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WORLD ECONOMIC FORUM

Advanced Air Mobility:
Paving the Way to Responsible Implementation

WHITE PAPER

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Foreword

Arunima Sarkar
Head of Frontier Technologies, Centre for the Fourth Industrial Revolution, World Economic Forum

Javier González
Partner, Kearney;
Co-Founder of the Kearney Advanced Mobility Institute

Advanced Air Mobility (AAM) is now an unfolding reality, one that has the potential to redefine how people and goods move across our skies, and one that will unlock additional services such as infrastructure inspection and wildfire detection. Yet unlocking this potential requires more than technological innovation; it demands a coordinated, strategic approach across industry, governments, civil society and academia.

To support this transition, the *AVIATE: Advanced Air Mobility* initiative has been at the forefront of shaping the responsible development and deployment of AAM into global transportation systems. Since its inception, AVIATE has brought together more than 40 industry-leading organizations – ranging from regulatory bodies to OEMs (original equipment manufacturers), operators and infrastructure providers – to develop actionable solutions to the most pressing AAM challenges. Our focus has been on driving real-world progress through practical implementation strategies that ensure AAM's growth is safe, sustainable and equitable.

This white paper synthesizes the main insights and charts a path forward for AAM's next stage of maturity. It outlines the most urgent priorities and the corresponding enabling actions that will define the industry's trajectory, emphasizing the need for collaboration and alignment across the value chain. The paper also reinforces the importance of leading principles in guiding AAM's implementation, ensuring that its development not only meets economic and operational objectives but also serves broader societal goals by being responsible. Finally, this paper provides an overview of lessons learned from real-world drone projects with the aim of transferring knowledge to other AAM vehicle projects – concrete examples of what works and what the broader AAM industry can learn from early movers.

AAM's impact extends across sectors, affecting, among others, healthcare, logistics, emergency response and urban mobility. However, coordination is needed to unlock this impact and to ensure deployments help advance societal, environmental and economic goals. The AVIATE initiative and its multistakeholder community remain dedicated to supporting this effort, inspiring the collaboration necessary to navigate the challenges ahead.

The road to large-scale AAM adoption is still being paved, but the direction is clear. The insights and recommendations presented in this paper provide a foundation for the next phase of industry development, one that will be shaped by collective action and a commitment to innovation that serves both business and society. We invite all stakeholders to join us in advancing this vision, ensuring that the skies of the future are not only more connected but also more sustainable and inclusive.

Executive summary

Advanced Air Mobility (AAM) is transitioning from concept to reality, with real-world implementation already progressing across selected use cases.

While drones have already gained traction, especially for societal use cases, to progress other use cases, as well as the broader integration of AAM into transportation networks, requires additional efforts and industry-wide coordination.

Successful AAM implementation hinges on mobilizing the full value chain – authorities, infrastructure providers, investors, suppliers, OEMs (original equipment manufacturers) and operators – around clearly defined and aligned priorities, responsibilities and enabling actions. Progress will not come from isolated efforts but from joint, structured action addressing multiple shared interdependencies. The joint priorities are situated at a strategic level and span multiple dimensions, ranging from technological readiness to operational maturity over regulatory evolution and market viability. Priorities include aligning regulatory frameworks with operational needs, deploying infrastructure for both light and heavy AAM vehicles, ensuring airspace integration and building commercially viable models that earn societal trust.

Having a clear and shared north star across stakeholders helps ensure alignment in efforts across the value chain. This white paper outlines 11 key principles as a central vehicle to ensure responsible industry growth. These principles serve as a critical foundation, ensuring that AAM is not only technologically and commercially viable but also safe, sustainable and equitable. Their application varies by use case but remains essential for building long-term trust and societal acceptance. These 11 principles are segmented into three responsibility pillars:

- **Safety and security** as a non-negotiable foundation for every deployment
- **Societal and environmental sustainability** as a guiding benchmark for long-term value creation
- **Resilience and economic growth** that balances innovation with public interest

In doing this, the suggestions support real-world decision-making and help manage complexity across the industry. The paper illustrates how these principles translate into real-world decisions, reinforcing the need for a values-driven approach to AAM development.

The path forward also benefits from a good understanding of the lessons learned from pioneering real-world drone projects. Although less complex than AAM deployments with larger vehicles, drone deployments have faced several hurdles that they have now overcome. The learnings from drone projects offer valuable direction for scaling additional AAM applications. Cross-cutting lessons from drone operations show that success requires three enablers:

- **Operational feasibility** through early stakeholder coordination
- **Financial viability** through scalable and modular deployment models
- **Social acceptance** through visible public benefits and local partnerships

Real-world drone use cases – including humanitarian disaster relief, healthcare and environmental monitoring – demonstrate how mission-specific ecosystems can be built using affordable technology, open-source platforms and agile coordination across national and local actors. These insights offer a transferable blueprint for other AAM vehicles.

With AAM steadily progressing towards real-world deployment, the aviation industry is poised to change significantly over the coming decades. The industry has made significant strides, but the road to large-scale AAM adoption is still being paved. Major gaps remain. For example, larger AAM aircraft face untested challenges related to high-CAPEX business models, robust maintenance ecosystems and deeper multimodal integration. Future success will require sustained investment, regulatory clarity and continued cross-sector collaboration to achieve responsible AAM implementation. Beyond improving air transport, AAM has the potential to reshape industries, with applications spanning from tourism to emergency response, elevating the aviation experience while delivering tangible societal benefits.

Now is the time to act to ensure this transformative period leads to positive outcomes. AAM's success hinges on global collaboration, industry-wide commitment and a shared dedication to responsible implementation. The next phase will not only define the pace of adoption but also determine the long-term role of aviation in society.

Introduction: Pursuing the large-scale implementation of AAM

Advanced Air Mobility, although still in its emerging phase, is expected to evolve into a substantial and transformative industry.

The aviation sector is entering a new innovation area as a result of Advanced Air Mobility (AAM) developments. AAM allows for new use cases in passenger transport (e.g. point-to-point shuttles and medical evacuation), cargo transport (e.g. heavy air cargo and last-mile parcel delivery) and other services (e.g. inspection and maintenance).[1]

The AAM term is used by the industry to encompass the deployment of many different types of vehicles, from smaller drones to larger electric aircraft such as vertical take-off and landing (VTOL) and short take-off and landing (STOL) craft. These vehicles are innovating the aviation sector in different ways, including in relation to their autonomy capabilities and novel propulsion systems. All combined, the market for AAM is projected to grow significantly, with estimates suggesting it could reach close to $80 billion by 2034.[2] The expected AAM market growth is driven by the need for efficient, sustainable and rapid transportation solutions, both in increasingly congested urban environments and in underserved suburban and rural areas where infrastructure is limited.

Although AAM is still in its early stages, the momentum is real. Some segments of the AAM industry, particularly drone applications, are starting to transition from an early emerging phase into a growth phase. Globally, there are hundreds of drone pilot projects in the deployment phase, some of which have moved from the pilot phase into regular operations.

