SUPPLY CHAIN MANAGEMENT REVIEW
December 2025

The year in supply chain

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Looking back, moving forward

Our annual Best of SCMR *issue revisits the year's most-read stories, the innovations that inspired change, and five hopes for a stronger supply chain in 2026.*

As another year draws to a close, I find myself reflecting on just how much change—and progress—we've seen across the global supply chain community. The year began with some uncertainty with a new administration entering Washington, and as of the time I'm writing this, that uncertainty remains. But I'd rather not focus on political issues, instead, I'd like to introduce you to our annual December issue, where we once again have pulled together a collection of the year's most compelling stories, insights, and perspectives from *Supply Chain Management Review*'s many contributors throughout the year.

Each article included here was selected because it resonated deeply with readers, whether through the number of times it was read, shared, or cited in conversations. Together, they represent the "Best of *SCMR*" in 2025: stories that shaped our understanding of leadership, technology, and the ever-evolving role of the supply chain in business success.

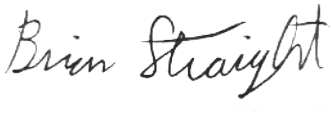
From Muhammad Ali's lessons in resilience and reinvention applied to supply chain costing, to the growing recognition that supply chain leadership now drives growth and competitive advantage, this collection captures the ideas that mattered most. We revisited the perennial question of whether it is better to "make or buy" your supply chain, and we looked at how supply chain awareness must permeate every department, from finance to R&D, if companies truly want to perform at their best.

In addition to these standout features, this issue includes two new supplements that showcase the innovation and forward-thinking that continue to define this industry. The first: "NextGen 2025: Where supply chain innovation came to life," recaps our annual conference in Nashville, highlighting the award winners, case studies, and emerging technologies shaping the next generation of supply chains. The second: "Using digital twins to master supply chain volatility," dives into one of the most talked-about tools of the year—digital twins—a technology giving planners the power to simulate change and prepare for disruption with unprecedented confidence.

As we turn the page to a new year, I'm encouraged by the momentum and ingenuity I continue to see from supply chain leaders, innovators, and practitioners around the world. Even during unpredictable times. Looking ahead to 2026, here are five things I'm hoping for:

- **Greater investment in people.** Technology is driving industry forward, but it will only take us as far as the people that run supply chains can handle. Empowering and upskilling talent should be a priority in 2026.
- **Faster progress on sustainability.** Sustainability became a bit of a taboo word in 2025, but at conference after conference this year, companies plowed forward. It may not be a public relations initiative, but sustainability remains a proven, profitable venture for supply chains willing to meet the moment.
- **Smarter use of AI.** Plenty of AI projects dot supply chain operations, but many are not providing a return on investment. Strategic investment in AI is paramount to a successful project. Find the right use case and scale as appropriate. Bigger doesn't always mean better.
- **More resilient sourcing networks.** The 2025 geopolitical environment reinforced the lessons we all learned during COVID about diversification and resilience. As we moved further from COVID, though, many forgot those lessons. The current tariff environment has brought those lessons back to the fore. Let's not forget them this time.
- **A stronger connection between the C-suite and the supply chain.** This should go without saying, but the more alignment and engagement the supply chain has with the C-suite, the better the outcome. Movement in the area lost momentum in the past year or two, but it's time to get the supply chain involved at the beginning once again.

As always, thank you for reading, for sharing your perspectives, and for being part of the *SCMR* community. Here's to a productive, innovative, and resilient year ahead.



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Speak financially, get results: Revisited

To elevate S&OP from tactical to strategic, supply chain leaders must speak the language of finance—and involve finance early and often.

By Larry Lapide

I recently attended a New England Chapter of the Institute of Business Forecasting and Planning (IBF) presentation, given by a seasoned planning manager from a local Boston-area based company. She was formerly at a large, well-known Midwest company and gained plenty of experience working on its sales and operations planning (S&OP) /integrated business planning (IBP) process team. She moved to the Boston area to implement a new S&OP process at the local company.

While successful in implementing it there, she said she was struggling a bit to get timely input from the finance department with respect to whether or not finalized S&OP demand-supply plans were synchronized with the company's financial performance goals. It seemed that the input was not provided on a routine basis, and if so, provided after S&OP plans were approved. Near the end of the talk, she asked the audience if anyone had ideas on how to get finance more involved. I offered a simple solution to her problem: Just break up, or parse, your S&OP process into two or more pieces to force the finance group to calculate the performance numbers for each one and just add them up.

After looking at me quizzically, I elaborated, explaining that I had students do research for their MIT Master's thesis on what businesses do when they have to develop multiple S&OP plans. (In whimsical terms, the students needed to address the challenge, analogously recalling that after "Humpty Dumpty had a great fall, all the king's horses and all the king's men could not put Humpty together again.")

The students' research found out that P&G, for example, has around 100 forecasting processes and 100 S&OP processes running simultaneously. When asked how it put all the pieces together, P&G managers said the finance group does it. The students' final recommendation in the thesis was that in order to make sense of multiple independent S&OP plans, financial managers needed to run the numbers for each, and add them together to get the company's enterprise-wide S&OP plans.

The manager rephrased that this, for example, means a profit-and-loss statement needs to be developed for each process. And of course, she noted that one has to make sure that demand and supply match for each process to ensure independence of the processes. To wit, I said: "Yes." (See Insights column: "Parsing holds key to better S&OP" (March/April 2012).

I view an SO&P team as being navigators that advise the executive team on whether a company is projected to be on a trajectory to achieve its annual financial performance goals. This includes both the profit-and-loss (P&L) statements, as well as the financial balance sheets that show assets. Thus, it is paramount that all S&OP operational plans be translated into their implications for a company's financial picture. In addition, this task has to be done by a finance manager(s) on the S&OP team. If not, there would be no reason to have representation by the finance organization on the team.

It has been my long-held view that supply chain managers need to be more adept at understanding financial statements and analyses. Much of supply chain planning is done in terms of the number of units to be sourced, made, and delivered. Minimally about the dollars and cents of it all. Over 12 years ago, in my Insights column titled "Speak financially, get results" (September/October 2012), I postulated that because finance is the language of business, managers should become schooled in financial analyses. A revision to that column follows.

***

I got my doctoral degree from the University of Pennsylvania's Wharton School of Business in an area called operations research (OR). As a new graduate, I'd explain to people unfamiliar with the discipline that it involves the use of the scientific method and quantitative analysis to solve business problems. I had been trained in decision theory, quantitative modeling, and optimization techniques.

When someone would ask what my favorite graduate course was, I would carry on excitedly about my OR methodology course. It was taught by a famous professor who delighted students with stories about companies that had successfully used OR to solve some of their most pressing business problems. Math applied to the real world of business—what course content could be better than that? At least that's what I thought at the time. I now think "introduction to accounting" should be added to the mix.

Financials are the language of business

During my 45-plus years of business experience, several things have made me realize the importance of accounting and financial reports to understanding what really makes a business tick. Here are several points to consider.

First, in my November 2008 Insights column, titled "The operational performance triangles," I presented a triangle that can be used to help conceptualize whether a balanced set of operational performance objectives align to competitive corporate strategies. Two points of the triangle, efficiency and asset utilization, represent those types of performance objectives that directly affect a company's income statement and balance sheet, respectively. (The third point on the triangle represents customer response objectives that do not directly affect financial reports). My point in that column was that supply chain professionals need to understand how the first two types of operational objectives—efficiency and asset utilization—relate directly to financials.

Also, whenever a large-scale project is to be undertaken, a business case analysis must be developed in financial terms. So, before a supply chain project can get started, executives need to be convinced that it will improve financial performance over the long run.

Lastly, I'm now convinced that all future supply chain leaders will need to be good business people first and supply chain experts second. For this to happen, they must become conversant in the language of business, which is accounting and financially based.

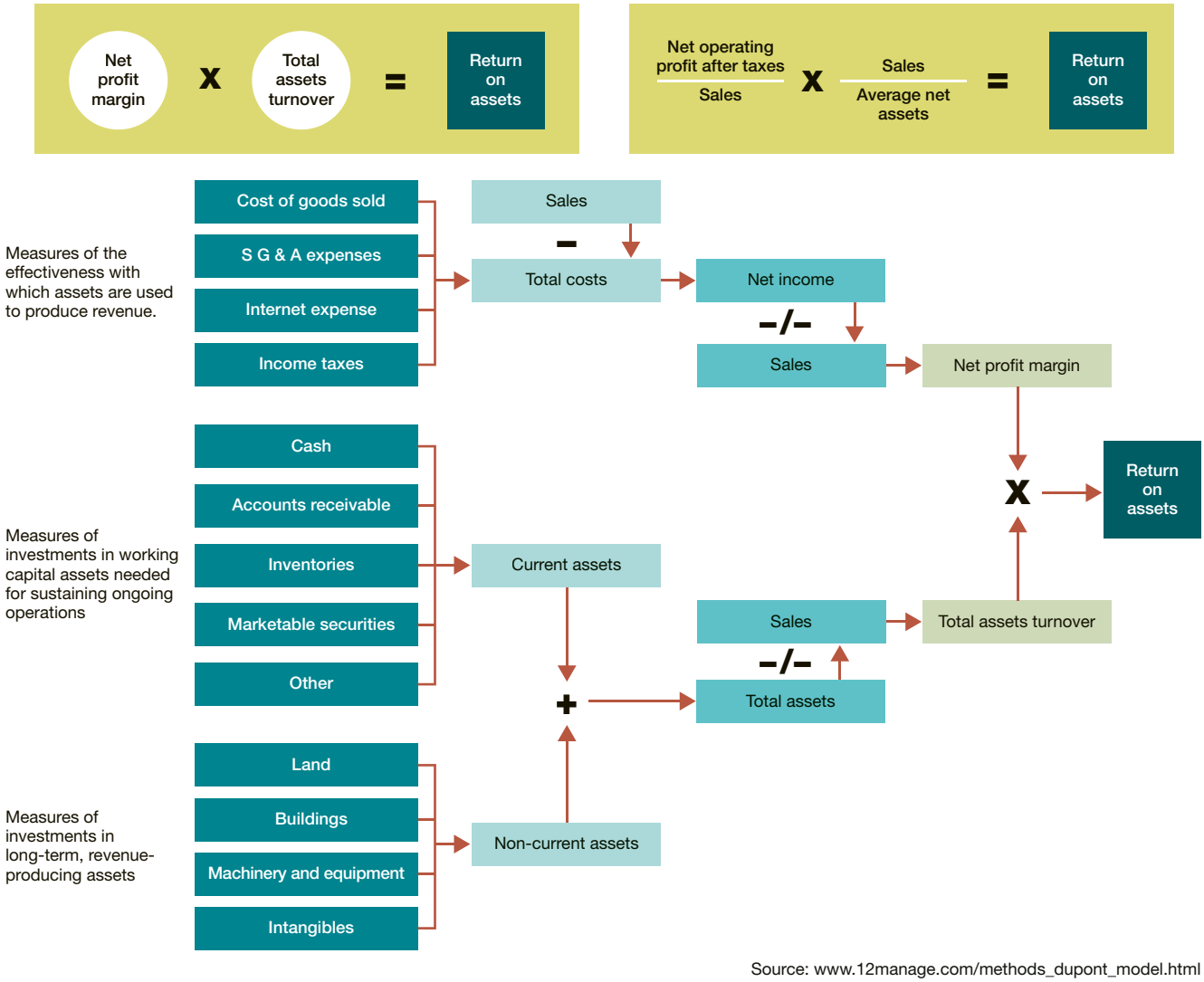
The DuPont Model

Put very simply, all supply chain managers should become conversant in accounting and finance if they want to get ahead. Once conversant, they will be able to build business cases that will resonate closely with executive-level thinking. The DuPont Model (shown in Figure 1) is a good blueprint to use when developing a business case. The model, which according to Wikipedia was established in the mid-1920s, has been used by managers over the years to translate operational plans into their expected financial impact on return-on-assets (ROA). While simple, the model is robust in showing the interconnections among operational productivities, revenues, operating costs, assets and inventories, and their impact on ROA.

Using a model such as this allows managers to translate operational supply chain improvements into their financial impact. For managers that adopt the model and follow my advice to "think financials," their executive presentations will go from being "bored-level" to "board-level." This will help them get the executive approvals they need, as well as those promotions they want. •

FIGURE 1

The Dupont model



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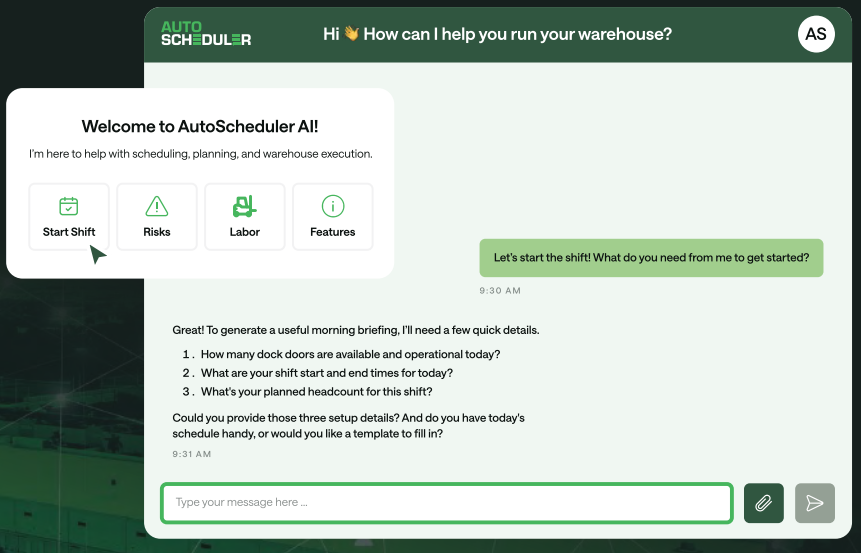

Better AI does not always mean bigger

New technologies and approaches are paving the way to more efficient use of AI systems.

By Ken Cottrill, editorial director, MIT Center for Transportation & Logistics

Ken Cottrill, editorial director, MIT Center for Transportation & Logistics, kencott@mit.edu

The advent of AI as a widely available business tool has given rise to numerous applications that are proliferating at a dizzying pace. As we strive to stay current with the latest applications, it's essential not to overlook the ongoing efforts to enhance existing ones.

The MIT Center for Transportation & Logistics' 2025 Crossroads conference, titled *Technology Advances & the Impact on SCM*, on March 17, 2025, provided a glimpse of these efforts and how they enhance the effectiveness of AI and machine learning.

Inspired models

AI systems known as large language models (LLMs) utilize vast datasets and machine learning to process and manipulate human language. LLM applications, such as powering chatbots and providing answers to questions, have experienced impressive growth over recent years. However, their potential is more limited in edge applications such as robots and self-driving vehicles.

As LLMs have increased in size, so have their memory and computational demands. Consequently, utilizing these models in mobile applications that lack the requisite capacity and cloud connectivity is challenging.

A new type of deep learning architecture called liquid neural networks (LNNs) could overcome this limitation. LNNs bring the information and language processing power of AI to the physical world in which robots and autonomous vehicles operate, explained Daniela Rus, director of the MIT Computer Science and Artificial Intelligence Laboratory (CSAIL), one of MIT's iconic research labs.

A worm inspired the development of this new type of neural network. C. *elegans* is a tiny roundworm with a brain that accomplishes a great deal with minimal neural resources. Like human gray matter, the worm's brain is composed of cells called neurons connected by synapses. However, the creature's brain performs all the tasks it needs to survive using a mere 302

neurons and 8,000 connections. By comparison, the human brain has around 100 billion neurons and 100 trillion connections.

Research on the worm's streamlined neural network architecture inspired Rus and her team to develop LNNs. These economy-size AI models are easier and more cost-effective to build than LLMs. Being simpler, their decision-making is easier to understand, a crucial advantage in applications where machines interact with humans.

Importantly, LNNs learn on the job and are extremely nimble and adaptable, especially when applied in dynamic, unpredictable environments. Hence, they can run on the relatively small computers found in robots and other mobile machines deployed widely in supply chains.

They also deliver key performance advantages, said Rus. For example, in tests conducted by her team, LNNs outperformed established neural networks in enabling drones to detect and locate objects placed in different settings. LNNs also perform well in situations involving image recognition. An example is enabling self-driving vehicles to recognize groups of pedestrians, which can be challenging for algorithms owing to the amorphous shape of such groups. According to Rus, LNNs are adept at staying focused on the road ahead and reacting to unexpected road hazards.

Her team has installed the technology in an autonomous ground vehicle operating in the container port of Singapore. The vehicle navigates busy lanes between stacks of containers smoothly and parks in spaces within a five-centimeter margin of accuracy.

More applications of LNNs are in development. Rus is co-founder of Liquid AI, an MIT spin-off. The enterprise has launched AI products utilizing pioneering models for the financial services, biotech, and consumer electronics industries, which are claimed to deliver improved performance with a significantly lower memory footprint.

Defter robots

The emergence of AI-powered humanoid robots is indicative of the rapid pace at which the design of these machines is advancing. Online videos of robots doing backflips and other acrobatics give the impression that the machines are becoming as agile and dexterous as humans.

However, as Pulkit Agrawal, associate professor at CSAIL, pointed out at the Crossroads conference, this is not the case. The robots that perform aerobatically do so in closed, controlled environments; expose them to the outside world and they falter. For example, a robot can be designed to fetch a sponge to clean up a spill, but probably lacks the dexterity to wipe up the mess.

The challenge, said Agrawal, is developing general-purpose robots that can match human adroitness in most everyday environments.

A significant obstacle to achieving this goal is the method used to train today's robots. LLMs can learn by downloading vast volumes of data from the web, but this is not an option for robots, Agrawal said. The conventional method is imitation learning, where a human demonstrates the actions required to complete specific tasks or teleoperates a robot. Staging such demonstrations to generate the data needed for teaching the robot is costly and labor-intensive. Additionally, because a relatively small amount of task-specific data is used, robots trained to carry out a particular task may struggle if the environment or task changes.

CSAIL is developing more efficient robot training programs by utilizing large volumes of data from various sources, including computer simulations and camera images. Researchers can unify the multiple streams and use machine learning to process the data.

Enabling robots to replicate precise movements performed by human hands is particularly challenging, especially when handling and manipulating complex objects. The new training approach offers promising solutions to this problem. For example, researchers are using a silicone gel in conjunction with cameras to sense and record the depressions made by a human hand when manipulating the gel and map these intricate movements to robots.

In the future, companies may develop simulations for training robots to perform various tasks, or these programs could be included with the machines supplied by vendors.

Ideas machine

If, over the next two years, an employee's use of generative predictive AI does not represent one-third to one-half of his or her's professional day, that person is on an exit path or working for an enterprise that will become a zombie organization, maintained Crossroads speaker Michael Schrage, visiting scholar at the MIT Initiative on the Digital Economy.

However, to get the most out of this revolutionary technology, people must apply critical thinking. That means utilizing AI to challenge assumptions, scrutinize evidence, and stress-test conclusions, to make more precise, sound, and context-specific decisions.

Schrage emphasized that AI is an options engine rather than an answer machine. It is a powerful tool for assessing tradeoffs and generating ideas; a new-generation sounding board for ideas. AI is also extremely fast. He described a session where executives interrogated an AI model that yielded insights in four minutes that would have taken four weeks using traditional research, writing, and editing methods.

Yet too many people accept AI's outputs without applying rigorous critical thinking, he argued. This must change if AI's full potential is to be realized.

To avoid this mistake, users must ask the right questions. The better the prompt, the better the information on which to base decisions. Prompts shaped by adjectives and adverbs are less likely to elicit mediocre responses. And users should not be afraid to demand more meaningful answers from a model if its output seems too vague or not incisive enough, advised Schrage.

