TATA CONSULTANCY SERVICES

TATA

TCS Future-Ready Skies Study 2025

How strategic choices are powering aerospace's next decade

Contents

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Foreword

Charting the Future-Ready Skies

Aerospace has always been an industry where ambition is matched by precision and safety. Today, that ambition is being redefined as technology moves from supporting operations to shaping enterprise strategy—transforming how aircraft are designed, manufactured, and operated. The industry is no longer simply reacting to disruption; it is laying the foundation for **Future-Ready Skies that are safe, secure, predictable, reliable, and sustainable.**

This study captures the sector at a pivotal moment. Manufacturers anticipate that within the next five to seven years, **40% of aerospace production will run as dark factory operations**, powered by intelligent robotics, analytics, and AI. **70% of advanced air mobility companies are already pursuing commercial initiatives**, accelerating the transformation of infrastructure, scale, and business models. Yet this momentum coexists with fragility—only **28% of executives say they could pivot sourcing within 30 days** of a Tier-1 disruption, illustrating the need for supply chains that are **intelligent, resilient, and perpetually adaptive**.

The shift extends well beyond manufacturing. In maintenance, repair, and overhaul, **64% of providers expect measurable ROI from predictive analytics and AI-driven maintenance within five years**, demonstrating how intelligence is redefining performance economics. Together, these trends mark rearchitecturing of the industry, where decision intelligence, AI-driven operations, and human expertise are deeply intertwined.

At TCS, we see this moment as a **leadership opportunity**. Aerospace enterprises that design intelligence into their operations, embrace adaptability, and empower their people with AI will lead the next decade of flight.

I believe this report provides a meaningful perspective for leaders ready to act boldly. It reaffirms our belief that the skies we are building are not only connected and sustainable, but future-defining.

Executive summary

This report, based on a survey of 323 senior aerospace industry leaders across North America and Europe, reveals an industry in transition. Traditional manufacturing norms are being reimagined, while new entrants in the electric vertical takeoff and landing (eVTOL) segment are challenging established norms. Simultaneously, supply chains are being reconfigured for resilience, and maintenance operations are transitioning from cost centers to strategic value drivers.

Spanning three core segments – aerospace manufacturers, advanced air mobility (AAM) companies, and MRO providers – the findings offer a snapshot of how aerospace manufacturers and operators are prioritizing investments, navigating barriers, and recalibrating for supply chain resilience. Our research identifies three key findings from our survey respondents:

- On average, respondents anticipate 40% of their manufacturing operations to be lights-out, requiring minimal human intervention, within the next 5-7 years
- Nearly three-fourths (70%) of AAM companies are actively building or involved in commercial projects
- Less than a third (28%) of respondents across all segments say they can reroute sourcing within 30 days of a Tier 1 shock

> In our work with our customers, we see that AI is transforming the value chains across the aerospace industry leading to improved product design and development, predictive maintenance, enhanced safety and risk management, operations optimization, and improved autonomous flight capabilities. We are seeing increased interest in AI applications driving real business value focusing on reducing operational costs, improving efficiency, and enhancing passenger experience. Data continues to be a differentiator for our customers with many rethinking their enterprise-wide data strategies to fully leverage the benefits of AI.
>
> *– Ozgur Tohumcu, General Manager - Automotive & Manufacturing, Amazon Web Services (AWS)*

Accelerating toward a human-centric, AI-guided future

Digital transformation and advanced technologies are unlocking new frontiers in predictive analytics, automation, and immersive tools. But how far will autonomy go for the aerospace industry?

Despite interest in automation, expectations for "lights-out" factories – a fully automated manufacturing process where production operations occur with minimal to no human interaction or presence – remain tempered. While ambition is high, aerospace manufacturers surveyed expect less than half (40%) on average of their operations to be fully lights-out by 2035 (see Figure 1). The majority anticipate a hybrid approach, with continued human oversight for an average of 60% of their operations.

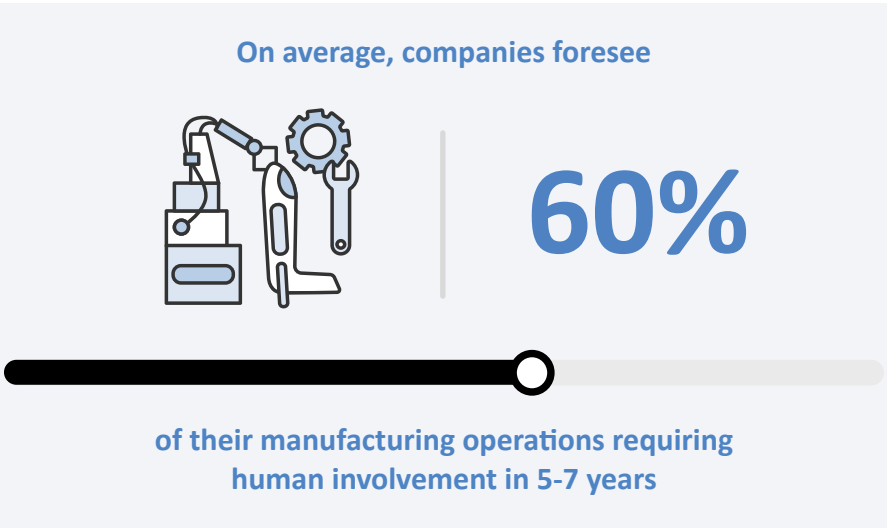

Figure 1. Aerospace manufacturers: *What percentage of your manufacturing operations will likely require human intervention in 5-7 years and what percentage will be running autonomously? (n=135)*

The MRO providers we surveyed largely concur with manufacturers on autonomy. When asked about the expected level of autonomy in MRO by the end of the decade, few MRO providers surveyed expect fully autonomous MRO workflows for routine tasks, yet around a third envision semi-autonomous repair workflows. (see Figure 2).