Other AAM segments, despite the fact that they are in earlier stages of their development, are also garnering increasing attention, as this is the point at which substantial investment is required to build the necessary infrastructure and capabilities and to ensure that the rigorous and demanding certification standards of the aviation sector will allow their deployment. Looking back, traditional aviation also began slowly – initially serving only a narrow set of applications – before becoming one of the cornerstones of the global economy.

The past aviation timeline and lessons learned, as well as initial lessons from drone implementations, can help diverse AAM segments to pursue their expected potential.

To this end, this white paper focuses on three key critical points for AAM implementation:

- First, aligning on a north star for responsible AAM implementation. This involves examining what responsibility means in the context of AAM and establishing the principles to guide this process. A responsible vision and mission for the industry is also important for unlocking social acceptance of this incipient technology. This is discussed in Section 1.

- Second, understanding the current priorities of the different stakeholders along the value chain and identifying enabling actions to enable their success. The strong interdependencies among stakeholders require collaboration across stakeholders, from authorities to investors, and from OEMs to operators. This is discussed in Section 2.

- Third, analysing lessons learned from early drone deployments. They serve as valuable insights for larger drone deployments, as well as for early pilots in other AAM segments with larger aircraft types. Lessons learned are primarily derived from societal use cases and highlight both the relevance of these applications as well as the complexity of implementation in real-world environments. This is discussed in Section 3.

Taken together, these three points set the foundation for responsible and successful AAM implementation as the vision of having drones and other AAM vehicles implemented at a large scale becomes more tangible. Moreover, the rapid advances in technology and the growing demand for innovative transportation solutions underscore the urgency to act now.

1 Establishing responsible implementation as the north star for AAM efforts

Responsible AAM implementation rests on three pillars: ensuring safety and security; advancing societal and environmental sustainability; and inspiring resilience and economic growth.

In strategic contexts, a north star is a guiding vision that helps align existing and upcoming efforts with a common goal. Responsibility in transportation involves creating systems that are safe, environmentally friendly, economically viable and beneficial for wider society. For the AAM industry, having a north star that is followed by all stakeholders is crucial to ensure acceptance from regulators and the wider public of this incipient technology. This, in turn, creates a strong foundation for achieving efficient implementation and long-term viability for the industry. The purpose of this section is to detail the concept of responsibility through leading principles and examples of concrete actions.

Narrowing it down, responsibility in the specific area of AAM can be categorized into three pillars:

- Safety and security
- Societal and environmental sustainability
- Resilience and economic growth

These three dimensions work towards the overall aim of creating a positive impact on society through AAM solutions. Figure 1 defines these three pillars in the context of AAM. For example, the inclusivity aspect in the societal dimension ensures that the roadmap for AAM implementations goes beyond serving an initial premium segment and helps enhance mobility for underserved communities, such as those lacking infrastructure. Overall, these three pillars are essential for building AAM implementations that are not only technologically advanced but also widely accepted and beneficial to the wider public.

Building on these pillars, Figure 2 translates responsibility into 11 principles, which make the concept of responsibility more tangible. They were developed building on the urban sky principles, published by the World Economic Forum.[3] They help provide a clearer framework for stakeholders along the value chain to follow when making design and deployment decisions, ensuring that safety, sustainability, resilience and economic growth are prioritized throughout the whole implementation process.

FIGURE 1 | **Responsibility pillars in the context of AAM**

Responsibility in AAM implementation

Safety and security

Ensuring secure operations, public safety and robust cybersecurity to protect lives and build trust

Societal and environmental sustainability

Reducing emissions, using sustainable materials and providing inclusive, affordable access to AAM services while engaging communities to promote benefits for society and the environment

Resilience and economic growth

Building resilient AAM systems that can adapt to changing conditions and developing sustainable business models to support long-term economic growth

Source: World Economic Forum

FIGURE 2 | **Key principles for responsible AAM implementation**

Infrastructure integration
Emphasize integration into multimodal transportation strategies to enhance connectivity and efficiency

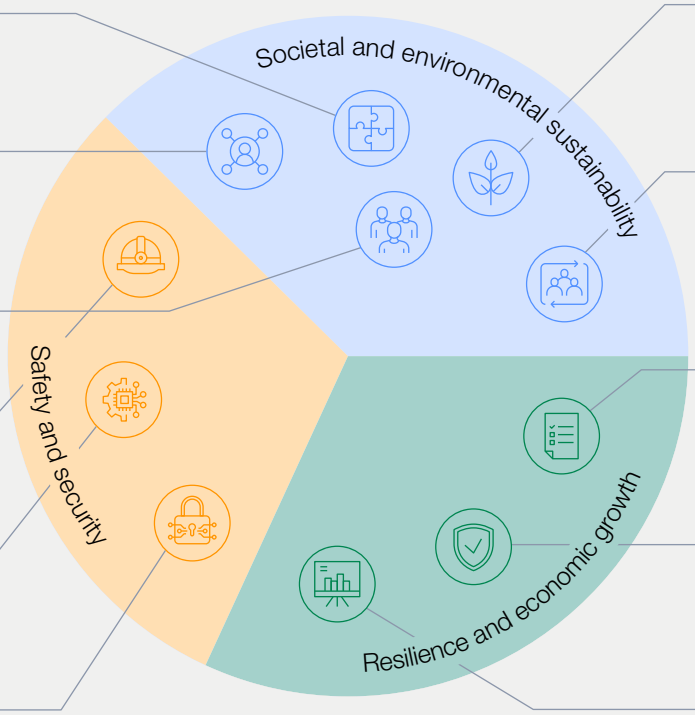
Community engagement
Engage with communities to understand and address their concerns

Equity of access
Promote equitable access to AAM services for all communities

Safety first
Prioritize safety in all aspects of AAM operations

Data privacy
Protect the privacy and security of data collected through AAM operations

Cybersecurity
Implement robust cybersecurity measures to protect AAM systems from threats



Sustainability
Ensure AAM contributes to environmental sustainability including noise pollution

Human-centricity
Promote a human-centred approach in AAM development to enhance user experience and acceptance

Interoperability
Include the need for interoperability across different AAM systems and platforms to ensure seamless operations

Reliability
Design AAM systems to be robust against disruptions (e.g. weather, technical failures) and adaptable to changing conditions

Business viability
Develop and maintain sustainable business models to ensure long-term growth

Safety and security | Resilience and economic growth | Societal and environmental sustainability

