CYLAD

INSIDER'S PERSPECTIVE

AEROSPACE SUPPLY CHAIN

Resilience as a Core Competitive Advantage

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This paper discusses the urgent need for enhanced supply chain resilience in the aerospace industry amid record backlogs, complex multi-tier networks, and persistent supplier disruptions.

It outlines a structured risk management framework – including operational, financial, and strategic dimensions – stressing how data-driven monitoring, AI-powered forecasting, and multi-tier supplier transparency can turn companies from reactive firefighting to proactive prevention.

Here, we offer practical strategies for supplier segmentation, risk categorization, and early warning implementation, to support OEMs and suppliers in creating robust, future-ready supply chains and sustaining competitive advantage in an ever-evolving market.

Introduction

Aerospace supply chains are under constant pressure. For example, Airbus has been struggling to meet its delivery targets in recent years, with only 766 instead of 800 aircraft delivered in 2024, and 790 instead of 820 in 2025[1]. This struggle is mostly caused by quality issues and persistent engine shortages[2]. Often, the root cause lies in the supply chain's structure and its interdependencies across OEMs, as production priorities of suppliers need to be balanced between different OEMs. This is not only a European issue: according to AE Industrial[3], "the average American commercial aerospace OEM has more than 200 tier-1 suppliers and over 12,000 second- and third-tier suppliers." This sheer complexity, combined with limited transparency into lower-tier suppliers and the still incomplete introduction of dual sourcing, significantly amplifies risk. Even a minor disruption at one lower-tier supplier can delay aircraft deliveries. Due to extensive qualification timelines, swiftly obtaining a new supplier is rarely feasible. As a result, ensuring supply chain resilience is not optional – it is existential.

Despite early signs of stabilisation in some companies, disruption remains the norm in the industry. In response, some firms are turning to vertical integration, acquiring strategically critical firms in their supply chain to regain control over critical components.

For example, a consortium of Airbus, Safran, and Tikehau Capital acquired Aubert & Duval in 2023 to "secure our critical parts and materials supply chain"[4], while Boeing and Airbus have acquired Spirit AeroSystems to gain tighter control over delivery quality and timeliness[5].

> In May 2025, the industry hit a record backlog of 16,000 aircraft[6], while deliveries in 2024 were still around 10% below pre-COVID peaks (1,187 versus 1,332)[7].

Such moves are hardly surprising given the widening gap between market demand and production capacity. In addition, there has been a noticeable shift in aircraft type mix. For example, Airbus has seen the share of single-aisle aircraft in its deliveries rise from 77% in 2015 to 88% in 2024, showing an increasing market concentration on smaller aircraft for short- and mid-range flights[8].

[1] https://www.handelsblatt.com/unternehmen/industrie/flugzeugbauer-airbus-kappt-auslieferungsziel-fuer-2025/100180480.html, December 3, 2025
[2] https://simpleflying.com/airbus-ceo-company-on-track-to-meet-2025-delivery-goals-despite-engine-shortage/, September 10, 2025
[3] Aerospace & Defense sector report, year-end 2023, Mesirow Financial
[4] https://www.airbus.com/en/newsroom/press-releases/2023-04-airbus-safran-and-tikehau-capital-finalise-acquisition-of-aubert, April 28, 2023
[5] https://simpleflying.com/boeing-spirit-aerosystems-takeover-whats-next/, August 17, 2025
[6] https://www.aircraftinteriorsinternational.com/industry-opinion/aircraft-orders-soar-by-900-creating-a-record-aircraft-order-backlog.html, July 2, 2025
[7] Official numbers from Airbus, Boeing, and Embraer
[8] Annual reports of Airbus, Boeing, and Embraer

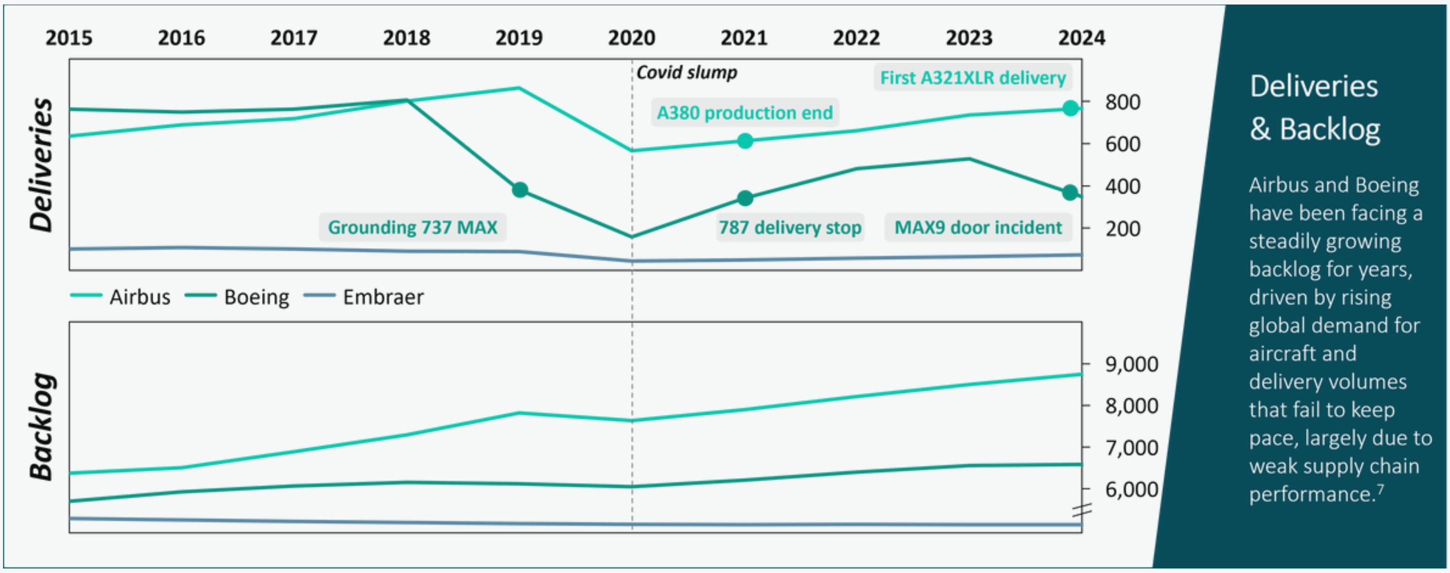


Figure 1. Aircraft Deliveries and backlog over the past decade
"Persistent supply chain bottlenecks have prevented OEM´s to keep pace with demand, driving a steadily growing backlog over the past decade."

Despite barriers to changing aircraft models, such as aftermarket access and the unique capabilities of the aircraft, the displayed aircraft delivery backlog presents both risks and opportunities: companies that can ramp up production at pace will gain market share, while those that fall behind may lose ground to new entrants from China and other emerging regions. In such an environment, supply chain resilience is no longer just about risk management – it has become a core competitive advantage. OEMs and Tier 1 suppliers must focus on minimising future disruptions by enhancing supply chain transparency and resilience and diversifying their supplier base.

/ Four major hurdles to effective supplier diversification, driving lead time and costs

First, any new component entering the supply chain must undergo rigorous certification and qualification by bodies such as EASA and the FAA, a lengthy process.

