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# Exploring and Optimizing Factors Driving Successful Collaboration between Airlines, Airports and Air Traffic Control in Developing Countries: A MCDM Approach

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**ABSTRACT**

This research explores the critical factors that drive successful collaboration between airlines, airports, and Air Traffic Control (ATC) in developing countries, with a specific focus on the Indian aviation sector. Amid rapid global transformations in air transport driven by rising demand, environmental regulations, and technological innovation, developing countries face unique challenges. This study applies the Multi-Criteria Decision-Making (MCDM) approach, particularly the Analytic Hierarchy Process (AHP), to identify and prioritize the most influential factors contributing to effective collaboration among these key stakeholders. Expert insights were gathered and analyzed using structured pairwise comparisons and consistency checks. The findings suggest that revenue sharing, contingency planning, and real-time weather responsiveness are among the most significant enablers of collaboration. The study contributes practical implications for policy formulation, strategic planning, and operational improvements within the aviation sector.

The study also considers the broader socioeconomic impact of enhanced collaboration, including improved passenger satisfaction, reduced operational delays, and optimized use of resources. Additionally, it discusses how enhanced stakeholder alignment can foster innovation in air travel infrastructure and service delivery. In light of rapid technological advancements, collaborative models are becoming increasingly data-driven and real-time responsive, which calls for adaptive strategies in policy and operations. The research framework not only identifies priorities but also provides a scalable methodology that can be replicated in other developing economies.

## 1: Introduction

The aviation industry has become a key pillar in the economic development of nations, especially in emerging economies. Airports, airlines, and air traffic control authorities are central to this system and must work together effectively to ensure efficient, safe, and sustainable operations. In developing countries like India, this collaboration becomes even more critical due to infrastructural constraints, growing passenger volumes, and limited technological integration.

The interdependence between airports, airlines, and ATC is undeniable. Airlines rely on airports for access, infrastructure, and passenger services, while airports depend on airlines for traffic that drives commercial revenue. ATC ensures safe navigation and efficient traffic flow in increasingly congested skies. The synchronization of objectives, strategies, and technologies among these three stakeholders is essential to improving performance metrics such as on-time departures, cost efficiency, and customer satisfaction.

Despite the known benefits of collaboration, many challenges persist: misaligned objectives, regulatory bottlenecks, technological disparities, and lack of coordinated contingency plans. Most research in this area has focused on developed economies or on isolated dimensions of collaboration (e.g., financial models or environmental impacts). This study fills a critical research gap by holistically analyzing collaboration dynamics in the context of developing countries, using AHP to systematically evaluate and rank collaboration-enabling factors.

The research is guided by the following objectives:

- To identify key factors that influence collaboration between airlines, airports, and ATC.
- To analyze how these factors contribute to operational and strategic goals.
- To apply the AHP methodology to prioritize these factors based on their relative impact.

Moreover, the chapter outlines how collaborative efforts directly influence airport capacity optimization, reduction of airspace congestion, and strategic development of regional connectivity. These elements are vital for nations looking to enhance tourism, trade, and regional mobility. Emphasis is also placed on the role of public-private partnerships and policy-level interventions to strengthen aviation frameworks. The introduction concludes by acknowledging that future air transport growth, especially in high-demand markets like India, will rely heavily on strategic coordination across infrastructure, operations, and regulatory agencies.

## 2: Literature Review

The literature on aviation collaboration can be divided into three broad categories: general collaboration theory, aviation-specific collaboration, and MCDM-based studies.

### *2.1 General Collaboration Studies*

Studies in general business and public administration highlight the importance of coordinated communication, leadership, and shared objectives in successful collaborative networks. Concepts such as vertical integration, shared value creation, and coalition-based decision-making have been emphasized. These frameworks are foundational for understanding how aviation partnerships can be structured. Several studies also explore collaborative maturity models and the stages of trust-building among stakeholders. Researchers like Spekkink and Boons (2016) provide evidence that pre-existing social structures significantly affect the trajectory and outcome of collaborations.

### *2.2 Aviation Collaboration*

Airline-airport relationships have evolved through deregulation, privatization, and technological change. Research has examined marketing-based and capacity-based models of collaboration, emphasizing mutual benefits in route planning, infrastructure sharing, and coordinated scheduling. Studies by Tunčikienė and Katinas (2020), and Bejjani (2017) have highlighted success stories of alliances, such as Lufthansa and Munich Airport, which showcase the competitive advantage achieved through deep integration.

Other works have examined the implications of terminal sharing, integrated passenger services, and route code-sharing agreements. These collaborative mechanisms help reduce redundancy and improve customer experience, particularly in hub airports. Strategic alliances have been shown to impact not just profitability but also environmental sustainability through joint fuel-efficiency programs and noise reduction strategies.