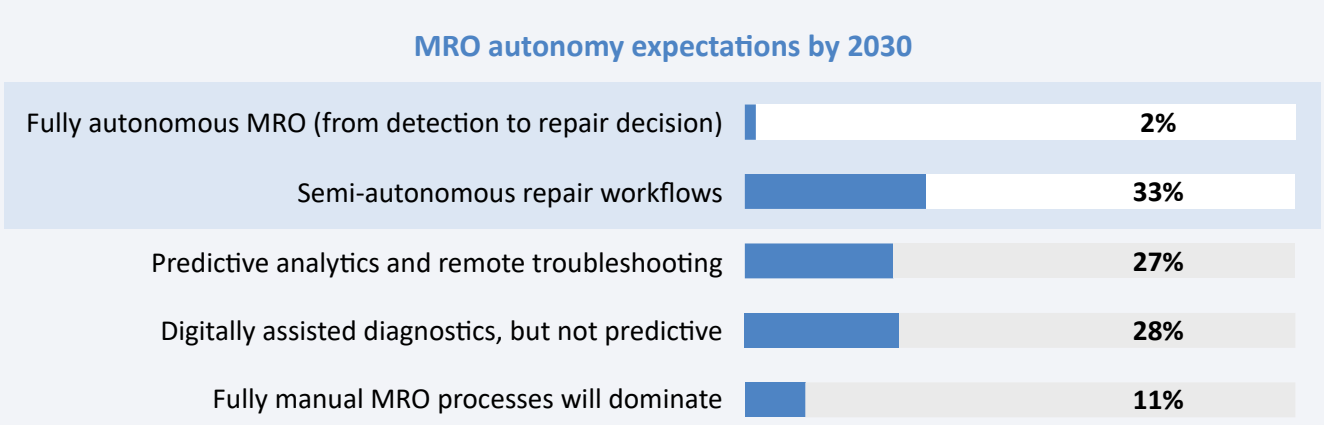

Figure 2. MRO providers: *What level of autonomy do you expect your Maintenance, Repair and Overhaul (MRO) operations to achieve by 2030? (n=138)*

The remainder expect human-led maintenance to persist. While MRO providers have been heavily investing in digital technologies (such as mobile task cards for technicians, digital planning, and connected data insights), further advances in autonomy would require significant digitalization and investment both within their own systems and across their sub-contractor ecosystem.

> In these challenging times, aerospace and defense enterprises are aggressively looking to adopt technologies to be more agile, streamline operations and reduce costs while balancing innovation with security, scale, and mission-critical precision. For opportunities to drive innovation and achieve their strategic objectives, they are targeting Industry 4.0, digital twins, resilient supply chains, predictive maintenance/ MRO, IT/OT, and connected/integrated ecosystems.
>
> *– Naresh Lachmandas, Senior Partner, Aerospace & Defense, Avasant*

In addition, the rise of agentic AI is adding a new dimension to the push toward autonomous operations. This shift is reshaping how decisions are made by harnessing AI and applying it to highly subjective, high-stakes areas like supply chains, where human experience and situational nuances all weigh heavily on decisions.

In the supply chain area in particular, respondents indicated that human involvement is still very much integral to decision making. Around a third see challenges around complex engineering and regulatory requirements that require a human in the loop. And only a small number (6%) say they not only would trust AI agents to fully automate operational supply chain decisions but are already doing so. However, the vast majority are open to it, provided that transparency and control follows (see Figure 3).

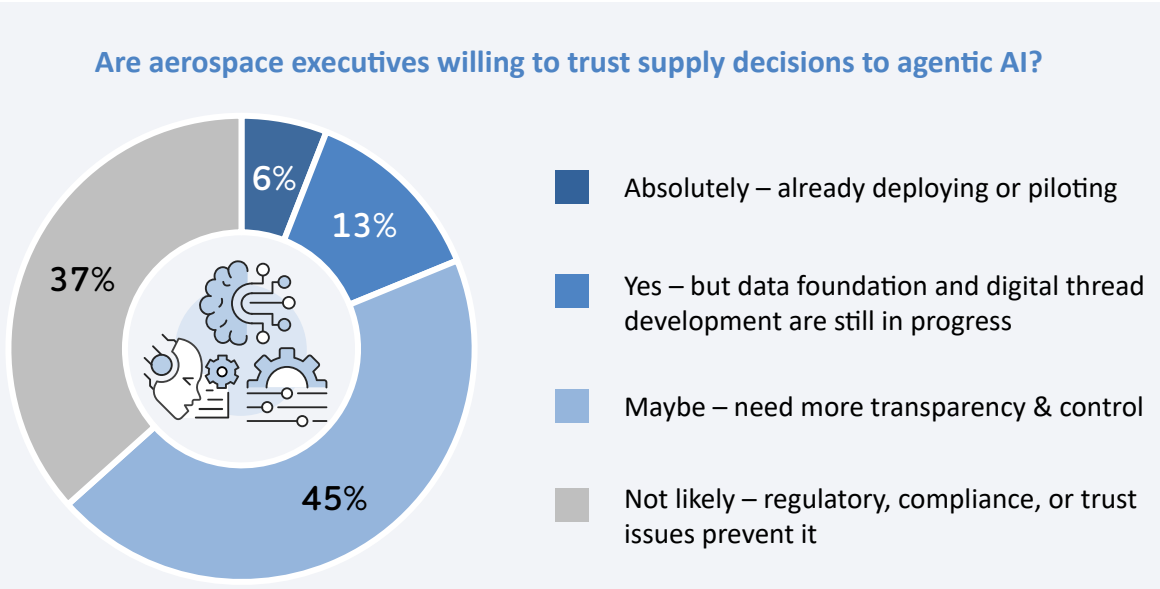

Figure 3. All respondents: *Would you trust AI agents to fully automate operational decisions in your supply chain? (n=323)*

As the conversation continues to evolve around human-machine collaboration, Industry 5.0 – which combines advanced automation with human-centric design and emphasize human-machine collaboration, sustainability, and resilience — is emerging as a bridge. A growing share of aerospace manufacturers see Industry 5.0 factories as more realistic than full autonomy.