Second, many components used in commercial aircraft fall under dual-use regulations, meaning they can be used for both military and civil applications; as a result, they are subject to strict export controls, and compliance must be addressed from the outset. Further, establishing a new supplier requires a complete industrialisation process, including process capability assessments, tooling validation, production ramp-up, and first-article inspection.

Finally, rigorous risk-mitigation measures must be implemented before integrating any new supplier, including on-site audits, supply-chain resilience assessments, and contingency planning. These four challenges are further compounded by risk-sharing agreements, steep employee learning curves, and shared investments with existing suppliers – all of which reinforce supplier lock-in.

Where diversification proves difficult, increasing supplier monitoring becomes critical. Enhanced transparency enables OEMs to identify risks early and respond in a timely, targeted manner. Although the industry broadly acknowledges the need for greater visibility and control, progress has been limited.

In many organisations, tracking budgets remain so constrained that only minimal monitoring is feasible, preventing any systematic view of performance or emerging bottlenecks. This structural underinvestment makes it difficult to build the foundational processes, tools, and data models required for effective monitoring.

As a result, reliable as-is and to-be data, essential for any meaningful analytics, are often not adequately available. While adoption of data analytics, digital twins, and end-to-end visibility tools is gaining momentum, many players still lack consistent insight into their lower-tier suppliers.

A concerted push towards a more data-driven, proactive supply-chain governance model is therefore urgently needed, supported by dedicated investment. This holds true both for preparing potential vertical integration and for monitoring all Tiers of suppliers to enable precise performance tracking and accurate delivery forecasting. It is therefore a vital step on the path to more robust and resilient supply chains. As a beneficial side effect, supply chain-related costs such as expediting, warehousing, and out-of-stock costs may also be reduced.

To support this transformation, this paper outlines a structured approach to assessing and strengthening aerospace supply chain resilience, from risk categorisation through risk assessment down to forecasting techniques and proactive intervening. The aim is to equip leadership teams with the tools and focus needed to build resilient, future-proof supply chains.

Qualitative Risk Assessment – Mapping Supply Chain Vulnerabilities

To strengthen supply chain resilience, aerospace companies must move from reactive firefighting to proactive, data-driven detection. Traditional metrics like cost, quality, and on-time delivery are necessary but lagging and largely Tier 1 bound; they surface issues after they occur and give limited visibility into Tier 2 & 3. What's needed is multi-tier monitoring that captures early signals (e.g., capacity utilization, lead-time variance, audit and certification status, exception trends) so small Tier 3 deviations are contained before they amplify into Tier 1 bottlenecks or OEM line-stops. For example, a modest capacity slip at a Tier 3 casting house with 26-week cycles can drain Tier 2 buffers within weeks, push Tier 1 module deliveries late, and jeopardize OEM output despite stable demand.

Supplier management teams often use the Kraljic Matrix (Figure 2) which segments suppliers by profit impact and supply risk into four categories: non-critical, leverage, bottleneck, and strategic items. In aerospace, however, the supply-risk axis must explicitly weight recertification timelines, regulatory/ design lock-ins (e.g., ITAR, AS/EN 9100), long-lead tooling, and single-source constraints. When these variables are included, even low-spend parts can classify as strategic or bottleneck. The Kraljic Matrix is just an example of how traditional tools provide structure but miss aerospace-specific complexity.

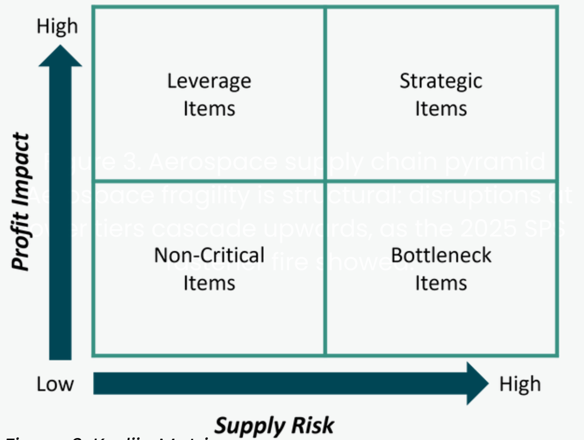


Figure 2. Kraljic Matrix
"Aerospace challenges the Kraljic logic: spend ≠ strategic importance."

This is why a qualitative risk assessment is essential. It fills the gap by enabling forward-looking analysis: mapping vulnerabilities, identifying fragile nodes, and guiding proactive mitigation such as dual sourcing, capacity development, or compliance support. For example, applying an "on time and on quality" classification helps assess supplier performance beyond cost. Here, "on time" reflects delivery reliability, while "on quality" tracks consistency against technical specifications. Suppliers performing poorly in either dimension are flagged as high-risk and prioritized for corrective action.

The following visual (Figure 3) illustrates this cascading fragility where each Tier carries different risks. For example: raw material shocks at Tier 3, requalification bottlenecks at Tier 2, and coordination challenges at Tier 1.

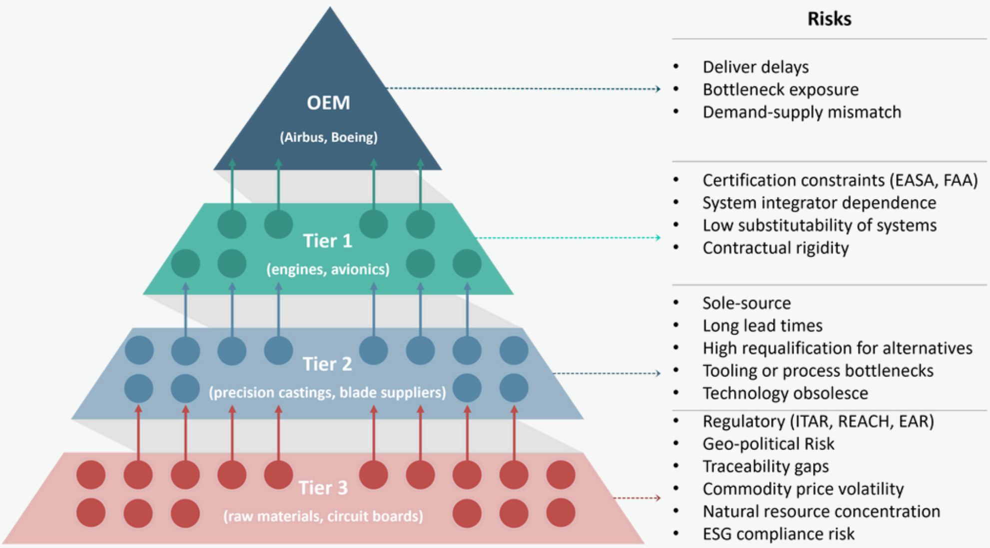


Figure 3. Aerospace supply chain pyramid
"Aerospace fragility is structural: disruptions at lower tiers cascade upwards, as the 2025 SPS fastener fire showed."

A recent real-world event illustrates this cascading fragility: In May 2025, a fire at an SPS Technologies plant, the sole source of critical fasteners for Boeing, accounting for ~15% of global supply, disrupted production across the supply chain[9]. With Tier 3 production halted and Tier 1 as well as Tier 2 integrators lacking alternatives, Boeing's OEM assembly targets were jeopardized. The incident demonstrates how fragility at a single lower-tier node can result in full-system disruption.

