Managing Aviation as a System

A Five-Spheres Framework for Strategic Aviation Management

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Abstract

This paper develops a systems-oriented framework for strategic management across the aviation industry, grounded in the aviation systems perspective introduced by Wittmer and Bieger (2011). The aviation industry requires different organizations at its core to navigate the complex environment of aviation. The aviation system framework aims at reducing complexity in different areas including ecosystem interdependencies, regulatory uncertainty, technological disruption, geopolitical volatility, and sustainability pressures simultaneously. Traditional management approaches often focus on isolated operational, technical, or financial indicators, thereby underestimating the systemic nature of value creation, competitiveness, and resilience within the aviation ecosystem.

Building on systems theory, ecosystem theory, dynamic capabilities, and paradox theory, this paper proposes the Aviation System 5-Spheres Model as an integrative framework for strategic management in aviation. The model conceptualizes aviation as an adaptive socio-technical system shaped by five interconnected environmental domains: economic, political/regulatory, technological, ecological, and social spheres. The framework further translates these conceptual dimensions into workshop-based managerial canvases designed to support strategic diagnosis, executive alignment, scenario development, capability assessment, target-picture design, and transformation planning.

The paper contributes to aviation management practitioners and scholars in three ways. First, it extends systems thinking into aviation management by integrating environmental forces, ecosystem actors, organizational capabilities, and strategic tensions into a coherent analytical framework. Second, it operationalizes systems theory into a practical workshop architecture suitable for executive education, consulting engagements, organizational transformation, and strategic planning across different aviation sectors. Third, it demonstrates how competing objectives such as efficiency and resilience, growth and sustainability, or innovation and regulatory compliance can be visualized and managed through collaborative facilitation processes.

The framework is applicable across multiple actors within the aviation system, including airlines, airports, air navigation service providers, aircraft manufacturers, regulators, and other ecosystem participants. By emphasizing the interdependencies among these actors, the Aviation System 5-Spheres Model provides a holistic perspective for understanding and managing the increasing complexity of the global aviation system.

1. Introduction

Aviation is among the most globally interconnected and institutionally complex industries. The aviation system comprises a diverse set of actors, including airlines, airports, air navigation service providers (ANSPs), aircraft manufacturers, regulators, logistics providers, tourism organizations, and technology partners, all operating within a network of technological infrastructures, regulatory systems, economic relationships, and societal expectations that continuously evolve over time. Consequently, strategic management in aviation increasingly involves the orchestration of interdependencies across organizational and institutional boundaries rather than the optimization of isolated functions.

Historically, management focused heavily on operational efficiency, capacity utilization, safety performance, and financial outcomes. While these dimensions remain important, they are no longer sufficient for understanding long-term competitiveness and resilience. Climate change, geopolitical fragmentation, digital disruption, labor shortages, sustainability regulation, technological innovation, and changing mobility preferences have fundamentally altered the strategic landscape of aviation. As a result, aviation organizations are increasingly required to balance competing objectives while simultaneously responding to environmental uncertainty and ecosystem-wide changes.

This paper argues that aviation should be conceptualized as an adaptive socio-technical system embedded within broader environmental and ecosystem structures. Such a perspective enables managers and policymakers to better understand systemic risks, feedback loops, interdependencies, and second-order consequences that emerge across the aviation value network. The proposed Aviation System 5-Spheres Model provides both a conceptual architecture and a practical facilitation framework for strategic reflection, executive workshops, organizational transformation, and decision-making across different sectors of the aviation industry.

By integrating systems theory, ecosystem thinking, dynamic capabilities, and strategic management perspectives, the framework offers a holistic approach to understanding how environmental forces shape the behavior and performance of aviation actors. In doing so, it provides a common strategic language that can support airlines, airports, ANSPs, manufacturers, regulators, and other ecosystem participants in navigating increasing complexity and uncertainty within the global aviation system.

