

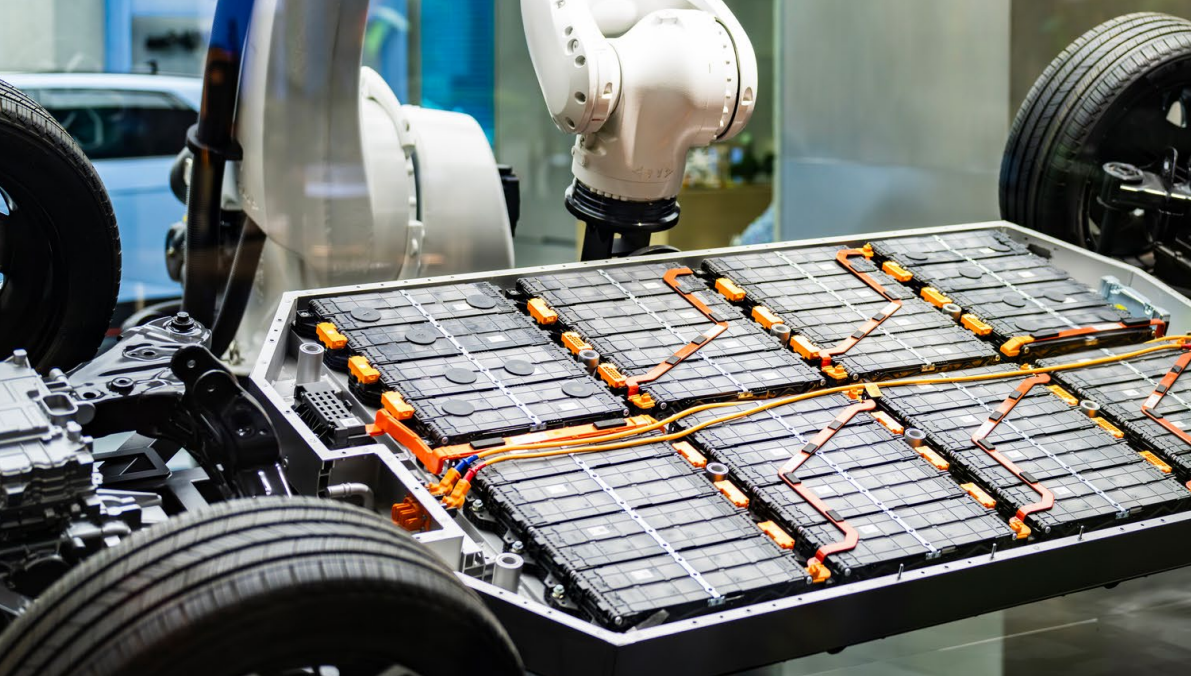
MOODY'S

Supply chain insights:

Navigating disruption in automotive supply chains

We take a deep dive into key disruptions in the automotive supply chain and highlight ways to anticipate and mitigate potential disruption





12.8
YEARS IN 2025

The average age of light trucks and cars in the United States as of 2025

Introduction

Automotive supply chains in North America today face a complex landscape of risks due to economic volatility, electrification initiatives, and regulatory pressures. Those companies with extensive global supply chains are especially vulnerable to macroeconomic disruptions, including demand fluctuations, inflation of raw materials, and margin compression.

Meanwhile, the transition to electric vehicles (EVs) introduces new structural risks. Suppliers of EV components are encountering significant challenges related to: the availability of battery materials, such as rare earths, lithium, nickel, and cobalt; dependencies on semiconductors; and limited regional production capacity for battery cells, which could result in bottlenecks that could halt assembly lines. At the same time, the aftermarket's reliance on aging internal combustion engine (ICE) fleets is raising exposure to shortages of service parts should struggling suppliers fail.

Adding to these pressures are heightened safety and compliance requirements, costly recall liabilities, and the substantial capital investments needed for emerging technologies. These factors are collectively increasing financial and operational vulnerabilities across the supplier network.

This intricate risk menu necessitates proactive oversight of quality, delivery performance, and supplier financial health, to help mitigate and address potential cascading disruptions.

TOP EV SUPPLY CHAIN ISSUES IN NORTH AMERICA

- 1. Battery materials & cell/module supply** (lithium, nickel, cobalt, graphite; localized US/Canada capacity still scaling)
- 2. Power electronics** semiconductor chips, subject to semiconductor cycles
- 3. Thermal management cooling plates, heat-pump components**
- 4. Software/OTA quality** feature interactions causing service events
- 5. High-voltage safety/repair protocols & insurer economics** battery diagnostics, pack reparability affecting total-loss decisions. Industry analyses and trade sources consistently emphasize the “fewer mechanical parts, more electronics & battery” shift.

Executive Summary

KEY RISKS FOR AUTOMOTIVE SUPPLIERS

1. Financial vulnerability and demand fluctuations

Suppliers are highly sensitive to sudden changes in production schedules, raw material price swings, and OEM pricing pressures. Limited liquidity, tariffs and rising interest rates increase the risk of bankruptcy, especially for small-to-mid-tier suppliers. These issues often show early warning signs like quality problems, delivery delays, and surges in freight costs, which tend to come before insolvency.