Some organizations conduct "promptathons" (similar to hackathons, where programmers and other tech professionals brainstorm to elicit ideas). These exercises are relatively inexpensive to stage and can be highly effective in competitive analysis and developing cross-functional ideas. Promptathons can focus on specific challenges, such as the tradeoff between automation and augmentation. Organizations can create repositories of prompts to facilitate their use of AI.

Other approaches involve employing LLMs to analyze recorded conversations, such as Zoom transcripts, to extract insights and options, and utilizing AI models to stimulate debate and discussion.

Schrage urged organizations not to take AI at its word, but to use its outputs to foster ideation and challenge assumptions about how supply chains are designed and managed. We are only at the beginning of this revolution, he said. By the end of 2026, the potential of LLMs is expected to have increased by a factor of five compared to their current capacity. •

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Augmenting human capabilities and driving future supply chains with Agentic AI

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Agentic AI systems embed intelligence at every node of the supply "NETWORK," thereby driving actions, decision-making, and self-learning.

By Vinay Sharma and Ahish Bindumadhavan

The wave of AI technologies is driving both excitement and skepticism in the supply chain professional community. The promise of catching the excitement of a rogue wave fueled by numerous possibilities of democratization and autonomy from new knowledge, solving complex supply chain problems in seconds, driving decision-making, and enabling process and technology adoption at scale. However, it must, at the same time, address the skepticism arising from governance and regulatory challenges, increased AI skill gaps, security, data availability, and sustainable use of technology.

Among the many variants of artificial intelligence (AI), we will examine how Agentic AI promises to augment human capabilities and create a hybrid workforce of the future (human and machine) to drive the accelerated supply chain transformation journey. We will explain the nature of the agent, the architecture of an agent, and the evolution of the Agentic AI supply chain, and compare and contrast the impact of agents on the activities and point of view of various supply chain stakeholders.

What is an intelligent agent?

An intelligent agent can be thought of as a "stateful" software entity capable of achieving complex tasks with advanced learning and limited direct supervision. It can decompose complex tasks, reason based

on its progress and adjust its solution approaches over multiple steps. The defining characteristic of an intelligent agent is its probabilistic and highly adaptive behavior in response to dynamically changing environments and goals.

Components of an agent within an Agentic AI system

Orchestrator. The primary task of the orchestrator is to coordinate the activities across the various components that make up the agent. The orchestrator not only receives inputs from other agents or users but also facilitates interactions among the planner, executor, and memory components of the agent.

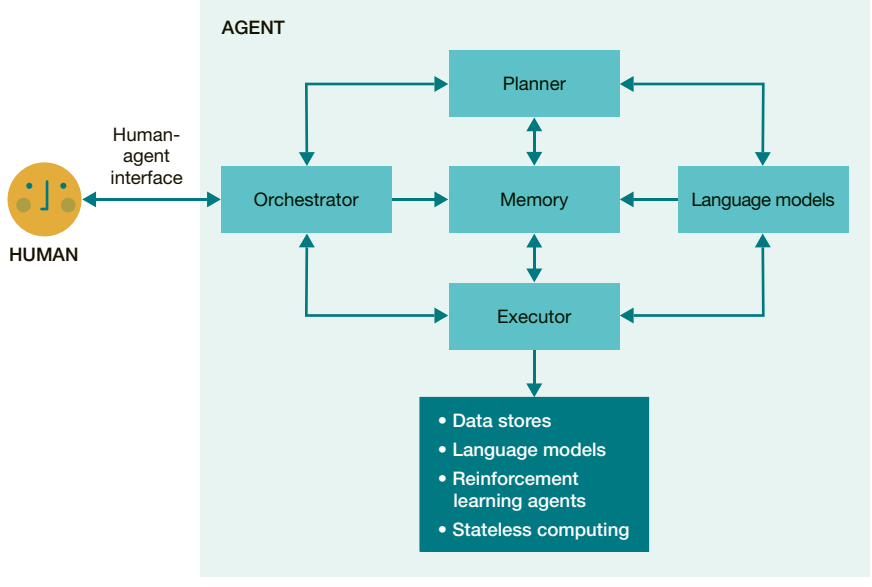
Planner: The primary task of the planner component is to decompose the request received from the orchestrator and reduce it into a sequence of manageable tasks and agent components. The planner has intimate knowledge of the various authorized systems that can be used to accomplish the tasks and leverages a Large Language Model (stateful) to identify the sequence. It then associates the tasks with the respective systems.

Executor. The executor agent component is designed to interact with other systems and executes the tasks sequentially as specified by the planner. The systems it interacts with could be other agents, enterprise databases, LLMs, etc. that comprise the supply ecosystem commerce domain.

Memory. The memory component provides memory services to other components. It acts as a store of past decisions and as a cache for the current activities of the other various components/agents.

FIGURE 1

Single agent architecture with human in loop



Source: TCS

Supply chain as a network of agents

Traditionally, the supply chain has been viewed as a network of sequential, autonomous nodes connected transactionally. Absent digitalization, the physical nodes in the network typically operate in silos and interface with each other locally. Significant information asymmetry results in locally optimal decisions. The next stage of supply network maturity is the development of digital twins operating in an ecosystem network of digitally connected nodes. The digital twins enable the interaction of the physical and the digital dimensions across the entire supply chain network capturing the essential dynamics of the supply network's ecosystem commerce data and processes. However, these digital twins struggle with real-time data sharing across systems, and the resultant supply chain, while supported on a strong technology backbone, is still largely human-driven.

New-age Agentic AI technologies leverage and augment the development of digital twins and robotic process automation (RPA). Unlike traditional AI learning models that simply respond to inputs based on predefined patterns, Agentic AI systems can react autonomously to plan actions, initiate responses, and offer resilience to the dynamics of ecosystem supply networks based on intended and unintended causes arising from changes to the market environment.

Evolution of Agentic AI supply network management

Future agents trained in enterprise supply chain network knowledge will support business stakeholders in their decision-making. As agents scale in their capabilities, the emergent needs of the stakeholders can only be met by enabling inter-agent communication. Agentic AI technology enables the transition from a human-driven supply chain to a human-centered autonomous supply chain network.

FIGURE 2

Architecting a future-ready network of supply chain agents

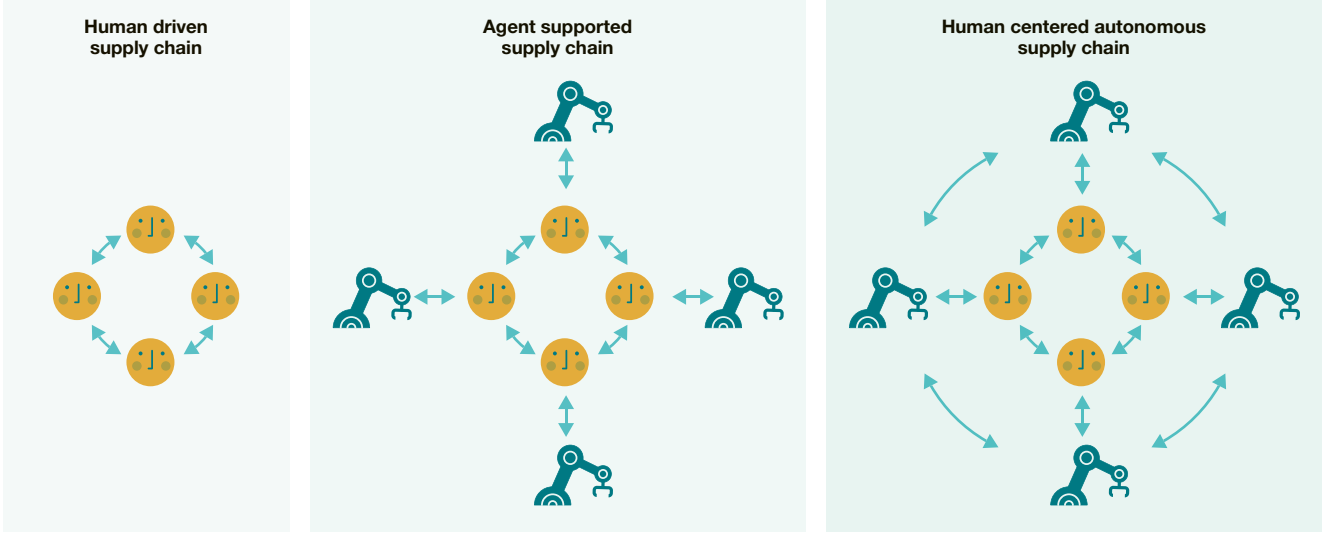


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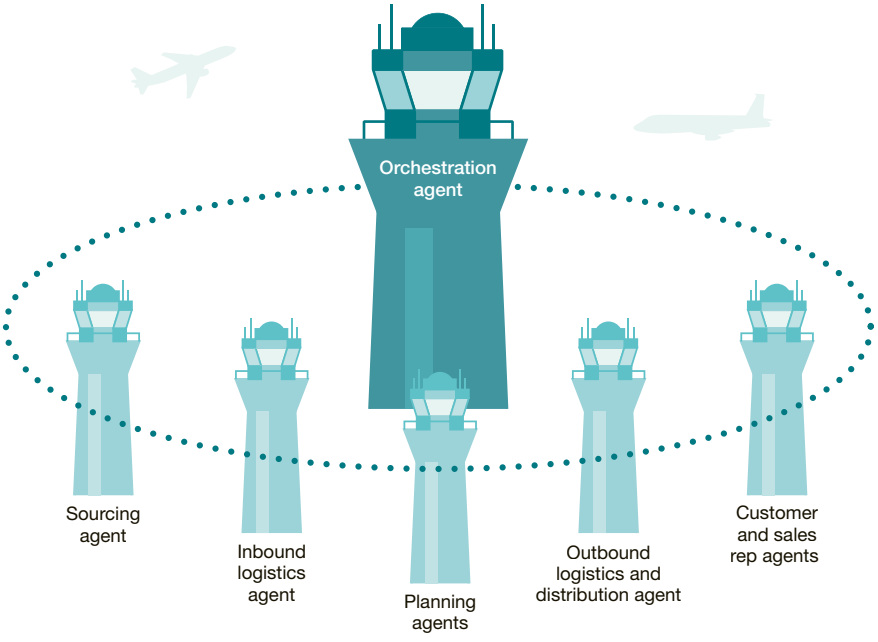
FIGURE 3

Network of supply chain agents driving collaborative ecosystem orchestration



Source: TCS

Architecting a future-ready network of supply chain agents

The digital supply chain network of tomorrow can be viewed as an ecosystem network of supply chain agents. These autonomous agents can sense and learn from the external environment, collaborate with each other to make decisions and act upon them. These Agentic AI supply chain networks will be flexible, scalable, robust, and fault-tolerant. Such multi-agent systems will have the following architectural components.

1. Agents. Individual intelligent agents trained in supply chain domains such as order fulfillment, demand planning, procurement, supply planning, transportation and distribution, logistics and operations planning, etc.

2. Environment. The ecosystem universe from which the multi-agent system receives data to build models. Agents are trained to scan the environment to sense conditions that may affect the flow of goods and associated responses. The result is a resilient, "sense-and-respond" autonomous ecosystem supply network. While the model determines the actions and decisions to respond to fluctuating market dynamics, the ecosystem environment involves human engagement with agents to collaborate to resolve exceptions.

3. Communication framework. The agents communicate with each other through standard agent communication languages. Supply chain agents' communication typically involves actions such as informing, requesting, queries, etc. The communication framework also enables interactions between agents. Based on the goals, the interaction between agents involves cooperation, coordination, and/or negotiation. For instance, the demand and supply agents can be involved in negotiations in which the agents collaborate to make and accept demand and supply proposals and can even terminate the negotiation process if the goals defined by the human user are unmet.

Agent network structure/architecture. Depending on their use, the agents can be organized in a hierarchical or decentralized structure. A typical hierarchical layout is a control tower where a master agent controls and drives the activities of multiple other agents. A decentralized agent network/architecture can be effectively leveraged to solve

TABLE 1

Supply chain leaders in the future

Role	Current Activities (without Agentic AI)	Future Activities (with Agentic AI)
SUPPLY CHAIN LEADERSHIP	• Develop supply chain strategy, roadmap, and governance plans • Value drivers, technology implementation, adoption, and change plans • Collaboration with various software and service providers and drive supply chain initiatives • Drive collaboration among different functions such as demand, supply, logistics and procurement	• Provide active guidance to orchestration agents and allow bi-directional learning • Enable Agentic AI supply chain framework for supply chain organizations considering knowledge orchestration • Define AI guardrails for an ethical, transparent, and secure supply chain network • Enable ecosystem collaboration with the sharing of knowledge, use cases, and KPIs across different supply chain functions
DEMAND PLANNER	• Market trends analysis • Promotion planning • Collaboration with sales and channel partners • Drive statistical forecasting • Collaboration with supply, logistics, and other supply chain functions • Drive consensus forecasting • Develop various demand scenarios and prepare strategies to develop additional revenue and risk mitigations	• Collaboration with different supply chain agents will be driven by the demand agent • Comprehending the output of scenario analysis, providing scenario recommendations • Performance dashboards and KPIs will be built, analyzed, and presented with AI prompts • AI demand agents will drive synchronization with external systems and drive the machine learning algorithms for forecasting
SUPPLY PLANNER	• Collaboration with demand, logistics, and procurement functions • Drive supply planning considering various supply constraints • Develop various supply scenarios and drive improvements in inventory and demand fulfillment	• Comprehending supply plans with scenario what-ifs in natural language • Suggestions for various replenishment and fulfillment strategies driving improved service level and inventory performance • Negotiate with demand and inventory agents to arrive at the optimal plans
LOGISTICS PLANNER	• Develop logistics plans considering optimal networks, costs, and transportation modes • Develop track and trace and proactive risk mitigation actions • Collaboration with demand, supply planners, and logistics service providers	• Automated load builds, network route optimization, and logistics mode selection • Logistics performance and KPIs with AI prompts • Collaboration with planning and procurement agents
SOURCING SPECIALIST	• Develop sourcing strategies for various commodities • Collaborate with vendors and drive optimal sourcing plans with spending improvements	• Automated supplier collaboration with supplier performance and relationship management • Spend analytics and identification of maverick spend

Source: TCS

emergent problems in the supply chain network. For example, a network /architecture fosters resilience as it is flexible and adaptive by its nature. Newer agents can be plugged into the existing Agentic AI supply chain without significantly affecting the real-time operations of the existing supply chain. The division of labor in the Agentic AI supply chain mirrors that of the real-world supply chain network. The greater efficiency of the Agentic AI supply chain network vis-à-vis physical supply chain network is due to the elimination of information silos and efficient, faster collaboration between autonomous agents in dynamic environments.

Role of the supply chain leaders in the multi-agent supply chain system

Future supply chain leaders will have to transform from current supply chain business models to new Agentic AI models that manage autonomous agents to drive automation, advanced decision-making, and organization structures that foster a culture of collaboration and continuous improvement. The table on Page 16 summarizes the change in the life of supply chain leaders in the future.

Implementing a supply network with agents and humans in the loop: The future is now!

Future supply chain managers will need to work collaboratively with supply chain agents to accelerate decision-making and eliminate bottlenecks to optimize supply chain performance. They will have to monitor the behavior of the Agentic AI supply network, define guardrails and rewards for agent behavior, and provide active guidance, based on their experience, to agents to achieve defined outcomes.

Such dynamic interactions between human managers and agents in multi-agent supply chain systems will act as iterative feedback loops enabling these systems to refine decisions and adapt to complex business environments. Supply chain managers must also guard against unintended consequences of agent decisions and must implement decision-making within an evaluative framework comprising agent recommendations, tacit knowledge, ethics, and business goals.

Managers must ensure that a multi-agent supply chain architecture is designed to facilitate the explainability of agent actions and audit of inter-agent interactions. For example, in the context of supply chain planning, the manager must be able to evaluate the decision-making process of the planning agent—the number of supply nodes explored to satisfy demand, the trade-offs made between levels of inventory and overall service levels of the network, etc.

For all their promise and abilities, agentic supply chains are human-made systems which embed the knowledge in the form of models. Managers cognizant of their capabilities can augment their decision making to build robust, resilient, adaptive and self-learning supply chains of the future. •

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.

THE RUMBLE IN THE SUPPLY CHAIN:

KNOCKING OUT THE BARRIERS TO TRUE SC COSTING

By Stanley E. Fawcett, Amydee M. Fawcett, A. Michael Knemeyer, and Sebastian Brockhaus

Muhammad Ali was the greatest boxer, but he also learned tough lessons along the way about being just "good enough." Supply chain managers can take valuable lessons from Ali's greatest losses.

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When Cassius Clay Jr. was 12 years old, someone stole his new bike. Upset, Clay told a police officer he wanted to *"whup"* the thief. The officer, Joe Martin, responded that Clay had better learn to fight first. Martin enrolled Clay at his local gym, where he taught Clay to box. So began the career of the man you know as Muhammad Ali, arguably the greatest heavyweight boxer of all time. *Sports Illustrated*, the *BBC*, *Newsweek*, and *Time* all named Ali the "Athlete of the 20th century."

Clay started turning heads in 1960, winning Olympic boxing gold in Rome. Four years later, at age 22, Clay, an 8-to-1 underdog, stopped Sonny Liston to win the heavyweight title. He changed his name to Ali two weeks later. Pundits consider Ali the greatest for two reasons. He reigned in the Golden Age of heavyweights, beating greats like Liston, Joe Frazier, and George Foreman. And he did things never seen—before or since—in boxing. As a young champ, Ali was scary fast. He was almost unhittable. As he aged, Ali recreated himself, blending an unmatched will to win with unsurpassed ring savvy. Ali became the only three-time lineal heavyweight champion.

Perhaps you're thinking: "Ali was amazing, but what can I, a supply chain leader, learn from his story?" One response: "Ali was remarkably resilient, his longevity notable. To remain relevant, he repeatedly reimagined 'The Sweet Science.'" The more insightful story, however, is a cautionary tale. When he took training seriously, Ali was unbeatable. Yet twice he took dangerous opponents—Ken Norton and Leon Spinks—lightly. The result: Humbling defeats. What went wrong? Ali convinced himself he was "good enough" and failed to pay the price—i.e., to sacrifice—to get into fighting shape.

In 30 years working with supply chain champions, we have repeatedly watched this psychology play out as companies pursued winning competencies. Nowhere have these mind games undercut desired outcomes more than in the quest for strategic SC costing capabilities. Let's take a closer look.

Knockout costing capabilities

Great boxers aren't just brawlers. They enter the ring with a plan to strategically exploit an opponent's weaknesses. Pierce Egan, back in 1813, described this scientific approach to fighting as "The Sweet Science," which Ali skillfully deployed.

The Sweet Science in the ring

Before matches, Ali employed psychological warfare to rile opponents up and wear their wits down. During weigh-ins, he taunted. During interviews, he insulted. He snuck onto rivals' turf to unbalance them. Sonny Liston, who feared no one, thought Ali was crazy, an unnerving notion.

In the ring, Ali met rivals—at least the toughest ones—with a well-defined plan. Before the first Liston fight, Ali didn't just study tape of Liston's recent fights; he dissected Sugar Ray Robinson's footwork, rhythm, and timing. Ali's goal: Use non-stop motion to wear down the more powerful Liston. He likewise danced in Ali-Frazier II to keep the hard-hitting Frazier off balance.

Before the Rumble in the Jungle, Ali goaded, "George can't hit what his eyes can't see." Yet in the ring, Ali settled into the ropes letting Foreman punch himself out. Ali's rope-a-dope tactics set Foreman up to be knocked out in the eighth, earning Ali his second heavyweight crown. Ali got scientific again to avenge his loss to Leon Spinks, clinically dismantling the young champ. Title number three to Ali.