Within a decade, the majority of the aerospace manufacturers we surveyed expect at least some portion of their production systems to align with Industry 5.0 principles (see Figure 4).

Percentage of manufacturing facilities in next 5-7 years operating as Industry 5.0 – combining advanced automation with human-machine collaboration, sustainability, and resilience

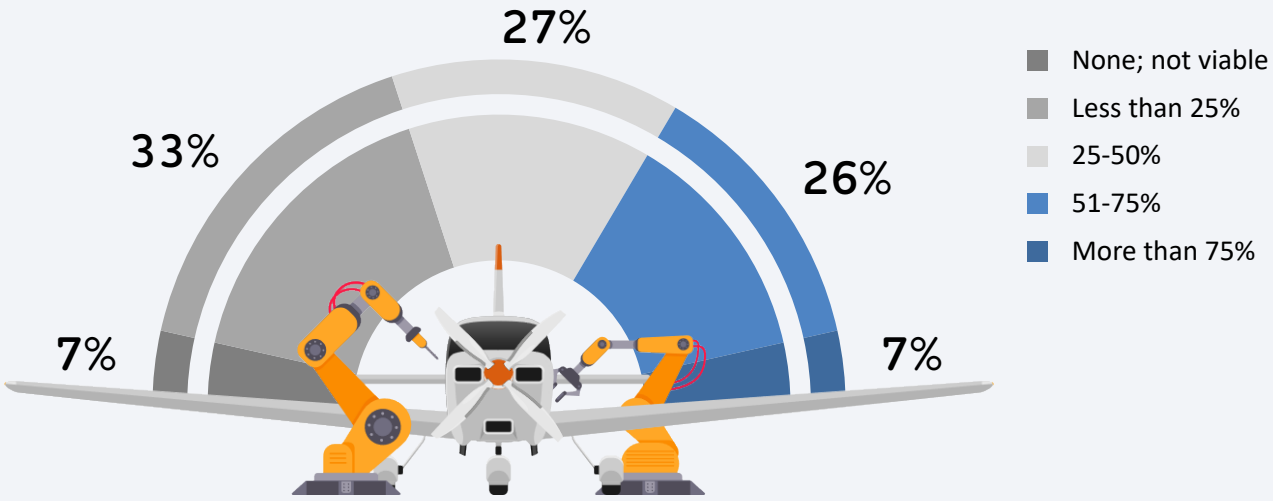

Figure 4. Aerospace manufacturers: *What percentage of your manufacturing facilities could realistically operate as "Industry 5.0" factories (operations that combine advanced automation with human-centric design – emphasizing human-machine collaboration, sustainability, and resilience) within the next 5–7 years? (n=135)*

From lights-out manufacturing operations to autonomous repairs and AI-led decision making, there's a common theme: in an era of advanced automation, the future of aerospace is human-centric AI. It's not the absence of people that leads to superior outcomes, but the elevation of their role through customized, intelligent technologies that support decision-making, planning, and real-time responsiveness.

> Artificial intelligence is the key to multi-domain digital thread integration, more specifically, the use of AI agents, or "digital engineers" that take over on the work of connecting and moving data. But to achieve this, the foundation models these agents are built upon must be taught the language of engineering in manufacturing, and then these AI agents must be integrated with industrial-strength engineering tools. The future of the aerospace industry depends on this integration to close their workforce gaps and reduce their cycle times. However, AI alone will not solve these problems. These problems will be solved once human engineers become far more efficient by using physics-based digital tools with integrated agentic AI.
>
> *– Todd Tuthill, Vice President, Aerospace & Defense Industry, Siemens Digital Industries Software*

Digital twins on the rise across the aerospace ecosystem

While approaches to autonomy may differ among organizations, it's clear that AI is already having a significant impact across the aerospace industry, attracting major investment and strong optimism. Unsurprisingly, the manufacturers surveyed view it as the leading candidate to transform aerospace by 2035, ranking it above the other technologies in terms of impact (see Figure 5).