2. Electrification challenges for EV part suppliers

The rapid adoption of electric vehicles brings new structural risks. EV suppliers depend heavily on critical minerals (lithium, cobalt, nickel, graphite) and battery cell capacity, much of which is sourced from Asia despite efforts to bring production back to the U.S. These suppliers also face shortages of semiconductors, especially silicon carbide for power electronics. The EV supply chain relies on fewer, more complex components, increasing the effect of any failure, from battery modules to thermal management systems.

3. Aftermarket reliance and service part risks

As the average vehicle age in North America reaches 12.8 years, the aftermarket becomes the primary source of service demand¹. Disruptions among Tier-2 and Tier-3 suppliers threaten maintenance for millions of vehicles, impacting mobility, insurance, and consumer confidence. The need for dealerships and OEMs to supply parts for longer model lifecycles adds to inventory complexity and ties up capital in parts distribution.



¹<https://www.kbb.com/car-news/average-car-now-12-8-years-old/?msocid=399d36d4b542629d1d4723e4b4dd6327>

4. Safety, regulatory, and recall risks

Safety recalls remain a significant compliance concern, as shown by the Takata airbag crisis, which took a decade to resolve². OEMs must handle costs and liability when a financially distressed or bankrupt supplier provides a defective part. Regulatory scrutiny and reputation risks heighten the financial impact, especially in cases involving fatalities or widespread quality issues.

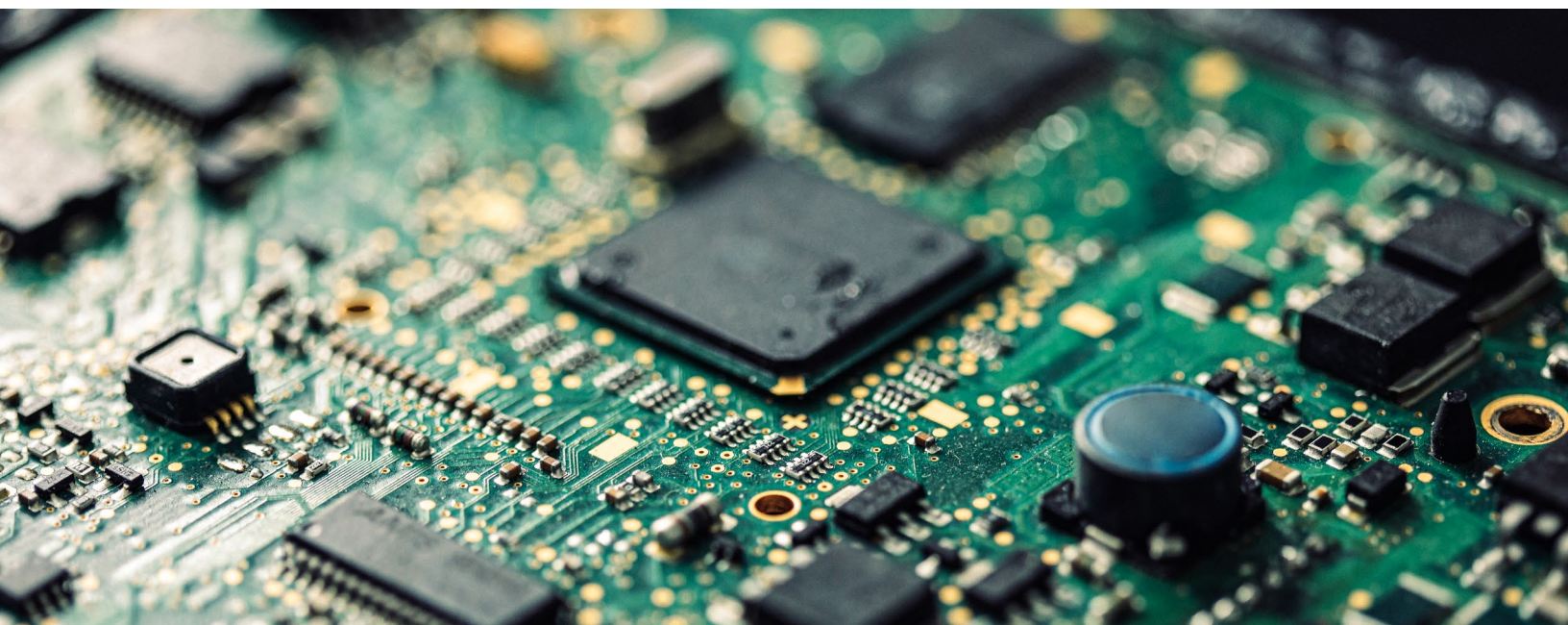
5. Operational challenges: ICE vs. EV supply chains

EVs have significantly fewer mechanical parts—around 17-20 moving parts in the drivetrain compared to hundreds in internal combustion engines (ICE)—making them simpler to maintain in many respects. However, their reliance on electronics, software, and specialized materials introduces challenges, such as battery diagnostics, high-voltage safety, and software updates, which create new vulnerabilities and heightened demands on dealer training and aftermarket support.