2. Theoretical Foundations

The 5 Spheres model is grounded in general systems theory (Von Bertalanffy, L. 1968), which conceptualizes organizations as open systems embedded within larger environments. Furthermore, the St. Gallen Management Model (Rüegg-Stürm 2019) served as a structure for integrating spheres and stakeholders in the supply and demand systems. Systems theory emphasizes interdependence, adaptation, emergence, and feedback processes. In aviation, these characteristics are especially salient because different players depend on each other. E.g. airlines depend on airports, regulators, suppliers, digital platforms, and international political agreements simultaneously.

The model also draws on ecosystem theory (Crober 1999, Jørgensen 2007). Rather than competing solely through internal resources, airlines, for example, increasingly create value through ecosystem orchestration involving airports, alliances, distribution systems, logistics providers, and tourism actors (Bieger, T., Wittmer, A. 2006). Competitive advantage therefore depends not only on operational efficiency but also on relational positioning and collaborative capability.

Dynamic capability theory (Teece, D. J. 2007) further underlines the framework. Under conditions of turbulence and uncertainty, organizations must continuously sense environmental change, seize opportunities, and transform capabilities. For example, airlines capable of integrating sustainability, digitalization, operational resilience, and customer-centric innovation are more likely to sustain long-term competitiveness.

Finally, the framework incorporates paradox theory (Smith, W. K., Lewis, M. W. 2011) by recognizing that airline strategy increasingly involves managing tensions rather than maximizing singular objectives. Efficiency and resilience, affordability and sustainability, or centralization and agility often coexist as competing but interdependent strategic priorities.

Figure 1. Aviation System 5-Spheres Model



Source: Adapted from Wittmer and Bieger's 2011 and 2021 aviation systems framework

3. The Five Environmental Domains (Spheres)

The Aviation System 5-Spheres Model identifies five environmental domains that directly shape airline strategy and market dynamics.

The political and regulatory environment shapes market access, taxation, emissions policy, and safety standards. Governments remain central actors in aviation because air transport intersects with sovereignty, infrastructure policy, and national economic development. Regulatory uncertainty can significantly alter route economics and competitive positioning.

The economic environment influences aviation demand, pricing structures, profitability, and investment capability. Macroeconomic growth, trade patterns, exchange rates, labor costs, and fuel prices strongly affect airline performance. Economic volatility therefore requires adaptive capacity management and financial resilience.

The social environment includes demographic trends, customer preferences, lifestyle changes, labor market dynamics, and mobility behavior. Societal expectations regarding flexibility, safety, wellness, and responsible business conduct increasingly influence aviation demand and legitimacy.

The ecological environment has become a defining strategic dimension for aviation. Climate change, emissions reduction targets, sustainable aviation fuels, and societal sustainability expectations create both constraints and opportunities. For example, airlines must reconcile growth ambitions with ecological legitimacy and airports can become enablers of sustainable aviation.

The technological environment continuously transforms operations and customer expectations. Aircraft innovation, artificial intelligence, digital platforms, automation, and data analytics reshape cost structures, operational efficiency, and service personalization. For example, airlines and airports increasingly compete through digital ecosystems and information capabilities.

4. Aviation as an Ecosystem

Aviation should not be understood as a linear value chain but rather as a multidimensional ecosystem characterized by interdependent actors and infrastructures. For example, airlines rely on airports for connectivity and capacity, on manufacturers for technological advancement, on regulators for market access, and on digital intermediaries for customer reach.

The ecosystem perspective changes the logic of strategy. Instead of focusing exclusively on direct competitors, aviation companies must manage relationships across a broader network of stakeholders in coopetitive environment. Strategic outcomes emerge from interactions between actors rather than from isolated organizational decisions.

For example, sustainability transitions require coordination between fuel suppliers, governments, airports, aircraft manufacturers, and airlines simultaneously. Similarly, digital transformation depends on integration between airlines, distribution systems, payment infrastructures, and customer data ecosystems.

This perspective also highlights systemic vulnerabilities. Disruptions affecting one component of the aviation ecosystem can rapidly propagate across the network. The COVID-19 pandemic demonstrated how interconnected operational, regulatory, social, and financial dimensions are within global aviation systems.

5. Strategic Tensions and Leadership

One of the most important implications of the framework is that strategy increasingly involves balancing strategic tensions driven by the dependencies within the ecosystem. Executives face contradictory demands that cannot be resolved through traditional optimization logic.