/ Supplier Product Criticality – Segmenting Exposure

In aerospace, criticality is defined less by spend and more by impact: even a low-cost, certified subsystem can create significant risk if disruptions trigger lengthy recertification delays of substitution products or alternative suppliers.

Classification frameworks therefore help segment supplier products by their role in flight-critical systems. Raising OEM awareness of regulatory constraints and fragility factors yields clear benefits by mitigating potential losses from supply chain delays.

[9] https://www.wsj.com/business/airlines/boeing-seeks-plan-b-after-fire-destroys-key-suppliers-plant/, March 6, 2025

To support risk management, products should be classified not only by their function but also by the difficulty of replacing them. The following visual (Figure 4) presents a supplier product criticality framework, structured along three dimensions (A/B/C):

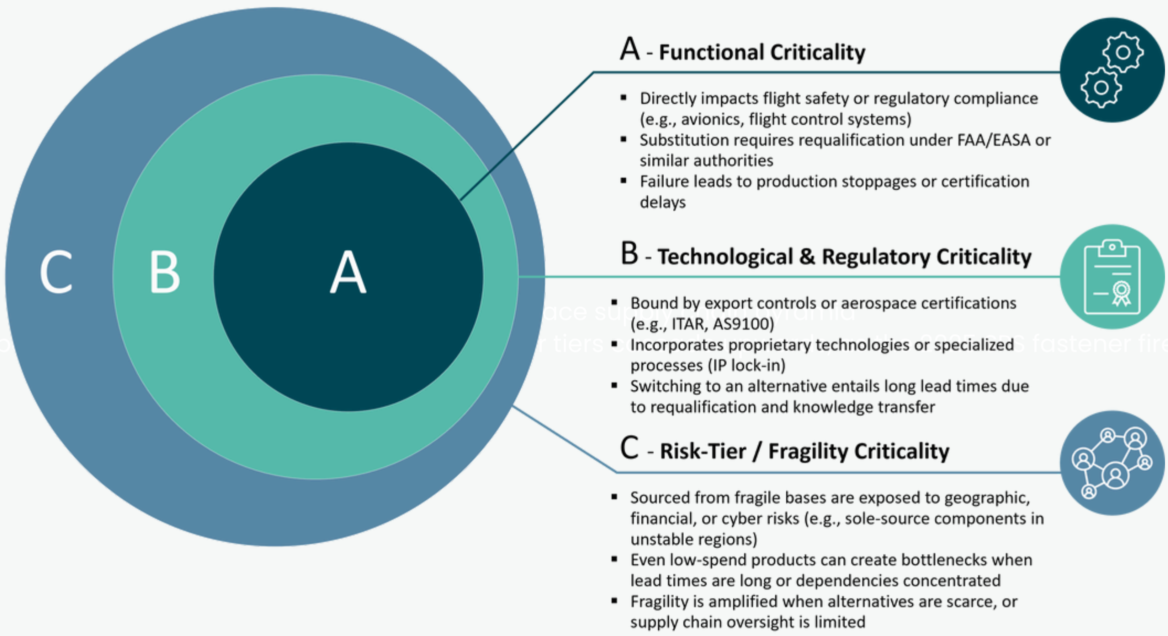


Figure 4. Supplier Criticality Framework
"Three forms of criticality drive substitution risk and guide mitigation priorities."

Category A products influence flight safety through their function. Although supply delays do not compromise safety, missing or uncertified components can stop assembly and postpone the aircraft's certification timeline. Category B products are technologically or regulatorily constrained, where proprietary processes or export controls make switching suppliers slow and costly. Category C products are fragile due to geographic concentration, long lead times, or lack of alternatives: even low-spend items can create bottlenecks if no substitutes exist.

Importantly, the three categories are not a hierarchy of "more" or "less" critical but reflect different types of criticality. Each category points to distinct mitigation activities: Category A products require redundancy and regulatory buffers to ensure continuity. Category B products call for strategies to manage technological or regulatory lock-ins, such as licensing, co-development, or long-term agreements. Category C products demand geographic diversification, qualification of alternatives, and close monitoring of fragile supply bases.

This structured view helps supply chain leaders apply targeted mitigation strategies such as prioritized audits, supplier monitoring, or contractual risk-sharing tailored to the product's role and vulnerability. It is also a powerful complement to the "on time and on quality" classification introduced earlier: while that approach highlights how a supplier performs on reliability and delivery (with consistent on-time and on-quality performance as the target state), the A/B/C lens reveals how difficult a given product would be to replace. Taken together, they provide leaders with both a performance and a dependency perspective.

Criticality reflects how difficult a product is to substitute, but the way risks materialize depends not only on dependency but also on the nature of disruption. In practice, disruptions arise either from external shocks that test resilience or from internal misalignments that challenge collaboration.

The next chapter builds on this baseline, detailing how resilience and collaboration risks shape supplier exposure across operational, financial, and strategic dimensions.

Supply Chain Risk Types and Dimensions – A Strategic Management Framework

Supplier risk is inherently multidimensional, with disruptions originating from two fundamentally different sources: resilience risks, driven by external shocks such as geopolitical conflicts, cyberattacks, or natural disasters; and collaboration risks, caused by internal misalignment such as poor coordination, unclear expectations, or weak contracts.

Resilience risks are largely uncontrollable yet have far-reaching impacts, whereas collaboration risks can arise even without external stress, undermining day-to-day execution.

The following matrix (Figure 5) highlights the key differences between resilience and collaboration risks, including their origins, examples, impacts, visibility, and typical mitigation approaches.

	Resilience Risk	Collaboration Risk
Risk Origin	▪ External Shock (uncontrollable)	▪ Internal Misalignment (controllable)
Examples	▪ Geopolitical conflict ▪ Cyberattack ▪ Natural Disaster	▪ Misaligned contracts ▪ Poor coordination ▪ Siloed data
Impact	▪ Disruptions across product lines ▪ Regulatory delays ▪ Production halts	▪ Rework ▪ Delays ▪ Reduced responsiveness
Visibility	▪ Often low – risks merge suddenly	▪ Higher – but can be ignored due to siloed ownership
Mitigation Approach	▪ Scenario modeling ▪ Digital twins ▪ Supply diversification	▪ ERP integration ▪ Joint KPI´s ▪ Performance-based contracting
Tools	▪ AI-driven dashboards ▪ Stress testing tools ▪ Real-time alerts	▪ Contractual SLAs ▪ Shared planning platforms ▪ Supplier portals

Figure 5. Resilience vs. Collaboration Risk Typology
"External shocks and internal misalignment form the two core supplier risk types."

The resilience–collaboration lens builds directly on the criticality framework. Products with high A or B scores, which are difficult to substitute, require resilience-oriented strategies to withstand external shocks. Products with high C scores, fragile but replaceable, often demand stronger collaboration and governance mechanisms to manage dependencies. Together, these perspectives ensure both shock absorption and operational stability.

Building on this distinction, the framework shown on the right (Figure 6) structures supplier risks into **three dimensions: OPERATIONAL, FINANCIAL, and STRATEGIC**. Managing these risks demands value chains engineered for structural robustness today and adaptability to tomorrow's disruptions.

Each dimension should be assessed across varying time horizons and supplier-levels (I–III), with typical threats, countermeasures, and performance indicators identified to enable effective, data-driven resilience management.