6. Cyber risk

Comprised of a multitude of suppliers and vendors, a typical automotive supply chain provides ample points of entry for hackers to compromise and, ultimately, disrupt an OEM's immediate systems and networks, as well as user's connected devices. Research by Kaspersky has indicated that around two-thirds of automotive leaders believe supply chains are vulnerable to cyberattacks³.

Since cyberattacks can originate anywhere in the value chain, training and awareness programs are important to upskill employees on cybersecurity best practices, as well as vetting potential suppliers for cyber readiness during selection. In the age of data driven decisions and AI, supply chains have become more interconnected than ever. They rely more on the ecosystems of networks that connect the individual transactions of producing, procuring, shipping, manufacturing, and final mile delivery. The nodes that represent threat vectors are multiplying from wearable peripheral devices, servers and mobile Wi-Fi. The weighing against how well your supplier's Cyber security measures up to these threats when requalifying suppliers should be enhanced to reflect this new environment.



²<https://www.commerce.senate.gov/services/files/998a3b71-e717-4a25-904c-5882b2dc23d0>

³<https://www.csoonline.com/article/652299/automotive-supply-chain-vulnerable-to-attack-as-cybersecurity-regulation-looms.html>



Why continuous supplier monitoring is essential

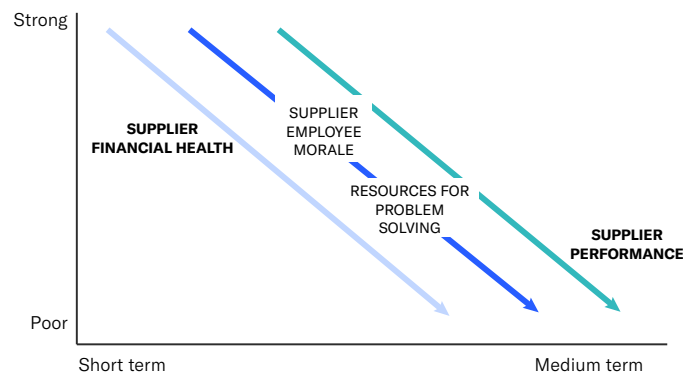
Due to the interconnected nature of our modern supply chain ecosystem, a threat introduced to any part of the supply chain can cause a domino effect. Whether it is a cyberattack or geopolitical hotspot, the effects can be felt throughout the value chain.

As a result, early detection is critical. Leading OEMs and Tier-1 suppliers use early-warning systems that combine:

- Financial indicators (liquidity ratios, leverage, liens, lawsuits)
- Operational signals (quality issues, missed delivery deadlines, premium freight incidents)
- Compliance alerts (regulatory findings, safety campaigns, negative media)

Proactive detection helps with early resource planning, tooling adjustments, and supplier support, preventing minor issues from turning into line-stops or recalls. This is especially important as the industry manages dual supply chains, one for the ICE aftermarket and another for the growing EV sector.

Deterioration in a supplier's financial health often leaves to lower employee morale and shortage of problem solving sourcers, which translate to poor product quality, increasing cost, and delivery problems.



The aftersales supply chain:

WHY IT'S MISSION-CRITICAL

- **North America's "vehicles-in-operation" (VIO)** base is vast and aging, so service/repair demand dwarfs new-car sales in any given year. In the U.S., the average vehicle age hit a record 12.6 years in 2024 and 12.8 years in 2025, underscoring how much of the fleet requires ongoing maintenance and parts⁴.
- **Any disruption at auto-parts suppliers, especially Tier-2/Tier-3** (castings, electronics, chemicals, rubber, resins), ripples into exponential risk to the auto maker in terms of on time delivery, shipping schedules and maintaining inventory.
- **Availability risk:** fewer alternators, control arms, chips, tires, batteries, etc., creating repair backlogs that keep cars off the road.
- **Increased cycle-time risk** due to a higher number of disruptions.
- **Longer lead times** (capacity constraints, logistics bottlenecks) delay maintenance.
- **Price risk due to input volatility** (steel/aluminum/resins/rare earths) passes through into aftermarket prices. Financial distress amplifies operational risk.
- **Automotive suppliers are unusually exposed to:** Demand whiplash (model/program changes, mid-cycle design tweaks, EV/ICE mix swings).

- **OEM dependence & pricing power** (single-customer or few-program concentration). Capital intensity (tooling, PPAP, launch costs) and working-capital strain (inventory + receivables).

When margins compress or liquidity tightens, quality slippage, delivery misses, and reliability problems are often seen. These are also early warning signs often tied to standard automotive supplier metrics e.g. parts per million (PPM), on-time delivery, and premium freight. IATF 16949 and OEM CSRs formalize monitoring for exactly these indicators.

To put this into perspective, take First Brands Group's Chapter 11 filing in September, which sent shockwaves through the private credit and CLO markets.⁵ On the surface, it looked like a typical US auto-parts supplier: brake systems, filtration products, and a footprint across the automotive sector. But behind that façade was a complex web of more than \$10 billion in liabilities, opaque factoring arrangements, and supply chain financing structures now under legal scrutiny.⁶ Collateral pledges are being contested. As a result, lenders are asking tough questions.