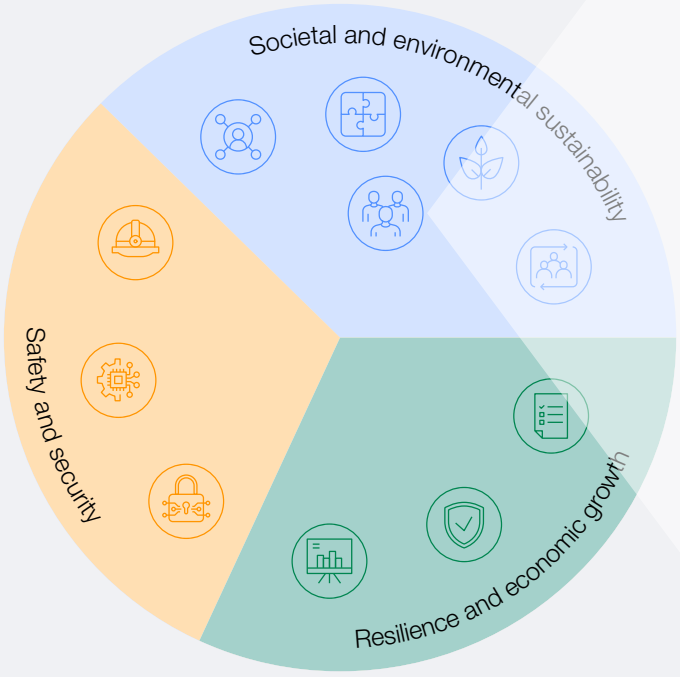
Source: World Economic Forum

When considered early, these principles help ensure that the actions taken align with the long-term needs of the industry and society, and they prevent negative consequences resulting from irresponsible or short-sighted implementation. Additionally, aligning to the principles can help inspire public trust, reduce delays and accelerate adoption. For example, building resilience in from the outset helps avoid costly disruptions later. As such, responsibility – and to this end the outlined principles – should not be seen as a constraint but rather as a lever to reduce risk and create long-term value.

Applied across the entire implementation journey, the principles offer consistent guidance through complexity and uncertainty. Some principles, such as safety first, need to be strictly followed from day one, while others, such as equity of access, will only reach their full potential as the industry matures. They all help stakeholders stay focused on shared goals, however, enabling responsible growth and sustained public support. Box 1 highlights examples of how selected principles can be applied across various AAM use cases.

BOX 1 Application of selected key principles in specific AAM use cases

As AAM moves from concept to implementation, the application of key principles becomes essential for guiding real-world decision-making. In the examples below, three selected principles – equity of access, human-centricity and interoperability – are explored in an illustrative manner across different AAM use cases. It is important to keep in mind that the way a principle is applied varies depending on the context, stakeholders involved and maturity of the implementation. Nevertheless, the examples illustrate how embedding principles into the design and operation of AAM services helps align innovation with broader societal goals.

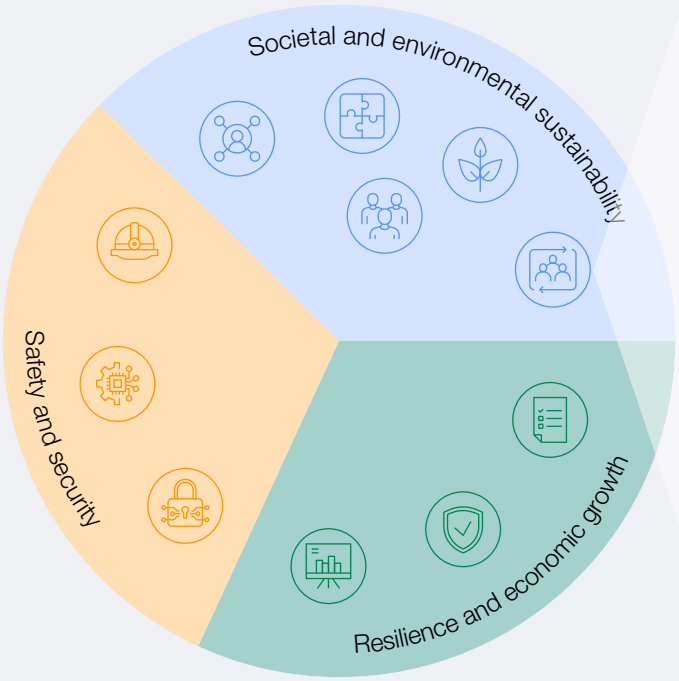


Equity of access

Case example: Air taxis

Goal: Make air taxis more accessible

Benefits	Examples of actions in line with the principle
Inclusive mobility	— Establish dedicated routes and services for underserved areas to ensure consistent access — Partner with local governments to subsidize fares for low-income passengers when no alternative is available
Enhanced connectivity	— Develop infrastructure in underserved areas to support air taxi operations, such as vertiports and charging stations — Integrate air taxi services with existing public transportation systems to create seamless travel experiences
Greater social equity	— Engage with local communities to understand their specific needs and tailor services to address those needs effectively — Conduct outreach programmes to educate and inform communities about the benefits and usage of air taxi services

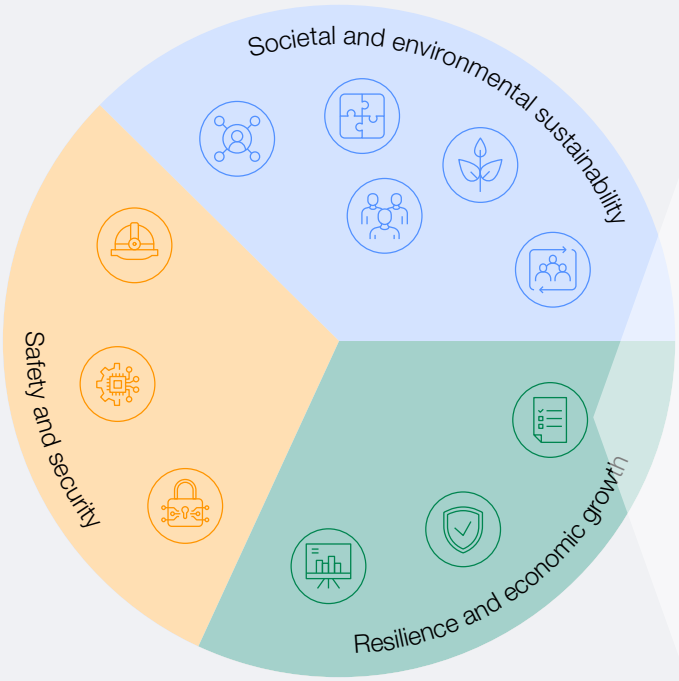


Human-centricity

Case example: Remote B2C delivery drones

Goal: Make human–technology interaction easier for remote B2C delivery drones

Benefits	Examples of actions in line with the principle
Enhanced user experience	— Conduct user research and usability testing to gather feedback and improve the delivery process — Incorporate accessible design features to accommodate customers with different needs
Increased public acceptance	— Engage with communities through workshops and focus groups to understand their expectations — Communicate design choices and safety measures to the public transparently
Higher adoption rates	— Adapt ordering and delivery processes to users' environment to enhance convenience of various customer needs — Offer personalized delivery options to cater to diverse customer requirements



Interoperability

Case example: Heavy-lift drone logistics

Goal: Make heavy-lift drone logistics interaction possible with other physical or digital infrastructure

Benefits	Examples of actions in line with the principle
Amplified integration	— Develop standardized protocols and interfaces for data exchange between digital systems — Collaborate with industry stakeholders to establish common interoperability standards
Improved efficiency	— Implement interoperable software, hardware and processes across different heavy-lift drone platforms — Train personnel in the use of interoperable systems to ensure smooth operations
Eased scalability	— Design modular and scalable drone infrastructure that can adapt to existing and future technologies — Update interoperability standards to accommodate technological advancements regularly

Source: World Economic Forum

2 Aligning stakeholder roles for responsible AAM implementation

AAM advances require aligned roles and responsibilities, structured priorities and enabling actions and a commitment to responsible implementation.