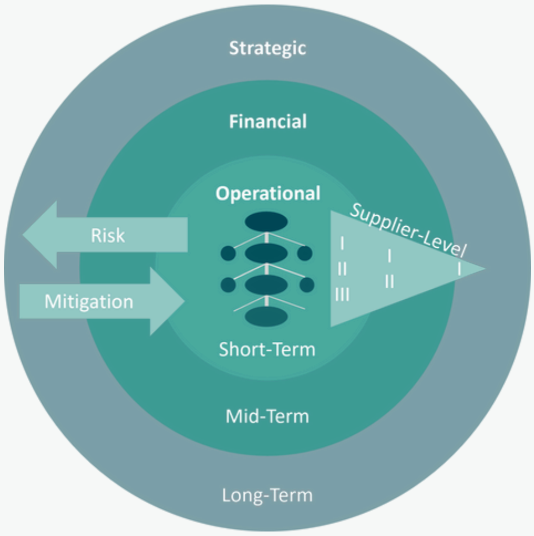


Figure 6. Supply Chain Risk Dimensions
"Operational, financial, and strategic risks evolve over different time horizons and across all supplier levels, each requiring targeted mitigation."

This framework illustrates how risks frequently originate as operational disturbances, escalate into financial strain, and, if left unchecked, evolve into strategic threats. At the same time, it shows that effective mitigation begins from the outside – through long-term supplier development and sourcing strategies – and works inwards to stabilize day-to-day operations.

/ Operational Risks – Ensuring Day-to-Day Continuity

When operational risks manifest immediately, they disrupt the supply chain's ability to maintain a stable output. Typical drivers include material shortages, equipment breakdowns, labour disruptions, and delayed transport. To address these challenges, companies apply structured corrective action requests (SCARs) – a formal processes with clear ownership, root cause analysis, and fixed resolution deadlines.

They also reduce dependency risks through dual sourcing of critical materials, which is rare due to high qualification costs, and by maintaining pre-qualified substitutes, which are tested and approved in advance to accelerate recovery during disruptions.

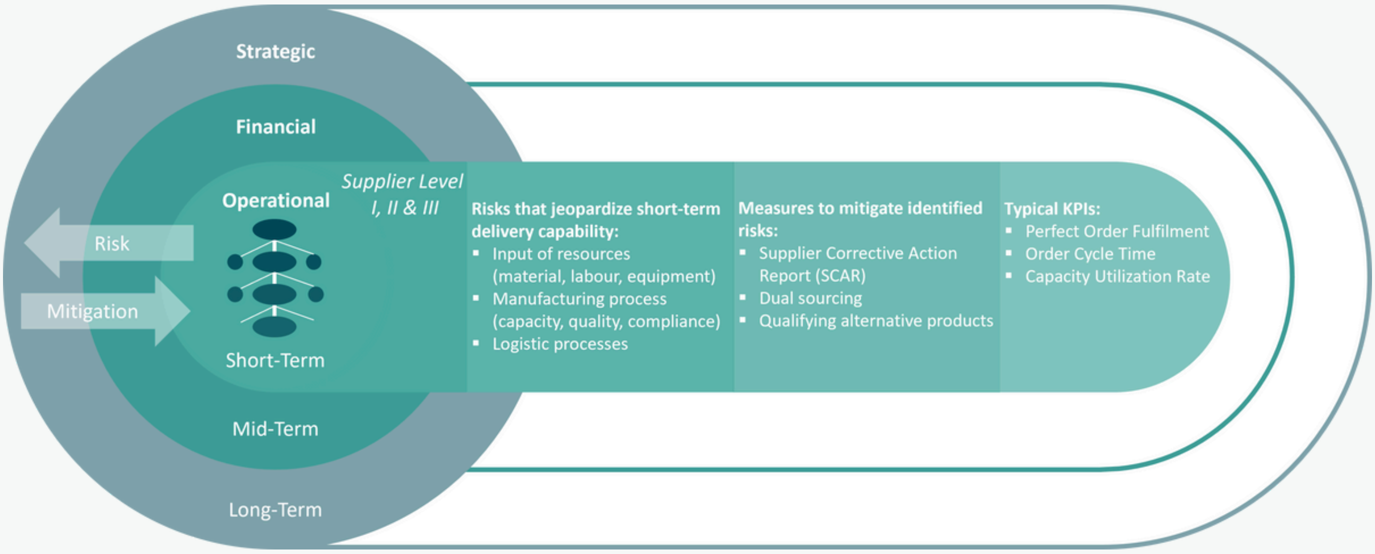


Figure 7. Operational Risks
"Operational risks affect day-to-day delivery performance – targeted actions and KPIs stabilize short-term output across supplier tiers."

TYPICAL KEY PERFORMANCE INDICATORS

- **Perfect Order Fulfilment:** measures the percentage of customer orders delivered in full, on time, without errors, and with correct documentation, reflecting overall supply chain reliability and customer satisfaction for planned and unplanned demand (e.g., AOG).
- **Order Cycle Time:** shows the time from order placement to delivery and thus demonstrates the supplier's responsiveness.
- **Capacity Utilization Rate:** assesses how effectively production capacity is used and helps identify inefficiencies or overcapacity situations.

/ Financial Risks – Safeguarding Economic Stability

Financial risks undermine supply continuity by eroding the financial health of suppliers, often driven by liquidity shortages, high leverage, margin pressures, or commodity volatility. Suppliers in the aerostructures sector are particularly at risk here, as they have high capital commitment due to their equipment-intensive business model.

Companies mitigate this exposure primarily through three levers: supplier financing, financial monitoring, and contractual buffers. Supplier financing instruments, such as reverse factoring, dynamic discounting, or similar mechanisms, stabilize working capital, improve suppliers' cash flow, and protect production-critical partners, if shorten payment periods aren´t sufficient anymore.

Continuous financial health monitoring through, for example, credit scoring, balance analytics, and payment trend analysis identifies declining solvency early. Contractual buffers, like indexed pricing, minimum volume guarantees, or comparable arrangements, help maintain commercial viability under volatility.

For example, during the Covid pandemic, forecasts were partially agreed as binding purchase commitments to shift the risk from suppliers to OEMs. In addition to the impact that financial risks have on the stability of the supply chain, there is also the reverse effect. For example, unstable supply chains can lead to financial risks, as more liquidity is tied up in safety stock. This can create a risk along the entire supply chain.