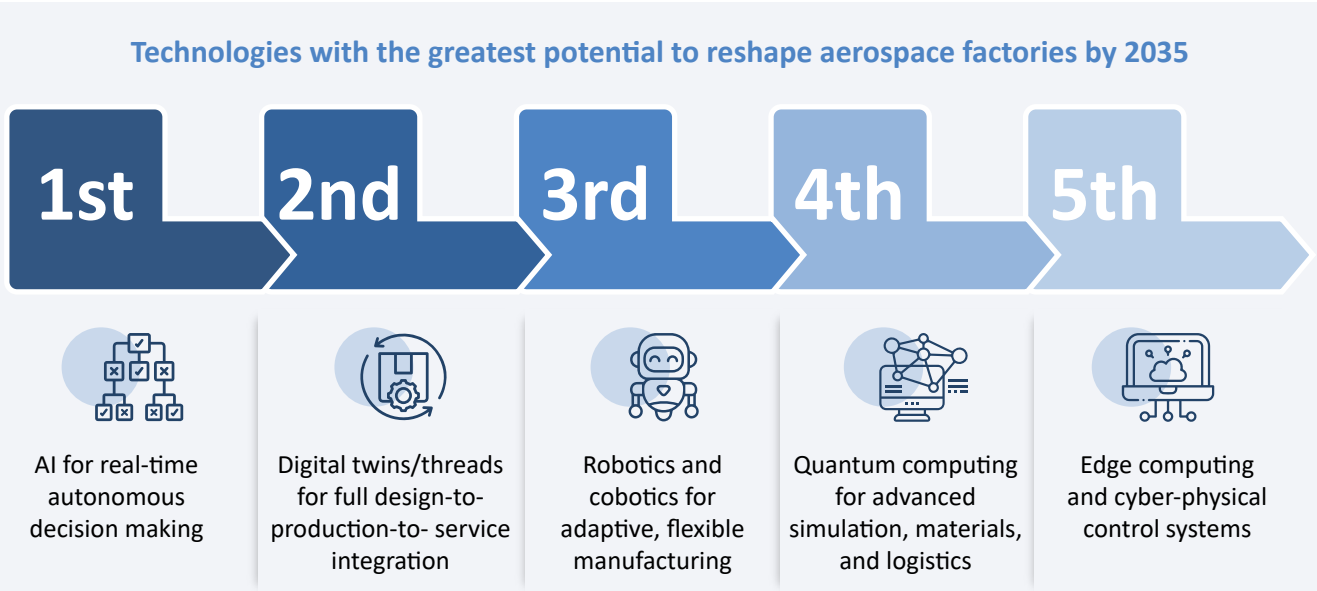

Figure 5. Aerospace manufacturers: *Which emerging technology has the greatest potential to fundamentally reshape aerospace manufacturing by 2035? (n=132; not shown: "No major disruption expected in this timeframe," n=3)*

The 3 stages of digital thread maturity

1. **Virtualization:** Using data to create digital models of individual physical objects or processes.
2. **Activation:** Connecting models to edge, core, and cloud data sources and enhancing them with AI and AR/VR for real-time, predictive simulation.
3. **Integration:** Evolving into dynamic digital threads that fuse data, context, and computation, seamlessly linking physical operations with digital intelligence across the value chain.

Beyond AI, digital twins ranked second, signaling their growing importance across aerospace operations. This echoes our findings in the recent TCS Digital Twindex Report Series on Future-Ready Manufacturing. Similar to other manufacturing subsectors, aerospace leaders have moved beyond experimentation as digital twins have evolved. Digital twins now power everything from individual machine diagnostics to ecosystem-level orchestration, simulate "what-if" scenarios, and optimize operations.

One major enabler of digital twins is the digital thread: the connected data and workflows that span the entire lifecycle. The digital thread represents a more advanced stage of digital twin maturity, representing a seamless data flow across the lifecycle (see sidebar).

Our survey reveals a strong start in digital thread implementation among aerospace manufacturers. When asked to rate their digital thread maturity, three-fifths of surveyed respondents have begun implementing digital threads (see Figure 6). While the majority have data available, only a few have achieved digital thread maturity across selected products, and the challenge remains to seamlessly connect major platforms and large data environments. Those still in planning and pilot stages (34%) have the opportunity to proactively establish an enterprise integration strategy.

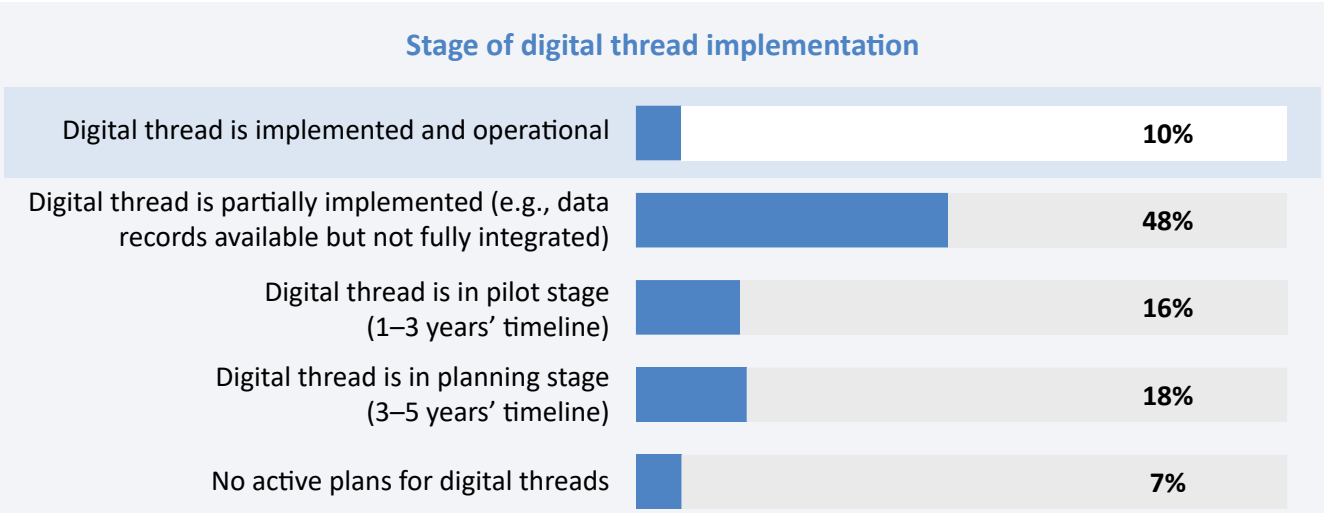

Figure 6. Aerospace manufacturers: *Where does your organization stand in implementing a digital thread across the product lifecycle? (n=135)*

Because digital twins/threads inherently span design, manufacturing, and in-service support, executives may see it as a meta-platform that can absorb AI, edge analytics, and even future quantum solvers as modules—making it a promising technology for the 2035 horizon and beyond.

> Global aerospace, especially for defense, is moving toward a future driven by autonomy, AI, digital twin, and connected supply chains. For India, this is both a challenge and an opportunity — to contribute world-class capabilities and establish itself as a trusted partner in building the future of aerospace systems for defense.
>
> *– Sukaran Singh, MD & CEO, Tata Advanced Systems*

A faster, vertical future takes flight with AAM

With commercial certification on the horizon, electric vertical takeoff and landing (eVTOL) vehicles and broader advanced air mobility (AAM) ecosystems are attracting significant attention. A well-known contributor to global emissions, there is considerable pressure on the aerospace industry to reduce its environmental impact and AAM initiatives aim to deliver a cleaner alternative to traditional aviation.