With AAM moving steadily towards real-world implementation, it is necessary to identify the collaborative steps needed to unlock further progress. While certain applications have already gained traction, unlocking additional use cases and integrating AAM into transportation networks remains a long-term effort, as outlined in Section 1. This evolution demands not only innovation but also system-wide collaboration across a dynamic and evolving value chain.

To get there, the industry needs to overcome a set of persistent hurdles:

- **Technological readiness:** The development of AAM solutions requires advances in battery technology, autonomy capabilities, air traffic management systems and vehicle reliability. Ensuring seamless integration into existing airspace infrastructure remains a major milestone.
- **Operational maturity:** Scalable deployment of AAM relies on the ability to manage fleets efficiently, secure take-off and landing zones and integrate AAM into broader multimodal transport networks.
- **Regulatory evolution:** Authorities worldwide are still defining the frameworks for AAM, balancing innovation with public safety, privacy and societal acceptance. Without clear regulatory pathways, large-scale investment and deployment remain constrained.
- **Market viability:** The economics and value unlock of AAM must be compelling for both public and private investors. Business viability, cost-efficient infrastructure and value-add use cases are critical to making AAM commercially viable.

The challenges in these four categories do not exist in isolation. For example, a breakthrough in one area – such as vehicle technology – adds value only if other parts of the system (e.g. regulation, infrastructure and economics) are ready to support it. This interconnectedness underscores the need for strategic alignment and collaborative execution among stakeholders across the AAM value chain. Thus, AAM will only reach maturity through a gradual, collaborative shift.

Moreover, implementing AAM at scale is not a linear process; it is a multidimensional challenge that demands synchronized efforts from stakeholders across different domains. All stakeholders involved play a role in driving AAM forward – the stakeholders together make up the value chain necessary for AAM implementation. However, to drive progress, value chain stakeholders must take ownership of distinct priorities while recognizing the critical role of collaboration in achieving them. Each group carries unique responsibilities, with specific priorities that reflect their role in scaling AAM responsibly:

- **Authorities** define the legal and regulatory frameworks that shape safety, airspace integration, certification and societal acceptance. Their priorities include closing transportation gaps, enabling growth beyond societal concerns, establishing international standards and promoting stakeholder engagement.
- **Investors** provide funding for early pilots, industrial ramp-up and infrastructure deployment – balancing risk with long-term growth potential. Priorities for investors include applying mission-oriented investment strategies, getting clarity on business potential, ensuring economic viability, diversifying funding sources and promoting environmental, social and governance (ESG) investments and sustainable life cycle.

- **Infrastructure providers** deliver the physical and digital backbone (e.g. vertiports, energy supply, connectivity) required for safe and efficient operations. Their priorities include creating modular infrastructure, elevating existing facilities, establishing standards and architectural interoperability and introducing public–private concessions for AAM operations.

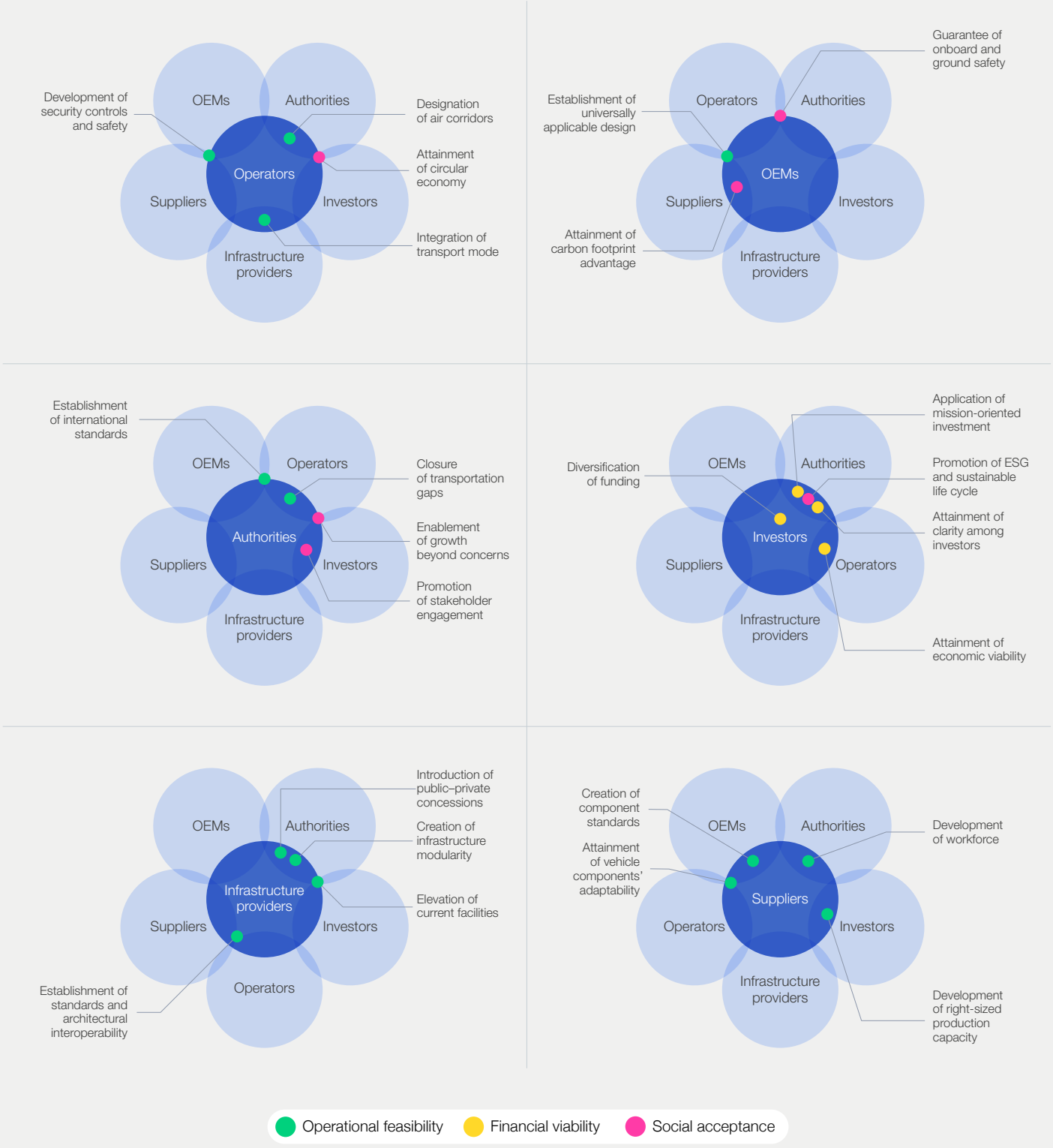
- **Suppliers** develop critical systems such as propulsion, batteries, sensors and avionics, enabling both safety and efficiency. Their priorities involve designing adaptable vehicle components, developing the right-sized production capacity, building a technologically competent workforce, creating component standards and ensuring secure, strategic sourcing.