The Sweet Science in the supply chain

Great companies aren't just profitable. They gain an enduring strategic edge by consistently creating unbeatable value. True costing, the name we give to refined, evidence-based costing practices, is supply chain's sweet science. True costing enables companies to knock out misperceptions and outpoint rivals through superior decision-making. It empowers managers to exploit opponents' weaknesses, reimagine SC relationships, and earn customer trust.

TABLE 1

A knockout true costing portfolio

COSTING TOOL	HOW DOES IT WORK?	EXAMPLE
Total costing	Identifies and evaluates all relevant costs of a decision so that options can be holistically compared, and an apples-to-apples decision made. Total costing helps mitigate unintended consequences.	National Semiconductor used total costing to redesign distribution, setting up a centralized DC in Singapore. Delivery lead times were cut in half. Although air freight costs skyrocketed, overall logistics costs dropped 2.5%.
ABC costing	Assigns costs to activities that create them. E.G., if a customer orders a product, what activities are initiated, and what resources are used in those activities. ABC costing reveals the true cost of delivering a product or service.	M.D. Anderson Cancer Center embraced ABC costing to calculate costs of 160 services. In one instance, insight led to a redesign that trimmed staffing by 17%, increased patients assessed by 19%, and lowered costs 46%.
Should costing	Models a value-added process—using key cost drivers such as labor and materials costs, product configurations, and technology options—to estimate what a product or service should cost.	Honda builds exacting should-cost models to gain insight into supplier costs. Deep insight into supplier costs helps Honda negotiate prices, identify best practice, and drive learning across the supply chain.
Target costing	Sets a target cost by subtracting desired profit from a competitive market price. Cost breakdowns detail opportunities—e.g., design, material, or supplier changes—to achieve the target cost.	IKEA uses target costing to achieve prices 30% to 50% below rivals. IKEA sets the target price and cost and then selects materials and manufacturers to hit the target. Final design tweaks make sure the target becomes reality.

Source: Authors

True costing enables advantage. Consider this scenario. You've put true costing to work. During a price negotiation, a supplier argues your cost estimates are too low. You walk through the costing together. Two "aha" moments are possible.

1. Your costing is accurate. The outcome: You teach the supplier how to improve their processes.

2. Your costing is wrong. The result: The supplier teaches you how to improve your costing model.

Both are wins. As long as Option #1 occurs most frequently, you earn trust across the supply chain. Competence builds confidence, a valuable psychological edge.

Equally powerful, true costing leads to better decisions, processes, and products. You deliver unique, valued customer experiences, enabling you to win in the marketplace. Critically, winning creates fans. Just as fans came to fights to see Ali, SC partners will want to be in your corner.

Building knockout costing capabilities

For the Sweet Science to work, the boxer must work. No matter how scientific or strategic your fight plan, if you don't put in the effort to build needed capabilities, you get pummeled. The ring is unforgiving. Mike Tyson explained: "Everyone has a plan until they get punched in the mouth."

Ali grasped preparation's power at an early age. Joe Martin, Ali's first coach, trained thousands of boys. He described Ali's determination and willingness to sacrifice, saying:

"When he first began coming around, …
he was just ordinary … About a year later, though,
you could see that the little smart aleck—I mean, he's
always been sassy—had a lot of potential.
He stood out because, I guess, he had more
determination than most boys, …
He was a kid willing to make the sacrifices necessary
to achieve something … I realized it was almost
impossible to discourage him. He was easily
the hardest worker of any kid I ever taught."

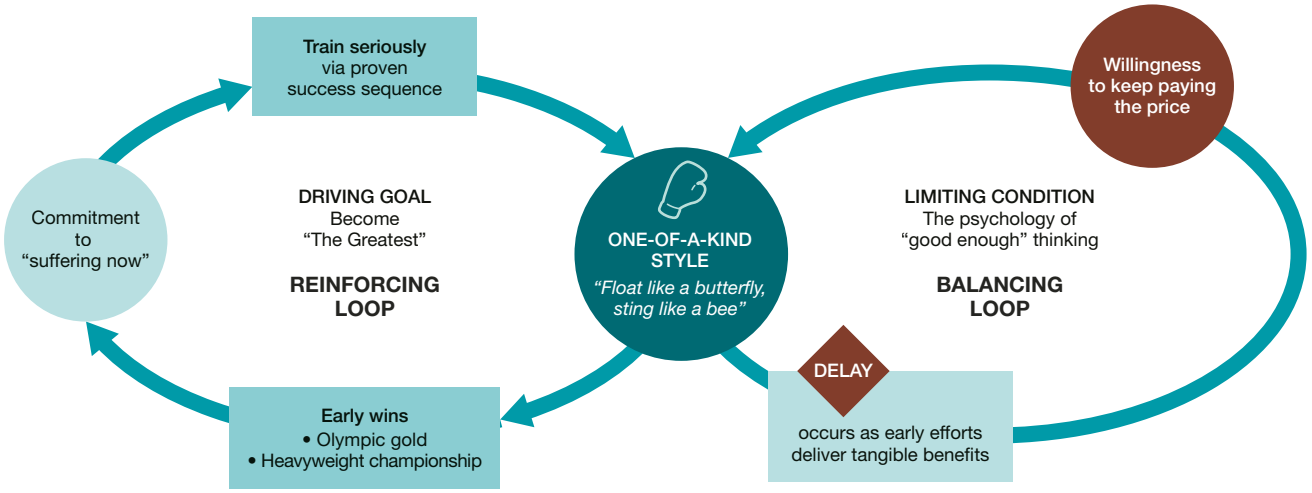
Ali's early results—Olympic gold at 18, world heavyweight champ at 22—validated Martin's assessment. Preparation precedes power. As Ali said, "It's not bragging if you can back it up."

Ali's early attitude, work ethic, and success

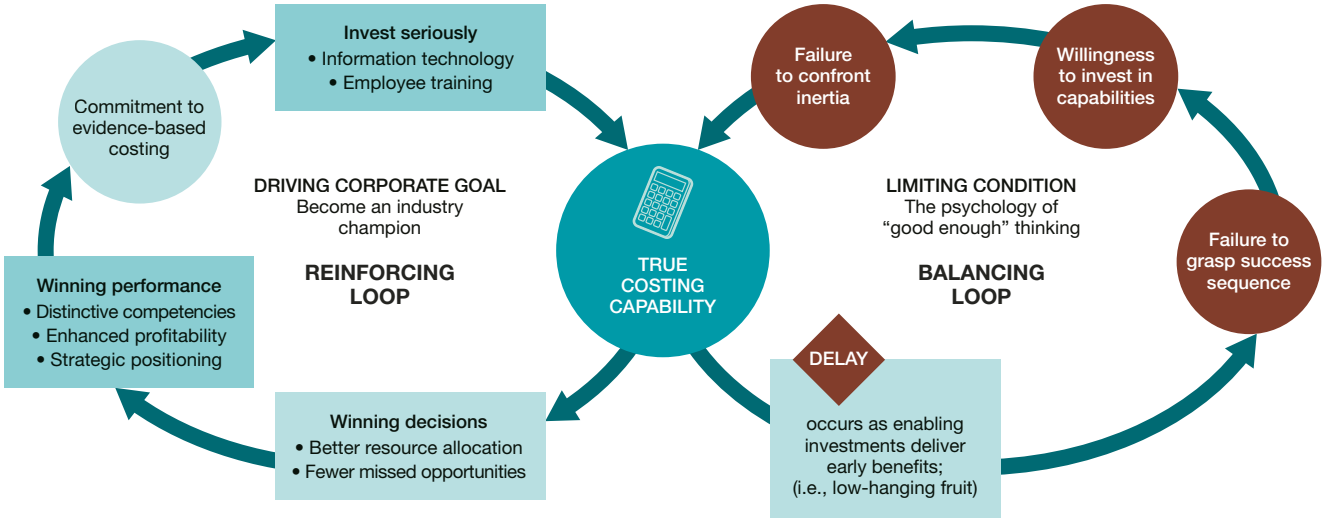
FIGURE 1

A model of capability development

PART 1: Understanding Muhammad Ali's career



PART 2: Grasping how to develop true costing capabilities



Source: Authors

make his later lapses against Norton and Spinks more puzzling. How could he drop his guard at such pivotal moments? We answer this question by depicting Ali's ring results as a limits-to-growth model, which emphasizes the power of painstaking preparation and the need to avoid the psychology of "good-enough" thinking. Grasping these dynamics can help you devise a fight plan to build prized true costing capabilities.

Painstaking preparation the Ali way

Boxing is brutal. Imagine stepping into a ring for 15 three-minute rounds of punishment. Heavy hitters like Liston, Frazier, and Foreman landed punches at over 1,000 psi force. After taking 440 fearsome punches from Frazier, Ali described the Thrilla in Manila as "like death." But it was Frazier's trainer Eddie Futch who stopped the fight after 14 rounds. Frazier's eyes had swollen shut, leaving him defenseless. Futch had seen four fighters die in the ring. Your takeaway: Survival demands preparation. To compete for the title, the price is painstaking training.

Though Ali didn't like training, he liked the results. So, when he had "something to prove," he trained seriously. Before the Rumble in the Jungle, Ali asked former champ Joe Louis, "Did you ever chop wood when you were training?" Louis responded, "All the time." Ali said, "I think I'll chop some before the Foreman fight." Louis advised: "Better chop a lot." Ali did, and he stopped Foreman in the eighth round. Swinging an axe boosted Ali's confidence, but it was just a small part of his three-step, 16-week quest to "float like a butterfly, sting like a bee"—and regain the title.

1. Get to weight. Ali's training for the Rumble in the Jungle began at Fighter's Heaven, his camp in Pennsylvania's Poconos mountains. He spent the first weeks running before dawn, hiking up hills, and cutting down trees. The goal: Get to weight. At 212 pounds Ali was unstoppable. He weighed 221 in his loss to Norton, 224 in losing to Spinks.

Ali started gradually, only running a mile a day at first—a difficult task wearing his favored heavy army boots. He then added a mile a day until he reached his 6-mile goal. After a week, Ali added an afternoon workout to his routine. In eight weeks Ali dropped 10 pounds.

2. Build endurance. Once at weight, Ali ratcheted up the intensity. His goal: Build endurance efficiently. He sought the stamina to go the distance, i.e., 15 rounds (longer than Liston or Foreman needed to KO most opponents). At this stage, he trained through pain to exhaustion. His goal: Hurt more in training than he would in a fight. Ali counted on being able to outlast rivals.

3. Reach peak performance. In the final weeks before the fight, Ali had one goal: Enter the ring in peak mental and physical condition. To get psyched for the

FIGURE 2

A day in camp with Ali

4:30A	WAKE UP, PRAY
5:30	6-MILE RUN
7:00	BREAKFAST (protein, fresh fruits)
9:00	RELAX
11:00	NAP
12:30P	PHYSICAL TRAINING
4:00	MASSAGE
5:00	DINNER (low-fat protein, fresh veggies)
6:00	EVENING WALK
7:00	SHOWER, PRAY
8:00	RELAX
10:00P	BEDTIME

- **Warm-up exercises** (15 minutes)
- **Shadow boxing** (five 3-minute rounds)
- **Heavy bag** (six 3-minute rounds)
- **Jump rope** (20 minutes)
- **Speed bag** (three 3-minute rounds)
- **Sparring** (light early, intense late)
- **Core exercises** (e.g., bicycle crunches)
- **Cool down** (often shadow boxing)

Source: Authors

fight, Ali studied film on every Foreman fight. As he identified a Foreman vulnerability, he formulated a plan. At the end of the first round, he would make a call. If his legs couldn't dance 15 rounds, he would cajole Foreman into punching himself out. This rope-a-dope strategy was Ali's secret—not even his corner knew.

To be physically primed, Ali raised the intensity of his training. Eight days before the Rumble in the Jungle, he described his afternoon workout, saying:

> *"On this day I have three rounds of shadowboxing, five rounds on the speed bag, four skipping rope, three on the heavy bag. After that I go in the ring with my sparring partners, feeling the kind of fatigue I know will come in a real fight, but I drive myself through nine hot three-minute rounds of boxing. I'm ready."*

When Ali invested in this structured success sequence, he never lost. Fighting Foreman for the title was the right incentive to get Ali to pay the champion's price.

Painstaking preparation the SC way

Global competition is also brutal, customers are often unforgiving. Painstaking preparation precedes building winning competencies, beginning with SC costing. Our work with SC leaders shows managers get it. They know they need better costing to make winning decisions. So, how do they prepare? They invest in IT and employee training, which deliver early benefits. However, peak performance remains out of reach. Why, you ask? Answer: Managers haven't figured out costing's success sequence. The result: They come to the market ill-prepared to earn the title, "industry champion."

Now, a little good news: Our research delineates costing's success sequence. It parallels Ali's training regimen—and is just as demanding (see Table 2).

1. Know thyself. Ali knew his ideal fighting weight; you must know your core competencies. Then you can target costing investments efficiently to gain the insight needed to enhance these core competencies. Many decisions don't require deep costing insight. Don't waste time on them.

2. Think systemically. Ali relied on disciplined training to build the endurance to go the distance. You also need disciplined action to define key systems and identify relevant costs. You must dig into the details. If you only capture some relevant costs your decisions are just guesstimates.

3. Create visibility. Ali achieved peak performance by confronting the brutal facts, i.e., the need to train rigorously, keep a strict diet, and give up sex. Your big challenge: You can't confront the brutal facts if you can't see them. You must create deep process visibility to get costing right.

TABLE 2

Costing's success sequence

BOXING	TRUE COSTING
Get to weight	**Know thyself:** Define the key competencies that help you win in the marketplace. Focus knockout costing on these competencies.
Build endurance	**Think systemically:** Pursue systems thinking so you can identify all relevant costs. Spotting relevant costs is the key to enduring decisions.
Reach peak performance	**Create visibility:** Make processes visible so you can assess relevant costs accurately, efficiently, and quickly. Peak performance follows.

Source: Authors

Now, an invitation: Just because most managers don't grasp costing's success sequence doesn't mean you can't. ALDI, the German deep discounter, integrates true costing into critical SC decision-making. Consider

how ALDI pursues costing's success sequence.

• **Know thyself.** Every employee knows ALDI's core competency is taking costs out everywhere, a feat that enables ALDI to offer convenient shopping for quality products—at the lowest prices!

• **Think systemically.** Systems thinking is ALDI's modus operandi. Executives always ask, "If we do this, then what happens?" Systems thinking guides the analysis that yields the answers.

• **Create visibility.** SC mapping and optimization modeling are part of ALDI's standard decision-making toolkit. The goal: Envision how decisions will impact costs and performance.

With this toolkit, true costing comes naturally and is helping ALDI rise up the ranks of the world's most formidable grocers. Even Walmart winces when ALDI steps into the ring. One final thought: ALDI built its own Fighter's Heaven in Austria to design the supply chain of the future. Your takeaway? ALDI has made Ali-like investments to do the costing needed to come to market ready to win.

Good enough thinking: Ali's nemesis

Ali's psyche played an outsize role from the outset of his pro career. He had vision, was a quick study, and was willing to pay victory's price, but nobody could tell him what to do. Consider his relationships with trainers Archie Moore and Angelo Dundee.

1. Archie Moore. In November 1960, Ali's advisors sent him to train at light-heavyweight champ Archie Moore's camp, the Salt Mine. Moore required fighters to cook meals, wash dishes, and scrub floors. Ali didn't like being "ordered" around. He quit camp after less than a month.

2. Angelo Dundee. Ali landed with Angelo Dundee, who quickly grasped that working with Ali was a "whole different ballgame." Ali didn't respond well to classic training. He claimed, "Angelo doesn't train me." Angelo agreed. What did Angelo do? Rather than instruct, Angelo guided. The key: Ali needed to feel he was the innovator, "doing things on his own."

Ali's MO revolved around a simple equation. If his estimation of expected benefit (or feared loss) was greater than the effort he needed to invest, he paid the price. Here's the key point: It was Ali's estimation that mattered. Sadly, Ali often sensed he was "good enough." The result: He often trained less than he should have. Talent and will delivered more than one escape. But the threat of miscalculation was ever-present. Twice complacency caught up with Ali, leading to humbling losses.

1. Regaining the title. After Ali lost the "Fight of the Century" to Joe Frazier, he plotted a rematch. Then the unexpected happened: George Foreman knocked Frazier out. Ali would need to earn a title shot against Foreman. Ken Norton stood in his way.

Though the 6th-ranked heavyweight, Norton was mostly unknown. Sportscaster Howard Cosell noted the fight should be "a routine exercise for Ali." Ali agreed, underestimating Norton. He entered the ring teeming with confidence. He left with a broken jaw—and a deflated reputation.

What went wrong? Ali shortcut his tried-and-true success sequence. He trained fewer than three weeks. Skipping roadwork, Ali tired quickly on the heavy bag. Herbert Muhammad, Ali's manager, chided him for overconfidence and poor conditioning. Ali didn't listen.

2. Repeating mistakes. Ali got "lazy" again in 1978 as he prepared to face Leon Spinks. Spinks, an ex-marine and Olympic champ, had only fought six pro bouts. Spinks' inexperience seduced Ali into thinking the fight would be easy. To Ali's way of thinking, Spinks was just an "amateur."

Taking Spinks lightly cost Ali dearly. Setting aside his proven success sequence, Ali only trained two weeks, sparring fewer than two dozen rounds. Butch Lewis, who promoted the fight, noted Ali ate more, worked less, and sloughed off in the gym. Ali's fight weight: 224 pounds.

The result: A split-decision loss. During the post-fight press conference, Ali gave Spinks credit for fighting a good fight, but admitted, "I messed up; I was lousy. … He made fools of everybody, even me."

Ali lamented the loss was "my own fault."

You could rightly conclude that the price for overconfidence—i.e., Ali's sense of "I'm good enough"—was disaster. Yet, defeat gave Ali something to prove, a reason to return to the ring—and to his success sequence! Ali's record in rematches: Perfect, he never lost.

Consider Ali's response to the Spinks' loss, the defeat that stung the most. He said, "I had to fight him again. I wanted to get my title back. What they paid me didn't matter." He committed to "get up and run with the moon and the stars." And he did, running three to six miles every morning and enduring "tortuous ring exercises" each afternoon (including 200+ rounds of sparring). Ali described the sacrifice:

> *"I've never suffered like I'm forcing myself to suffer now. I've worked this hard for fights before, but never for this long. All the time, I'm in pain; I hurt all over. I hate it, but … I don't want to lose and spend the rest of my life looking back and saying, 'Damn, I should have trained harder.'"*

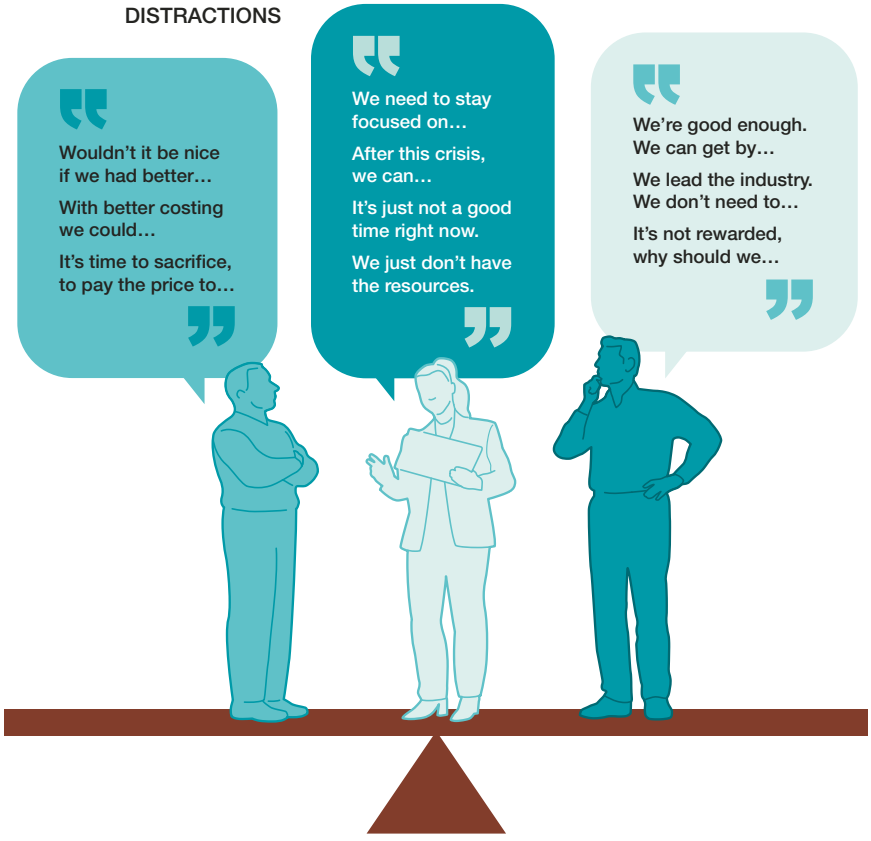
Such was the psyche that made Ali "the greatest."