Efficiency initiatives may reduce resilience by eliminating operational buffers. Sustainability investments may increase short-term costs while strengthening long-term legitimacy. Premium differentiation may conflict with low-cost competitive pressures. Centralized governance may improve control while reducing organizational agility.

The framework therefore encourages leadership teams in the aviation industry to visualize and discuss tensions explicitly. Through workshop exercises and facilitation processes, executives can identify current positioning, desired positioning, and unacceptable strategic zones.

This perspective aligns with paradox theory (Smith, W. K., Lewis, M. W. 2011) in organizational research, which argues that successful organizations sustain competing objectives rather than eliminate them. Aviation leadership increasingly requires ambidexterity, systems awareness, and adaptive decision-making.

The following chapter uses five important stakeholders (Airlines, Airports, ANSPs, Manufacturers, Regulators) exemplary to highlight how the aviation system model can be used as a framework for workshops and can have implications on the strategy.

6. Implications for Strategic Management across the Aviation System

A central premise of the Aviation System 5-Spheres Model is that strategic outcomes in aviation emerge not from the actions of individual organizations alone but from the interactions among multiple actors operating within a shared system. While all aviation stakeholders are exposed to the same economic, political/regulatory, technological, ecological, and social environments, they occupy fundamentally different positions within the aviation ecosystem and therefore face distinct strategic challenges.

The framework suggests that understanding these differing roles is essential for effective strategic management. Airlines, airports, air navigation service providers, manufacturers, and regulators each contribute to the functioning and evolution of the aviation system in different ways. Consequently, the implications of environmental change vary according to the actor's role, responsibilities, and position within the value network.

Table 1. Strategic Roles within the Aviation System

Actor	Primary Role within the Aviation System	Core Strategic Challenge
Airlines	Resource Integrators	Adapting business models to changing market conditions
Airports	Ecosystem Orchestrators	Balancing local, regional, and global stakeholder interests
ANSPs	System Coordinators	Ensuring safety, capacity, and resilience under increasing complexity
Aircraft Manufacturers (OEMs)	Innovation Orchestrators	Anticipating and enabling future technological transitions
Regulators	Institutional Architects	Balancing innovation, safety, sustainability, and public interests

Airlines: Integrating Resources into Customer Value

Airlines occupy a unique position within the aviation system because they intercept directly with customers and bring the business into the aviation value network. Their primary challenge is not simply operational efficiency but the continuous adaptation of business models to changing environmental conditions. As economic volatility, sustainability pressures, digital transformation, and evolving customer expectations reshape aviation markets, airlines must continuously reconfigure networks, fleets, partnerships, and service propositions to remain competitive.

Airports: Orchestrating Aviation Ecosystems

Airports create value by enabling interactions among a diverse set of ecosystem participants, including airlines, passengers, regulators, mobility providers, logistics actors, and local communities. Unlike airlines, airports are geographically embedded and therefore simultaneously serve regional development objectives and global connectivity requirements. Their strategic challenge lies in balancing these often competing interests while creating attractive environments for airlines, passengers, investors, and communities.

Air Navigation Service Providers: Coordinating System Performance

ANSPs occupy a central coordinating role within the aviation system. Their primary responsibility is to ensure the safe, efficient, and orderly flow of air traffic across increasingly complex airspace environments. As technological innovation, traffic growth, environmental requirements, and geopolitical uncertainty increase system complexity, ANSPs must balance safety, capacity, resilience, and sustainability while coordinating a broad network of aviation stakeholders.

Aircraft Manufacturers: Driving Technological Transformation

Aircraft manufacturers play a critical role as innovation orchestrators within the aviation ecosystem. Their strategic challenge extends beyond aircraft production to shaping the future technological trajectory of aviation. Advances in propulsion systems, digital technologies, automation, sustainable aviation fuels, advanced materials, and future mobility concepts require

manufacturers to anticipate long-term industry needs while coordinating innovation efforts across airlines, airports, regulators, suppliers, and research institutions.