- **OEMs** develop certified AAM vehicles, often coordinating closely with both regulators and suppliers. Their priorities are focused on guaranteeing onboard and ground safety, establishing universally applicable vehicle designs, getting certified vehicles and reaching product-market fit.

- **Operators** bring AAM services to life by designing, launching and scaling real-world use cases – connecting technology with users and integrating AAM into mobility networks. Their priorities include designating air corridors, developing robust security and safety controls, enabling digital operations, ensuring integration with other modes of transport and achieving circular economy outcomes.

These key priorities are not exclusive to any one stakeholder group but are deeply interconnected across the whole value chain. Figure 3 highlights the main interconnections of these priorities with other stakeholders. Indeed, while each stakeholder group brings distinct priorities and responsibilities, only through joint enabling actions can the industry address the priorities that will shape AAM's future. These enabling actions are the glue that aligns efforts, reduces friction and accelerates outcomes.

FIGURE 3 | **Connections between key priorities**



Source: World Economic Forum

Further to Figure 3, below some of the interconnectedness of four of the mentioned priorities are analysed in more detail, highlighting the importance of coordination and collaboration across stakeholders:

- **For authorities,** ***establishing international standards*** is a key priority. Achieving this requires robust technical knowledge and validated data, especially on safety and airspace integration. **OEMs** can contribute to this process by, among other things, co-developing cross-sector airspace simulation environments. Such shared tools enable testing of edge cases across vehicle types and geographies, creating a strong, common foundation for international rule-making.

- **For authorities,** ***addressing the closure of transportation gaps*** is critical for ensuring public acceptance and sustainable industry growth. **Operators** can play a supporting role by engaging in public dialogue, by helping to shape coordinated communication strategies and by contributing data and insights from early deployments. The hands-on experience of operators makes them essential allies in closing transportation gaps.

- **For suppliers,** ***improving the adaptability of vehicle components*** is essential for supporting diverse platforms and evolving requirements. This can only happen efficiently if **OEMs** lead modular platform initiatives, trying to provide transparency around future interface standards. With greater alignment early in the design process, suppliers can reduce redesign cycles and speed up development, which benefits the whole value chain.

- **For suppliers,** ***developing a technologically competent workforce*** is a pressing challenge as the AAM industry scales. **Authorities** can support this by co-designing skills development programmes, including vocational training, certification pathways and regional incentives. This is especially important in emerging production hubs and underserved areas where workforce gaps could limit industrial growth.

Working groups, regulatory sandboxes, public–private partnerships and shared development platforms, which are emerging in different regions of the world, are vital mechanisms through which cross-stakeholder priorities are being advanced and interconnectedness is maturing. Additionally, it is important to keep in mind that the value chain itself, and the related priorities and dependences across stakeholders, are evolving over time as the industry matures – from vertically integrated to an ecosystem where stakeholders specialize and work in tandem to scale operations.

3 Learning from real-world drone deployments

Real-world drone projects show the importance of low-cost technology and can inform and benefit the wider AAM industry.

Beyond the differing priorities of stakeholders, hands-on experience is invaluable: real-world deployments are proving essential for the advancement of the emerging AAM industry. To date, most early deployments have focused on drone operations, particularly in logistics and healthcare, where initiatives are moving from pilot projects to larger-scale, routine operations. As a result, drones serve as a practical proxy for the broader AAM sector, offering critical lessons and operational insights that can inform the development and deployment of other AAM vehicles. This makes drones a natural starting point for extracting actionable learnings to support the wider implementation of AAM solutions.

Despite the diversity in size, mission and technological complexity, drones and other AAM vehicles face many of the same foundational challenges, such as securing regulatory approvals, integrating into airspace, building the necessary infrastructure and earning public trust. These are not just technical or operational challenges, they are systemic enablers, and they are just as critical for the successful deployment of passenger-carrying vehicles.

Drone applications have already demonstrated the viability of scaled aerial operations through real-world use cases. These deployments have provided important cross-cutting lessons across three critical dimensions: operational feasibility, financial viability and social acceptance. Table 1 summarizes key lessons learned from drone operations that are transferable to larger aircraft, and the rationale for their transferability. All lessons are the result of analysis of real-world deployments. Thus, the value is two-fold: first, they offer guidance to support the expansion of drone operations; and second, they contribute to advancing and speeding up the development and integration of larger AAM vehicles.

TABLE 1 **Lessons learned from real-world drone projects and their transferability to broader AAM operations**

Dimension	Lessons learned from real-world drone deployments	Transfer to other AAM vehicles	Rationale for transferability
 Achieving operational feasibility	Focusing on rural areas first proves to facilitate early adoption of drone operations	Prioritizing regional and suburban routes can also accelerate adoption of other AAM vehicles, but it might require a significant infrastructure effort for larger vehicles	Comparable airspace complexity and infrastructure constraints favour less congested areas for early deployment
	Adopting high level of automation proves to improve efficiency but also bringing new safety challenges	Integrating a high level of automation can enable efficiency and fleet management but can also involve new types of errors and challenges in human–machine interaction	Similar challenges with high level of automation, such as detect-and-avoid errors, or emergency decision-making limitations
	Implementing low-latency communication systems proves to enable fleet management and thus economies of scale	Deploying high-speed, fail-safe communication networks can be an enabler for AAM vehicles with high level of automation	Comparable reliance on real-time connectivity for autonomous coordination, airspace integration and congestion management
 Achieving financial viability	Entering high-value markets improves profitability and leads to faster ROI	Targeting premium air mobility services can enable early financial sustainability for AAM, but societal use cases, such as essential air services, will be vital for long-lasting operations	Comparable reliance on real-time connectivity for autonomous coordination, airspace integration and congestion management
	Diversifying revenue streams improves financial stability	Monetizing idle fleet capacity can create new revenue sources for larger aircraft operators (e.g. combined use cases of passenger and cargo)	Similar need to maximize asset use and revenue potential across multiple operational models
	Implementing predictive maintenance is critical for maximizing asset use	Deploying robust efficient maintenance processes can enable smooth operations	Similar requirement to minimize downtime and operational disruptions in safety-critical mobility ecosystems
 Achieving social acceptance	Ensuring inclusive services proves to inspire social acceptance	Ensuring inclusivity can lead to social acceptance; additionally, inclusivity in one service can generate a ripple effect, encouraging acceptance across diverse AAM use cases	Comparable acceptance model in which inclusivity enables social acceptance
	Maintaining transparency in operations proves to build public trust	Implementing awareness campaigns can strengthen public confidence in broader AAM adoption	Equivalent requirement for proactive communication to address concerns about safety, noise and regulatory oversight
	Forming strategic alliances proves to enable operations in a fragmented industry landscape	Forming strategic alliances can enable larger aircraft operations, even though that industry does not have a similarly fragmented landscape	Equivalent need for partnerships to navigate evolving regulations, infrastructure development and ecosystem integration