Good enough thinking: SC's nemesis

Getting psyched up to do hard things, like true costing, is also a SC challenge. Our work with

FIGURE 3

Why companies settle for good enough



Source: Authors

SC leaders shows that when it comes to costing, decision-makers often settle for good-enough, even when they know better! The result: Time and again, we've seen that skipping costing's success sequence—i.e., the painstaking preparation—leads to poor decisions and poorer performance. Regret results. Consider Boeing's tragic 21st-century track record.

As the 2000s began, Boeing and Airbus were locked in a fight for air supremacy. Airbus announced its 550-seat A380 in early 2000. Boeing responded with the 787—dubbed the Dreamliner—in January 2003. As the first commercial carbon-fiber airframe, the 787 promised to reduce operating costs 20% while elevating customer comfort. Airlines found the 787's value proposition irresistible. As 787 orders shot skyward, A380 sales stalled.

Boeing, however, couldn't deliver to promise. Design and production SNAFUs delayed delivery to All Nippon Airways, the 787's launch customer, from 2008 to October 2011. Why didn't 787 production get off the ground? To cut the 787's estimated $10 billion development cost in half, Boeing encouraged suppliers to take on the cost of designing and building major modules of the new plane. Suppliers weren't ready for this new development model—nor was Boeing.

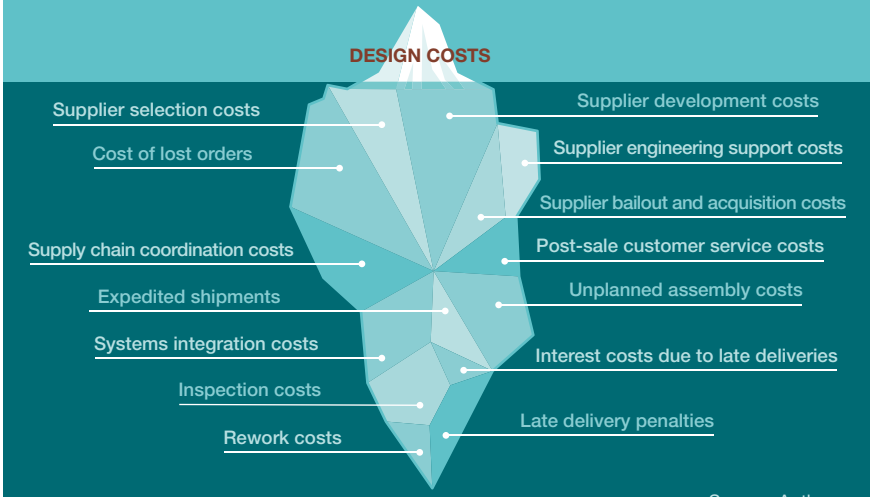
Now, the backstory. Early on, Boeing's SC team argued the shared-design-and-production model wouldn't work. They warned that Boeing was making decisions based on the "tip of the iceberg"—i.e., highly visible, upfront R&D costs—but ignoring the below-the-surface costs of managing the supply network. They didn't, however, do the costing. So the C-suite pressed forward! The resulting SC nightmare pushed launch costs to over $30 billion—3X the original cost estimate—and eroded Boeing's first-mover advantage by 3.5 years, giving Airbus space to launch the A350.

Here's the key point: Boeing decision makers, at multiple levels, succumbed to "good enough" thinking.

1. SC design. Confident in Boeing's design competence, C-suite executives felt Boeing was good enough to handle disruptions caused by the new development model. It couldn't.

FIGURE 4

The costs of good enough costing on Boeing 787 launch



Breakdowns in design, and in the SC work flow, staggered Boeing.

2. SC costing. Confident in their influence, SC leaders forgot a core reality, "If you don't have the numbers, it's just your opinion." By shortcutting costing's success sequence, they undercut their own influence. Their story was neither concrete nor credible.

Long story short: Good enough wasn't good enough, costing Boeing billions.

Curiously, unlike Ali, the 787 debacle didn't motivate Boeing to return to its success sequence. Still fixated on the "tip of the iceberg," good-enough thinking permeated Boeing's culture. The hubris of chasing short-term costs caught up to Boeing on the 737 Max program. Two avoidable crashes, killing 346 people, debased Boeing's reputation. Poor delivery, caused mainly by mandated groundings, dented Boeing's order log. Good-enough costing is often more expensive than you think.

Where champions are made

Ali smartly noted, *"Champions aren't made in gyms. … They have to have the skill, and the will. But the will must be stronger than the skill."* Will, or emotional fortitude, is more than the ability to take a punch. It includes the ability to counter good-enough thinking. Boxing's training-to-competition ratio is, after all, one of the highest in sports. For Ali's success sequence, the ratio approaches 1,000:1 (i.e., 16 weeks prep for an hour in the ring). Will is critical before the fight begins.

Because its success sequence is detailed and demanding, true costing's analysis-to-decision ratio is among the highest in a SC manager's toolkit. Because senior leaders often talk about but seldom measure and reward it, making the case for true costing also requires emotional fortitude. Further, when you need true costing's deep insight, if you haven't invested in its success sequence, you can't just turn it on. Will is needed before the day of decision arrives. Otherwise, you may find the price of poor decisions acutely painful.

Now, a warning: True costing's value emerges from better decision-making. But better decision-making requires you to think and act differently. If you're not ready for change, true costing's insight has little value, and its ROI is elusive. Inertia is your foe. For example, when a leading steel producer deployed ABC-costing, leaders learned key "A" customers were unprofitable.

They were shifting resources from "C" customers to secure more business from these "A" customers. The problem: These "C" customers were profitable. If pursued, the strategy would have led to bankruptcy. ABC-costing intervened, but action was needed. What were the decision makers' options?

- They could raise prices, a tough sell with "A" customers.
- They could fire their unprofitable "A" customers, perhaps viable, but impractical.
- They could pursue crucial conversations with these customers, engage in joint process re-design, and change the relationship to reduce service costs.

Here's your takeaway. ABC costing didn't just identify a problem, it informed the tough conversations and enabled the collaborative efforts needed to change course, reduce service costs, and create win-win relationships. This is the promise, and power, of true costing in all of its forms.

Like Ali, you may hate every minute of the nitty-gritty, sometimes painful preparation needed to make true costing a competitive capability. That said, success—both yours and your company's—depends on how well you use true costing to make better decisions, build better relationships, and exploit market opportunities. Ali would invite you to pay the price now and live the rest of your life as a champion. •

How supply chain leadership drives business growth, competitive advantage

By Brian Straight, editor in chief

No longer considered just a cost center, the supply chain now plays a pivotal role in generating new revenue opportunities and ensuring companies meet the rising demands of today and tomorrow. Procter & Gamble is proving how.

In the late 1980s and early 1990s, the idea that the supply chain could be a growth driver for a company was just in its infancy. Then, companies like Walmart, Amazon, Apple, and Zara, among others, started to realize that supply chain functions could be used to improve customer service and therefore improve customer retention and growth.

Walmart was among the first companies to implement cross-docking at scale—although the concept had been around for decades—giving it an advantage against competitors that were slower to respond. Apple has maintained tight control and relationships with its primary suppliers, allowing it to maintain greater control over its supply chain. Zara perfected the fast-fashion trend, enabling it to deliver items to stores within weeks versus the traditional six-month timeframe. And, of

course, Amazon and its renowned logistics network helped it grow quickly into an e-commerce giant. But what do all these companies have in common? They all sought a way to turn a traditional cost center into a competitive advantage. They are not the only companies, of course, as many others have attempted to leverage their supply chains. Few have mastered it, though.

To understand how a company can leverage its supply chain to become a growth orchestrator, we interviewed a number of senior leaders inside P&G to learn how the consumer-packaged goods firm has turned its supply chain into a differentiator that allows it to fulfill its goal of on-shelf availability and drive growth. It is a story of seamlessly integrating goal setting, data tracking, automation, engaged management, and people empowerment. Simply put, it is One Supply Chain.

One Supply Chain

Luc Reynaert is chief product supply officer at P&G. Over his 37-year career, he's seen firsthand that innovation in the supply chain is part of P&G's way of operating. "What I can tell you is that in my time with P&G, I've always been involved one way or another in growing the company and making sure the growth elements were there," he says.

In his previous roles as head of the supply chain for various P&G business units, Reynaert was responsible for helping bring new products to market, such as Febreze and Swiffer, and scaling their supply quickly to position them for significant category growth. One of the keys to his success was that he never lost that appetite for growth. "Identifying how the supply chain can grow the business is in my DNA, and then when I got into supply chain for the Home Care division or for the Fabric Care division, it was all about accelerating market growth," he explains. "How do we grow the category? Then, you need to make sure that you supply it and do it at the proper cost and cash."

Leveraging the supply chain (P&G calls it Product Supply) to grow its business is not a new initiative at the company. It actually started to gain traction in the 1990s when P&G launched its first iteration of its current supply chain strategy. Historically viewed as a back-office necessity, today's supply chain directly impacts revenue, customer satisfaction, and brand growth. P&G long ago recognized that and has been reinventing its supply chain with this mission in mind. It has gone through three iterations of its Supply strategy.

- **Supply 1.0.** Focused on manufacturing excellence, zero machine losses, and 100% employee engagement.
- **Supply 2.0.** Integrated the entire supply chain, from material suppliers to product distribution, to handle market volatility and demand surges.
- **Supply 3.0.** Extends the integration to retailers and consumers, making the system faster, more flexible, transparent, and cost-efficient.

As the strategy has evolved, it has remained consistent in its approach to satisfy the customer's desire and need for the right product when and where it was needed. For beauty and personal care brands, that has meant winning consumers through superior innovation delivered at speed, and ensuring product availability. These efforts are directly tied to sales and market share growth. Supply chain leaders at P&G align operations with corporate strategy to meet evolving consumer demands, leveraging advanced logistics, strategic supplier partnerships, and real-time demand forecasting. That strategy is underpinned by four elements, Reynaert says.

1. Supply in full. Ensures product availability.

2. Seamless data, touchless flow. Integrates digital tools for efficiency.

3. Superior employee experience. Empowers employees with the skills and work environment they need to succeed.

4. Sustainability. Enables P&G's efforts to reduce its environmental impact, help people reduce their impact while using P&G products, and scale industry-wide solutions that reduce environmental impact.

Reynaert says for P&G, the defining metric in 2025 is on-shelf availability.

"It is the importance of being on the shelf, online, wherever and whenever people want to shop," he says. "It also means producing quality products so that customers have a superior experience when they use our brands. We have a lot of effort there because if the quality isn't good, our consumers won't buy it."

To achieve that means the ability to innovate and pivot. It also means clear and consistent communication between division leaders, who disseminate the information through their teams. P&G has 10 different product divisions, each with its own president and supply chain leader. A key to Reynaert's position is ensuring each division is aligned to the overall strategy, even if that alignment looks different due to the unique needs of each business.

"The key here is how do you create that?" he asks. "An organization where they run their own show but understand

and can fully take advantage of our scale for co-developing solutions and advancing technologies. And then there is a commitment to help each other and make sure there is common ground for each of them to go and do that. A great example here is how we approach automation."

When Reynaert took on his current role, each division had its own automation strategy. Since that time, those strategies have aligned, and each division is offered a menu of automation options they can choose from. Reynaert stresses that a unit still has the autonomy to craft its own strategies to fit unique needs, but the need for five different units to create the same solution five times is gone. "We implement and execute at a much faster pace and make the necessary interventions to accelerate progress, but I still respect the independence for each unit to run its own supply chain," he says.

Leveraging data, AI, and automation

Technology is at the heart of P&G's supply chain transformation. Through integration of real-time data with retailers and suppliers, P&G enhances visibility across its global operations. Artificial intelligence and machine learning help optimize inventory levels, ensuring products move efficiently from manufacturing sites to store shelves or e-commerce platforms and eventually the consumer.

In North America, P&G's personal care planning team has automated more than 30% of manual supply chain processes, with a goal to reach 75% automation, says Jeffrey Chen, senior vice president-supply chain for P&G's Global Skin, Personal Care and Beauty Sector. AI-driven quality control further improves efficiency by reducing defects and optimizing production schedules. This level of digital integration enables P&G to react swiftly to changes in demand, minimizing disruptions and maximizing availability.

Visibility is at the center of P&G's skin care business, Chen notes. "We've worked very closely with our suppliers to drive the visibility of their systems from inventory to capacity, planning, and a quality standpoint," he says, adding that working customer signals into forecasts and business planning has helped shorten lead times. P&G has incorporated customer signals directly into production and replenishment operations and even taken that a step further by shipping items to customers in their original packaging when appropriate, eliminating additional touches and package handling.

"We can ship the products from our warehouses near the production line direct to shoppers at the shortest possible lead time, giving them the best quality, and also the least packaging waste so it improves service, improves cost structure, and improves sustainability," Chen explains.

Can Akcadag, who runs North American market distribution for the company, notes that having the data and the insight enables the distribution teams to ensure stores have the product when it is needed.

"Connected replenishment is really all about … working with retailers on the systems and settings to replenish in a way that our products are available whenever and wherever customers want to shop," he says. "The second part of that is with integrated networks, what we do is look at the physical flow of our product through our joint collective networks to drive efficiency."

Effectively doing this requires visibility throughout the supply chain, and P&G is mastering this by tracking products from warehouse to consumers' shopping carts, improving its forecasting accuracy, inventory management and overall efficiency. With this information flowing seamlessly and automatically between business units, distribution, and customers, P&G can develop joint business and supply plans with retailers. Together with retailers, the company is "focusing on identifying the losses in our supply chains that are related to the flow of information or the flow of the physical goods," Akcadag explains. "Then, [we] go after those losses and eliminate them in many cases through digitization and automation."

That data flow, Akcadag notes, is critical to the ability of the P&G supply chain to drive business results. "Data is super important, and consumption data is especially critical," he says, "but the more important part is how we use that data in our planning systems and work with retailers on actions that will maximize it. It's amazing the amount of data we have today, not only for our supply chain, but for the retailers' supply chain and our suppliers' supply chain. The power is in how we use that data."

That same data also allows P&G to maximize inventory flow—holding enough to ensure product can be shipped when needed but not too much that unnecessarily ties up cash. All that data is fed into the planning system and disseminated to production, leading to improved on-shelf availability. Most importantly, Akcadag says, is the ability to predict where availability challenges may arise so P&G and its retail partners can proactively address these before sales are lost. "Whenever we increase the availability levels, it becomes a win for the retailer and for us because it then grows our sales," he notes.

Sustainability as a business and consumer priority

Sustainability has become an important part of customer loyalty in recent years. A 2023 McKinsey and NielsenIQ study found that products making sustainability-related claims average 28% cumulative growth over a five-year period versus a 20% growth over the same timeframe for products that made no such claims. Sustainability is not just about designing, sourcing, manufacturing, and disposing of products in a way that minimizes environmental impacts throughout their entire lifecycle; it is also about the way the entire supply and value chains handle that product. At P&G, that has meant working on ways to reduce the impact and making sustainability a core pillar of Supply 3.0.

"In our beauty business, sustainability is embedded in our Responsible Beauty strategy," Chen says, pointing to the Olay Cleansing Melts product as an example. "This is the first in the industry where we have facial cleansing products in a fiber form so consumers can take a cleansing pad, then soak it in water, developing a rich soapy lather. Because they don't contain liquid, Olay Melts are more sustainable and lighter to transport."

Sustainability also extends to P&G's transportation strategies. Akcadag explains that P&G has been able to use seven North American "mixing centers" that are strategically located to deliver product to approximately 85% of customers within 24 hours. Those mixing centers handle multiple product lines from multiple business units, enabling the transportation teams to develop transportation plans that take advantage of efficiencies.

"Our fabric care products, in general, are heavier products, while baby care products are light," Akcadag says. "When we mix them, we enable the full utilization of the truck. Our mixing centers carry the whole portfolio. And for each of the businesses, based on the demand that they have for that region, we have clear inventory settings, and we expect the businesses to comply with those settings. That really enables us to have the products available there, enables mixing, and also enables us to deliver our products on-time, in-full to retailers at lower cost."

Unified supply chain strategy: Cross-division collaboration

P&G's scale gives it a unique competitive edge, allowing supply chain innovations to be applied across multiple product categories and deliver superiority. The company's supply chain approach ensures best practices and technological advancements are shared across business units. That requires a commitment from management to create a successful framework and then empower division leaders to innovate solutions that work for their units, ultimately sharing those innovations across business units.

For example, Alberto Gomez, senior vice president of supply chain innovation, points to how its popular Tide Pods line leveraged the expertise of engineers in its diaper production. The Tide Pod is, in essence, liquid surrounded by fabric on each side. That is exactly what a diaper's main job is—to capture liquid inside two pieces of fabric to keep babies dry. P&G used its expertise in producing diapers at high speed to perfect the Tide Pod production process.

That is just one example. Gomez says the goal is to use the scale of P&G to develop technologies and automation solutions that can be applied across business units. This approach is what brings Supply 3.0 to life, he says. The innovation team may work on technology such as automation in distribution centers, or it may be innovating more technical solutions such as the Tide Pods example. But its goal is to ensure that while each business unit may craft its own solutions, those solutions are vetted for possible use in other units. This includes things like automating quality checks so that 100% of products are inspected, Gomez says, noting that the use of vision systems, cameras and sensors are all utilized for this task.

The success of these initiatives is tied to the ability to communicate. "We have processes to continuously engage with our business units to understand the challenges, and we have engagements at multiple levels to problem-solve," Gomez says. "In many cases, another business unit might have developed a solution, and we play the role of facilitating the reapplication of that solution, which sometimes they don't have neither the time nor the ability to connect and reapply."

Workforce transformation: The human side of supply chain innovation

P&G recognizes that technology is only as powerful as the workforce behind it. Reynaert, along with the others interviewed for this article, repeatedly stressed the importance of the third pillar of its supply chain strategy: superior employee experience.

"Our foundational strategy is superior employee experience," Akcadag says. "We believe it all starts with

our people, and we constantly work on creating a culture and environment where our people are empowered, energized, and they can bring, and we can bring, the best out of them and they can reach their best potential. We believe that without having that unique culture in place, nothing will work."

Nearly two-thirds of P&G's workforce is in the Product Supply function, so education and upskilling are an important part of the Supply 3.0 strategy. Doing so provides additional benefits, Chen says. "We want to expand our people from just doing the repetitive data sorting work into more advanced analytics and supply chain optimization work which is way more fun and also a bigger value and superiority that is sustainable and absolutely critical for our business," he notes.