Regulators: Shaping the Institutional Environment

Regulators serve as institutional architects of the aviation system. Through legislation, certification, safety oversight, environmental policy, and market regulation, they establish the framework conditions within which all other actors operate. Their challenge is to balance multiple and often competing objectives, including safety, efficiency, sustainability, innovation, competitiveness, and public accountability. As aviation undergoes profound technological and societal change, regulators increasingly need to adopt systems-oriented approaches that consider second-order effects and interactions across the broader ecosystem.

Although these stakeholders fulfill different functions, they remain deeply interconnected through shared infrastructure, regulatory frameworks, technologies, and markets. Changes affecting one actor frequently generate consequences throughout the broader system. The Aviation System 5-Spheres Model therefore highlights the importance of systems thinking, cross-organizational collaboration, and ecosystem awareness as prerequisites for effective strategic management. Rather than optimizing individual organizations in isolation, aviation leaders must increasingly understand how value is co-created across the system and how environmental developments shape interactions among multiple stakeholders simultaneously.

From this perspective, long-term competitiveness, resilience, and sustainability are not solely organizational outcomes but system-level outcomes emerging from the coordinated actions of multiple actors within the aviation ecosystem.

7. Workshop Architecture and Facilitation Logic

The practical contribution of the 5-Spheres framework lies in its workshop architecture. The Aviation System canvases (see appendix 1) transform abstract systems thinking into participative strategic processes suitable for executive teams, consulting engagements, and educational contexts.

The workshop process typically unfolds across multiple stages. Participants first identify external environmental drivers through brainstorming and post-it mapping exercises. They then map ecosystem relationships, analyze organizational capabilities, identify strategic tensions, and prioritize transformation initiatives.

The use of visual canvases enables cross-functional dialogue and collective sensemaking. Rather than relying solely on PowerPoint-based communication, participants actively construct strategic interpretations through collaborative interaction.

Importantly, the framework encourages organizations to identify interdependencies and second-order effects. Participants draw connections between environmental domains, ecosystem actors,

and internal capabilities. This process strengthens systems thinking and improves strategic awareness.

The framework has strong pedagogical value because it enables experiential learning and integrated thinking of Participants such as executives, employees or, in a scholarly context, students alike can engage in scenario analysis, strategic prioritization, and ecosystem mapping exercises that mirror real-world managerial complexity.

8. Conclusion

This paper derived the Aviation System 5-Spheres Model as a systems-oriented framework for strategic management across the aviation industry. Building on systems theory, ecosystem theory, dynamic capabilities, and paradox theory, the framework conceptualizes aviation as an adaptive socio-technical system shaped by five interconnected environmental domains: economic, political/regulatory, technological, ecological, and social spheres.

The framework contributes conceptually by integrating environmental complexity, ecosystem interdependencies, organizational capabilities, and strategic tensions into a coherent managerial architecture applicable to multiple actors within the aviation system. Rather than focusing on individual organizations in isolation, the model emphasizes the interconnected nature of airlines, airports, air navigation service providers, manufacturers, regulators, and other ecosystem participants whose decisions collectively shape aviation performance and development.

The framework contributes practically by translating systems thinking into workshop-based facilitation tools suitable for executive strategy processes, consulting engagements, organizational transformation initiatives, and educational settings. The proposed canvases support strategic diagnosis, executive alignment, scenario development, target-picture design, transformation planning, and governance across different aviation contexts.

The implications developed for airlines, airports, ANSPs, aircraft manufacturers, and aviation regulators illustrate how the framework can support strategic decision-making across the broader aviation ecosystem. While the specific challenges faced by these actors differ, all operate within the same interconnected system and are increasingly required to balance efficiency, resilience, sustainability, innovation, and stakeholder expectations.

As aviation continues to face environmental uncertainty, digital transformation, geopolitical challenges and surprises, sustainability pressures, and evolving mobility patterns, systems-oriented management approaches will become increasingly important. Future research may further explore empirical applications of the framework across different aviation sectors, investigate system-level interactions among ecosystem actors, and examine how organizations can develop the dynamic capabilities required to navigate an increasingly complex and interconnected aviation environment.

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(AI (mainly chatgpt, claude and deeple) was used to rewrite the texts for language purposes. The picture of the 6 spheres model was produce with support of AI.)