As commercial eVTOLs inch toward certification, 88% say they have an active strategy for engaging in the AAM market, signaling a shift from curiosity to commitment. These strategies vary: 18% are investing in enabling components and technologies, 54% are actively building an AAM product or platform and 16% are already at the development stage (see Figure 7). This diversification suggests a recognition that AAM success will depend on both aircraft development and a robust supporting ecosystem.

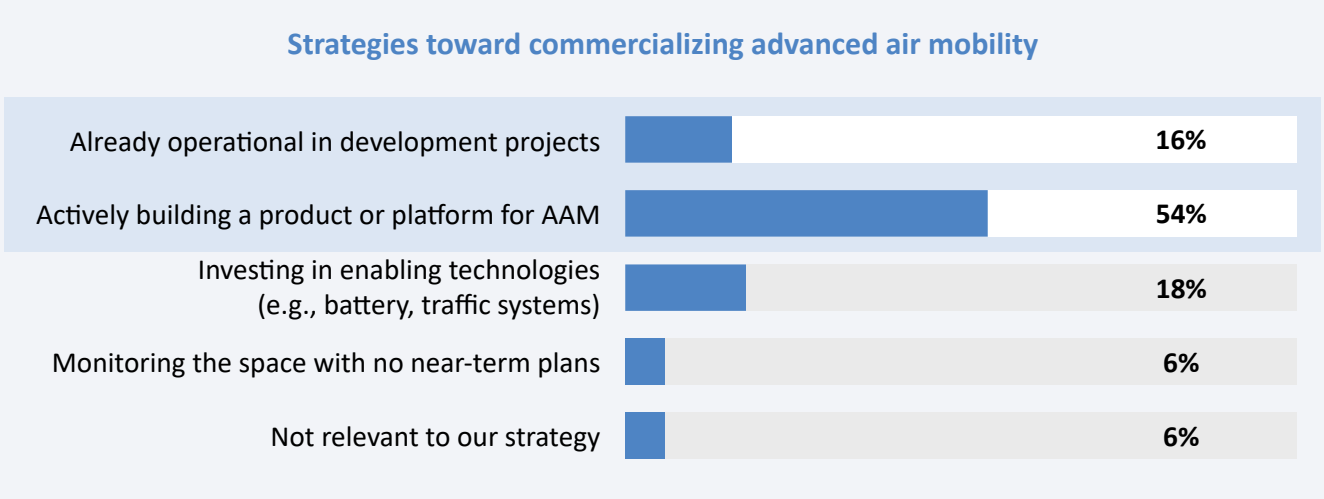

Figure 7. AAM companies: *What is your organization's current strategy towards eVTOL (Electric Vertical Take-Off and Landing) and Advanced Air Mobility (AAM) commercialization? (n=50)*

However, barriers to mainstream AAM adoption remain steep. Regulations remain the dominant concern, with 80% citing regulatory uncertainty as their most significant challenge, followed by concerns over economics and infrastructure readiness. (see Figure 8).

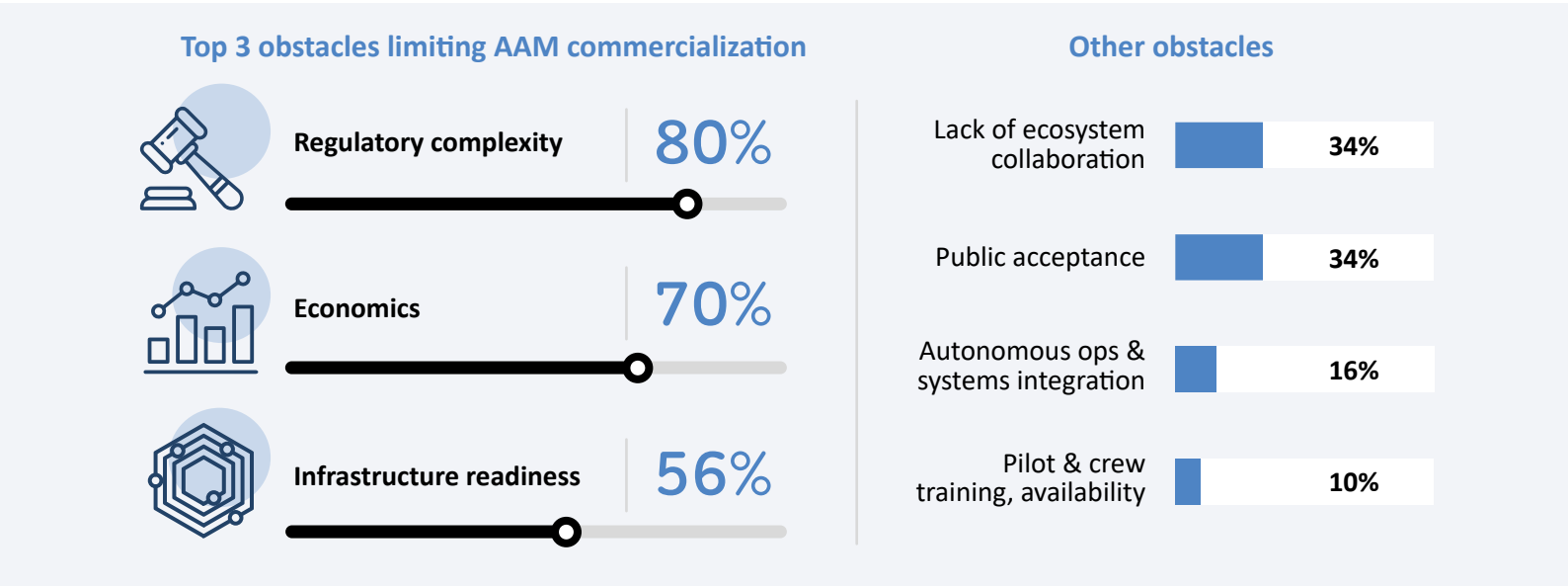

Figure 8. AAM companies: *What are the top barriers to AAM becoming mainstream? (n=50)*

These concerns highlight the multifaceted nature of AAM readiness – it's not solely a technological endeavor but a societal transformation. Winning trust, building ecosystems, and aligning with regulators and public-sector partners are just as critical as the airframes themselves.