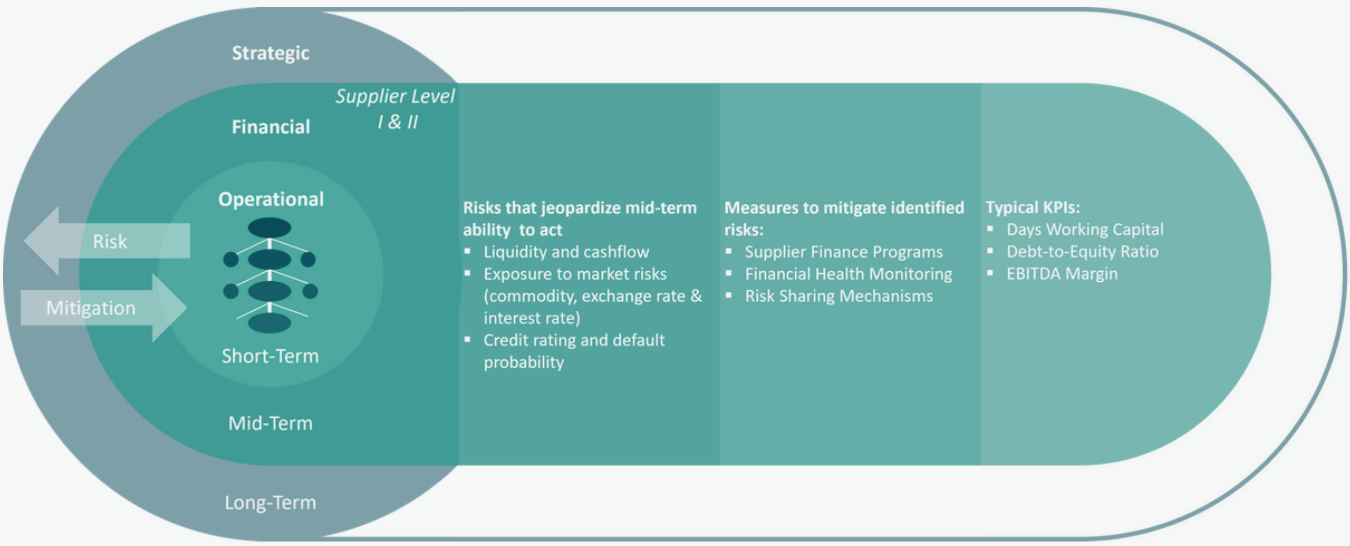


Figure 8. Financial Risks
"Financial risks threaten a supplier's mid-term ability to operate – proactive monitoring and financial levers support continuity and buffer volatility."

TYPICAL KEY PERFORMANCE INDICATORS

- **Days Working Capital:** measure the time required to convert inventory and trade receivables into cash inflows, highlighting potential liquidity strain if the cycle is excessively long.
- **Debt-to-Equity Ratio:** compares borrowed funds to equity to assess financial leverage.
- **EBITDA Margin:** evaluates operating profitability before interest, taxes, depreciation, and amortization, where low margins may imply limited future flexibility.

/ Strategic Risks – Designing Future-Ready Supplier Networks

Strategic risks threaten long-term competitiveness and typically stem from systemic concentration, innovation gaps, or geopolitical exposure. These risks can be mitigated through a range of long-term measures. Supplier development programs foster joint capability building through training, compliance initiatives, and co-investments, raising the maturity levels of strategic suppliers.

Strategic sourcing reviews evaluate the supply network's geopolitical distribution, redundancy, and ecosystem alignment to future-proof operations. Technology partnerships facilitate collaborative innovation, providing access to emerging capabilities while reducing reliance on dominant platforms.

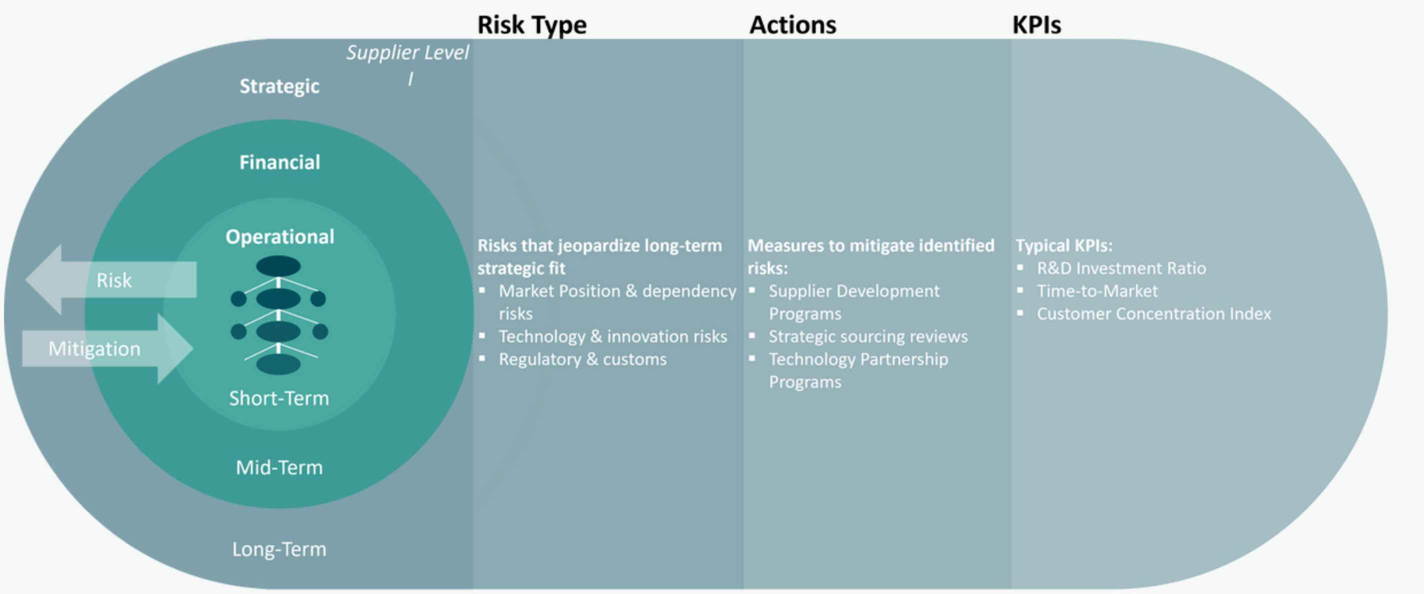


Figure 9. Strategic Risks
"Strategic risks shape long-term competitiveness and long-term supply security – mitigation requires structural partnerships, technology alignment, and forward-looking indicators."

TYPICAL KEY PERFORMANCE INDICATORS

- **R&D Investment Ratio:** shows the share of revenue allocated to innovation and reflects a supplier’s future orientation.
- **Time-to-Market:** shows the time needed from concept to product launch and thus demonstrates the supplier's innovative strength and industrialization capabilities.
- **Customer Concentration Index:** measures dependency on major clients and helps identify vulnerability risks.

/ Interaction of the Risk Dimensions

To achieve true supply chain resilience, organizations must address operational, financial, and strategic risks at the same time. These layers are tightly interconnected. Risks often appear first at the operational level. Daily disruptions can quickly spread outward, intensify financial pressures, and eventually trigger strategic threats.

Resilience therefore requires a coordinated approach. Operational measures form the frontline of continuity, while strategic initiatives and governance work from the “outer shell” inward, proactively addressing vulnerabilities before they disrupt core operations. When countermeasures and KPIs are aligned across all dimensions and supplier levels, reactive risk management turns into an integrated capability. This enables supply chains to sense, absorb, and adapt to shocks, no matter where they originate.

Timely action is critical to preventing risks from escalating. To both identify and address them effectively, robust early warning systems are essential. Such systems detect trends early and flag critical deviations in key metrics or external factors, enabling proactive countermeasures.

The next section explores how this principle can be applied to operational processes, with a focus on real-time data that supports proactive decision-making in day-to-day operations.

Ensuring Forecasting Accuracy – Strategic Supplier Monitoring & Collaboration

Building on the previous chapter's emphasis on integrated resilience – managing operational, financial, and strategic risks comprehensively – the logical next step is to examine how organizations can put this principle into practice. Anticipating and alleviating threats before they escalate depends heavily on systematic data collection and analytic foresight, not just on retrospective KPIs.