### *2.3 MCDM in Aviation*

Multi-Criteria Decision-Making methods, including AHP, TOPSIS, and ANP, have proven useful in evaluating complex strategic options. These approaches have been used in supply chain management, green airport strategies, and supplier selection. However, their application in evaluating collaboration among aviation stakeholders is limited. This study leverages AHP for its ease of use and capability to manage qualitative expert opinions.

Several case studies from Asia and Europe highlight the growing acceptance of MCDM in infrastructure planning. This supports the argument for using AHP as a suitable framework to address aviation collaboration in resource-constrained contexts. Works by Govindan et al. (2015) and Lahri (2020) underscore the applicability of AHP for sustainable performance measurement across industries, lending credibility to its use in this study.

### *2.4 Challenges in Aviation Collaboration*

The literature identifies common challenges such as poor leadership, lack of aligned goals, miscommunication, and infrastructure limitations. Regulatory restrictions often prevent dynamic partnerships. Cultural and technological disparities further compound the difficulty of collaboration in developing countries.

Additionally, coordination difficulties are worsened by fragmented data systems, lack of trust, and minimal joint training programs across entities. Without cross-functional collaboration protocols, achieving shared KPIs remains elusive. Cummings and Mahmassani (2024) highlight airspace congestion and inconsistent ATC rules as major roadblocks in collaborative operations.

### *2.5 Collaboration Factors Identified*

Through synthesis of the literature, the following factors have been identified as crucial to collaboration:

- Revenue Sharing
- Contingency Planning
- Co-Creation
- Shared Technology Platforms
- Regulatory Flexibility
- On-Time Performance

- Real-Time Weather and Delay Management

Each of these factors has empirical backing and theoretical relevance. They will be further analyzed in the following chapters through model-based quantification and stakeholder feedback. Additional secondary factors, such as coalition loyalty programs, cloud-based systems, and joint infrastructure development, also warrant consideration due to their supporting role in seamless collaboration.

## 3: Model Development

To translate the theoretical framework into an operational strategy, a Collaborative Decision-Making (CDM) model was designed. This model integrates input from literature, expert opinion, and empirical priorities into a three-pronged stakeholder framework: Airports, Airlines, and ATC. These stakeholders were chosen based on their essential roles in ensuring aviation service delivery in both normal and crisis scenarios.

The Airport group includes critical collaboration drivers such as Revenue Sharing, Real Estate & Hub Operations, Co-Creation, Regulatory Framework, and Technical Harmonization. These dimensions reflect the importance of both infrastructural alignment and financial partnership. Airports serve as foundational nodes for operational execution and strategic growth, hence their inclusion as a primary category.

For Airlines, the model emphasizes factors that directly impact service delivery and strategic risk mitigation. These include Contingency Planning, Loyalty Programs, Cloud-based Infrastructure, On-Time Performance, and Network Frequency. Airlines are central to executing the customer interface and bear most of the reputational risk associated with delays or disruptions.

The ATC dimension captures factors like Weather Response Mechanisms, Delay Mitigation, Shared Technology Platforms, and Congestion Management. These factors are unique in that they govern the broader operational airspace within which both airlines and airports function. ATC collaboration influences every stage of air travel, from departure sequencing to in-flight routing and terminal approach coordination.

The model also assumes that not all stakeholders exert equal influence in all scenarios. For example, during extreme weather, ATC collaboration is more critical, while during infrastructure development, airport collaboration is emphasized. This interdependency is modeled using weighted matrices within AHP.

Furthermore, the model captures the hierarchical relationship between general and sub-factors, aligning with Saaty’s approach in AHP, which ensures rigorous prioritization. It facilitates the identification of performance gaps and strategic misalignments, offering stakeholders a diagnostic as well as a planning tool. A graphical representation and explanation of the CDM model structure is included in the appendix for better clarity.

## 4: Methodology

This study adopted a structured methodological framework using the Analytic Hierarchy Process (AHP), a robust Multi-Criteria Decision-Making (MCDM) tool designed to quantify expert judgments and establish a hierarchy of priorities among decision criteria. AHP is particularly suitable for complex and subjective decision environments such as stakeholder collaboration in aviation.

### *4.1 Research Design and Data Collection*

The research design involved two main stages: (1) identification of relevant collaboration factors through a comprehensive literature review and stakeholder consultations, and (2) prioritization of these factors using AHP. To implement the model, expert input was collected through interviews and questionnaires based on pairwise comparisons.

Participants included professionals from Indian aviation authorities, airport operators, airline executives, and ATC controllers. A total of 21 experts responded, representing both public and private organizations. Experts were selected using purposive sampling to ensure domain-specific knowledge and familiarity with inter-organizational coordination.

### *4.2 AHP Model Construction*

The AHP process began by defining the problem (i.e., evaluating collaboration priorities) and establishing the goal hierarchy. At the first level, the overarching goal was defined as "Enhancing Collaboration Among Airlines, Airports, and ATC." The second level contained the stakeholder categories, and the third included the identified factors under each stakeholder.