> As the aerospace industry rapidly evolves to meet the expanding demand over the next decade, businesses face the challenge of scaling through efficient and environmentally sustainable solutions. This report offers a comprehensive perspective on the current status of digital technology adoption in the industry and presents valuable insights for effectively integrating emerging technologies, such as digital twins, digital threads, and AI, into business processes spanning the end-to-end supply chain, encompassing procurement, manufacturing, MRO, and customer interactions.
>
> *– M.S. Krishnan, Ross School of Business, University of Michigan*

MRO providers push to digitize and scale

Maintenance, repair and overhaul (MRO) providers have been investing heavily in a range of powerful technologies that can help accelerate solutions to the biggest aerospace challenges like customer experience, operational productivity, and business collaboration across the value chain. These include blockchain, AI, and predictive analytics, especially when combined with the capabilities of digital twins, digital threads, AR/VR, and robotics.

Our findings show that the vast majority are investing in these technologies. Further, confidence is strong, with around a third on average anticipating an ROI on MRO tech within three years (see Figure 9). Similar to aerospace manufacturers, MRO providers anticipate the biggest payoff from AI and digital twins, with around three-fifths of MRO providers expecting an ROI from these two technologies within five years.

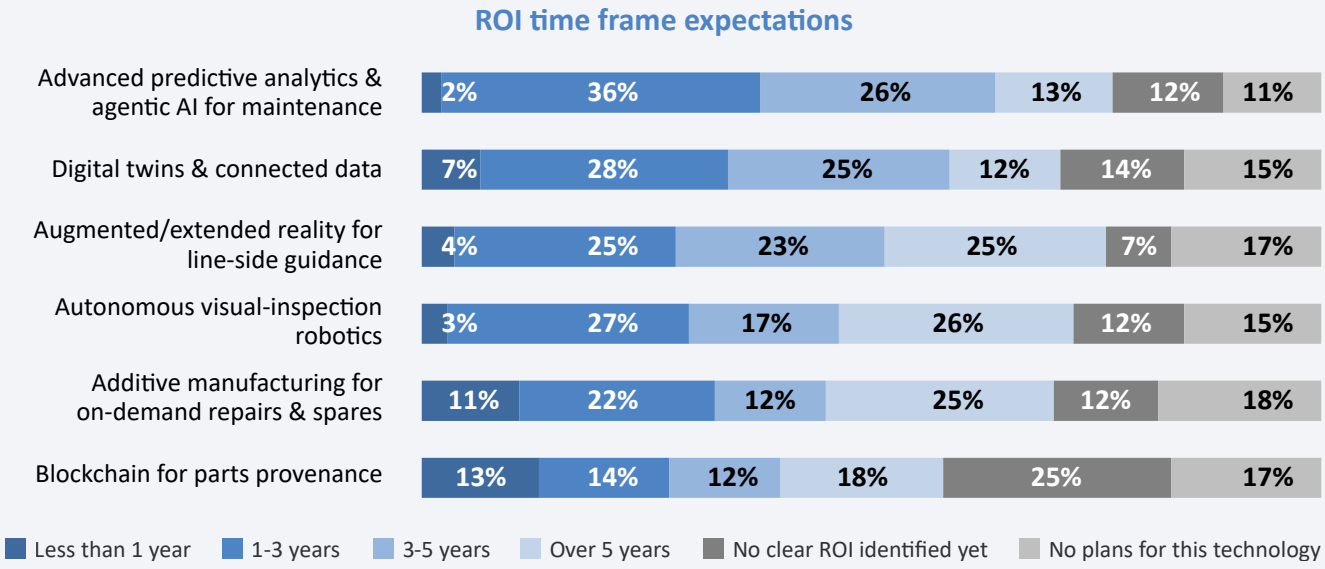

Figure 9. MRO providers: *What is your expected ROI period for these MRO technology investments (n=138)*

The stakes are high. Just 5% of respondents say their digital MRO strategy is already scaled. For the rest, 80% of executives surveyed anticipate a negative impact from rising operational costs, increased downtime, revenue, and customer churn if their digital MRO strategies fail to scale (see Figure 10). These consequences could disrupt capacity planning for tools and facilities and undercut profitability, especially as demand for faster turnaround grows.

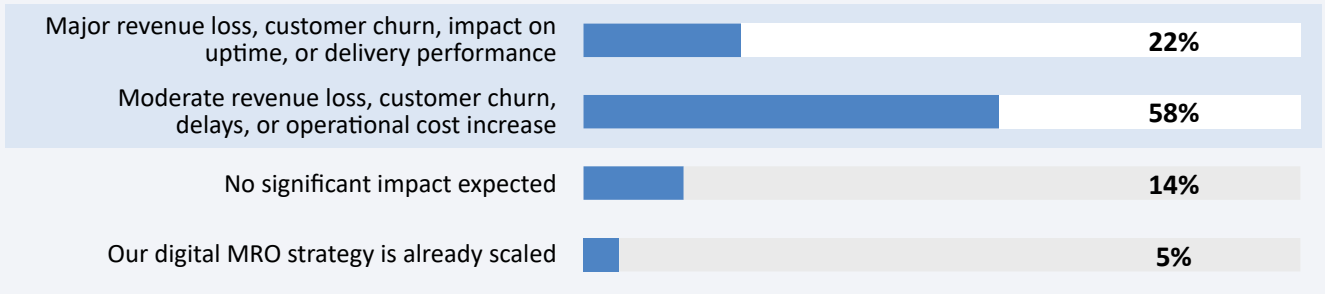

Figure 10. MRO providers: *What would be the business impact if your digital MRO strategy cannot scale by 2028? (n=138)*

Pivot-ready supply chains remain elusive

As MRO providers, aerospace manufacturers, and AAM companies invest in AI, digital twins, and other advanced technologies, they're not just optimizing performance but building resilience. In an industry as complex as aerospace, organizations must be able to proactively adapt and react to unexpected events and disruptions.