A 2021 Great Place to Work survey of 5,000 P&G employees found that 71% felt it was a great place to work and 81% said they were proud to work there. P&G also ranks highly on Glassdoor's rating system and had an employee retention rate of 85% over a 12-month period of July 1, 2023, through June 30, 2024, according to company data.

Measuring success: Key metrics & business impact

Most supply chains are data heavy in 2025, and P&G is no different. While its main metric is on-shelf availability, it does track a number of different measures—all of which add up to direct impact on business outcomes. Each unit has some unique objectives, but regardless of the metric tracked, it is geared toward efficiency and the ultimate goal of turning the supply chain into a growth driver. Some of the key performance indicators P&G tracks include:

1. On-shelf & online availability. Tracks whether products are available at the right time and place for consumers.

2. Cost to serve. Measures efficiency in delivering products to customers while minimizing costs.

3. Supply in full & on-time, in-full (OTIF) metrics. Ensures that deliveries meet retailer expectations in quantity and timeliness.

4. Consumption data for demand planning. Tracks real-time sales and consumption data from retailers.

5. Transportation & logistics optimization. Vehicle fill rate and other logistics metrics.

6. Promotional event performance. Tracks incremental sales generated from promotions and adjusts inventory & replenishment based on demand surges.

7. Sustainability metrics. Packaging and logistics efficiency.

8. Employee & operational productivity. Annual company survey scores, attrition rates, and reduction in manual supply chain processes

The results speak for themselves. Despite economic uncertainties and market fluctuations, P&G's supply chain strategy has helped to enable record business performance, reinforcing the company's position as a leader in the consumer goods industry. P&G has seen its revenue grow from $71 billion in 2020 to over $84 billion in 2024. All while continually reducing costs and identifying new sources of productivity to reinvest in growth.

Conclusion: Lessons for other companies

P&G's approach to supply chain leadership offers valuable insights for companies looking to transform their operations, including the following.

- **View supply chain as a revenue driver:** Shift from a cost-cutting mindset to a growth-oriented strategy.
- **Leverage AI and automation with purpose:** Implement technology that increases efficiency and highest quality standards while delivering enhanced employee and consumer satisfaction.
- **Integrate sustainability with business strategy:** Align environmental ambitions with operational improvements.
- **Empower supply chain leaders:** Provide autonomy and decision-making power to supply chain executives to drive business success.

By prioritizing innovation, collaboration, and sustainability, P&G is a living example of how a well-executed supply chain strategy can be a powerful engine for business growth.

So how does this all tie together to enable the supply chain to be a growth accelerator for P&G? First, improving efficiency supercharges customer service, which leads to better on-shelf availability and ultimately, improves customer satisfaction. Akcadag sums up the process more succinctly, pointing to a recent retailer promotion.

"Recently, one of the retailers we work with ran a promotion. Because our supply chains are connected, we could immediately see the increase in consumption and provide a real-time signal back to our manufacturing system to produce more of those products, he explains. "As a result of that, the retailer reordered, and we were able to deliver all that product without any supply issues and that added … millions of dollars to our business during that promotion."

That's the business bottom line of the One Supply Chain. •

To make or buy the supply chain?

By Sangho Chae, Thomas Y. Choi, and Glenn Hoetker

Decisions on how deeply to manage your supply chain require in-depth analysis and discussion, and even mirror classic make-or-buy decisions. The question is: Which approach is correct for your business?

All companies are engaged in outsourcing. They outsource production or service operations, and when they do, they typically rely on their first-tier suppliers to select and manage second-tier suppliers and beyond—what we call deep-tier suppliers. However, cost pressure, high-profile supply disruptions, quality failures, and sustainability scandals caused by deep-tier suppliers have raised concerns about delegating sourcing decisions to the first-tier suppliers.

For example, a Toyota first-tier supplier worked with a semiconductor supplier called Renesas. In 2021, there was a fire at this second-tier supplier. This unfortunate incident amid the global chip shortage forced Toyota to cut production by 40%. The question of whether Toyota should have been more involved in selecting this second-tier supplier arises. Similarly, H&M faced public backlash recently when reports linked its second- and third-tier cotton suppliers in Xinjiang, China, to forced labor. It posed reputational and financial risk for H&M.

Such incidents point out the importance of visibility and control over deep-tier suppliers. However, it is neither practical nor feasible for companies to manage all upstream suppliers directly. This raises a critical question: *How should companies strategically approach the selection and management of deep-tier suppliers?* Many firms tend to react only after supply chain problems happen, often by creating direct relationships with deep-tier suppliers that caused the problem or pressuring first-tier suppliers to switch their suppliers. But these reactive measures are often arbitrary and devoid of a systematic approach.

In our *Journal of Supply Chain Management*

article published in April 2024, we introduced a practical, structured decision-making framework to guide companies on when and how to approach the selection and management of deep tier suppliers. The key insight behind our framework is that decisions regarding the selection and management of second-tier suppliers and beyond (i.e., deep-tier suppliers) mirror the classic make-or-buy decision, but at the supply chain level. When a company delegates the sourcing decision involving subcomponents or sub-services to its first-tier supplier, it is effectively "buying" this first-tier supplier's supply chain. This buying company relies on the first-tier supplier to select and manage the suppliers that lie further upstream. In contrast, when a company takes an active role in selecting or managing certain deep-tier suppliers, it is "making," at least in part, the supply chain by directly shaping supplier choices and oversight. Building on this make-or-buy analogy, we identify three strategic approaches that companies can adopt to govern multi-tier supplier networks: *supply-chain buy, supply-chain make,* and *hybrid* approaches.

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Supply-chain buy

In the supply-chain buy model, a buying company outsources production or service operations to its first-tier suppliers and delegates the selection and management of second-tier suppliers and beyond. The buying company considers this first-tier supplier a one-stop shop. It follows a *hands-off* strategy, where the first-tier supplier is responsible for managing the suppliers that lie beyond the buying company's purview. A well-known example is how global retail brands partner with supply chain management firms like Li & Fung. Li & Fung coordinates sourcing, logistics, and supplier relationships across a vast network of over 15,000 suppliers in 60 countries, allowing brands to concentrate on design, branding, and customer engagement rather than upstream supply chain management.

Supply-chain make

Under the supply-chain make approach, the buyer continues to outsource production or service operations to its first-tier suppliers but retains the right to directly control the selection, contracting, and management of some second-tier suppliers and beyond. The buying company is now looking deeper into the supply chain beyond its first-tier supplier. This strategy follows a more *hands-on* approach, where some deep-tier supplier selection and management decision-making remains centralized in the buying company. Honda and Toyota employ a supply-chain make practice known as directed sourcing, where the company directly contracts with some second- and third-tier suppliers and mandates that the first-tier suppliers work with these designated deep-tier suppliers. Another notable example is Apple's supply chain strategy. While Apple contracts manufacturers like Foxconn for final assembly, it holds on to most of the sourcing decisions at the component level. Apple actively manages relationships with over 180 component suppliers worldwide, ensuring strict compliance with quality, sustainability, and labor standards.

Hybrid approaches

Hybrid approaches distribute responsibility of supply-chain make or buy decisions across the buyer, its first-tier suppliers, and some external stakeholders. The intent is to collaboratively select, manage, and monitor deep-tier suppliers. Companies employing hybrid approaches often implement strategies such as the following.

- Approved vendor lists: Buyers and suppliers share a pre-approved list of deep-tier suppliers to ensure compliance and reliability.
- Collaboration with deep-tier suppliers: Buyers and deep-tier suppliers strategically collaborate to improve coordination, quality standards, and operational efficiency.
- Joint supplier training and risk assessments: Buyers and first-tier suppliers collaborate with non-governmental organizations and monitoring agencies to ensure sustainability, ethical sourcing, and compliance with labor regulations.

An example of a hybrid approach comes from IKEA's sustainability initiative in its cotton textile supply chain. IKEA conducts training and workshops with both first-tier suppliers (cutting and stitching) and deep-tier suppliers (dyeing, weaving, ginning, and farming) to improve social and environmental outcomes. By working across several supply chain tiers, IKEA strengthens supplier capabilities while reinforcing resilience and sustainability commitments. Table 1 summarizes the three approaches to supply-chain make or buy.

Having introduced the three approaches to supply chain make-or-buy decisions, we now present a practical decision-making framework to help companies evaluate the options across supply-chain make, supply-chain buy, or hybrid approaches. The insights are taken from two influential theories from economics and management: transaction cost economics and the capabilities view. We adapt them to the complexities of multi-tier supply chains.

Transaction cost economics, recognized with Nobel Prizes in Economic Sciences in 1991 (Ronald Coase) and 2009 (Oliver Williamson), explains how firms decide between in-house production and outsourcing by assessing transaction costs—the costs associated with managing external exchanges. These include costs for gathering information, negotiating contracts, monitoring suppliers, and managing risks associated with outsourcing. The higher the complexity and uncertainty of an exchange, the greater the costs. If outsourcing reduces overall costs

and improves efficiency, companies often choose external providers. However, when managing suppliers becomes costly and risky, keeping operations in-house may be the better option. Many firms also adopt hybrid approaches, collaborating with suppliers while maintaining partial control through long-term partnership or joint ownership.

Outsourcing decisions also depend on a company's core strengths—some firms outsource activities in which they lack expertise, while others retain certain processes in-house to safeguard their competitive advantage. The capabilities view emphasizes the importance of aligning outsourcing decisions with a company's key competencies. Even if outsourcing incurs higher transaction costs, a firm may still choose this option if the required capabilities for in-house management do not align with its existing expertise. Conversely, if outsourcing appears cost-effective but the activity in question strengthens the company's core competencies, it may be strategically beneficial to keep it in-house. Ultimately, the decision between outsourcing and internal management requires a careful balance between transaction costs and company capabilities to enhance efficiency and maintain competitiveness in supply chain operations.

TABLE 1

Three approaches to supply-chain make or buy

Governance strategy	Description	Control level	Example
SUPPLY-CHAIN BUY	The buyer outsources manufacturing to first-tier suppliers, who then manage the selection and oversight of deep-tier suppliers.	**Low** First-tier supplier handles sourcing and management.	**Li & Fung's customers** Delegates management of supplier networks to Li & Fung.
SUPPLY-CHAIN MAKE	The buyer outsources manufacturing but directly selects and contracts some deep-tier suppliers to ensure quality and compliance.	**High** Buyer retains direct control over deep-tier suppliers.	**Apple** Manages 180+ component suppliers in the deep tier while outsourcing assembly to its first-tier supplier.
HYBRID APPROACHES	The buyer, first-tier suppliers, and third parties collaborate to select and manage lower-tier suppliers.	**Medium** Shared responsibility across multiple stakeholders.	**IKEA** Works with suppliers at multiple tiers to enhance sustainability.

Source: Authors

In the context of the supply-chain make or buy decision-making, sourcing capability becomes the most prominent capability. Sourcing capability is a company's ability to find, evaluate, and work with suppliers effectively. Think of it like a chef selecting ingredients for cooking in a restaurant—it is not just about picking the cheapest option but also about ensuring quality, reliability, and good relationships with suppliers. A company with strong sourcing capability has skilled purchasing managers, clear processes for selecting and working with suppliers, and good communication between different departments. These abilities help the company avoid risks like suppliers delivering poor-quality products or failing to meet deadlines. Over time, businesses develop these capabilities through experience, technical knowledge, and strong supplier partnerships.

One critical risk in managing multi-tier supply chains is opportunism from the first-tier supplier. When a company delegates sourcing decisions to a first-tier supplier, it assumes that the supplier will act in its best interest when selecting and managing deep-tier suppliers. However, if performance evaluation is difficult or information is not fully transparent, the first-tier supplier may take advantage of its position. This could include cutting costs by choosing lower-quality suppliers, misrepresenting costs to increase margins, or neglecting proper oversight of deep-tier suppliers. Such opportunistic behavior can lead to quality issues, compliance failures, and reputational risks for the buying firm. Understanding when and how to mitigate this risk is essential for making informed supply chain governance decisions.

Integrating these premises of transaction cost economics and the capabilities view and extending them into the context of multi-tier supply chain management, we offer the decision-making framework seen in Figure 1.

Consider a supply-chain make approach if:

Your company has invested in specialized assets linked to some deep-tier suppliers.

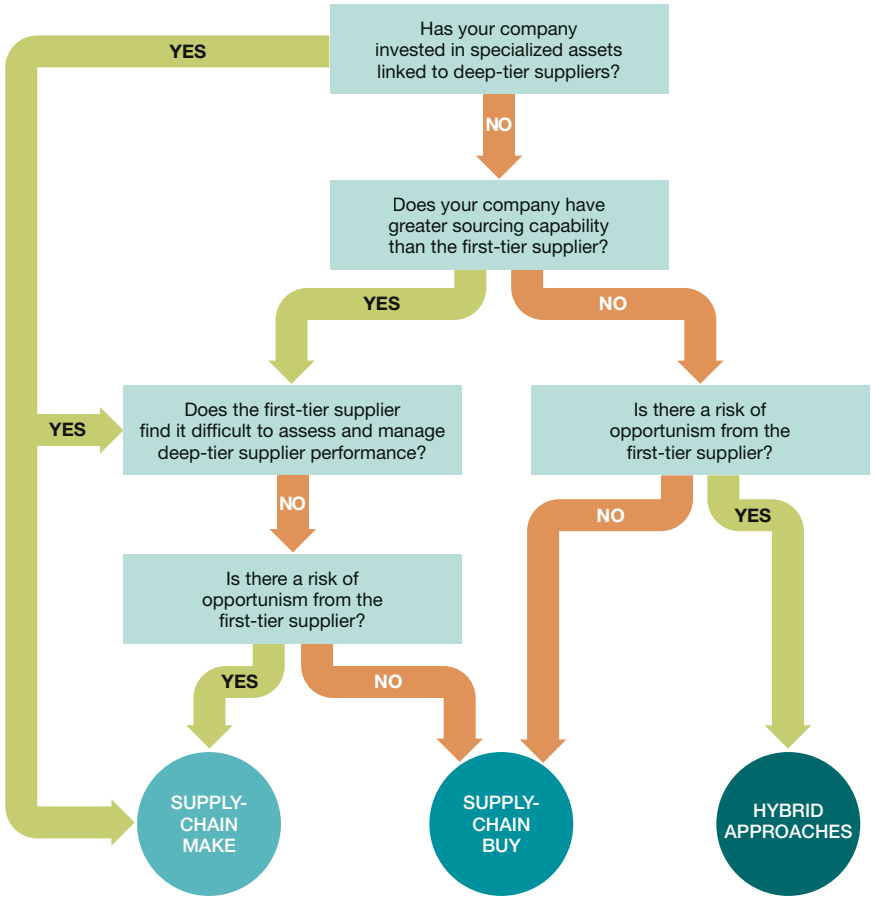
Buyers sometimes invest in specialized assets—such as production equipment and know-how—when working with deep-tier suppliers, especially for key components. These investments develop through direct collaboration, engineering programs, and prior experience. For example, Apple worked with Catcher Technology, a second-tier supplier, to develop the MacBook's aluminum body. Instead of sourcing from Foxconn, which also had aluminum casing production capabilities, Apple remained committed to Catcher due to its prior investments in the supplier's capabilities. This ensured access but also created dependency, leading Apple to manage this second-tier supplier more closely. When a company has made significant investments in a deep-tier supplier, allowing a first-tier supplier to control sourcing decisions poses a risk—the first-tier supplier might replace the specialized supplier. Therefore, companies should consider supply-chain make to mitigate such risk.

Your company has stronger sourcing capabilities than your first-tier supplier, and the first-tier supplier struggles to assess and manage deep-tier supplier performance.

Evaluating a supplier's performance can be complex. While buyers can analyze quality data and conduct inspections, some issues may surface only after further use or processing. Identifying the root cause of defects can be difficult, and suppliers may shift the blame. Moreover, factors like environmental and social compliance are often hard to measure. When deep-tier supplier performance is difficult to track, the risk of hidden quality issues, cost-cutting, or non-compliance increases. If your first-tier supplier struggles to assess certain deep-tier suppliers, but your company has the expertise to do so more effectively, it is best to take direct control. In such cases, a supply-chain make approach ensures greater oversight and reduces risks. For example, Boeing's first-tier supplier, Vought, was making the rear-end fuselage model for its 787 Dreamliner. Vought struggled to manage the deep-tier suppliers that were making components for the module. The problem became aggravated to a point where Boeing had to take a drastic measure by acquiring the Vought operation that was making this module.

FIGURE 1

Decision-making framework for supply-chain make or buy



Source: Authors

There is a risk of opportunism from the first-tier supplier.
The first-tier supplier may exploit its position as the broker between your company and deep-tier suppliers by hiding costs, selecting lower-quality suppliers, or neglecting supplier management. When you suspect this type of behavior from your first-tier supplier, you should first assess your sourcing capability and seriously consider managing deep-tier suppliers directly. For instance, Keyboardio discovered its first-tier supplier had secretly sourced keycaps from a deep-tier supplier using inferior materials, only realizing the issue after months of disputes over quality. In such cases, closer oversight of deep-tier suppliers helps prevent hidden risks and ensures product integrity. If your company has stronger sourcing capabilities than the first-tier supplier and there is a risk of the first-tier supplier acting in its own interest against your company's, supply-chain make approaches can help maintain quality and transparency.

Consider a supply-chain buy approach if:
The first-tier supplier has the capability to assess deep-tier supplier performance, and the risk of opportunism from this supplier is low.
If the final product's quality can readily be assessed, any issues with subcomponents should be traced back to the first-tier supplier, thereby making it accountable for its sourcing decisions. In such cases, the risk of opportunism is low, and your company can comfortably delegate sourcing to the first-tier supplier. For example, when Google partnered with Flex to develop Chromecast, it relied on Flex's sourcing and manufacturing expertise without concerns about supplier mismanagement. Because Chromecast is a relatively simple product, Google had no difficulty assessing Flex's performance and did not need direct control over deep-tier suppliers.
Your first-tier supplier has strong sourcing capabilities, and you can rely on them to manage deep-tier suppliers without risk of opportunism.
When a first-tier supplier has strong sourcing capabilities and can be trusted to manage deep-tier suppliers effectively, delegating sourcing decisions can streamline operations and reduce administrative burdens. A well-established first-tier supplier often has expertise in their particular industry, closer relationships with upstream suppliers, and better negotiation power, allowing it to secure higher-quality components at competitive prices. Your company's direct involvement in deep-tier supplier selection and management may be comparatively inefficient and may even be disruptive. In such cases, a supply-chain buy approach enables your company to focus on core competencies while benefiting from the first-tier supplier's expertise in supplier selection and management.

Consider hybrid approaches if:
Your first-tier supplier has strong sourcing capabilities, but you do not have confidence that they will manage deep-tier suppliers without risk of opportunism.
If you deem your first-tier supplier's sourcing capability to be good, maybe even better than your own, taking full control of indirect transactions may not be the best option. The supplier may be better equipped to manage deep-tier suppliers, negotiate favorable terms, and ensure smooth operations. However, completely handing over these decisions can create challenges, especially when there is uncertainty about the first-tier supplier's transparency or trustworthiness. A hybrid approach can help strike a balance. By working closely with both the first-tier and deep-tier suppliers, your company can benefit from the first-tier supplier's expertise while selectively maintaining oversight to reduce the risk of hidden quality issues or cost-cutting. This collaborative approach allows your company to retain strategic influence without taking on the full burden of managing deep-tier suppliers.