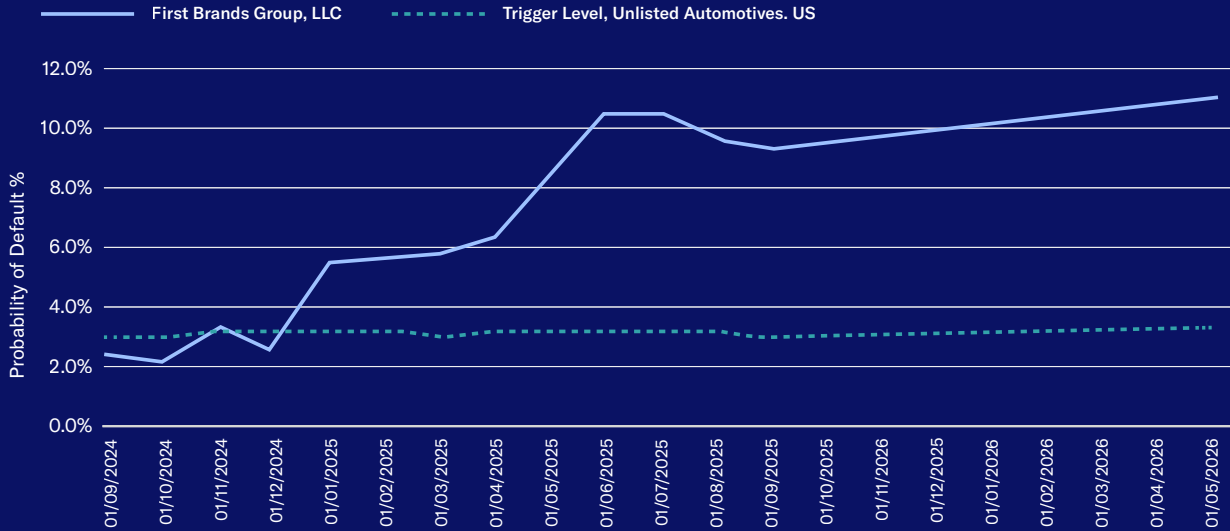


⁴<https://www.bts.gov/content/average-age-automobiles-and-trucks-operation-united-states>

⁵<https://www.ft.com/content/fa10cd1f-6b4a-4e21-b258-6340c767a3fb>

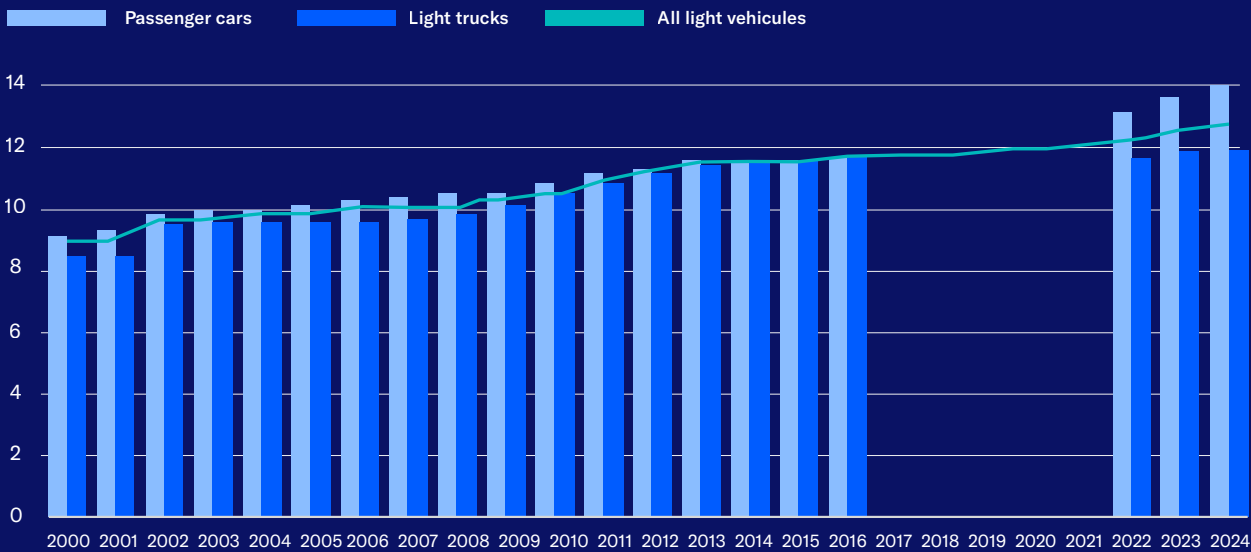
⁶<https://www.reuters.com/markets/us/auto-parts-maker-first-brands-files-bankruptcy-protection-2025-09-29/>

The chart below shows the company’s probability of default (PD) as measured by Moody’s EDF-X model. The dotted line marks the sector “trigger level” – a threshold that flags when a company’s risk profile diverges materially from its peers. First Brands crossed that line in early 2025, well before loan prices reacted.