Nowhere is the need to face disruption more evident than across the global supply chain ecosystem, where delays, shortages, and shifting demands can ripple across operations for both the short and long term. For the aerospace industry, staying ahead means the ability to continuously adapt, anticipate and evolve.

However, less than a third of respondents across all segments say they could pivot sourcing within 30 days if a Tier 1 supplier were hit with a sudden disruption (see Figure 11).

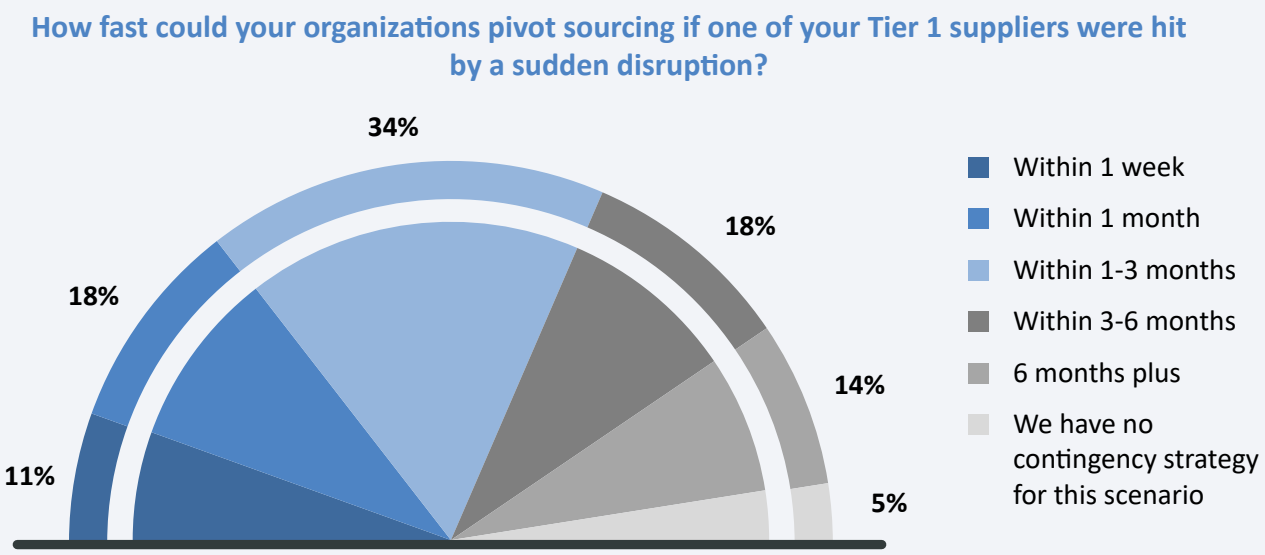

Figure 11. All respondents: *If one of your Tier 1 suppliers were hit by a sudden disruption, how fast could your organization pivot sourcing? (n=323)*

In this area, MROs are outperforming the other segments surveyed, with 39% of respondents stating they could respond to a Tier 1 supplier disruption within 30 days compared to 18% for aerospace manufacturers and 28% of AAM companies. Considering frequent global disruptions and shorter cycles of technology innovation, organizations across the aerospace ecosystem will need to become much more adaptive. Being at ease with perpetual change and having the tools and mindset to turn it to advantage will enable the industry to better navigate the shifting global environment.

Next steps: Strategic focus areas for future-ready skies

The decade ahead will redefine aerospace. Our analysis of the survey results found that leaders are betting on AI and digital twins to transform design and production, AAM to open new markets, and custom intelligence to empower decision makers.

We see several imperatives that could significantly influence aerospace over the next few years. Concerted effort in these areas will be critical for a successful transition that balances goals with requirements.

Build a responsive supply chain

Aerospace and aircraft companies must strengthen four foundational pillars to build supply chain resilience: supplier programs, predictive and cognitive ability, simulations and event-response procedures, and sourcing strategies. Success requires implementing “tier-N visibility” programs to see beyond direct suppliers, deploying AI-driven digital twins for end-to-end virtual replicas, and establishing control towers for real-time decision making. By leveraging machine learning for pattern recognition, blockchain for traceability, and simulation exercises to test preparedness, manufacturers can transform their supply chains into agile, intelligent ecosystems capable of withstanding disruptions from geopolitical tensions to material shortages.

Driving digital engineering excellence in aerospace

To stay ahead in the competitive aerospace industry, it's crucial to accelerate digital engineering transformation, going beyond the implementation of digital threads. Success hinges on adopting practices that seamlessly integrate design, simulation, manufacturing, and service operations throughout the product lifecycle. Organizations must focus on building connected digital engineering ecosystems. These ecosystems leverage enterprise digital threads to create data flows, establish control and visibility across the value chain, and speed decision-making with contextual insights. This convergence of capabilities leads to faster time-to-market, reduced physical prototyping costs, and enhanced quality through continuous simulation and optimization. The future demands enterprise-wide interoperability. This represents a fundamental shift from traditional document-based processes to fully integrated digital engineering workflows, positioning aerospace companies for sustained innovation and competitive advantage.

Create the AAM ecosystem

The success of advanced air mobility companies hinges on mastering three critical differentiators: advanced manufacturing capabilities, supply chain strategies, and MRO networks as the sector transitions from conceptual development to operational deployment. AAM companies must deploy vertically integrated production architectures with rapid design-manufacturing-test loops, leverage digital twins and model-based systems engineering for precision manufacturing, and adopt blockchain-based traceability for supply chain resilience. Winners will orchestrate entire aerial mobility ecosystems with industrial-grade backbone and digital precision, integrating out-of-autoclave composite fabrication, end-to-end digital thread integration, and predictive logistics platforms to achieve scalable production and operational excellence.