Conclusion

In navigating the complexities of supply chain make-or-buy decisions, companies must carefully balance cost efficiency, risk management, and strategic sourcing capabilities. While a hands-off supply-chain buy approach may offer cost savings and operational simplicity, it can also expose firms to potential supply disruptions, quality failures, and reputational risks. In contrast, a supply-chain make strategy may provide greater control. Still, it demands more investment in supplier oversight. Hybrid approaches may offer a middle ground, enabling firms to collaborate with first-tier and deep-tier suppliers while maintaining flexibility. Ultimately, there is no one-size-fits-all solution. Each company must assess its transaction costs, sourcing capabilities, and strategic priorities to determine the most suitable governance approach. By applying our decision-making framework, as shown in Figure 1, companies can move beyond reactive multi-tier supply chain management and adopt a proactive, structured strategy to enhance resilience, sustainability, and long-term competitiveness. •

SCM FOR EVERYONE: Making your business understand the supply chain

By Kai Hoberg, Rico Merkert, and Marianne Jahre

Supply chain decisions affect—and are affected by—nearly every function in a firm. Yet sales, R&D, or finance often act without realizing the impact that their decisions have on the supply chain.

While historically often neglected, the last five years have shown that supply chain management (SCM) is mission-critical for many firms. From pandemic disruptions to geopolitical shocks and bottlenecks after natural disasters, many companies have learned the hard way that supply chains (SC) are not just operational workhorses, but instead key enablers of resilience, agility, brand recognition, and growth. However, recognizing SCM's importance does not automatically translate into smarter decision-making of non-SCM departments and the company overall. While analytics and data are often seen as key enablers for such decisions, more tacit knowledge and management is required: Organizations must truly embed SC thinking into everyday decisions across all functions.

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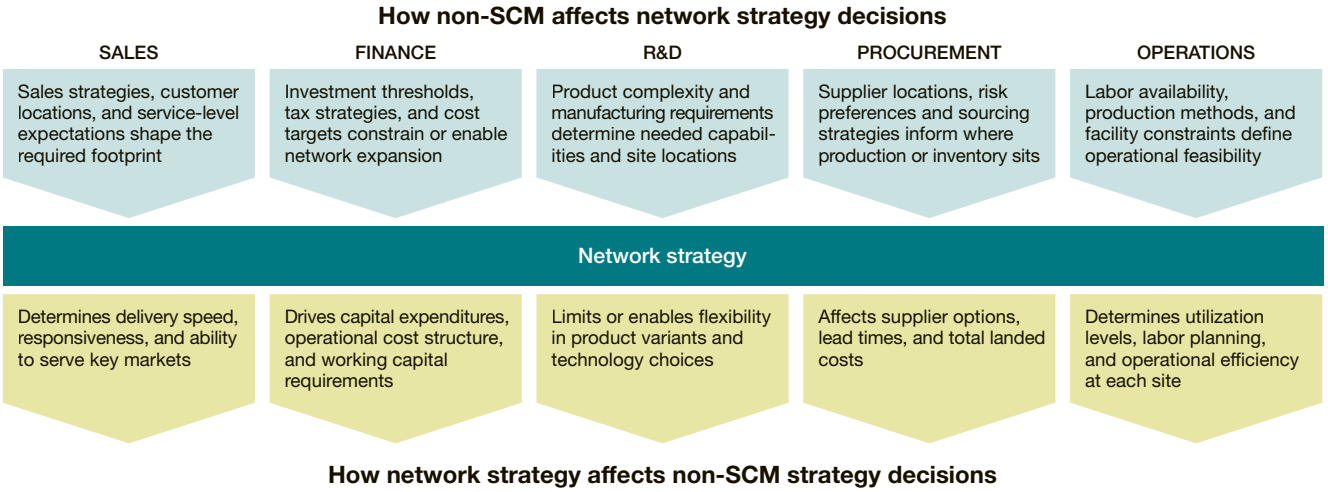
key enablers of resilience, agility, brand recognition, and growth. However, recognizing SCM's importance does not automatically translate into smarter decision-making of non-SCM departments and the company overall. While analytics and data are often seen as key enablers for such decisions, more tacit knowledge and management is required: Organizations must truly embed SC thinking into everyday decisions across all functions.

Ultimately, a range of departments beyond the supply chain function are involved in SCM decisions that are inherently cross-functional: They typically influence, and are influenced by, nearly every part of the business, including the CEO. Yet too often functions like sales, research & development, or finance make decisions without understanding their impact on the supply chain both up and downstream. A last-minute promotion, a product design change, or a new working capital initiative can unravel even the best supply chain plans. At the same time, key SCM decisions, such as network strategy, inventory choices or sourcing modes, have significant implications for other functions, shaping service levels, cost structures, and customer experiences (see Figure 1).

What many businesses lack is a shared understanding of how the SC works, how decisions in one area influence or constrain others, and how deeply these dynamics are tied to the firm's overall success. This article offers a practical guide to help non-SCM teams and their leaders understand the true value of SCM and engage more effectively across functions.

FIGURE 1

Cross-functional interplay around network strategy



Source: Authors

Why SCM is often poorly understood

Let's be honest: Many people working in non-SCM functions have no clue about SCM. There are many real-life anecdotes: Sales promises a delivery date to a customer without asking about manufacturing capacity constraints. R&D designs a custom part that no one can source. Product management rolls out six new package sizes and five new colors without considering the increased complexity in the SC. We find three common reasons for this behavior that go beyond mere ignorance.

1. Businesses operate under severe time constraints with functional teams constantly pressured to meet their specific key performance indicators. With so much on their plate, taking time to understand how the SC works (or how their decisions affect it) often feels like a luxury they cannot afford. As SCM is rarely seen as urgent until something breaks, SC considerations are routinely deprioritized in managers' daily work.

2. It is common that sales, R&D, and finance lack SCM exposure and therefore deep knowledge. Many terms and concepts are unknown to professionals who have not been exposed to how SCs work. Concepts like lead time variability, safety stock, or capacity planning can be unfamiliar or misunderstood. Terms like MOQ, ATP, or OTIF combined with the often inward-facing communication style of SCM-teams make it even harder for "outsiders" to engage. However, without a basic understanding, it is difficult to grasp how seemingly minor decisions can disrupt the SC. This knowledge gap is not about intelligence; it's about exposure and the absence of a shared language.

3. Inherent challenges in SCM are indeed difficult to understand—even for those who try. SCM requires an end-to-end understanding as decisions in one area often have cascading effects across the entire chain. Moreover, SCM decisions are non-linear: small changes in demand or supply conditions can lead to disproportionately large disruptions or cost swings. Further, they are ambiguous: relationships between cause and effect are often unclear, and trade-offs rarely come with simple answers. This combination of linked, non-linear and ambiguous makes SCM fundamentally harder to grasp than many other business domains.

SCM is both structurally complex and cognitively demanding, which requires cognitive investment, or its lack thereof often results in misunderstandings. Yet the consequences of this gap are real: misaligned decisions, avoidable disruptions, lost profit opportunities, and dissatisfied customers. That is why, in our view, building basic SCM fluency across the organization is not just helpful, but essential.

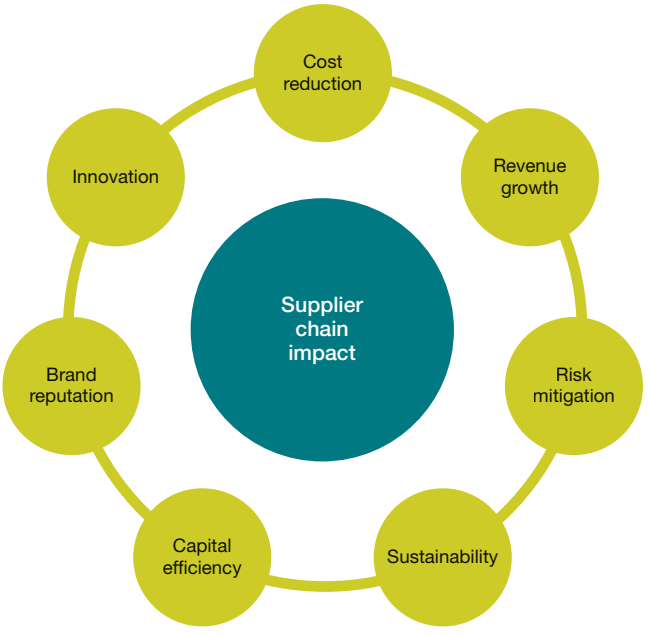
What everyone should know about SCM

For a long time, many businesses treated SCM as a secondary concern; merely an execution task to follow from the "real" work of product innovation and customer acquisition. Once R&D launched a brilliant new product and sales secured new business, SCM was expected to distribute it cheaply and without complications. But that view has changed. More and more companies now recognize that the SC should not just be seen as a cost center, but as a potential source of competitive advantage. SC powerhouses such as Apple, Amazon, P&G, and Unilever have demonstrated that superior SC capabilities can be a strategic differentiator—even if this might (initially) come at higher costs.

This mindset shift from perceiving SCM as a cost center to recognizing it as a strategic lever is reflected in the SC impact rubric (see Figure 2). In many companies, the SC contributes far beyond operational *cost reduction*, though this remains an important consideration. SCM can enable *revenue growth* by ensuring product availability and enabling faster market entry. For example, Shein's ultra-fast fashion model uses real-time demand data and digital manufacturing to launch new styles in days rather than weeks. *Risk mitigation* is another core contribution of SCM, which builds resilience into sourcing, production, and distribution networks. When natural disasters disrupted semiconductor supply, companies like Toyota avoided prolonged downtime by actively managing supplier

FIGURE 2

SC impact rubric



Source: Authors

networks through dual sourcing strategies and deep Tier 2 and Tier 3 visibility.

SCM is also central to *sustainability.* Unilever, for instance, reduced its environmental footprint through SC redesign and a strategic shift to recyclable materials. SCM enhances *capital efficiency* by optimizing inventory levels, working capital deployment, and asset utilization. As an example, P&G improved cash flow by starting to manage planning processes globally and synchronizing SC operations. Well-managed SCs further shape the *brand reputation*, particularly through consistent service and responsible sourcing. Patagonia, for example, embeds ethical SC practices and transparency into its brand promise, thus creating differentiation and trust. Finally, SCM enables *innovation* by creating operational flexibility to support modular designs, pilot-scale production, and rapid scaling. Tesla, for example, has redefined automotive SCM by vertically integrating key components like batteries and software, enabling faster innovation cycles and in-house control over critical technologies.

However, to unlock this strategic potential it is imperative for the other business functions to understand at least some basic SCM principles. This knowledge doesn't require deep technical expertise, but it does require awareness of how decisions ripple across the end-to-end chain. Some SCM fundamentals are universal, such as understanding key tradeoffs. For example, lead times determine when products can be delivered, shaping customer expectations and launch plans. Inventory acts as a buffer against uncertainty avoiding stockouts but overstocking ties up capital. Large demand variations are increasing the need for buffer inventory. In this context, forecast accuracy becomes essential: inaccurate or overly optimistic forecasts can result in overproduction, excess inventory, or unmet demand. Poor forecasts also tend to amplify the bullwhip effect, where small shifts in customer demand cause increasingly large fluctuations in upstream orders. This leads to instability, supplier stress, and avoidable costs throughout the SC.

Equally important are the trade-offs between cost, service, and risks that SC managers constantly navigate. Offering faster delivery or holding more inventory may improve service levels but comes with financial and operational implications. Increasing product variety may boost sales but adds complexity and cost for planning and fulfillment. Similarly, sourcing from low-cost regions can reduce unit costs but may increase lead times and expose the business to greater risks. Without a shared understanding of such dynamics, even well-meaning choices in one business function can disrupt another. A firm-wide grasp of these basic SCM principles enables better alignment, faster response, and more resilient performance across the organization.

These SCM concepts are relevant to anyone in sales, R&D, finance, or marketing who interact with product availability, timelines, or service expectations. Other elements are more function specific (See Table 1). Sales and marketing need to understand what the SC can reliably

TABLE 1

Overview of tailored SCM knowledge by function

FUNCTION	KEY SC KNOWLEDGE AREAS
Sales	• How service levels affect customer satisfaction and loyalty • Fulfillment and inventory impact of promotion campaigns • Realistic delivery dates based on supply chain constraints
R&D	• Availability and lead times of critical components • How product design affects sourcing and production • Material choices and their impact on sustainability goals
Finance	• How inventory ties up working capital and liquidity • Cost-to-serve variation across products and customers • Exposure to supplier and logistics disruption risks
IT	• Importance of clean, timely, and structured master data • Integration between planning tools and ERP systems • Role of digital tools in SC visibility

Source: Authors

deliver, how service levels are shaped, and the fulfillment implications of promotions or custom offerings. R&D must be aware of how design choices affect sourcing, manufacturability, and supply flexibility, especially when working with new or specialized components. Finance should understand how working capital, cost-to-serve, and risk exposure are influenced by SC decisions such as inventory levels or supplier terms. Finally, IT plays a crucial role through enabling data visibility, system integration, and digital tools that power SC planning and execution. Equipping each function with tailored SCM knowledge is critical for deepening understanding and enabling more informed, aligned decisions.

How to elevate SCM understanding

Supply chain managers must acknowledge the critical truth: non-SCM colleagues face challenges in understanding the supply chain. Expecting cross-functional alignment is unrealistic, and if SCM wants better collaboration, they must take the lead in making supply chain concepts more accessible, more visible, and more actionable across the business. That starts with knowing where your organization stands. A SC awareness maturity assessment (see Table 2) can help reveal blind spots across departments and indicate where targeted interventions e.g. trainings, playbooks, or workshops, are most needed.

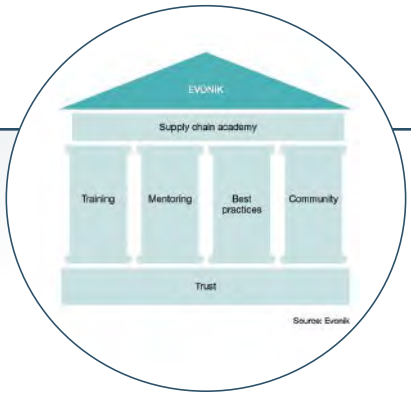
Creating short, engaging training modules is often the first step (see Evonik sidebar). But this is not about lecturing—it is about co-creating understanding. Invite other functions into conversations, use real examples, and tailor content to their decisions and KPIs. A sales manager doesn't need a lesson in logistics theory. They need to know how lead time promises affect capacity needs and inventory levels. R&D needs to understand the sourcing implications

TABLE 2

Supply chain awareness maturity assessment

LEVEL	STAGE	NON-SCM MINDSET	ILLUSTRATIVE QUOTES
1	Unaware	• Supply chain is invisible • No understanding or interest	*"That's SCM's problem."* *"We just place the order."*
2	Aware but passive	• Acknowledges SCM exists but sees it as back-office or tactical	*"We know they're busy, but we need this now."*
3	Reactive	• Involves SCM when problems arise • Decisions are made in silos	*"Why didn't supply chain tell us this would be an issue?"*
4	Engaged	• Seeks input from SCM in planning and execution • Begins to understand interdependence	*"Let's check with SCM before we commit."*
5	Integrated	• SCM is embedded in decision-making across functions • Shared KPIs and joint ownership	*"How will this impact our supply chain? Let's plan this together."*

Source: Authors



Supply chain for non-SC executives at Evonik Industries

By Dr. Thomas Schamberg, vice president supply chain strategy, Evonik Industries

Evonik Industries is a leading specialty chemicals company comprising 13 distinct business lines, operating global supply chains. A prevalent challenge Evonik encounters is that many functions outside the supply chain often lack a comprehensive understanding of its operational imperatives and the ramifications of their decisions. To bridge this knowledge gap, Evonik's SC Academy launched a program entitled "Supply Chain for Non-Supply Chain Executives."

This initiative is specifically designed for executives from various departments at Evonik who do not have direct involvement in SCM. The program features interactive, face-to-face training sessions, accommodating groups of 20 to 25 participants. The first training was conducted in North America, where Evonik rigorously analyzed real-world scenarios and decisions made by teams in research and development, sales, finance, and information technology. By contextualizing SC challenges pertinent to their respective functions, they not only identified shortcomings but also collaboratively explored avenues for improvement.

Participation in the training is entirely voluntary, reflecting Evonik's commitment to cultivating a positive perception of SC operations across the organization. Rather than mandating attendance, executives are encouraged to recognize the value of understanding supply chain dynamics. Evonik aims to offer these sessions four to five times annually. After training the initial cohort of executives, the program will be extended to future leaders and high-potential employees.

This initiative strengthens cross-functional collaboration and equips executives with the insights needed to make informed decisions that enhance supply chain performance. In doing so, it drives greater efficiency and effectiveness throughout the company, reinforcing Evonik's position as a forward-thinking leader in the specialty chemicals sector. By fostering a culture of shared understanding and collaboration, Evonik aims to optimize operations and deliver exceptional value to its stakeholders.

of choosing a rare or long-lead-time component.

Playbooks translate SCM principles into practical, role-specific guidance that supports smarter decisions. Effective playbooks include one-page summaries on core concepts such as lead time, inventory, forecast accuracy, or the bullwhip effect, designed for quick reference and cross-functional accessibility. They should also include clear, visual illustrations of key trade-offs to help non-SCM teams understand the implications of their choices in everyday scenarios.

Workshops offer a hands-on opportunity to explore real trade-offs, aligning shared objectives, and foster cross-functional dialogue around common bottlenecks. When embedded in strategy sessions or team offsites, they help shift perceptions and bring SCM from the sidelines into the core of business planning.

However, leaders of other business functions need to be convinced that their teams should spend time on this. Therefore, you need to showcase the benefits speaking their language e.g. "understanding SCM helps you make promises you can keep" or "visibility into supply constraints helps you prioritize the right market." Framing SCM literacy as a way to create impact using the SC Impact Rubric by hitting revenue targets, avoiding rework, or improving customer experience makes the time investment far more compelling.

Once other functions start engaging with SCM principles, leadership must reinforce this shift. Mentorship is another underutilized lever for building that awareness. Pairing SCM leaders with high-potentials from functions like sales, R&D, or finance creates informal learning channels, fosters cross-functional empathy, and builds lasting connections. These relationships help non-SCM talent develop a better appreciation for how their decisions affect the broader value chain long before those decisions show up as problems in a KPI dashboard. To reinforce this mindset, trade-offs must be surfaced early—not when firefighting has already begun. Too often, SCM concerns only become visible once a plan unravels. Visual tools, such as dashboards comparing customer promises with operational realities, help make cost, service, and risk trade-offs tangible at the right moment when choices are still being made.

Equally important is learning from experience. Post-mortems of both SCM failures and successes should be institutionalized, not just to assign blame or celebrate performance, but to promote shared understanding. Analyzing what went wrong (or right) across planning, sourcing, manufacturing and delivery can help break down silos and prevent repeat mistakes. One important step could be to actively recognize and celebrate SCM-savvy behavior, especially when it comes from outside the SCM function. When a commercial team adjusts its offering based on lead time realities or a product development team reuses an existing component to improve availability, it sends a strong signal: supply chain awareness is noticed, appreciated, and valued across the organization.

Ultimately, awareness and appreciation are necessary but not sufficient. Sustainable cross-functional alignment requires shared incentives. As long as functions are measured against narrow, siloed KPIs, like volume sold or R&D speed to market, they will act accordingly. But when performance is tracked against end-to-end metrics, e.g. such as cost-to-serve, working capital, or on-time-in-full delivery, collaboration becomes more natural and more rewarding.