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Appendix. Aviation System Workshop Canvases

The Aviation System Canvases intend to help to moderate strategy workshops where a wholistic view is wanted. They help to integrate an understanding from surrounding spheres to the dynamics of the market and the stakeholders. Strategic configurations and tensions are the foundation of transformation.

The workshop canvases operationalize the Aviation System framework into a practical facilitation methodology. The canvases support executive workshops, consulting engagements, MBA teaching, and organizational transformation initiatives by structuring discussion around environmental complexity, ecosystem relationships, strategic tensions, and transformation priorities.

The below canvases have been applied at a case for an airlines and might need slight wording changes for other players.

CANVAS 1 – AVIATION SYSTEM OVERVIEW

Understand the system that shapes the airline

EXTERNAL ENVIRONMENTS

- **ECONOMIC** — What economic forces impact our business?
- **POLITICAL / REGULATORY** — What laws, policies and regulations affect us?
- **TECHNOLOGICAL** — What technologies create change or disruption?
- **ECOLOGICAL** — What environmental pressures and constraints exist?
- **SOCIAL** — How are society and customer behavior changing?

AVIATION ECOSYSTEM

AIRPORTS | OEMS & SUPPLIERS | REGULATORS & GOVERNMENTS | ANSPs | ALLIANCES & PARTNERS | INTERMEDIARIES & PLATFORMS | CUSTOMERS & DEMAND | TOURISM & CARGO / LOGISTICS

AIRLINE OPERATING MODEL (17 FACTORS)

1. Network & Routes
2. Fleet & Equipment
3. Product & Service
4. Pricing & Revenue Management
5. Sales & Distribution
6. Marketing & Brand
7. Operations & Flight Operations
8. Airport Management
9. Maintenance & Engineering
10. People & Organization
11. Partnerships & Alliances
12. Information Technology & Digital
13. Data & Analytics
14. Sustainability & Environment
15. Finance & Treasury
16. Procurement & Supply Chain
17. Governance & Risk Management

ENABLERS

- INFRASTRUCTURE (Airports, ATM, IT, Ground)
- REGULATION & POLICY FRAMEWORK
- RESEARCH & DEVELOPMENT

Value Opportunities | Risks / Threats | Conflicts / Tensions | Current Strengths | Capability Gaps | Critical Future Capabilities

HOW TO USE

1. Generate Ideas (Individually) → 2. Share & Cluster (Together) → 3. Discuss & Prioritize (Vote) → 4. Decide & Document (Agree) → 5. Act & Review (Iterate)

POST-IT GUIDE

- Green – Opportunities
- Red / Pink – Risks
- Yellow – Conflicts / Tensions
- Blue – Strengths / Enablers
- Orange – Gaps
- Purple – Future Capabilities / Bets

TIPS FOR FACILITATORS

- One idea per Post-it
- Keep it short and visible
- Encourage diverse perspectives
- Focus on decisions, not just analysis
- Revisit connections and second-order effects

CANVAS 2 – STRATEGIC CONFIGURATION & TENSIONS

How we position and balance key strategic trade-offs

PART A – STRATEGIC CONFIGURATION RADAR

Where are we today, where do we want to be?