For the aerospace industry, where complexity and volatility are intensifying, it is essential to translate early warning signals into tangible daily practices. Achieving this requires leveraging advanced forecasting and supplier monitoring technologies that transform risk detection from a reactive process into a real-time, forward-looking capability.

The following section therefore examines how accurate forecasting and comprehensive monitoring tools enable proactivity and resilience at the operational level of supply chains, offering aerospace manufacturer immediate visibility and actionable insights for continuous improvement and rapid escalation response.

/ Supplier Monitoring & Tools

Effective early warning systems require tools that turn visibility into control. Supplier monitoring provides the baseline discipline. It covers three areas:

- **Performance management:** tracking on-time delivery, defect rates, and first-pass yield enables early detection of deviations.
- **Development and diversification**: collaboration with critical suppliers on capacity, compliance, and maturity reduces concentration risk.
- **Regulatory and quality compliance:** enforcing AS9100, ITAR, and FAA/EASA standards, together with traceability, prevents certification delays and lock-in effects.

Modern supplier monitoring platforms now convert audit and compliance data into benchmarking analyses, allowing organizations to compare supplier performance objectively and identify specific areas for targeted improvement. By transforming compliance data into actionable intelligence, these systems demonstrate how monitoring is evolving beyond mere reporting, empowering companies to shift towards proactive supplier development and risk mitigation.

An example of this evolution is the Aero Excellence™ framework[10]. The Aero Excellence™ framework is an industry-standard approach to supplier evaluation, launched by leading European aerospace associations to strengthen operational, environmental, and cybersecurity maturity. It has been adopted by Airbus, Safran, Collins, and other major players, enabling companies to benchmark against harmonized criteria, undergo structured self and expert assessment, and earn maturity recognition on levels from Bronze to Gold. This process helps streamline performance enhancement, boosting resilience and competitiveness throughout the European aerospace supply chain.

Building on this foundation, advanced tools provide predictive insights. AI-driven risk scoring consolidates supplier data into forward-looking indices; dashboards and control towers deliver end-to-end visibility; scenario modelling and digital twins allow organizations to simulate disruptions and stress-test strategies; and blockchain traceability strengthens compliance and auditability. Rolls-Royce demonstrates this in practice through its five-year adoption of Aerogility's AI-driven digital twin solution, enabling large-scale scenario planning and data-informed decisions across the value chain[11].

The application of these tools depends on the risk type they address. Resilience risks are best anticipated through AI-driven scoring, scenario modelling, and digital twins, which provide predictive insights and validated contingency strategies. Collaboration risks are best managed through dashboards and control towers to enable shared visibility together with blockchain traceability to strengthen transparency, governance, and auditability.

[10] https://www.scsframework.org.uk/news/a-guide-to-aero-excellence/; June 24, 2025
[11] https://aviationweek.com/mro/emerging-technologies/rolls-royce-selects-aerogility-strengthen-ai-capabilities; January 11, 2024

/ Achieving Risk Forecasting Accuracy to Enable Early Detection

To strengthen resilience, aerospace manufacturers must move beyond retrospective KPIs and periodic evaluations, adopting advanced forecasting systems that continuously assess live production, quality, and delivery data across all supplier Tiers.

Modern supply chain management integrates the tools introduced before to monitor key metrics such as inventory turnover, production cycle times, and delivery performance in real time. By providing immediate visibility into the supply chain, these systems enable rapid detection and resolution of anomalies, such as inventory shortages, production delays, or shipment discrepancies.

According to recent industry research and academic studies, AI-driven predictive analytics increase demand forecasting accuracy by up to 40% and can pinpoint supplier defaults with 70-90% precision. This gives companies the ability to shift from lagging indicators to early warning signals – enabling faster intervention, improved continuity, and optimized resource allocation.[12],[13],[14],[15]

To achieve forecasting accuracy, aerospace suppliers need to use real-time dashboards, heatmaps and digital twins to turn data into insights, quickly detect bottlenecks, and predict disruptions. Predictive analytics leverages historical data to forecast demand and simulate scenarios, enabling faster, more effective responses to supply chain risks and smoothing production flow.

[12] https://www.sciencedirect.com/science/article/pii/S0166361524000605; November, 2024
[13] https://www.scm.dk/ai-demand-forecasting-how-it-works-and-why-its-replacing-traditional-methods; June 12, 2025
[14] https://www.mothersontechnology.com/blogs/enhancing-supplier-performance-and-risk-management-with-ai-ml/; May 8, 2025
[15] https://papers.ssrn.com/sol3/papers.cfm?abstract_id=5198856; April 3, 2025

/ Integration of Demand Forecasting and Supplier Monitoring

A stable, robust, and ideally cycle-adaptive demand forecast from OEMs provides the foundation for targeted supplier management.

In practice, **CYLAD's Demand Tracker** is a proven solution to detect, measure, and evaluate client demand volatility at every level – from consolidated forecasts down to individual order lines.

The platform provides historic tracking and real-time monitoring of changes in forecasts, orders, and deliveries, enabling teams to detect critical anomalies, trigger collaborative discussions with suppliers, and anticipate changes to priorities before they impact production.

By making demand variation and unreliability fully visible, the Demand Tracker helps companies stabilize production planning, maximize capacity usage, reduce working capital tied up in excess inventory, and improve the reliability of on-time-delivery.

This directly mitigates the bullwhip effect common in aerospace supply chain and reinforces the collaborative relation between suppliers and OEMs. If manufacturers generate forecasts that reliably reflect market dynamics and adapt to industry cycles, they can coordinate with suppliers well in advance instead of only reacting afterwards.

Supplier monitoring then serves as feedback and control system: by continuously collecting and evaluating operational data from all Supplier Tiers, companies can create a viable dataset that supports accurate, real-time predictions and scenario analyses – and thus validate forecast expectations.

Operatively, this integrated approach enables immediate detection of deviations from expected performance, triggering automated warnings and actionable interventions. For example, a sudden dip in a supplier's on-time delivery rate or a spike in non-conformity rates can be detected by AI systems, prompting task forces or accelerated recovery measures, or even AI-suggested recovery actions after the learning phase to prevent cascading disruption.

Over time, the interplay of stable forecasting and thorough supplier monitoring enables strategic improvements. Trends identified through continuous monitoring highlight opportunities for dual sourcing, investment in critical capabilities, or realignment of supplier relationships to mitigate systemic weaknesses.

Ultimately, data-based integration of OEM forecasts and supplier monitoring transforms fragmented information into powerful, predictive intelligence enabling organizations to make confident, agile, and effective decisions in aerospace supply chain management.

The table (Figure 10) gives an overview of aerospace-specific challenges, respective data-driven solutions and tangible examples.

Aerospace-specific challenge	Data-driven solution	Example metric/ Visualization
Multi-tier supplier complexity	**Supplier Monitoring Platforms**	Supply chain control towers aggregating data from all Tiers
Extended lead times & material shortages	**Predictive Analytics Digital Twins**	Predictive analytics forecast demand spikes and shortages; digital twin models enable scenario planning for sourcing alternatives
Financial instability; increasing raw material prices	**Real-time Financial Analysis**	Financial analytics platforms optimize procurement, reveal cost-saving opportunities, and support resilient budgeting
Regulatory Compliance & Traceability	**Real-time Compliance Dashboards**	Integrated compliance dashboards and blockchain-based traceability track parts, processes, and documentation in real time
Demand Management	**Demand Tracker Platforms**	Dashboard tracking forecast changes, order volatility, and demand stability; Bullwhip risk indicators

Figure 10. Data Driven Supply Chain Solutions
"Digital tools enable earlier detection and faster response to aerospace-specific risks."