Conclusion

So why is it important that not just the SC geeks, but instead your entire business understand and live SCM? For a start, if they don't, the other functions in your organization may become an "enemy" that unintentionally ruins your supply chain efforts. Too often, well-intended decisions in sales, R&D, or finance cause friction, inefficiencies, or breakdowns simply because SC implications were not sufficiently

TABLE 3

Checklist for supply chain leaders

- Conduct supply chain awareness maturity assessment by function
- Offer short training modules
- Create SCM playbooks on key concepts and tradeoffs
- Facilitate cross-functional SCM workshops
- Establish mentorship programs for non-SCM high-potentials
- Create a "customer promise vs. operational reality" dashboard
- Force trade-off discussions early, not after firefighting starts
- Institutionalize post-mortems of SC failures and successes
- Recognize and reward SCM- savvy behavior outside SCM
- Ensure performance metrics reflect shared end-to-end objectives

Source: Authors

considered. That's why building a shared understanding of SCM across the organization is not optional—it's essential. This doesn't mean turning everyone into a supply chain expert. It means to equip each function with the fluency needed to recognize interdependencies, appreciate trade-offs, and contribute constructively to cross-functional decisions.

When non-SCM teams understand the fundamentals, they are more likely to coordinate early, flag risks, and align their actions with broader supply chain goals. The result: fewer surprises, fewer bottlenecks, and more resilient, cost-effective operations. Organizations that invest in SCM awareness don't just avoid problems; they unlock hidden value and potential. In today's environment, that level of understanding isn't a luxury—it's a competitive necessity. •

Why supply chain cybersecurity still falls short—and what leaders must do next

Cybersecurity is vital for supply chains to execute effectively and maintain trust with partners and customers.

By Marisa Brown, APQC

Marisa Brown is the senior principal research lead for Supply Chain Management at APQC. She leads APQC's supply chain team that conducts research to provide insights into benchmarks, best practices, and process improvements in supply chain planning, procurement, logistics, manufacturing, product development, and innovation. Marisa is a leader in supply chain with almost 30 years' experience in business, research, writing, speaking and consulting.

Supply chains rely heavily on digital technology to support interconnected global networks of suppliers, logistics providers, customers, and multiple other stakeholders. These technologies make modern supply chains possible, but they can also create vulnerabilities to cyberattacks. Global networks also mean that organizations must worry about their security and that of their partners as any link in the supply chain can be the target of an attack. Weaknesses can have a ripple effect, affecting multiple stakeholders and causing damage to other points in the chain.

In late 2024, APQC conducted a global survey of 2,500 cybersecurity professionals. The results show that supply chain leaders need to better understand supply chain vulnerabilities to cyberattacks, as well as the evolving nature of threats. Supply chain leaders are not expected to become IT leaders, but it is a reasonable expectation that they need to understand how supply chains are vulnerable to cyber attacks and how those threats are evolving. In addition, supply chain professionals need to take the lead on dealing with suppliers as a source of potentially devastating cyber risks that can disrupt their own businesses.

Timeliness measures are not encouraging

Cycle times matter in the supply chain, and cybersecurity is no different. The research reveals that organizations have a lot of room for improvement, however. Figure 1 shows how organizations perform on several measures related to the timing of critical cybersecurity actions.

» Average time in calendar days to detect cybersecurity incidents.
» Average time in calendar days to respond to and recover from cybersecurity incidents.
» Average number of calendar days to notify customers of a breach.
» Average annual number of calendar days to apply security patches after they are released.

The most alarming cycle time is the number of days organizations need to detect incidents. At the median, they need almost six months to detect when an intrusion has happened. Globally, this number is often reported to be even higher, depending on the source, at 200-plus days. During this time, a bad actor has access to organizational systems, can lurk and observe, and may engage in further damaging activities such as a whaling attack. This is a type of phishing attack with a potentially larger payoff that involves a criminal pretending to be a senior member of the organization to gain the trust of other staff and access to sensitive information.

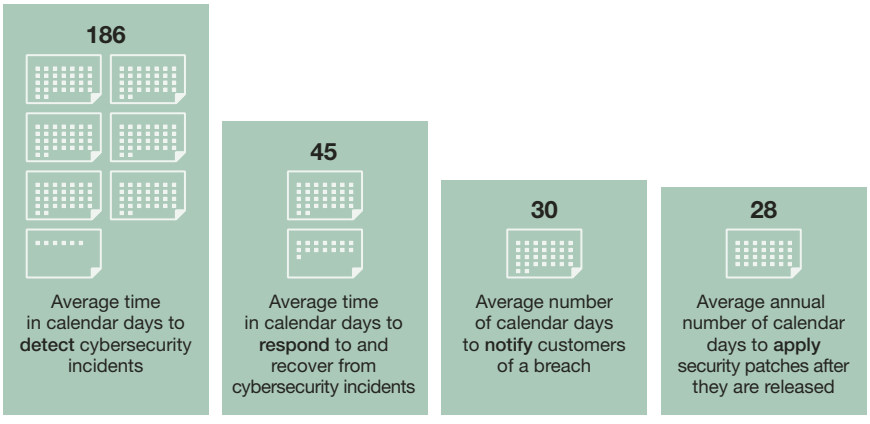
Also disturbing is that organizations take a median of one month to notify their customers of a security breach. This is on top of the six months it takes to detect an incident, meaning that customers have potentially had their identities and assets at risk for seven months—long enough to strike a serious blow to customer trust in an organization.

Once an organization detects an incident, it takes a median of one and one-half months to respond to and recover from the security breach. The time needed is a result of multiple factors, depending on the type and severity of attack. For example, after a ransomware attack, it's not as simple as getting the decrypter key and rebooting to recover. An organization must decrypt each system to restore affected files and then ensure the process has worked. The age of supply chain systems (some are frankly antiquated) can impact

FIGURE 1

Critical cybersecurity cycle times in days

Median value in days



Source: APQC

how long it takes for the restoration process to work, and systems can be reinfected if they are brought back up too soon. In some cases, impacted hardware has to be replaced. The recovery process can be a costly one, with downtime, data loss, and recovery activities all having associated expenses.

Organizations can mitigate the risk of cyberattacks due to known weaknesses by applying security patches to their systems. However, APQC found that organizations take a median of 28 days to apply patches once they're released. This gives bad actors nearly a month to take advantage of a known security flaw. Many cybersecurity breaches result from unpatched vulnerabilities, so it is essential for organizations to decrease the time needed to install these front-line defenses.

Current spending is insufficient

Although cybersecurity presents a clear risk to supply chains, organizations' spending on security is not keeping up. APQC's research shows that at the median, organizations spend only 0.5% of their total revenue on cybersecurity. For a company with $2 billion in annual revenue, this means only $10 million goes to cybersecurity for both IT and operating technology such as that which enables the supply chain.

This is a small amount compared to what organizations spend on other critical processes. For example, they spend a median of 49.6% of their revenue on manufacturing, which for the hypothetical $2 billion organization would lead to a cost of almost a billion dollars. Ten million dollars hardly seems like enough to protect a manufacturing investment this large, let alone the rest of the supply chain and enterprise.

Steps leaders can take

Organizations can improve their cybersecurity readiness by identifying their vulnerabilities both within and external to the enterprise.

1. REVIEW YOUR VENDORS

The interconnected systems within supply chains mean organizations must be aware of their critical vendors' security risks—their vulnerabilities are YOUR vulnerabilities. Supply chain leaders can gain a better understanding of this by increasing the percentage of vendors that have undergone security reviews. At the median, organizations report that they have reviewed 90% of their critical vendors. To have 10% be of unknown risk presents a potentially serious problem for supply chains. Organizations can start addressing this by leveraging the relationships built by their procurement professionals. Positioning increased cybersecurity as benefitting the partnership can motivate vendors to collaborate on security. A chain is only as strong as its weakest link.

2. SECURE DEVICES ON YOUR NETWORK

APQC also asked about the percentage of devices on organizational networks that have known vulnerabilities. As shown in Figure 2, both the median and the 75th percentile have 10%. Considering the number of devices that may be at an organization, this percentage could equal a large number of unsecured devices. And bad actors need only one entry

FIGURE 2

Percentage of devices on the organizational network that have known vulnerabilities

Source: APQC

point to gain access.

These are devices with known vulnerabilities. On top of this, there are most likely devices with unknown vulnerabilities.

One key step to address both known and currently unknown vulnerabilities is staying proactive on security patches, an integral part of any organization's cybersecurity strategy.

3. ENGAGE IN CONTINUOUS IMPROVEMENT

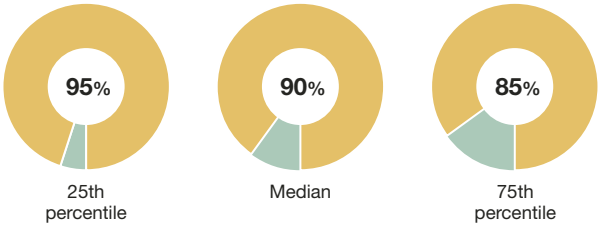
As threats evolve, organizations must evolve their cybersecurity strategies. APQC has found that only 11% of organizations have fully implemented or optimized a continuous improvement program for cybersecurity. Evaluating vendors and securing the network are essential components for security, but regularly looking at whether the current actions are sufficient allows a company to be proactive in an ongoing effort to change as risks change.

4. INCLUDE PEOPLE AND CULTURE

People are the most important resource for any organization, but from a cybersecurity standpoint they can also be a great risk. Social engineering threats are on the rise and the tactics used by bad actors continue to get more sophisticated. As shown in Figure 3, at the median, 90% of employees have completed cybersecurity training in the past year. Organizations should build a culture that values cybersecurity by taking steps to increase the frequency and extent of training as threats evolve.

FIGURE 3

Percentage of employees who completed cybersecurity training in the past year



Source: APQC

According to APQC's research, only 20% of organizations have fully implemented or optimized a culture of security, with employees understanding their role in cybersecurity. On the other end of the spectrum, 27% of organizations have not taken any real action toward creating

this culture. Making security an integral part of the company culture helps keep it top of mind for employees and seen as less of a burden. Companies that do not demonstrate that security is a priority can give their employees the impression that security is "someone else's job."

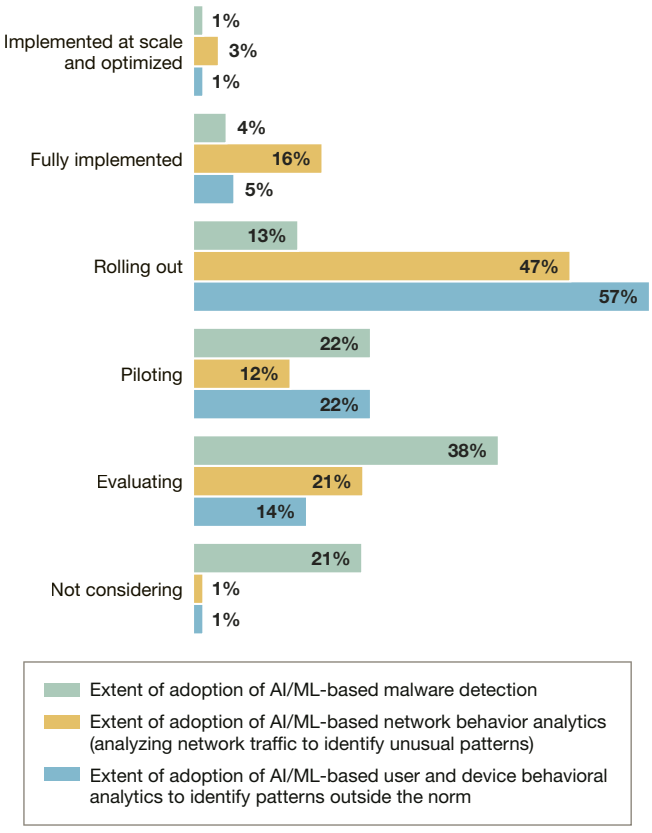
An essential component of employee training is education, specifically on social engineering or on bad actors using psychological manipulation to trick employees into divulging sensitive information or providing access to systems. So far only 21% of organizations have fully implemented this type of awareness training. Given that so many security breaches originate from these types of phishing attacks that initially target people versus the system, companies should be proactive in training employees on how to identify social engineering risks.

5. ADOPT RESILIENCE AND BUSINESS CONTINUITY PLANS

Many organizations have adopted a business continuity plan for cybersecurity that can help the business recover from an incident. According to APQC's research, 70% have a plan fully implemented or optimized, and 28% are in the process of rolling one out. Although it is good news that organizations have plans to ensure they recover as fast as possible following an incident, they should also invest more in proactive training and cultural changes that can reduce cybersecurity risks.

FIGURE 4

Extent of adoption of AI or machine learning for cyber analytics



Source: APQC

Adopting AI and machine learning helps both sides

Some organizations are embracing AI as a tool for cybersecurity. As shown in Figure 4, more than half are starting to use device and user behavioral analytics to identify abnormal patterns. Nearly half are using AI or machine learning to analyze network traffic to identify unusual patterns.

Although this technology can be helpful in detecting potential risks, bad actors are also using AI to unleash more sophisticated attacks. One method in which they do this is through deepfakes, or fake audio, images, or video that mimic real people's voices or appearance. These can be used to mimic a company's senior leaders to gain access to sensitive information. Companies can combat these threats using tactics such as establishing code words that senior leaders use if a supply chain professional, for example, is unsure of the person making contact.

Add proactive to reactive

The reality is that organizations cannot completely eliminate all cyber threats, although they are much better positioned if they reduce their risk through proactive planning. Reviewing vendor security, protecting devices on the network, engaging in continuous improvement, adopting a security culture, and having a business continuity plan can reduce the risk of an incident and also mitigate the impact if an incident does occur. Another important proactive move is to conduct regular internal security assessments and audits against established frameworks such as ISO 27001 and the NIST Cybersecurity Framework.

An additional step that organizations can take is to invest in cyber insurance. This covers the financial losses resulting from incidents such as ransomware attacks and data breaches, as well as ransom payments and malware remediation. Cyber insurance policies often require the purchasing organization to take risk mitigation steps like ensuring data backups cannot be modified, installing patches, and using multifactor authentication.

An organization's cybersecurity strategy must include multiple steps that work in tandem to protect the company and all the parties involved in the supply chain. A thoughtful, well-managed strategy combined with loss mitigation measures such as cyber insurance ensures that the organization can be both proactive to reduce risk and reactive to reduce loss.

Data in this content was accurate at the time of publication. For the most current data, visit apqc.org.

About APQC

APQC (American Productivity & Quality Center) is the world's foremost authority in benchmarking, best practices, process and performance improvement, and knowledge management (KM). With more than 1,000 member organizations worldwide, APQC provides the information, data, and insights organizations need to support decision-making and develop internal skills. Learn more.

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A reordering of the COO and CSCO logistics agenda

COOs and CSCOs face a dual mandate: cut costs now while building supply chains that are both productive and enduring.

By Michael Zimmerman and Korhan Acar

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Persistent volatility from tariffs, inflation, high borrowing costs, and geopolitical shocks has made disruption the operating baseline. Rate disparities, capacity swings, and mode-specific risks add more complexity.

The old agenda, once dominated by sourcing and cost levers, is transferring relevance to a broader set of priorities. Cost savings alone will no longer suffice in defining the reputation of a COO or CSCO.

Today's leaders are judged on their ability to deliver across the following three fronts.

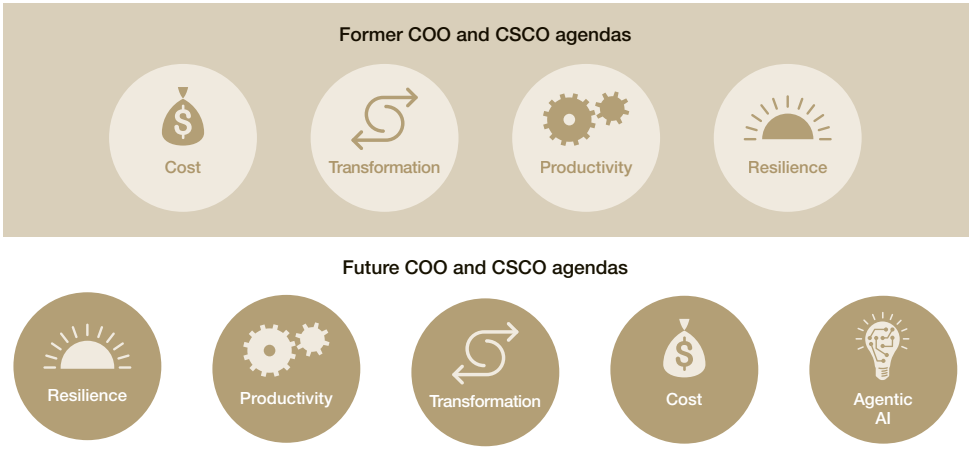
- **Resilience:** not only shock absorption, but also cost discipline, ensuring adherence to budgets while reducing concentrated sourcing risks
- **Productivity:** increasingly the way to create efficiency and competitiveness, with AI delivering immediate, pragmatic gains inside and outside the four walls
- **Transformation:** future-proofing supply chains through digital integration, ESG alignment, and network redesign

Quick wins such as mini-bids, customs hygiene, and automation are stabilizing operations and unlocking savings today. At the same time, leaders must invest in resilience, productivity, and transformation to ensure their supply chains can withstand disruption and generate a lasting advantage.

Resilience has vaulted to the top of the COO and CSCO agenda. Tariffs, shifting trade policies, and geopolitical instability are no longer episodic

FIGURE 1

Shock absorption: Resilience against constant volatility



Cost savings alone will no longer suffice in defining the reputation of a COO or CSCO

Source: Authors

shocks. They define the operating environment. Ocean freight rates surged more than 50% on key lanes during tariff-driven frontloading, airfreight remains soft yet unpredictable, while U.S. road lingers at the bottom but could bounce back at any time. These swings expose how fragile networks become without the agility to flex quickly. The challenge is less about preventing volatility and more about absorbing it: safeguarding service continuity, mitigating cost exposure from price swings, and protecting against concentrated risks.

Leading companies are acting decisively. Many are diversifying their sourcing footprints with "China+X" strategies, reducing their dependence on concentrated sources. Others are tightening customs processes to eliminate hidden costs. Visibility investments are gaining traction: Coca-Cola Consolidated, for example, uses predictive tracking to provide real-time ETAs and improve delivery reliability. Structural flexibility is becoming the norm. Quarterly mini-bids give shippers leverage in volatile markets, expanded carrier portfolios reduce exposure, and scenario planning quantifies risks and aligns stakeholders on the value of preparedness.

Resilience, often seen as defensive, can instead be wielded as a competitive weapon. The benefits, such as disruptions avoided, customers retained, and costs contained, are often invisible, making investments harder to justify.

Scenario modeling helps bridge this gap by showing the cost of disruption and the ROI of preparation. Done well, resilience shifts from a hidden insurance policy to a visible driver of performance and trust. COOs and CSCOs who elevate shock absorption can withstand disruption and position their companies to outperform rivals in volatile conditions.

Operational advantage: Productivity is the next lever for competitiveness

The easy wins from sourcing have largely been taken. After years of freight recession, most companies have already squeezed rates to their

limits. Today's favorable market—truckload contract rates below prior-year levels and stable LTL pricing—offers only temporary relief. Sourcing and cost takeout are now an expectation, a baseline responsibility of every COO and CSCO. Sustained competitiveness requires going farther and unlocking productivity inside the enterprise.

Leading companies are already proving this shift. Walmart, DHL, and Coca-Cola are deploying autonomous bots and AI to streamline sourcing activities and redeploy talent into higher-value work. UPS has used AI-driven route optimization (ORION) to cut millions of miles a year, saving fuel and labor while improving on-time performance. Amazon applies robotics and AI in fulfillment centers to automate repetitive tasks, reduce cycle times, and free up human associates for quality and customer-facing work. Agentic AI is accelerating this evolution by automating transactional tasks and enabling teams to focus on planning, collaboration, and higher-value activities.

