael and his team maintain constant vigilance, safeguarding the integrity of our customers’ supply chains.

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