/ Data-Driven Decision-Making – From Reaction to Prevention

In aerospace supply chains, the shift from reactive problem-solving to proactive prevention is driven by integrated data and analytics across all supplier levels and OEMs. Rapid decision loops, real-time data streams, and comprehensive dashboards empower suppliers to identify anomalies early on, troubleshoot emerging issues, and continuously improve quality and delivery performance throughout the network.

On the OEM side, aggregated insights from predictive analytics and AI-driven alters allow for strategic intervention, optimization of sourcing strategies, and implementation of preventive actions before disruptions escalate.

The visualization (Figure 11) illustrates a dual-cycle approach to data-driven decision-making in aerospace supply chains, emphasizing the transition from reactive problem-solving to proactive risk prevention.

On the left, the cycle represents the supplier levels focusing on supplier performance management. Importantly, the right-side preventative actions, dashboards, and analytics are not only relevant to OEMs, but each supplier level can (and should) implement similar preventive and predictive practices within their own networks.

By adopting advanced data tools and scenario modelling, level 1, 2 and 3 suppliers can proactively monitor incoming supply streams, manage risks, and ensure their own resilience – mirroring the OEM's strategic approach at every level of the chain.

For these practices to deliver maximal value, it is essential that data flows openly and seamlessly across all supplier levels and the OEM, enabling end-to-end visibility and shared insights throughout the supply network.

The overlapping area highlights the integrated flow of real-time information, enabling both suppliers and OEMs to synchronize actions and foster a supply chain culture that continuously develops from reaction to prevention.

This visual integration stresses that data-driven supply chain management is not an isolated linear process, but rather a continuous, adaptive cycle where real-time performance informs strategic actions, and strategic feedback enhances operational performance.

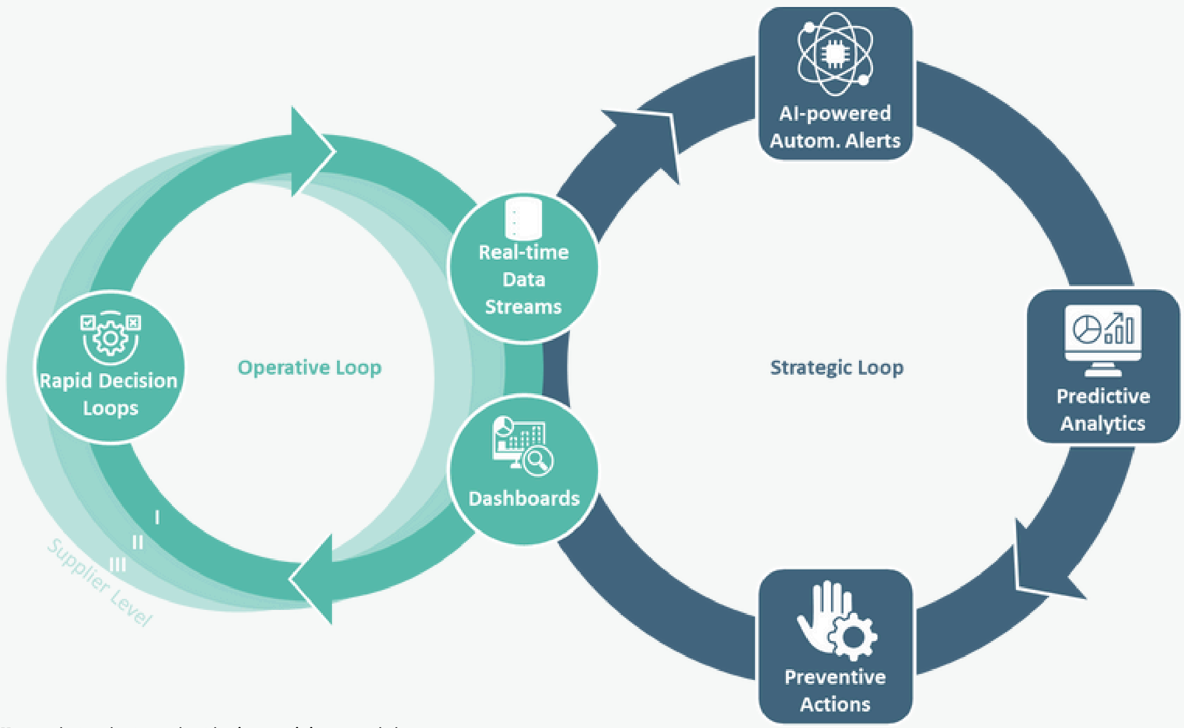


Figure 11. Dual-Cycle Supply Chain Decision Model
"Real-time data links operational decision loops with strategic prevention, enabling a shift from reactive to proactive supply chain management."

REAL-LIFE EXAMPLE

Adapting OEM Forecasts in Aerospace Supply Chains

In practice, OEM forecasts transmitted to aerospace suppliers are rarely accurate and should always be treated as a moving target rather than a fixed plan. Our experience has shown that an OEM demand schedule normally needs continuous corrections. No supplier can rely exclusively on the forecast provided to steer their own production and procurement decisions.

This is a widely known challenge in the industry, particularly since Aircraft on Ground (AOG) material requirements from OEMs are almost impossible to plan in advance. Long lead times and volatile customer demand often make OEM forecast data outdated and unrealistic by the time suppliers are able to act upon it.

To adjust the given forecast and achieve better alignment with actual market requirements, **aerospace suppliers need to implement calibration/ validation steps:**

- **Analyse Historical Data:** Compare OEM forecasts with past cycles and actual demand to pinpoint deviations
- **Engage OEM directly:** Use continuous exchange and informal updates beyond official releases
- **Track Market Intelligence:** Monitor airline orders, and maintenance cycles for early signals
- **Monitor Order Backlogs:** Consider customer orders and aftermarket demand
- **Plan for Risk:** Use buffers, and flexible scenarios to include late changes
- **Optimize Sourcing:** Apply dual sourcing and lead-time strategies to cancel out forecast inaccuracies
- **Integrate AOG Material Contingencies:** Account for the largely unforeseeable nature of AOG requirements by setting aside emergency capacities or quick-response channels

Example from a specialized aerospace supplier and service provider (Figure 12)