Productivity has shifted from incremental cuts to a source of structural advantage. Leading supply chains are redesigning processes and adopting digital tools that release capital, free capacity, and sharpen decision-making. AI plays a pivotal role by removing routine work while enhancing human judgment. Together, these changes create organizations that can redirect resources into resilience and transformation. In this context, operational advantage is not a one-off project but a continuous way of operating—keeping supply chains lean, adaptive, and positioned for growth.

Transformation: Redesigning for any eventuality

Transformation connects today's resilience and productivity gains to long-term advantage. Disruptions have hardened supply chains, but they've also revealed a larger truth: yesterday's networks and tools will not sustain the next decade. Trade flows are shifting, ESG pressures are intensifying, and parcel and last-mile expectations are evolving faster than legacy systems can adapt. Tariffs are forcing leaders to revisit Incoterms, bonded warehouses, and FTZ strategies, which are pain points felt acutely in medical devices, consumer electronics, automotive, and apparel, where globalized supply chains and high cross-border flows make exposure especially pronounced.

What's new is that AI has moved from experimentation to delivering proven ROI in cost savings, productivity, and resilience across logistics. Leading companies are deploying modular agents built to address chronic transactional pain points such as freight audit and pay, rate management, spend analysis, lane and volume forecasting, carrier discovery and qualification, RFx preparation and launch, bid evaluation, negotiation and award, and contract and rate ingestion.

Reported outcomes include a 97% productivity improvement in freight audit, a 32% reduction in freight leakages, and faster bid cycles that sharpen carrier allocation. Early adopters are already deploying these capabilities at scale, automating hundreds of millions in freight spend and managing millions of shipments with real-time transparency.

At the same time, network redesign remains crucial. Leading companies are pursuing "China+X" sourcing models to spread risk and embedding

sustainability directly into logistics, guided by ESG criteria for suppliers, routes, and facilities. Digital platforms and logistics knowledge graphs are adding another layer of adaptability, stitching together ERP, TMS, procurement tools, and unstructured data to create end-to-end visibility. In the last mile, the competitive landscape is diversifying: FedEx and UPS are on diverging paths, regionals such as OnTrac are gaining share, and gig-economy players such as DoorDash and Uber are reshaping expectations with crowdsourced flexibility. Predictive analytics and AI-enabled decision platforms help leaders navigate this fragmented market with agility.

Rather than predicting the next disruption, transformation means redesigning supply chains for resilience, sustainability, and digital agility. Companies that adopt modular AI agents, redesign networks for adaptability, and embed ESG into logistics will not only bend without breaking, but also capture growth that less-prepared rivals leave behind.

Hot topics as immediate catalysts

Tariffs, inflation, borrowing costs, and geopolitics dominate today's headlines. They create turbulence, but they also show leaders where their networks are fragile. A poll of global heads of logistics confirms this: resilience and adaptability outrank both lowest landed cost and service as the top design principle for 2026. At the same time, executives admit the biggest driver of unplanned costs today is not freight rates, but volatile demand signals and forecast errors.

Hot topics evolve beyond short-term problems and act as catalysts. A tariff spike can reset sourcing or customs practices. Inflation presents an opportunity to strip out hidden costs. Higher interest rates sharpen the ROI bar, pushing leaders toward AI and automation with fast payback. And geopolitical shocks reinforce the case for diversified carriers and structured scenario planning. Quick wins in tariff hygiene, forecasting accuracy, or AI pilots demonstrate value while freeing resources to fund long-term resilience and transformation.

The COO and CSCO dual mandate

The mandate is clear: deliver results now, and build for what's next. Quick actions such as tariff mitigation, AI-enabled productivity, better forecasting, and more agile networks are now essential. They are the foundation of future transformation.

Resilience and adaptability are the leading design priority, outpacing cost or service. Leaders are realistic about AI. ROI is most visible in demand forecasting and inventory optimization. But they also acknowledge the talent challenge: the most crucial next hire is a data scientist, far ahead of traditional logistics veterans or logistics profiles.

Future-ready supply chains demand more than cost control. They require resilience to withstand shocks and contain costs, productivity to release capital and capacity, and transformation to retool networks for ESG, trade shifts, and last-mile evolution. By committing to this agenda, leaders move beyond survival and turn uncertainty into a competitive advantage that rivals cannot match. • . •

A SPECIAL SUPPLEMENT TO:
SUPPLY CHAIN MANAGEMENT REVIEW

NEXTGEN 2025:
Where Supply Chain Innovation Came to Life

By Bridget McCrea, Contributing Editor

Industry leaders met in Nashville to share lessons, explore emerging tech and strengthen collaboration across the global supply chain.

Supply chain leaders are under more pressure than ever. Rising costs, tariffs, unpredictable demand cycles, and a persistent talent shortage continue to test even the most advanced operations. At the same time, technology is changing the pace of innovation. Artificial intelligence (AI), robotics, and analytics aren't just experiments anymore—they're being sewn into the very fabric of the modern supply chain.

As companies push to connect systems, boost visibility, and build resilience, the supply chain is evolving into a smarter, more data-driven network. That evolution is at the core of the NextGen Supply Chain Conference, where industry leaders gathered in Nashville to share ideas, learn more and explore what's next.

Now in its seventh year, the conference brings together senior executives, thought leaders, and technology innovators to explore the future of supply chain management. With a program featuring keynote presentations, breakout sessions, and the annual NextGen Supply Chain Awards, the event spotlights the technologies and strategies shaping tomorrow's supply chains.

The event takes place every October and has been growing steadily since inception in 2019, the very first year it brought together supply chain executives, technology providers, and practitioners to focus on emerging technologies. Each year, the conference attracts an impressive mix of manufacturers, distributors, retailers, and logistics professionals who are shaping the next generation of global supply chains.

"NextGen continues to set the standard for forward-looking supply chain dialogue," said Brian Ceraolo, CEO & president of Peerless Media. "This year's discussions reflected the urgency and opportunity in front of us, from AI-driven decision-making to resilient operations, and showed how collaboration across the ecosystem will define tomorrow's leaders."

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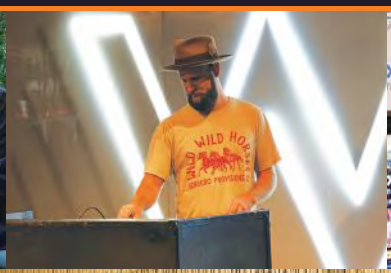


NEXT GEN
Supply Chain Conference


NEXT GEN


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Driving the momentum

Held Oct. 22-24 at the W Nashville Hotel, the NextGen Supply Chain Conference moved to a new home this year (from Chicago) and promised a fresh, focused, and future-ready experience for attendees, speakers, and sponsors. With 60-plus speakers, including executives from Johnson & Johnson, FedEx Supply Chain, Eli Lilly, Dole Packaged Foods, Uber Freight, Maersk and Kellanova, the event showcased the technologies and strategies transforming global supply chains.

The conference opened with Val Marchevsky, EVP & CTO of Uber Freight, delivering the Thursday morning keynote, "Reimagining Logistics with AI: Turning Intelligence into Action." Marchevsky detailed how AI is transforming logistics. On Friday, Todd Stillwell, vice president of supply chain and manufacturing for Dole Packaged Foods, delivered the morning's keynote presentation. Stillwell shared how the company is scaling its midsized CPG supply chain for innovation and growth by leveraging flexible manufacturing, streamlined logistics, and data-driven forecasting.

The NextGen Supply Chain Conference's informative sessions spanned AI, robotics, automation, digital twins, resilience, and sustainability, pairing strategic keynotes with practitioner-led case studies to deliver actionable takeaways attendees can deploy immediately.

Along with its rich educational program, the event offered peer-level networking and sponsor-hosted sessions from innovators including AutoScheduler, Cycle Labs, Hai Robotics, GreyOrange, TGW Logistics, and Warehouse on Wheels. Panel discussions throughout the week highlighted how companies are turning next-generation concepts into operational realities. Executives shared how they're scaling automation, integrating AI into planning and building resilience into global networks that still face unpredictable demand.

Attendees heard practical advice on aligning people, process, and technology to achieve measurable results. This year's program also emphasized collaboration across the supply chain ecosystem. Speakers from the manufacturing, logistics, retail, and technology sectors discussed how data sharing, transparency, and partnerships can drive better performance at every level. The event's diverse, cross-industry mix gave participants a chance to compare strategies and learn from peers facing similar challenges.

Between sessions, attendees connected at networking receptions, solution showcases, and roundtable discussions that encouraged open dialogue. The new Nashville setting brought fresh energy to the event and helped set the stage for a more interactive and community-driven experience.

"There was a real sense of momentum in Nashville this year," says Ceraolo. "You could feel the energy in every session and hallway conversation. People weren't just talking about the future of supply chain; they were building it together."

Celebrating innovation and excellence

The conference also honored excellence with the 2025 NextGen Supply Chain Awards, sponsored by Zion Solutions Group, recognizing end users, solution providers, and startups advancing digital transformation across global supply chains. For example, FedEx Supply Chain was recognized for its use of AI to improve planning and execution, Sysco for its digital transformation initiatives, and GNC for advancing robotics in its distribution operations. On the solution provider side, Quickcode.ai was honored for its AI-driven optimization tools, Easy

Fresh thinking. New approaches

For the first time ever, the NextGen Supply Chain Conference featured breakout sessions presented in five 90-minute blocks on Thursday morning, with the sessions duplicated in the afternoon so all attendees could participate in as many sessions as possible. The new format gave participants a chance to dive deep into focused discussions on automation, applied intelligence, strategy, optimization, and operational agility.

Moderated by editors, executives, and consultants from across the industry, the sessions explored topics ranging from AI-powered warehouse orchestration and tariff mitigation to digital procurement and risk management. Speakers from companies like IBM, Kellanova, RXO, Medline, and Toyota Motor Manufacturing shared practical insights on how supply chains of every size are adapting to new technology and global disruption.

The interactive format drew strong engagement from attendees and reflected the event's goal of stoking even more collaboration, creativity, and problem-solving among attendees. It also mirrored a growing reality across global supply chains: no company can solve these challenges alone. Building resilience now

Metrics for digital platforms that improve labor and cost visibility, and Corvus Robotics for robotics solutions that boost efficiency and safety. The Startup Award went to Dexory for its autonomous mobile robots and AI-powered DexoryView platform.

Diageo took home the Visionary Award, which recognizes bold, forward-looking approaches to supply chain transformation. The company has consistently ranked among Gartner's Top 25 Global Supply Chains and was a finalist in two categories of Gartner's 2025 Power of the Profession Awards. Diageo is advancing autonomous operations by harnessing digital technologies, advanced analytics, and artificial intelligence to improve efficiency, resilience, and customer experience across its supply chain.

"The Visionary Award recognizes companies that don't just adapt to the future of supply chain but actively shape it," says Brian Straight, SCMR's editor in chief. "Diageo is doing exactly that by demonstrating how digital transformation, innovation, and sustainability can come together to build supply chains that are not only efficient, but also responsible and resilient."

depends on stronger connections across suppliers, technology partners, service providers, and end users.

In fact, as automation, AI, and data continue to converge, collaboration is becoming the new measure of competitiveness. The most successful organizations aren't just adopting new tools; they're sharing ideas, aligning goals and breaking down the silos that once defined the field. The NextGen Supply Chain Conference helps them do that. Attendees come to learn, interact, and compare strategies, but they also leave with new ways to strengthen their own operations. Many take what they've heard back to their teams to spark fresh thinking, test new approaches, and challenge old assumptions.

Coming next year

Planning is already underway for the 2026 NextGen Supply Chain Conference. Building on the energy of this year's event in Nashville, Peerless Media and Supply Chain Management Review are preparing another high-impact program that will connect supply chain leaders, innovators, and solution providers from around the globe.

Next year's conference will dig deeper into how AI, automation, and data are reshaping supply chains. Expect an even sharper focus on collaboration, real-world problem solving, and fresh session formats designed to give leaders practical insight they can take home and put to work in their own operations.

"NextGen is more than a conference, it's a community of leaders who come ready to share openly about what's working and what isn't," says Straight. "That willingness to exchange real-world lessons is what makes this event special. It's where innovation meets honesty, and where the industry moves forward together."

As global supply chains become more intelligent, connected, and resilient, the 2026 NextGen Supply Chain Conference will once again provide a front-row seat to the trends and technologies shaping what's next. Mark your calendars and plan to be part of the conversation.

Visit **nextgensupplychainconference.com** to stay up to date on the 2026 NextGen Supply Chain Conference, including speaker announcements, early-bird registration, sponsorship opportunities, and exclusive event news as details are released throughout the year. •

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A SPECIAL SUPPLEMENT TO:
SUPPLY CHAIN MANAGEMENT REVIEW

Using digital twins to master supply chain volatility

By Bridget McCrea, Contributing Editor

A digital twin gives supply chain planners a safe way to test ideas and see how change affects performance in a largely unpredictable business environment.

Every new process or system needs a safe place to fail. In software development, teams use staging environments or "sandboxes" to test new ideas before they go live. They can build, experiment, and fix problems without real-world risk. If something doesn't work or show promise, they move on to the next idea.

Supply chain planners don't have these luxuries. Most of their experiments happen in the real world, where production schedules, budgets, and customer expectations are all on the line. Volatility has always been a part of supply chain management, of course, but there's just more of it coming from many different directions now. Shifting trade policies, new tariffs, the push to reshore and nearshore, and constant disruption are just some of the variables that can hit harder and faster than traditional planning models can handle.

Planning through that volatility requires more than experience or instinct, and that's where the digital twin comes in. Gartner

defines a digital twin as a digital representation of a real-world object or system. In practice, it's a software model that mirrors a specific physical asset, process, or organization. Companies can also combine data from multiple digital twins to create a broader view of connected operations (i.e., an entire plant, network, or city).

Virtual replicas of supply chains, digital twins help planners model new ideas, test scenarios, and see how changes ripple through the network before acting on them. It's the closest thing the supply chain world has ever had to a sandbox, and it enables faster, data-driven responses amid changing conditions.

Testing scenarios & modeling risk

Once considered a buzzword, digital twins are now a practical tool for supply chain planning. By creating a live digital replica of their operations—or, of one specific segment of their operations—companies can test scenarios, model risks, and adjust plans in real-time. In a market where change is constant, having this level of foresight turns planning accuracy into a competitive advantage.

When Om Prakash reflects on the use of digital twins in supply chain planning, he describes it as a "major step forward" compared to traditional modeling approaches. "Imagine you have a living, breathing virtual copy of your entire supply chain that updates in real-time and runs what-if scenarios constantly," says Prakash, senior procurement project manager at PIP Global Safety, Honeywell Safety Products, in Sterling Heights, Mich. "That's fundamentally different from traditional models."

Drawing on his experience at a previous company, Prakash says earlier data models acted like snapshots. They showed inventory levels or supplier performance—but only after the fact. Procurement data lived in one system, quality metrics in another, and inventory in a third. When a semiconductor supplier in Europe shut down, teams spent hours piecing together the full picture before they could act.

That fragmentation began to disappear when the company integrated 20-plus different data sources (e.g., supplier financial health, weather patterns, geopolitical risk, etc.) and built a dynamic model that mirrored every node, flow and relationship in its physical supply chain. The system ran continuous simulations to identify vulnerabilities and test responses before disruptions occurred.

The digital twin ran thousands of what-if scenarios automatically, and constantly stress-tested the network against real-world variables. That visibility helped planners quantify exposure instead of guessing. "We went from being blindsided by disruptions to having 14 days of advance warning on average," Prakash explains. During the October 2022 China lockdown, for example, companies with digital twin capabilities were actually simulating that precise situation one or two months earlier.

"While competitors were scrambling, these companies executed their playbooks within 48 hours," says Prakash, who now sees digital twins being used for demand forecasting, network optimization, and sustainability scenario modeling. Companies can pull in external signals like weather data, social trends, and economic indicators to create forecasts that adjust in real time.

Those insights help planners more confidently test whether supply can meet potential demand. The same technology advances network optimization by letting planners simulate long-term structural changes like nearshoring components, adding distribution centers, or rebalancing supplier capacity before taking action.

Prakash expects the next wave of digital twin usage to focus on sustainability scenario modeling. For example, organizations can use the technology to map carbon footprints across their networks, measure the effects of new environmental policies, and test circular economy strategies prior to implementation. "The key is that digital twins don't just give you better data; they give you actionable intelligence," he notes. "That's where the real value lies."

The AI acceleration factor

Picture a smart home that adjusts automatically to weather, energy prices and how many people are inside. Sensors feed data into one hub that learns, anticipates, and keeps everything running efficiently. A digital twin does the same for supply chain planning by connecting data from across the network, spotting patterns, and helping planners adjust their operations in real-time.

Jan Snoeckx, director analyst at Gartner, says the fully connected, end-to-end digital twin remains aspirational for most companies, although some are already moving closer to it. He says companies need stronger data connections, smarter analytics and clear boundaries that show where automation ends and human judgment begins. "The idea of a single model that mirrors the entire supply chain from end to end is powerful," he says. "But it also sets a very high bar."

Digital twins are also reshaping what it means to be a planner. As analytics and artificial intelligence (AI) handle the repetitive data work, planners are stepping into more strategic roles that Snoeckx describes as "orchestration." So instead of keying in data or approving every change, planners guide and supervise intelligent systems, set boundaries and make sure decisions align with business goals.

"It's not about replacing the planners," he says. "It's about giving them the visibility and intelligence to act as strategic partners to the business."

Looking ahead, Snoeckx expects AI to continue pushing digital twin adoption even further. For example, digital twins provide the context AI needs to make intelligent, supply chain-specific decisions. Without that foundation, automation can't work reliably. "AI and IoT are mirror enablers," he says. "Together, they'll drive the next wave of intelligent planning."

The digital twin as a technologist

A digital twin isn't just another analytical model. It's a living system that continuously monitors, learns and adapts across the supply chain. "Think of it as a digital replica of a physical supply chain," says Shashank Mane, VP of sales and go-to-market at Capgemini. "Traditional simulation tools could predict outcomes but a digital twin goes further by monitoring and diagnosing the network in real-time."

Digital twins can also predict what will happen and—if they're built properly—even

prescribe actions, says Mane, who recently worked with a manufacturer that used a digital twin to handle a last-minute order from a top customer without disrupting other commitments.

In the past, planners would've spent weeks collecting data from multiple systems and testing options manually. The twin did it in minutes by pulling live data from production, logistics, and inventory systems to test every scenario. "It allows experimentation at a completely different level," he says. "That's where companies see the real value of digital twins in planning."

First Things First

For companies ready to start using digital twins, Mane says it's best to begin with a strong foundation built on three essentials: digital insight, which connects equipment and software so data flows vertically; digital continuity, which links processes across departments; and digital convergence, where modeling and simulation come together. "When those layers work in sync," he notes, "you get a system that scales easily and provides continuous value."

To avoid common pitfalls, Prakash suggests these five starting points.

Secure executive support. Digital twin projects span departments, so they need leadership that can align goals and resources. A visible sponsor helps maintain momentum and keeps teams focused when priorities shift.

Start narrow but go deep. Build a full twin for one product line or region, show clear results, then expand. Early wins prove value and create internal advocates for the next phase.

Clean your data first. Standardize and validate data before layering in analytics or automation. A single, accurate data source prevents missteps and strengthens every decision that the twin supports.

Invest in change management. Training and adoption often take more time and budget than technology itself. People have to understand how to use the system and trust what it's telling them.

Celebrate the small wins loudly. Success stories drive adoption better than any training program can, so make sure everyone from the CEO to the shop floor manager hears about it. Recognizing quick wins builds momentum for long-term transformation.

By learning in stages, adding complexity gradually and celebrating small wins early, companies can build digital twins that actually work in practice. The enthusiasm will spread quickly when the digital twin prevents its first disruption. "Building an end-to-end digital twin can be challenging," Prakash says, "but once it's up and running, you'll wonder how you ever managed without it." •

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