Digital transformation for MRO

The future of aerospace maintenance, repair and overhaul depends on embracing AI-driven digital transformation to handle increasing fleet complexity and the expected market growth to $137 billion by 2030. MRO providers must implement integrated platforms that unify AI-powered directive interpretation, dynamic workforce allocation, computer vision-based inspections, and predictive maintenance systems. By leveraging the hundreds of terabytes of aircraft data per flight currently underutilized, providers can reduce inspection times by 40%, improve labor utilization by 25%, and cut aircraft-on-ground time by 25%. Success requires transitioning from reactive maintenance to proactive, intelligence-driven operations through cohesive adoption of AI, machine learning, computer vision, and augmented/virtual reality technologies.

> The aerospace industry is undergoing a profound transformation, driven by the urgent need for intelligent, sustainable, and resilient operations. Environmental mandates, regulatory shifts, and global disruptions are accelerating the move to zero-emission propulsion—electric, hybrid, and hydrogen—while rising cybersecurity threats and supply chain vulnerabilities demand smarter, more secure ecosystems.
>
> To stay competitive, aerospace firms are embracing digital reinvention. AI-driven analytics, digital twins, and blockchain are improving visibility and decision-making. Predictive maintenance with robotics and drones is streamlining MRO, while advanced cybersecurity frameworks are safeguarding mission-critical data.
>
> Looking ahead, generative AI and quantum computing will redefine aircraft design and prototyping. Immersive AR/VR and AI-enabled training will bridge workforce gaps. Strategic nearshoring and automation will build operational resilience. For aerospace leaders, embracing these technologies is not optional—it's essential to drive innovation, agility, and sustainable growth in a rapidly evolving landscape.
>
> *– Sahaj Kumar, Associate Research Director, Avasant*

Study demographics

Aerospace executives

Respondents encompass three key segments across the aerospace industry ecosystem. These include:

- Aerospace manufacturers n=135
- AAM and eVTOL leaders n=50
- MRO leaders n=138

Country representation

Executive champions

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This study was made possible by the dedication and effort of countless team members. A special thank you to these leaders for their collaboration and support:

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Global Head – Services Marketing Group & TCS Thought Leadership Institute, TCS

Derek Baker; Srilatha Bezgoan; Mansha Dhingra; Savio Sanjay Dmello; Matthew Hardeman; Abhinav Kumar; Kimaya Nemade; Pravir Kumar Rai; Laura Rudolph; Swarnil Saxena; Sobha Varghese; Kunal Makhija

About the study

Driven by TCS Manufacturing, the TCS Future-Ready Skies Study 2025 explores how essential stakeholder segments in the aerospace ecosystem are navigating industry transformation. Between April - May 2025, the TCS Thought Leadership Institute conducted a muti-segment survey of 323 respondents representing aerospace OEMs, MRO providers, and electric aircraft manufacturers from across North America and Europe.

Some data presented will not add up to one hundred percent due to rounding, and not every answer is included in the findings reported.

Since 2009, the TCS Thought Leadership Institute has initiated conversations by and for executives to advance the purpose-driven enterprise. Led by Serge Perignon, the Thought Leadership Institute conducts primary research to deliver forward-looking and practical insights around key business issues to help organizations achieve long-term, sustainable growth. For more information, visit tcs.com/insights/global-studies

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About Tata Consultancy Services

Tata Consultancy Services (TCS) (BSE: 532540, NSE: TCS) is a digital transformation and technology partner of choice for industry-leading organizations worldwide. Since its inception in 1968, TCS has upheld the highest standards of innovation, engineering excellence and customer service.

Rooted in the heritage of the Tata Group, TCS is focused on creating long term value for its clients, its investors, its employees, and the community at large. With a highly skilled workforce of 607,979 consultants in 55 countries and 202 service delivery centers across the world, the company has been recognized as a top employer in six continents. With the ability to rapidly apply and scale new technologies, the company has built long term partnerships with its clients – helping them emerge as perpetually adaptive enterprises. Many of these relationships have endured into decades and navigated every technology cycle, from mainframes in the 1970s to Artificial Intelligence today.

TCS sponsors 14 of the world's most prestigious marathons and endurance events, including the TCS New York City Marathon, TCS London Marathon and TCS Sydney Marathon with a focus on promoting health, sustainability, and community empowerment.

TCS generated consolidated revenues of over US $30 billion in the fiscal year ended March 31, 2025. For more information, visit www.tcs.com

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TCS Future-Ready Skies

Reimagining Aerospace. Powering a Future Without Limits.

For over 90 years, the Tata Group has been at the forefront of innovation across engineering, manufacturing, and operations—enabling the aerospace, aviation, and defense sectors to enhance productivity, elevate passenger experiences, and reduce environmental impact.

At TCS, our **Future-Ready Skies** vision builds on this legacy, fueled by deep domain expertise, strategic collaboration, and cutting-edge technologies. We are reimagining the aerospace value chain to deliver meaningful, measurable outcomes. From accelerating product innovation and optimizing digitally driven production, to enabling faster, insight-led decisions through generative AI—TCS helps organizations operate with greater precision, agility, and foresight. Our platforms power predictive maintenance and resilient fleet operations, driving performance and sustainability at scale.

With advanced capabilities in generative AI, digital twins, and quantum computing, we help our customers unlock new levels of operational excellence while advancing bold sustainability ambitions.

By shaping intelligent, adaptive ecosystems, TCS empowers aerospace enterprises to lead confidently—navigating complexity, scaling innovation, and forging a path to a connected, efficient, and sustainable future.

Together, we are building skies that are not just future-ready—but future-defining.

For more information, visit: tcs.com/what-we-do/industries/manufacturing