This wasn’t just another bankruptcy. It was a stress test for traditional due diligence – and a case study in why forward-looking analytics matter. Tools like EDF-X can surface hidden leverage, pressure in receivables, and off-balance-sheet risk before the market catches up.

AVERAGE AGE OF AUTOMOBILES AND TRUCKS IN OPERATION IN THE UNITED STATES



Source: Bureau of Transportation Statistics⁷

⁷<https://www.bts.gov/content/average-age-automobiles-and-trucks-operation-united-states>

Safety and compliance: a lose-lose scenario for supplier and automaker

RECALL SCALE

Safety recalls governed by the National Highway Traffic Safety Administration (NHTSA) continue to be a persistent reality, involving thousands to tens of millions of vehicles annually. The NHTSA Annual Recalls Report details recall volumes, challenges in achieving high completion rates, and logistics for remedies, each requiring stable supplier capacity and availability of service parts⁸.

CONSEQUENCES OF DEFECTIVE PARTS.

The Takata airbag crisis illustrated the profound implications: at least 27 deaths and hundreds of injuries in the United States, with a multi-year, multi-OEM remedy program that depended on increasing replacement inflator production and coordinating efforts among dealers, salvage yards, and vehicle owners⁹.

IF A KEY SUPPLIER GOES BANKRUPT:

- Recall obligations survive. OEMs remain legally responsible for providing a free remedy for safety defects, but execution depends on parts. If the original supplier is gone, OEMs must source a new supplier, redesign parts, or buy IP/tooling out of bankruptcy, often causing multi-month or multi-year delays and lower completion rates.
- Service-part scarcity can force park-outs (vehicles waiting for parts), rental fleets for customers, or, in extreme cases, buybacks when repairs can't be performed promptly, driving warranty and goodwill costs.
- The reputation damage and cost of losing trust in prospects, current customers, and the market in general is immeasurable.

ANNUAL RECALL DATA (UNITED STATES – ALL CAUSES)

YEAR	TOTAL RECALLS	VEHICLES AFFECTED
2022	932	30.7 million
2023	894	34.8 million
2024	1073	27 million

Source: The National Highway Traffic Safety Administration (NHTSA) 2024 Annual Recalls Report¹⁰

Market example

In 2025, Marelli, a globally recognized supplier of automotive components, announced its filing for Chapter 11 bankruptcy. Among Marelli's principal customers are prominent automakers such as Nissan and Stellantis (Jeep). These major Original Equipment Manufacturers (OEMs) source a comprehensive range of products from Marelli, including lighting, interior components, propulsion systems, exhaust parts, and electronics. Additionally, Marelli supplies lighting solutions to Audi and BMW. Currently, Marelli owes over \$700 million to its suppliers as it proceeds through the bankruptcy process. An ongoing debtor-in-possession financing arrangement of \$1.1 billion is in place to ensure continuous operations and prevent short-term supply chain disruptions¹¹. However, this situation exposes Nissan, Stellantis, and other stakeholders to potentially hundreds of millions of dollars in unsecured debt, or incur losses related to restructuring.

Dealer parts-holding requirements & the Internal Combustion Engines (ICE) vs. Electric Vehicle (EV) parts reality

There is no U.S. federal law requiring automakers to supply or service parts for 10 years. The NHTSA has clarified that no such mandate exists. The commonly cited “10 years” standard is generally a voluntary practice adopted by OEMs, aimed at meeting typical demand rather than fulfilling any legal obligation. (Note that this is distinct from right-to-repair and emissions)

Dealers, meanwhile, operate on OEM policies and local franchise agreements – rather than any universal legal requirements – and they do not physically stock every part for every model year. Instead, they prioritize high-demand (“fast-moving”) parts and rely on parts distribution centers (PDCs), regional depots, and overnight replenishment systems to meet customer needs efficiently. While they don’t stock everything, your example effectively highlights the scale of operations, which can be quantified in two ways:

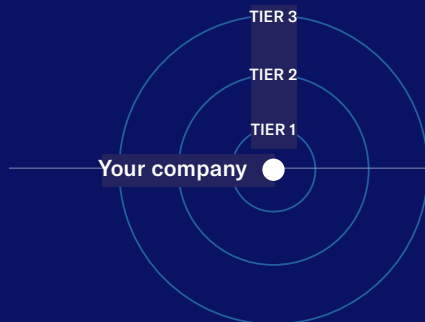
LET’S CONSIDER THE FOLLOWING SCENARIO:

A dealer supports 10 models multiplied by 10 model years, that equals 100 model years.

In such a scenario, the theoretical SKU universe is approximately 200,000 (2,000 parts per model multiplied by 100 model-years). In practice, many parts are shared across different model years and trims, and dealers stock a subset while sourcing the rest from OEM depots. Industry standards often cite over 30,000 parts per vehicle when counting down to nuts and bolts. Based on that, the total theoretical universe could be around 3,000,000 parts across 100 model years, which is impractical for a single store to hold. This is why networked inventory and forecasting have become increasingly important.