Experts performed pairwise comparisons of these factors using Saaty’s 1-to-9 scale, where 1 indicates equal importance and 9 indicates extreme preference. For each matrix, a consistency ratio (CR) was calculated to validate input reliability. Only matrices with CR $\leq 0.1$ were retained for analysis.

### *4.3 Data Processing and Weight Calculation*

All responses were tabulated in Microsoft Excel, and eigenvector calculations were used to derive the priority weights of each factor. The geometric mean method was applied where multiple expert judgments were aggregated. Each expert's matrix was individually checked for consistency, and the average CR for all matrices was 0.07, confirming acceptable input quality.

The final weights provided a ranked list of collaboration drivers within each stakeholder domain. This allowed for a holistic evaluation of the factors most crucial to overall collaboration success. Additionally, sensitivity analysis was conducted to test the robustness of results under slight modifications in priority weights.

### *4.4 Justification for Methodology*

AHP was chosen for its capacity to handle both qualitative and quantitative data and for providing a structured yet flexible decision-making environment. Compared to other MCDM methods like TOPSIS or ELECTRE, AHP offers greater transparency and simplicity in understanding expert preferences. It is especially effective when consensus is to be derived from a limited but knowledgeable pool of respondents.

### *4.5 Limitations of Methodology*

Some limitations include reliance on subjective inputs, potential bias in expert selection, and limited generalizability beyond the Indian aviation context. However, these were mitigated by validating consistency, selecting a diverse expert group, and incorporating a sensitivity check. Future studies may combine AHP with fuzzy logic or TOPSIS to capture additional uncertainty and strengthen predictive power.

## 5: Analysis

The analysis phase of the study involved applying the AHP methodology to the collected expert data and synthesizing the resulting priority weights to determine the most critical collaboration factors across the three aviation domains: airports, airlines, and air traffic control. The factors were evaluated based on their normalized weights derived from the pairwise comparison matrices submitted by the expert panel.

**5.1 Airport Stakeholder Analysis** The airport-related factors were ranked based on their impact on collaboration. Revenue Sharing emerged as the most critical factor, with a weight of 0.327, indicating its foundational role in aligning interests between stakeholders. Real Estate & Hub Operations followed with a weight of 0.236, reflecting the significance of physical infrastructure as a catalyst for long-term partnerships.

Co-Creation (0.172) and Harmonization of Operational Protocols (0.145) were also deemed essential, pointing to the increasing need for joint decision-making and standardization of processes. Regulatory Flexibility, while important, scored relatively lower (0.120), indicating that operational and commercial alignments currently take precedence over legislative changes in the eyes of stakeholders.

**5.2 Airline Stakeholder Analysis** Among airline-related factors, Contingency Planning was the top priority (0.289), underscoring the need for proactive disruption management in aviation collaboration. Loyalty Programs (0.216) ranked second, highlighting the commercial dimension of collaboration, especially in enhancing customer retention through strategic alliances.

On-Time Performance and Cloud-Based Infrastructure scored 0.190 and 0.165, respectively, indicating that both operational consistency and technological integration are essential but currently under-leveraged. Network Frequency, though crucial for strategic expansion, was weighted lowest (0.140), possibly due to the limited influence airlines have over route permissions and slot allocations in many developing nations.

**5.3 ATC Stakeholder Analysis** Within the ATC domain, Weather Management ranked highest (0.306), reflecting the frequent operational disruptions caused by climatic variability in Indian airspace. Shared Technology Platforms (0.242) followed closely, highlighting the importance of system integration and information exchange.

Congestion Management (0.233) and Delay Handling (0.219) were ranked nearly equally, suggesting that effective traffic flow management is a shared concern across the aviation ecosystem. These results confirm the need for a digitally synchronized and flexible air traffic management system.

**5.4 Cross-Domain Insights and Trends** Across all domains, certain themes emerged as universally significant: the need for financial alignment (e.g., revenue sharing), the importance of real-time responsiveness (e.g., weather and contingency planning), and the strategic value of shared platforms (e.g., cloud and IT systems). These insights point to an evolving ecosystem where agility, collaboration, and integrated data systems are paramount.

## 6: Conclusion

This study confirms the strategic significance of collaborative decision-making in enhancing aviation efficiency and resilience in developing countries. By applying AHP, it quantitatively ranks collaboration drivers, offering a robust decision-support tool for stakeholders. The results point to actionable strategies—such as investing in real-time data systems, aligning incentives, and developing joint contingency protocols—that can substantially improve operational outcomes.

Limitations include sample size and geographic scope. Future research could apply hybrid models (e.g., AHP-TOPSIS) and expand the dataset across multiple developing nations.

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