By examining the path that drones have taken in specific use cases, stakeholders can better anticipate obstacles, experiment with solutions and build collaborative frameworks – all essential for responsible AAM implementations. Much like commercial aviation evolved through iterative learning and progressive scale, AAM can similarly benefit from knowledge transfer and structured advances. Further to the overall learnings from Table 1, Boxes 2, 3 and 4 also dive into three specific applications in greater detail.

BOX 2 | Lessons from disaster response applications: Building a mission-specific ecosystem

One standout example of successful drone deployment in a societal context is the **World Food Programme's Digital Engine for Emergency Photo-Analysis (DEEP) initiative**.[4] In the wake of natural disasters, the WFP has used drones combined with artificial intelligence (AI) to assess damage and inform emergency response strategies more quickly and safely. Launched in 2017, the WFP's drone programme aims to improve preparedness and response to humanitarian emergencies by using aerial imagery and advanced data analysis.

Relevance and impact: Traditional methods of assessing damage post-disaster are often time-consuming and hazardous, involving ground teams navigating through potentially unsafe terrains. Recognizing the need for a more efficient approach, WFP identified the potential of drones to provide rapid, high-resolution imagery of affected areas. This capability allows for swift evaluation of damage to infrastructure, identification of inaccessible regions and informed decision-making regarding resource allocation and intervention strategies. For this purpose, WFP makes use of conventional end-user drones, requiring limited investments in infrastructure and maintenance, leading to limited costs for flying itself.

The success of the DEEP initiative is rooted in WFP's collaboration with a diverse network of partners. Engaging with academic institutions such as the Polytechnic University of Turin, WFP has enhanced the DEEP platform's machine learning algorithms to analyse both drone and satellite imagery effectively. Additionally, partnerships with organizations such as the German Aerospace Center (DLR) have expanded DEEP's capabilities to include infrastructure assessments like road conditions. On the ground, WFP works closely with national disaster management agencies, local service providers and technical working groups to ensure the seamless integration of drone operations into existing emergency response frameworks – always treating safety top of mind.

DEEP has been deployed in various countries, including Mozambique, Lebanon, Colombia, the Dominican Republic and Malawi, demonstrating its versatility across different disaster contexts. The platform's ability to operate offline addresses challenges related to connectivity in remote areas, ensuring that critical data analysis can proceed uninterrupted. By automating the damage assessment process, DEEP significantly reduces the time required to generate actionable insights, thereby enhancing the overall efficiency of humanitarian interventions.

WFP's DEEP initiative exemplifies the transformative potential of drone technology in humanitarian response. By addressing specific operational challenges through strategic partnerships and technological innovation, DEEP has set a precedent for the effective use of unmanned aerial systems in disaster management. This case underscores the importance of adaptability, collaboration and technological integration in enhancing the efficacy of humanitarian efforts worldwide.

Key lessons learned:

1. DEEP highlights the importance of building mission-specific ecosystems that combine low-cost hardware, open-source platforms and local know-how.

2. In both drone and future AAM vehicle deployments, especially in public service use cases, success will hinge not only on the aircraft itself but on the surrounding infrastructure, stakeholder coordination and regulatory agility.

BOX 3 | **Lessons from environmental monitoring applications: Boosting capabilities with image processing**

Another standout example of successful drone deployment in a societal context is **Costa Rica Flying Labs**. Part of a global network of local drone, data and AI hubs, Costa Rica Flying Labs enables communities to use drone technology for social good – notably in proactive environmental monitoring. In the country's Caribbean coastal regions, the NGO Guardian del Bosque has partnered with Flying Labs to protect sensitive ecosystems from human encroachment, monitor critical water resources and promote sustainable development. Traditional manual methods were too slow and limited in scale, prompting the launch of a drone-based initiative to deliver high-frequency, high-resolution data while building local capacity for environmental stewardship.

Relevance and impact: Traditional ecosystem monitoring involved ground teams surveying large tracts of land, a method that was time-consuming, limited in coverage and reactive rather than preventative. Recognizing these limitations, Flying Labs, with the support of WeRobotics, introduced drone technology into their conservation efforts. Using a single consumer drone, they conducted 10 flights covering approximately 100 hectares of sensitive terrain. The true innovation lay not only in capturing high-resolution imagery but in analysing multispectral environmental data to monitor changes and track specific tree species vital to local biodiversity, including parrot habitats.

Operational simplicity was a vital feature: the system required only the drone and several batteries, making it highly adaptable for field conditions with minimal infrastructure. By training local staff to pilot drones and interpret the resulting data, the initiative inspired a sense of ownership and built technical capabilities within the community itself. This model emphasized that effective environmental monitoring is not just about technology deployment but about creating a lasting, locally managed ecosystem of skills and knowledge.

