U.S. Airline Performance & Delay Analysis

1. Executive Summary

This report presents a comprehensive analysis of the U.S. domestic flight industry based on over 5.8 million flight records from 2015. The primary objective was to identify the key drivers of flight delays and cancellations, benchmark airline and airport performance, and provide data-driven recommendations. The analysis reveals that while the industry maintains an on-time arrival rate of approximately 79%, systemic challenges remain. Key findings indicate a significant performance gap between airlines, with carriers like Hawaiian and Alaska excelling while others like Spirit and Frontier consistently underperform. Furthermore, the majority of flight cancellations are driven by external factors such as weather and National Air System (NAS) constraints, with predictable seasonal peaks in winter and summer. Key recommendations include targeted operational reviews for underperforming airlines, strategic investment in NAS modernization, and enhanced seasonal resource planning across the industry.

2. Introduction

Flight delays and cancellations are a persistent challenge in the U.S. aviation industry, leading to significant costs for airlines, widespread inconvenience for passengers, and a negative impact on the economy. This project was initiated to analyze a large-scale historical flight dataset to uncover actionable insights.

Project Objectives:

- To clean, integrate, and prepare a large dataset for analysis.
- To identify the primary causes and patterns of flight delays and cancellations.
- To benchmark the on-time performance, delay severity, and cancellation rates of U.S. airlines.
- To develop an interactive Power BI dashboard for visualizing key performance indicators (KPIs).
- To formulate data-driven recommendations for airlines, regulators, and passengers.

3. Methodology

The project was executed in a structured, multi-phase approach using a modern data analytics toolkit.

- **Data Storage & Management:** PostgreSQL was used as the relational database to store and manage the 5.8 million+ flight records efficiently.
- **Data Cleaning & Integration:** Initial data cleaning and integration were performed using Jupyter Notebook with the pandas library. This involved handling missing values, creating a unified date column, and merging the flights, airlines, and airports datasets into a single, analysis-ready table.
- **KPI Calculation:** SQL VIEWS were created in PostgreSQL to pre-calculate key metrics (e.g., performance by airline, cancellation reasons), ensuring efficient processing in the visualization stage.
- **Dashboard Development:** Power BI was connected to the PostgreSQL database to build a dynamic and interactive dashboard. Data was modeled, and DAX measures were created to ensure accurate and reusable calculations.

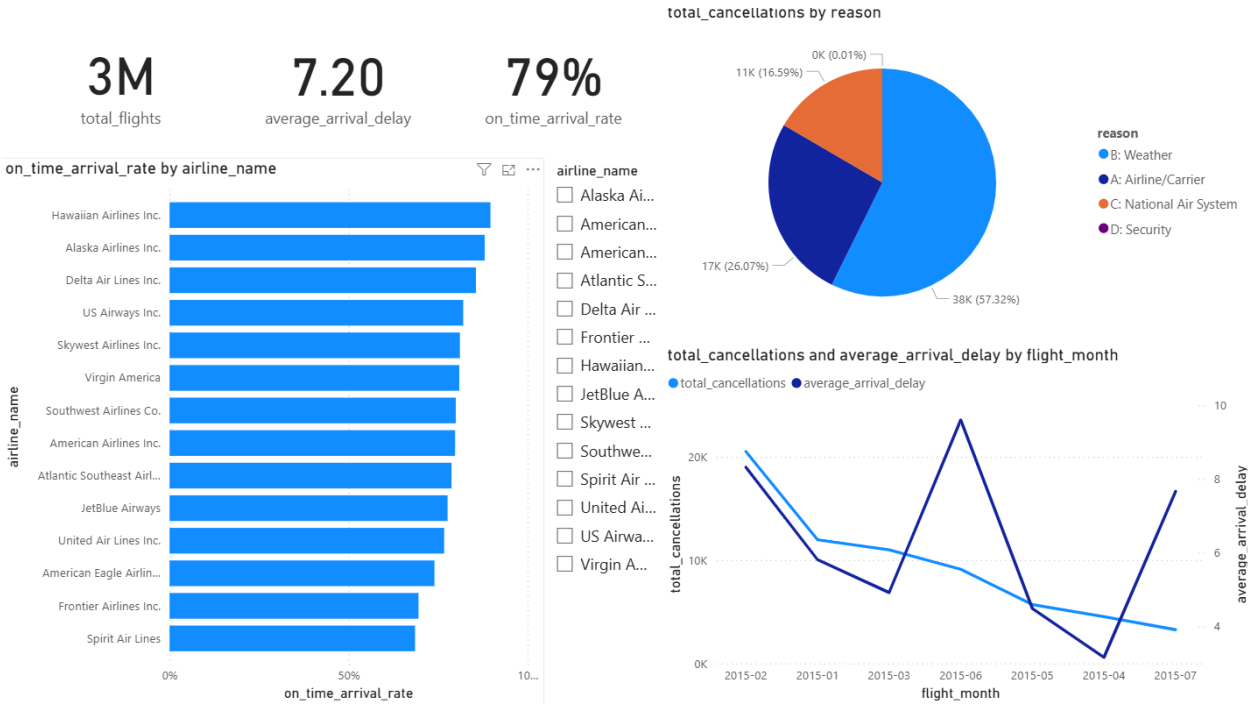
4. Analysis & Key Findings (Insights)

The analysis of the interactive dashboard revealed several critical insights:

- **Insight 1: Significant Performance Gap Between Airlines:** A wide disparity exists in on-time performance. Hawaiian Airlines and Alaska Airlines are the top performers, while Spirit Airlines and Frontier Airlines lag significantly behind the industry average.
- **Insight 2: External Factors Drive Most Cancellations:** The leading causes of flight cancellations are Weather and National Air System (NAS) issues, not factors within the airlines' direct control.
- **Insight 3: Performance is Highly Seasonal:** Disruptions peak predictably during winter (Dec-Feb) and summer (June-July) travel seasons, corresponding with adverse weather and high traffic volume.

5. Dashboard Highlights

The interactive Power BI dashboard provides a centralized view of all key metrics.



6. Actionable Recommendations

Based on the findings, the following recommendations are proposed:

1. **For Underperforming Airlines (e.g., Spirit, Frontier):** Conduct an internal operational review focused on controllable factors like crew scheduling and ground-handling efficiency to close the performance gap with industry leaders.

2. **For Aviation Industry Regulators (e.g., FAA):** Prioritize investment in upgrading the National Air System (NAS) to reduce system-wide delays and improve air traffic efficiency.

3. **For All Airlines' Operational Strategy:** Implement enhanced seasonal resource planning, increasing staff and standby resources during the identified high-risk winter and summer months.

7. Conclusion & Limitations

This project successfully transformed a large raw dataset into an actionable intelligence tool that clearly identifies the core challenges in U.S. airline performance. The findings provide a clear path for airlines and regulators to make targeted improvements.

Limitations:

- The analysis is based on data from 2015. A more current dataset would be needed to validate if these trends persist.
- The dataset does not include external economic factors (e.g., fuel prices, economic growth) that could influence airline operations and performance.