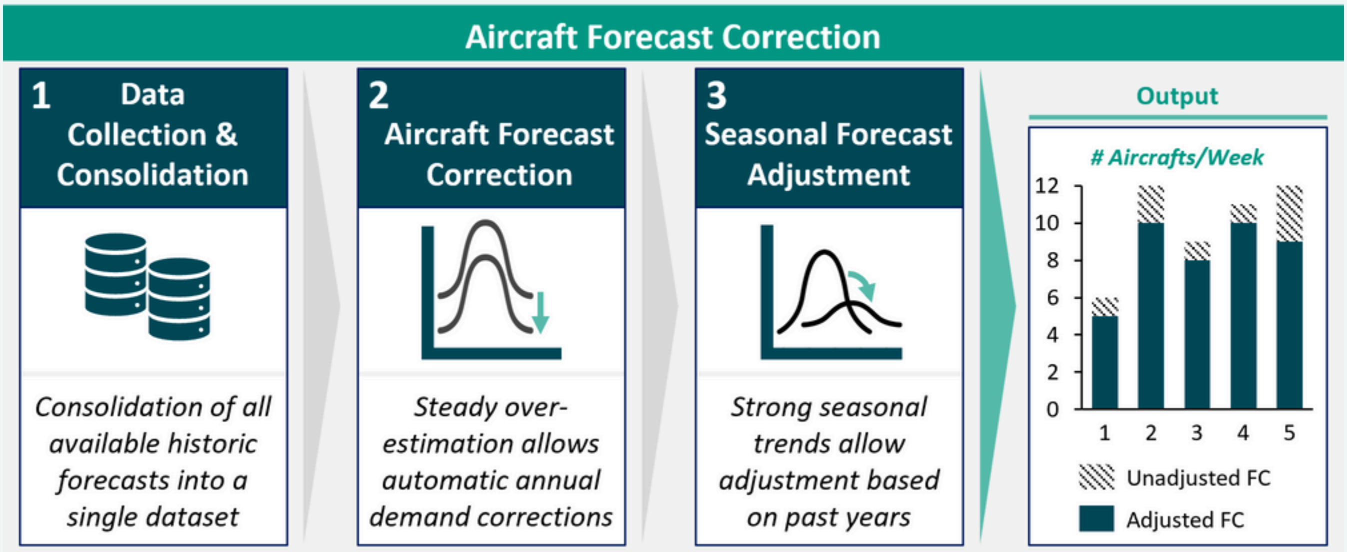


Figure 12. Forecast Correction Method (CYLAD Project Example)
"A three-step forecast correction consolidates historic data, removes bias, and applies seasonal adjustments to improve accuracy."

Here, we developed and implemented a standardized forecasting and forecast correction process.

Integrating customer patterns and seasonal adjustments with forecast coupling of short-term and long-term forecasts allowed for automated aircraft-level forecast corrections and greater transparency.

Historical forecast data was consolidated to detect and correct steady overestimation, and strong seasonal trends adjusted future forecasts.

+15%

increased accuracy by mapping, enabling better long-term planning for production and procurement

Conclusion

This paper has examined the multifaceted nature of aerospace supply chain resilience and outlined a structured approach for improvement. The sector faces pressure from supply shortages and supplier multi-tier complexity, all within a context of record order backlogs. Supply chain resilience is becoming an increasingly critical competitive advantage.

To address that, vulnerability mapping requires moving beyond cost, quality, and delivery metrics. Instead, evaluating supplier criticality and differentiating between resilience risks ("external shocks") and collaboration risks ("internal misalignments") is necessary. The presented strategic management framework covering operational, financial, and strategic risk dimensions, built around risk types, mitigation actions, and KPI systems, serves as guideline for risk mitigation. It highlighted that true resilience demands a synchronised approach across all risk dimensions, supported by robust quantitative analysis. Especially in times of high insecurity, forecasting accuracy and supplier monitoring are enablers of proactive, data-driven decision-making. Real-time visualisation, predictive analytics, and collaborative platforms enable rapid detection and resolution of anomalies.

> To strengthen resilience, aerospace companies should commit to building multi-tier supply chain visibility that extends beyond their immediate Tier 1 partners.

This requires integrating performance, compliance, and financial indicators from across the network into unified risk dashboards, enabling leaders to identify vulnerabilities early and act decisively. Resilience must be managed on two levels: resilience risks, stemming from external shocks, need to be mitigated through diversification, regulatory foresight, and scenario planning.

Collaboration risks, arising from internal misalignment, demand clearer contractual frameworks, aligned KPIs, and targeted supplier capability development. Investment in predictive analytics is essential. Real-time data, AI-driven risk scoring, and digital twins allow companies to shift from reactive problem-solving to proactive disruption prevention. Demand forecasting further optimise inventory management and production schedules, reducing cost and impact accruing from unexpected delays.

At the same time, financial stability of critical suppliers must be safeguarded through supplier financing programmes, indexed pricing clauses, and long-term volume guarantees, combined with continuous monitoring of liquidity and leverage.
Finally, institutionalising secure, real-time data sharing with key suppliers ensures that forecasts and performance metrics are transparently exchanged, aligning supplier KPIs with OEM strategic objectives and synchronising the broader ecosystem towards shared resilience goals.

The aerospace industry’s structure with its high regulatory barriers, long certification timelines, and concentrated supply bases means that supplier collaboration is no longer optional. Building resilience requires joint problem-solving, shared investment, and transparent data exchange.

Without a cultural shift towards partnership, even the most advanced monitoring tools will fall short. The current backlog and market momentum demand a respective mindset shift.

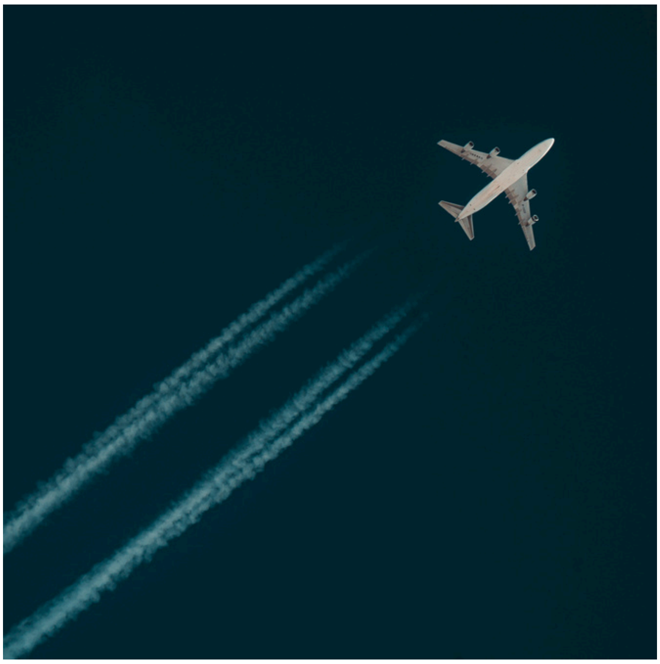
Outlook

Looking ahead, aerospace supply chains will face increased competitive pressure from emerging markets, greater regulatory scrutiny, and rapid acceleration in technology adoption.

In this environment, resilience will evolve from a defensive measure into a source of strategic advantage. Leaders will need to treat real-time data as a core operational asset and continuously reassess supplier portfolios in light of shifting geopolitical, technological, and environmental risks.

Furthermore, integrating sustainability criteria into resilience strategies, anticipating that green compliance will become as critical as airworthiness certification, will be key. A determining success factor will be the quality of available data from OEMs and tiered suppliers, as reliable datasets are the prerequisite for gradually leveraging predictive AI applications. Well-trained AI models already out-performing human monitoring capabilities, not only when it comes to detecting anomalies but also in suggesting appropriate mitigation measures.

However, given the inherent limitations of aerospace operations, particularly the limited scope for last-minute adjustments, every mitigation option must be carefully prioritized and implemented within tight timeframes.



Aerospace companies succeed in combining robust data foundations, predictive AI capabilities, and structured response mechanisms will not only safeguard their production lines and profitability but set the pace for global aerospace growth in the decades to come.

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About CYLAD

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