PART B – STRATEGIC TENSIONS

Key trade-offs we must manage

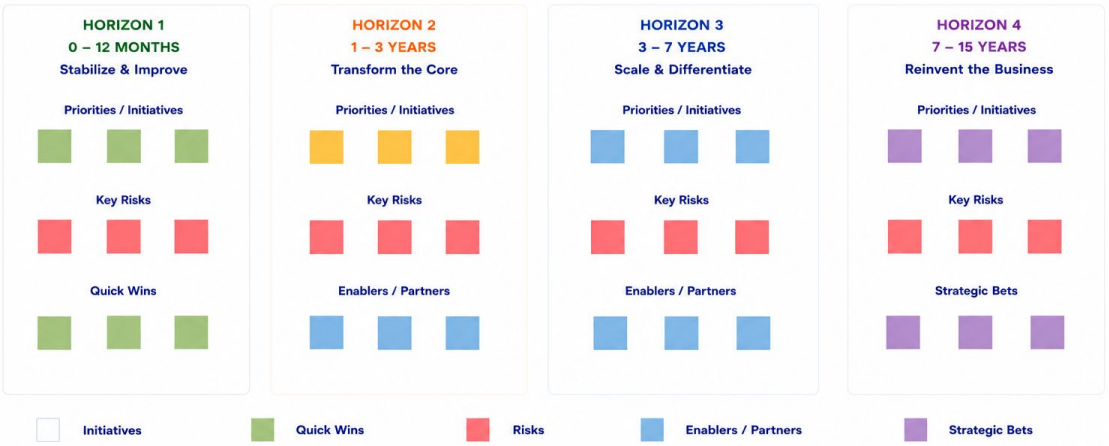
Tension	Current Challenge	Desired Balance	Strategic Actions
1. Cost Leadership (Efficiency)	High cost pressure reduces buffers and flexibility	Build flexible redundancy without compromising cost discipline	• Dymamic capacity • Scenario planning • Strategic buffers
2. Service Differentiation (Customer Experience)	Rising customer expectations	Deliver differentiated experience at sustainable cost structure	• Product modularity • Ancillary strategy • Process efficiency
3. Network Breadth (Connectivity)	Limited slots & hub constraints	Optimize network reach with profitable density	• Hub strategy • Route portfolio • Traffic flows
4. Operational Resilience (Reliability)	Irregular operations & disruptions	Robust operations with cost efficiency	• Real-time control • Recovery planning • Crew & asset flexibility
5. Sustainability Ambition (Environmental Impact)	Sustainability investments increase operating costs	Reduce emissions while maintaining affordable fares	• Fleet renewal • SAF roadmap • Operational efficiency
6. Digital Maturity (Data & Technology)	Legacy systems & digital gaps	Seamless digital capabilities	• IT modernization • Data platform • Automation & AI
7. Ecosystem Integration (Partnerships & Platform)	Complex partner landscape	Win-win value creation across ecosystem	• Partner alignment • Joint value capture • Platform strategy
8. Organizational Agility (Adaptability)	Slow decision-making	Fast, empowered organization	• Simplify structure • Empower teams • Agile ways of working

Key Takeaways / Decisions on Tensions

Current Position | Desired Future Position | Competitor Benchmark

CANVAS 3 – TRANSFORMATION PORTFOLIO

What will we do, when and why?



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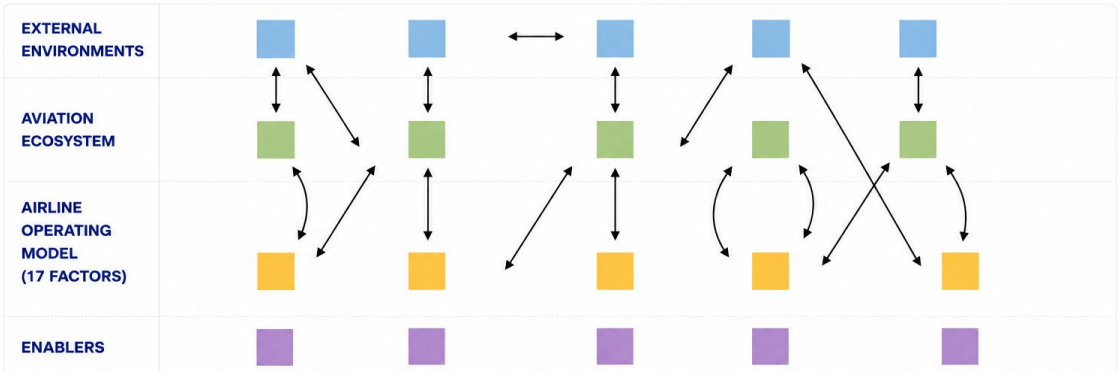
CANVAS 4 – SYSTEM CONNECTIONS MAP

How are forces, ecosystem and capabilities connected?



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CANVAS 5 – PRIORITY & DECISION MATRIX

What matters most?



Top 5 Priorities

1.
2.
3.
4.
5.

Key Decisions

HOW TO USE

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