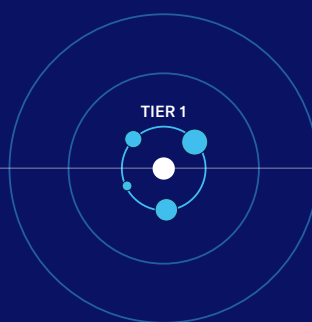
1. AN INTERCONNECTED SUPPLY CHAIN

Based on a supplier’s closeness to your business or your final product, there are likely multiple tiers of suppliers within your supply chain.



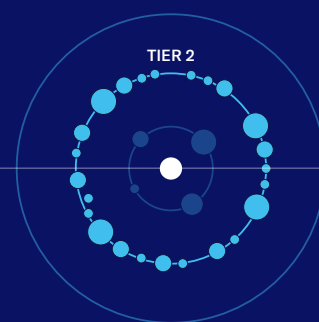
2. TIER 1 SUPPLIERS

These are your closest partners that directly conduct business with you, including contracted manufacturing facilities or production partners.



3. TIER 2 SUPPLIERS

The next layer of suppliers or subcontractors serve as a source for where your Tier 1 suppliers get their materials.



4. TIER 3 AND BEYOND

Additional tiers — further removed from your organization — are still connected to your business and can expose you to risk.



5. VALUE CHAIN RISK

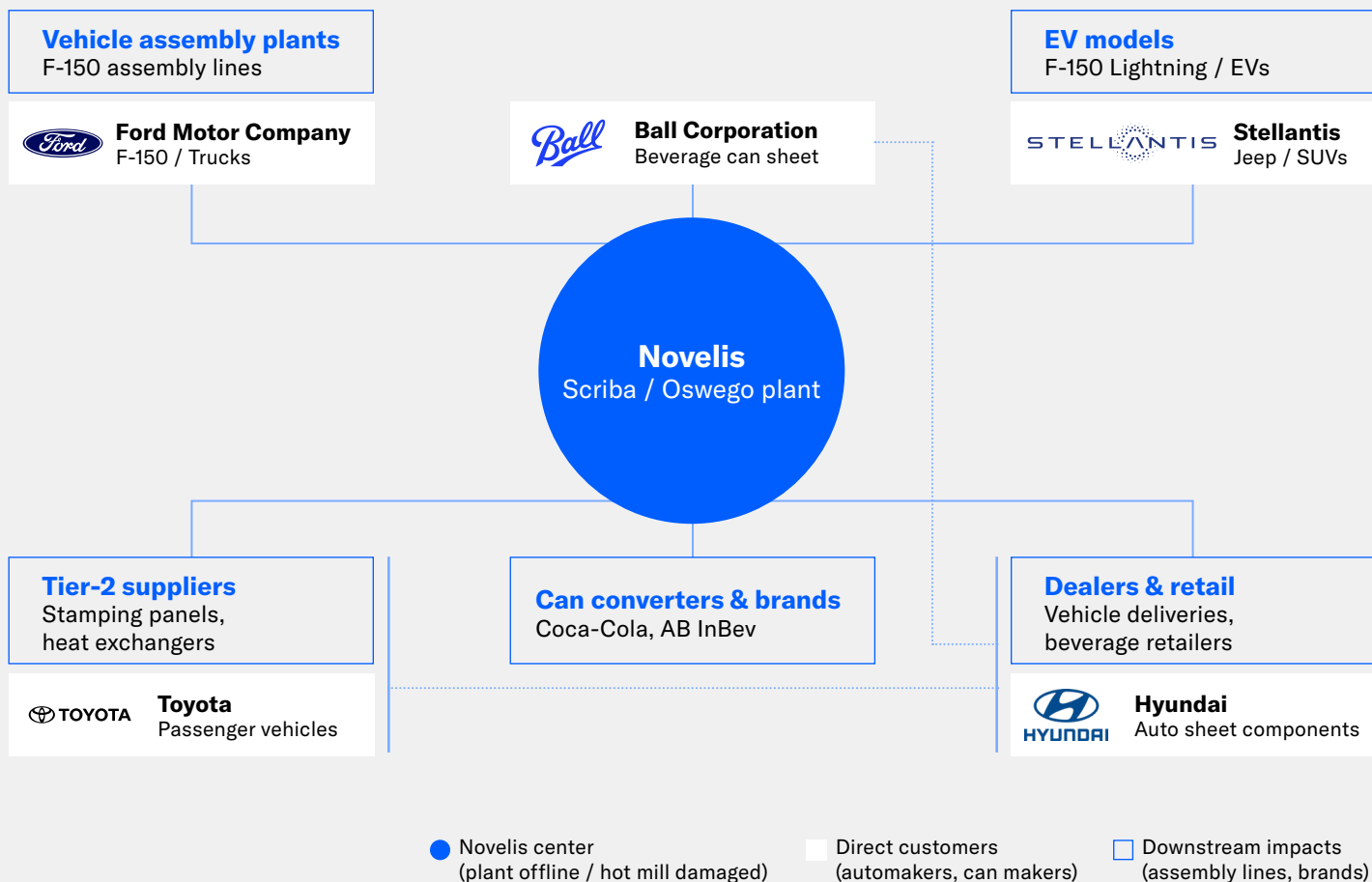
Knowing your supply base is fundamental to minimizing risks, which can occur further down the supply chain where they might not be immediately apparent.