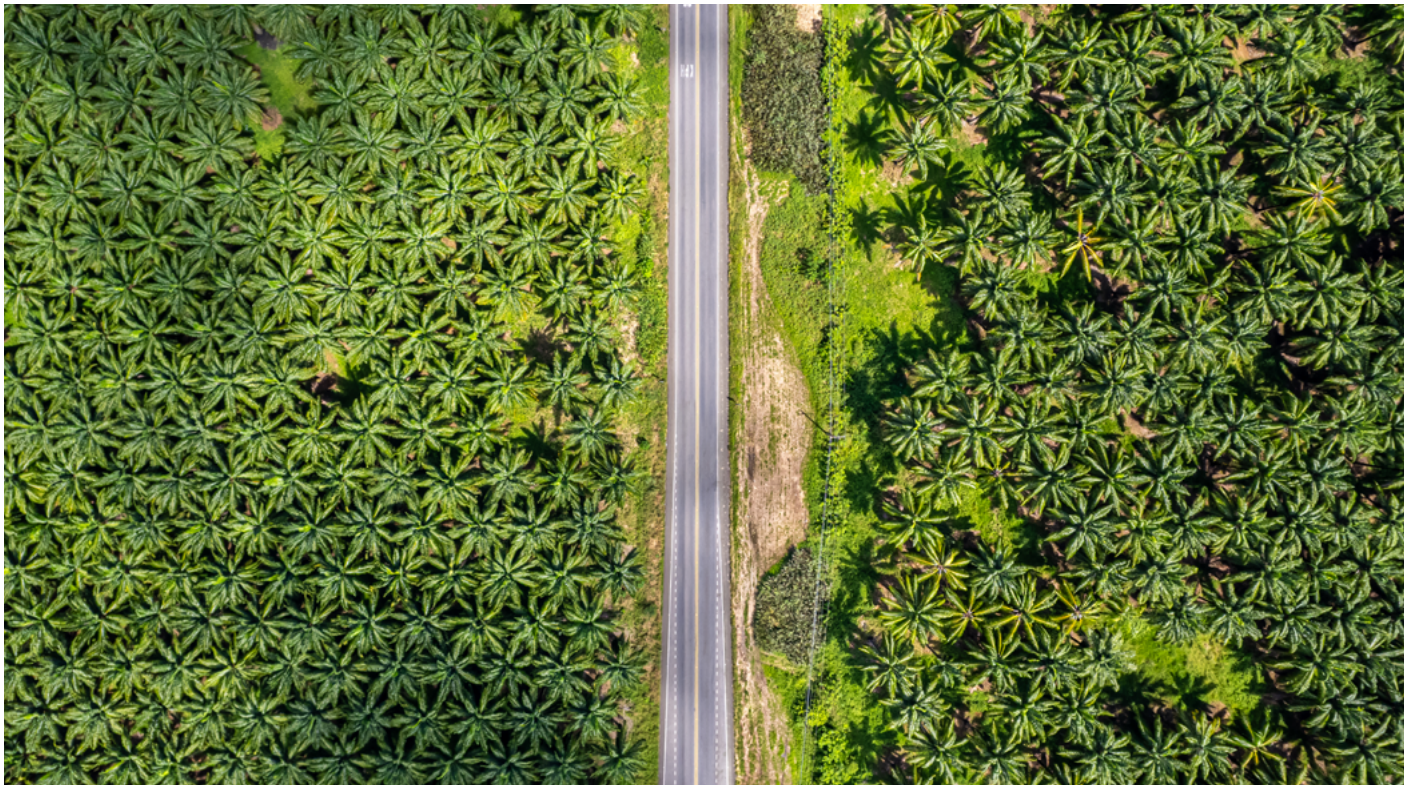
The success of Flying Labs was built on collaboration. Flying Labs led field operations and community engagement as well as providing technical training and operational support. Looking ahead, partnerships with Costa Rica's National System of Conservation Areas (SINAC) and private-sector actors in tourism and construction are being explored to expand the programme's reach and embed environmental monitoring into broader sustainable development efforts.

The initiative has sparked a greater awareness among local stakeholders regarding the possibilities of integrating technology into conservation efforts. Future plans include mapping climate-resilient zones that could serve as future wildlife refuges, developing software tools to automate vegetation analysis and scaling up local training programmes to ensure the community's long-term autonomy in managing environmental data.

Key lessons learned:

1. Costa Rica Flying Labs highlights the power of pairing simple, low-cost drone technology with strong local capacity-building to create sustainable environmental monitoring ecosystems, especially in areas where access is restricted due to difficult natural surroundings.

2. In drone deployments for monitoring, a regular revisiting of the same points is necessary to understand evolution over time, particularly when considering the required interaction with advanced image analysis tools.



BOX 4 | **Lessons from medical delivery applications: Accelerating adoption via multistakeholder collaboration**

One more example of the ways drones have been operated successfully in a societal context is **India's Medicine from the Sky (MFTS) initiative**.[5] In rural and remote regions of India, particularly in rural Telangana and in the mountainous Himalayan state of Arunachal Pradesh, healthcare delivery is often hindered by challenging terrain and poor infrastructure. The MFTS initiative, launched to address these challenges, uses drones to rapidly transport medical supplies and samples to areas that are otherwise difficult to access. The programme aims to improve the speed and efficiency of healthcare delivery in regions that face frequent stockouts and delayed medical deliveries, improving both the reach and effectiveness of healthcare services.

Relevance and impact: Traditional methods of delivering medical supplies in these areas are slow and unreliable, with road transport often taking several hours even for short journeys. In emergencies, such as snakebites or the need for life-saving medications, delays can be fatal. By taking advantage of drone technology, MFTS can deliver supplies much faster, often reducing delivery times by up to 10 times compared to road transport. The drones operate with minimal infrastructure needs, relying on basic landing zones and charging points and use real-time GPS to ensure safe, efficient operation. Drone service providers, such as Redwing Labs, manage the operation, which keeps costs low and ensures scalability.

The success of MFTS is rooted in collaboration between various stakeholders. The initiative has worked closely with government bodies like the Indian Ministry of Civil Aviation, which provided regulatory support, and local healthcare providers, such as Apollo Hospitals, and local collectorate districts in the areas of implementation and the corresponding state governments that facilitate the integration of drone technology into the healthcare system. Additionally, technical partners have ensured that drones are capable of handling temperature-sensitive deliveries, crucial for maintaining the efficacy of vaccines and other medications. The Ministry of Civil Aviation's collaboration and support of these projects, alongside local government support, has been essential for ensuring operational success.

MFTS has been deployed in regions with limited connectivity, overcoming one of the significant challenges faced by those in remote areas. The drones are able to operate efficiently even when connectivity is poor, thanks to their automated systems and offline capabilities. By facilitating more frequent and timely deliveries, the initiative helps to reduce stockouts and ensures that life-saving medicines are available when needed most.

Key lessons learned:

1. The MFTS initiative underscores the importance of building networks that integrate local knowledge, low-cost drone technology and sufficient infrastructure to enable successful deployments in remote areas.

2. Success in public service drone use cases, such as healthcare, will not only depend on the capabilities of the drones themselves but also on effective coordination among stakeholders, robust regulatory frameworks, self-sufficiency and the necessary ground infrastructure to support operations.

While drone operations provide valuable insights into the implementation of AAM, particularly around operational feasibility, financial viability and social acceptance, they represent only the first step on a much longer journey. Also, drone operations still need to scale further across a wide range of use cases, with new challenges and learnings that will be encountered along the way. Still, first learnings from drone deployments offer some transferrable lessons for a number of challenges in deploying larger aircraft, such as VTOLs, CTOLs and STOLs. These learnings will need to be combined with forward-looking strategies that prepare for the complexities of higher payloads, longer ranges and deeper integration into transport networks.

Conclusion

Shaping the future of AAM requires ensuring responsibility across the value chain.

With AAM already making inroads into real-world deployments, a responsible path forward requires multistakeholder alignment around a clear north star and a shared set of principles – anchoring developments in public interest and long-term value. Such principles (rooted in safety and security, societal and environmental sustainability as well as resilience and economic growth – see Section 1) aim not to remain abstract ideas. They are designed to accelerate responsible adoption while preventing setbacks and public backlash resulting from poor developments or deployments.