6. RISK^N – EXPONENTIAL RISK

Each organization in the value chain has a unique set of risk factors – from cybersecurity to human rights, physical climate risk to sanctions, and credit to geopolitical pressure.





The automotive supply chain is only as strong as its weakest link. Often, those links sit deep in the lower tiers. On September 16, 2025, a fire broke out at Novelis, North America’s largest rolled aluminum plant, which produces approximately 40% of the United States auto industry’s aluminum sheets. ¹²No one was injured, but the hot mill facility was immediately shut down.¹³

That single disruption rippled outward. Ford and other carmakers, including Stellantis, were forced to halt production of key models, triggering potentially billions of dollars in losses. ¹⁴It remains to be seen whether the repercussions could extend beyond autos given Novelis is a supplier to other industries including the beverage sector – with one canmaker representing 15% of the company’s quarterly sales.¹⁵

This event is a stark reminder: lower-tier suppliers can bring entire industries to a standstill. When one node fails, the consequences travel fast and wide. That’s why assessing risk across every tier of the supply chain is essential to maintaining business continuity.

To fully assess the cost of the production stoppage at Novelis, we need to factor in the current US tariff environment. Imported aluminum is subject to a 50% tariff, making domestic suppliers like Novelis an attractive alternative for manufacturers seeking relief. But just as Novelis could be expanding its US customer base, the fire has forced it to pause operations. Instead of capitalizing on a strategic growth window, the company is sidelined – thereby losing ground at a moment when demand is shifting in its favor.

¹²<https://www.wsj.com/business/autos/ford-toyota-aluminum-factory-fire-b806cb2f?mod=Searchresults&pos=1&page=1>

¹³<https://www.autonews.com/manufacturing/suppliers/an-aluminum-supplier-stellantis-1016/>

¹⁴<https://www.usatoday.com/story/cars/news/2025/10/20/ford-production-pause-plant-fire/86805319007/>

¹⁵<https://www.wsj.com/business/autos/ford-toyota-aluminum-factory-fire-b806cb2f?mod=Searchresults&pos=1&page=1>

<https://www.autonews.com/manufacturing/suppliers/an-aluminum-supplier-stellantis-1016/>

¹⁵https://www.packagingdive.com/news/novelis-aluminum-beverage-packaging-growth-bay-minette/757398/?utm_source=chatgpt.com

EV vs. ICE comparison (why EV service inventories look different): Moving parts



EVs eliminate entire ICE subsystems, such as the fuel, exhaust, ignition, and oiling systems. This drastic reduction dramatically decreases SKUs for many wear-and-tear mechanical items.



This also adds SKUs on the EV side for battery packs and subassemblies, high-voltage contactors, inverters, and other special tooling designed for EVs.

Cyber risk

Cyber risks are a growing and often underestimated challenge for automotive supply chain leaders. As vehicles become more connected and the industry relies heavily on global, multi-tiered networks of suppliers, vulnerabilities in digital infrastructure have multiplied. Cyberattacks targeting suppliers, systems, and third-party software can ripple across the supply chain, disrupting operations and jeopardizing intellectual property.

Such risks are particularly acute in the automotive sector, where manufacturing leaves little room for delays. A ransomware attack on a Tier 1 supplier, for example, can halt production lines and lead to cascading financial losses. Market examples support the case: in September 2025, Jaguar Land Rover (JLR) confirmed a cyber breach had disrupted its global production and retail systems, halting vehicle assembly across key sites and triggering a wider ripple effect across its supplier base¹⁶.

Meanwhile, breaches that expose sensitive design or proprietary manufacturing data put innovation and competitiveness at risk. The complexity of automotive supply chains – spanning Tier 2, Tier 3, and smaller suppliers – further complicates the task of managing cybersecurity, as many lower-tier vendors lack the resources to maintain robust defenses.

THREE PRIMARY VULNERABILITIES STAND OUT:

- 1 Supplier system breaches** – A cyberattack on a supplier's systems can expose sensitive data, disrupt production, or even compromise the integrity of delivered components.
- 2 Third-party software risks** – The use of shared or outsourced software systems increases the risk of attacks.
- 3 Overexposure of sensitive data** – Excessive sharing of proprietary information with suppliers, often without sufficient controls, creates opportunities for data theft or misuse.

¹⁶https://scw-mag.com/news/jaguar-land-rover-cyberattack-halts-car-production-and-disrupts-supply-chain/?utm_source=Klaviyo&utm_medium=email&utm_campaign=SCW%20Newsletter%201%20-%20September%202025

To mitigate these risks, supply chain leaders must prioritize cybersecurity as a strategic imperative. Key steps include:

- **Supplier vetting:** Identify high-risk suppliers and subject them to rigorous cybersecurity assessments.
- **Restricting data sharing:** Limit access to sensitive information and use secure platforms for communication and document sharing.

Continuous monitoring for early warning indicators in suppliers

Traditional supply chain key performance indicators (KPIs) often include PPM trends, or parts per million, which measure the number of defects per million parts produced. These KPIs are regularly monitored to prevent disruptions in supply chain coordination. Key risk indicators (KRIs) evaluate more significant and potentially disruptive events within the supply chain that could impact entire value chains. KRIs are often used to assess a supplier's performance regarding protection or redundancy against financial health, geopolitical issues, proximity to extreme weather, cybersecurity threats, regulatory compliance, and environmental, social, and governance (ESG) factors.

Among the most critical KRIs is financial health, which includes liquidity, debt ratios, and other economic indicators. Financial health is a leading indicator of operational risk, and ongoing monitoring helps organizations anticipate and prevent disruptions before they affect the supply chain. Monitoring a supplier's financial health is vital for avoiding disruptions since financial stress usually precedes operational failures. When liquidity becomes tight or leverage increases, suppliers often cut costs in areas directly impacting performance, such as quality assurance, labor stability, and preventive maintenance. These financial pressures can lead to quality issues, delivery delays, and reduced reliability—problems that, if unchecked, can result in line stoppages or shortages of aftermarket parts.

Tracking financial indicators like liquidity ratios, leverage, liens, and Moody's supplier performance risk scores gives companies early warning of potential risks before they turn operational. Proactive financial monitoring allows organizations to take corrective actions ahead of a crisis. This foresight is especially valuable in avoiding costly and time-consuming

- **Collaborative standards:** Work with suppliers to implement consistent cybersecurity protocols across all tiers. To include all integrated data sharing for inventory and warehouse management. supply chains, one for the ICE aftermarket and another for the growing EV sector.
- **Incident preparedness:** Develop contingency plans to address disruptions, such as diversifying supplier networks or maintaining buffer inventories.

consequences of supplier bankruptcy, where tooling, intellectual property, and work-in-process inventory could be tied up in legal proceedings, leaving OEMs without immediate options. Acting early helps prevent production line stops, recall failures, and contractual penalties.

Finally, monitoring financial health bolsters compliance and risk management. For suppliers producing safety-critical components, insolvency during an active recall can impair an OEM's ability to meet regulatory requirements, causing reputational damage and potential legal issues. Moody's research shows that financial deterioration appears months before operational problems become evident, making continuous credit health tracking—along with operational performance signals—the most reliable early warning system for supply chain resilience and continuity.





Summary

As of 2025, the North American automotive supply chain is balancing the dual demands of sustaining an aging internal combustion engine (ICE) fleet while scaling electric vehicle (EV) production, each with distinct vulnerabilities. Traditional suppliers face financial strain from raw material volatility, OEM pricing pressure, and demand swings, while EV suppliers contend with critical mineral shortages, semiconductor constraints, and limited domestic battery capacity. The aftermarket's reliance on Tier 2/Tier 3 suppliers heightens risks of parts shortages, service delays, and cost inflation,

and safety-critical recalls can be severely disrupted by supplier distress or bankruptcy. With regulatory scrutiny, capital-intensive tooling, and the high stakes of quality and delivery performance, the need for continuous multi-tier monitoring of financial health, operational metrics, and compliance signals has become more important than ever. Proactive detection and intervention now largely define supply chain resilience, protecting production continuity, aftermarket service capability, and brand reputation.

6x

Electric vehicles require **six times more minerals** compared to a conventional vehicle¹⁷

\$2.3m

The estimated cost of an hour's manufacturing downtime in the automotive industry¹⁸

\$300b

Tariffs on imports from Canada and Mexico threaten over **US\$300 billion** in annual automotive trade, and may raise vehicle prices by **\$3,000 to \$9,000**, particularly impacting Tier 2/3 suppliers¹⁹

4.7%

EBIT margins for automotive suppliers are projected to fall to **4.7% in 2024**, approximately two percentage points lower than pre-COVID levels²⁰

95%

Global battery-grade graphite production is centered in China, posing a significant geopolitical supply risk²¹

131

In 2024, there were **131 supplier M&A deals** in North America and Europe, a **16% year-over-year increase** driven by widespread financial and operational pressures²²

¹⁷<https://www.iea.org/reports/the-role-of-critical-minerals-in-clean-energy-transitions/executive-summary>

¹⁸<https://blog.siemens.com/2024/07/the-true-cost-of-an-hours-downtime-an-industry-analysis/>

¹⁹https://apnews.com/article/tariffs-cars-automakers-trump-canada-mexico-7d34c3ba8b96864ea77c6b16780cf349?utm_source=chatgpt.com

²⁰<https://www.rolandberger.com/en/Insights/Publications/Global-Automotive-Supplier-Study-2025.html>

²¹<https://energy.stanford.edu/news/confronting-chinas-grip-graphite-batteries>

²²https://www.capstonepartners.com/insights/automotive-industry-update/?utm_source=chatgpt.com

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