Achieving responsible AAM implementation requires more than establishing guiding principles; it demands the effective alignment of these principles with the diverse priorities of all stakeholders across the value chain, including authorities, investors, infrastructure providers, suppliers, OEMs and operators. Understanding the interdependencies among these priorities is essential, as actions taken by one group can significantly affect the objectives and outcomes of others (see Section 2). Only through clearly defined key priorities, enabling actions and robust collaboration can the sector move beyond isolated efforts and towards the creation of scalable, sustainable services.

To advance these priorities, the industry can draw on valuable lessons from early drone deployments. These real-world learnings provide practical insights that serve a dual purpose: first, they provide insights to help scale up drone operations; and second, they inform and accelerate the development and integration of larger, more complex AAM vehicles (see Table 1). Despite differences in vehicle size and complexity, both drones and other AAM vehicle types share critical dependencies on operational feasibility, financial viability and social acceptance. Using these early lessons enables the industry to accelerate progress, avoid repeating mistakes and create more effective, responsible implementation across the spectrum of AAM solutions.

Looking ahead, the opportunities for AAM extend far beyond local, small-scale projects, reaching into the fabric of a global, interconnected future. Future horizons for AAM will be defined by its ability to deliver additional societal benefits, enhance connectivity in underserved regions and seamlessly integrate into broader multimodal transport ecosystems. The deployment of drone-based logistics has already showcased the potential for AAM to revolutionize industries such as healthcare, agriculture and emergency response. Similarly, drone-based inspections are being used more and more across industries to increase safety, reduce the need for workers to perform hazardous tasks and improve operational efficiency. As AAM implementations advance across a wider range of vehicles, new use cases will emerge, offering novel ways to connect people and goods and to bring new value through enhanced services such as environmental monitoring and public safety support.

Achieving this vision requires a phased and structured approach, one that balances the drive for innovation and rapid scaling with the imperatives of safety and social acceptance. The principles discussed in this paper can serve as the foundation for this process, guiding stakeholders in decision-making and ensuring that progress aligns with broader societal goals. Whether it is to support regulatory alignment, infrastructure developments or commercial scalability, these principles provide a framework for navigating challenges and inspiring trust among the industry, policy-makers and the broader public.

Aviation has long been a testament to the power of global collaboration. The development of international safety standards, shared airspace management and cooperative research initiatives have propelled the industry forward. AAM needs to follow a similar trajectory. Cross-border cooperation and establishing harmonized policy and industry frameworks are vital to this end. The potential impact of AAM goes beyond simply introducing a new form of air travel; it can unlock the third dimension of services and redefine the role of aviation in society. The responsibility now lies with industry leaders, authorities and investors to ensure that this transformation is carried out with a long-term vision of responsibility in mind.

Contributors

World Economic Forum

Maria Alonso
Lead, Autonomous Systems

Pierre Maury
Strategic Integration Specialist, Aviation

Raphael Preindl
Project Fellow, World Economic Forum;
Senior Consultant, Kearney

Kearney

Pedro Aguas
Principal for Mobility, Defence, Advanced Industrials

Mario Arbery
Manager for Mobility, Defence, Advanced Industrials

Claudia Galea
Director Sustainability for Mobility, Defence, Advanced Industrials

Javier González
Partner and Co-Founder of the Kearney Advanced Mobility Institute

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Saud Alageel
Director, NIDLP, Saudi Arabia

Mousa Albargi
Executive Vice-President Logistics, NIDLP, Saudi Arabia

Nicolas Brieger
Head of the Drone and Vertical Mobility Academy, Touring Club Schweiz, Switzerland

Sonja Betschart
Co-Founder and Co-Pilot, WeRobotics, Switzerland

Borja Blond
Chief Executive Officer, NEOM Vertical Mobility Operating Company, Electric Innovative Air Mobility, NEOM, Saudi Arabia

Elizabeth Bourke
UAS Project Manager, United Nations – World Food Programme, Italy

Robin Brownsell
Director, Flight Crowd, United Kingdom

Satyanarayanan Chakravarthy
Professor Aerospace Engineering, Indian Institute of Technology Madras, India

Jay Choi
Chief Executive Officer and Co-Founder, Nearthlab, South Korea

Keeyung Choi
Professor, Inha University, South Korea

Jacques Coulon
Transportation Planning Manager, City of Orlando, United States

Jeffrey De Carlo
Aeronautics Administrator, Massachusetts Department of Transportation (MASS DOT), United States

Anna Dietrich
Policy Advisor, Association for Uncrewed Vehicle Systems International (AUVSI), United States

Tomohiro Fukuzawa
Chief Executive Officer, SkyDrive, Japan

Nikhil Goel
Chief Commercial Officer, Archer Aviation, United States

Waleed Gowharji
Project Lead, Centre for the Fourth Industrial Revolution, Saudi Arabia

Keely Griffith
Vice-President Strategic Programs, Association for Uncrewed Vehicle Systems International (AUVSI), United States

Kerissa Khan
Past President, Royal Aeronautical Society (2023–2024), United Kingdom

Fahad Khan
Head of Integrated Simulation Systems and Product Engineering, Supernal, United States

Eulsoo Kim
Marine and Aviation Bureau Director, Incheon Metropolian City, South Korea

Parimal Kopardekar
NASA Mission Integration Manager, Advanced Air Mobility, and Director, NASA Aeronautics Research Institute, NASA, United States

David McBride
Chief Technology Officer, Supernal, United States

Patrick McKay
UAS Data Operations Manager, United Nations – World Food Programme, Italy

Kapil Mittal
Global Head, Ericsson Digital Airspace, United Kingdom

Daniel Newman
Chief Technology Officer Advanced Air Mobility, Honeywell Group, United States

Jaroslaw Niewinski
Airport Operations Expert, Eurocontrol, Belgium

Han Park
Deputy Chief Technology Officer and Head of R&D, Supernal, United States

Daniella Partem
Head, Centre for the Fourth Industrial Revolution, Israel

Tom Plümmer
Chief Executive Officer and Co-Founder, Wingcopter, Germany

Carlos Saito
Coordinator, Costa Rica Flying Labs, Costa Rica

Vignesh Santhanam
Project Lead, Aerospace and Drones, Centre for the Fourth Industrial Revolution, India

David Shilliday
Vice-President and General Manager, Honeywell Group, United States

Dan Sloat
Founder and President, Advanced Air Mobility Institute, United States

Harrison Wolf
Associate, Advanced Aviation, Flight Safety Foundation, United States

Jia Xu
Chief Executive Officer, SkyGrid, United States

Production

Bianca Gay-Fulconis
Designer, 1-Pact Edition

Tanya Korniichuk
Illustrator, 1-Pact Edition

Simon Smith
Editor, Astra Content

Endnotes

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World Economic Forum
91–93 route de la Capite
CH-1223 Cologny/Geneva
Switzerland

Tel.: +41 (0) 22 869 1212
Fax: +41 (0) 22 786 2744
contact@weforum.org
www.weforum.org