Airline Delay Analysis

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Overview

This exploratory data analysis leverages Power BI to extract meaningful insights from comprehensive airline operational data spanning two years, multiple carriers, and airports.

The dataset includes key metrics such as flight volumes, delay categories, cancellations, and diversions across diverse time periods and geographic locations.

Key Analysis Areas:

- Delay patterns across five primary categories: carrier issues, weather, national aviation system, security breaches, and late aircraft

- Seasonal variations and temporal trends

- Carrier performance comparisons

- Geographic patterns and airport-specific insights

- Flight volume versus delay correlations

Through interactive Power BI visualizations, this analysis provides actionable insights to understand delay root causes, identify performance gaps, and support data-driven decision making for improved airline operations and passenger satisfaction.

Dataset Overview

- **Data Source & Scope**

    Source: FP20 Analytics

    Time Period: 2-year coverage

    Scope: Multiple carriers, airports, and operational metrics

- **Key Performance Metrics**

    Delay Rate: Percentage of flights experiencing delays >15 minutes

    On-Time Performance Rate: Percentage of flights arriving within 15 minutes of scheduled time

- **Data Dimensions**

    Temporal: Year, Month

    Carrier: Carrier ID, Carrier Name

    Geographic: Airport codes, names, latitude/longitude

    Operational: Flight volumes, delay categories, cancellations, diversions

- **Data Preparation**

    Data cleaning and validation completed

    Data enrichment performed to enhance analysis capabilities

    Dataset prepared for visual storytelling and interactive analysis

- **Analysis Limitations**

    Analysis scope limited to 2-year period

    Results reflect historical performance within this timeframe

Methodology

Delay rate

17.10%

On-time Performance rate

82.90%

- **Power BI Analysis Approach**

Interactive Dashboards: Dynamic visualizations enabling multi-dimensional data exploration

Data Modeling: Established relationships between carriers, airports, time, and delay categories

Visual Storytelling: Comprehensive charts including scatter plots, bar charts, and donut charts

Filtering Capabilities: Year-over-year comparisons with interactive slicers

- **Key Performance Indicators (KPIs)**

Delay Rate: 17.10% - Percentage of flights delayed >15 minutes

On-Time Performance Rate: 82.90% - Percentage of flights arriving within schedule

Delay Minutes by Category: Total delay time breakdown by cause

Travel Season Analysis: Peak vs off-peak performance comparison

Geographic Performance: Regional delay pattern identification

Analysis Framework

Temporal Analysis: Monthly delay trends and seasonal patterns

Categorical Analysis: Five delay causes (carrier, weather, systems, security, late aircraft)

Geographic Analysis: Airport region performance (inland vs coastal)

Carrier Benchmarking: Top 7 airline performance comparison

Operational Efficiency: Flight volume correlation with delay patterns

Delays Due to Weather by Airport (Top 8)

Airport	Delays
DFW	297
ORD	249
MSP	211
ATL	178
DEN	176
DTW	164
SLC	155
LAX	126

Key Findings Summary

High-Level Insights and Trends

- **Overall Industry Performance**

  17.10% delay rate with **82.90% on-time performance** indicates strong operational efficiency

  Industry maintains reliability despite operational challenges

  Performance consistency across 2-year analysis period

- **Seasonal Performance Patterns**

  Winter months (Jan-Feb) show highest delay rates at ~19%

  Fall season (Nov) demonstrates optimal performance at ~15%

  4-percentage point seasonal variation reveals predictable patterns

- **Geographic Performance Variations**

  Coastal airports experience higher weather-related delays

  Inland airports show different operational challenges

  Regional factors significantly impact delay patterns

Key Findings Summary

Most Significant Delay Patterns Discovered

- **Weather Dominance**

    Weather emerges as the primary delay driver across all airports

    Uncontrollable external factor represents largest operational challenge

    Geographic correlation between weather delays and airport location

- **Carrier Performance Gaps**

    Top-performing carriers maintain consistent on-time rates

    Performance variation exists across different airline operational models

    Carrier-specific delays represent controllable improvement opportunities
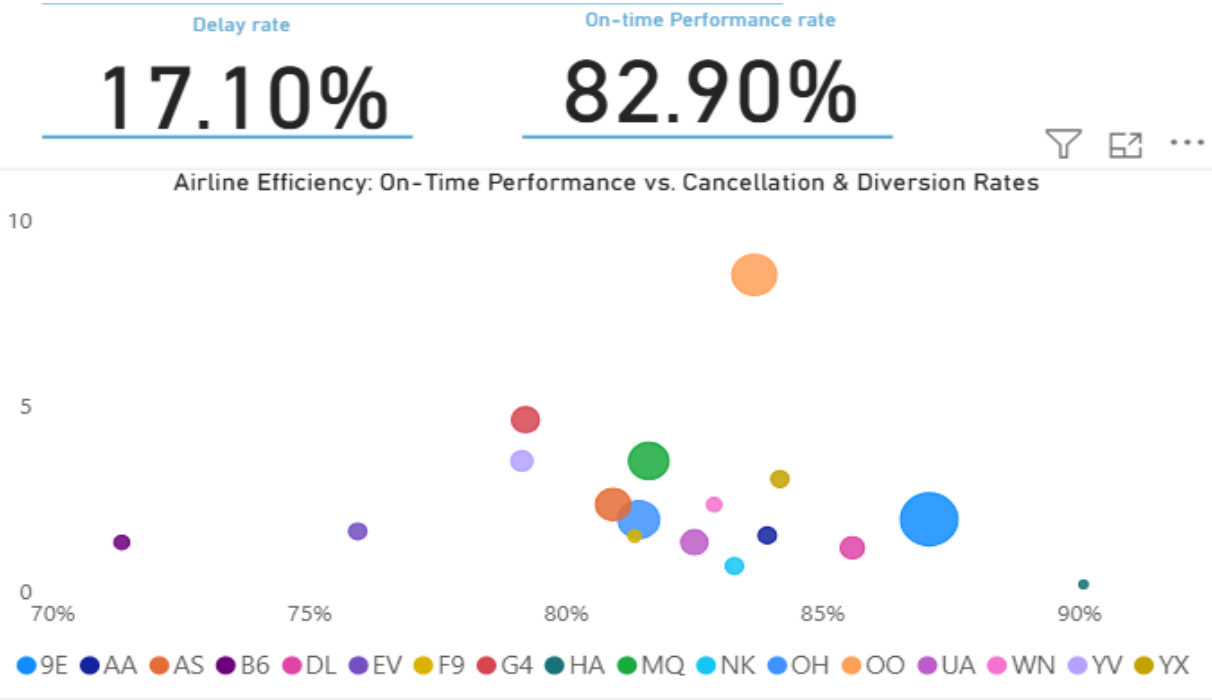
- **Travel Season Impact**

    Peak travel periods correlate with increased delay rates

    Off-peak seasons show improved operational efficiency

    Capacity management influences delay patterns during high-demand periods

Airline Delay Analysis

Delay rate
17.10%

On-time Performance rate
82.90%

Airline Efficiency: On-Time Performance vs. Cancellation & Diversion Rates

Delays Due to Weather by Airport (Top 8)

- **Airline Efficiency Overview**

SkyWest Airlines Inc.
- **On-time performance:** 83.68% (highest)
- **Cancellation rate:** 8.51%
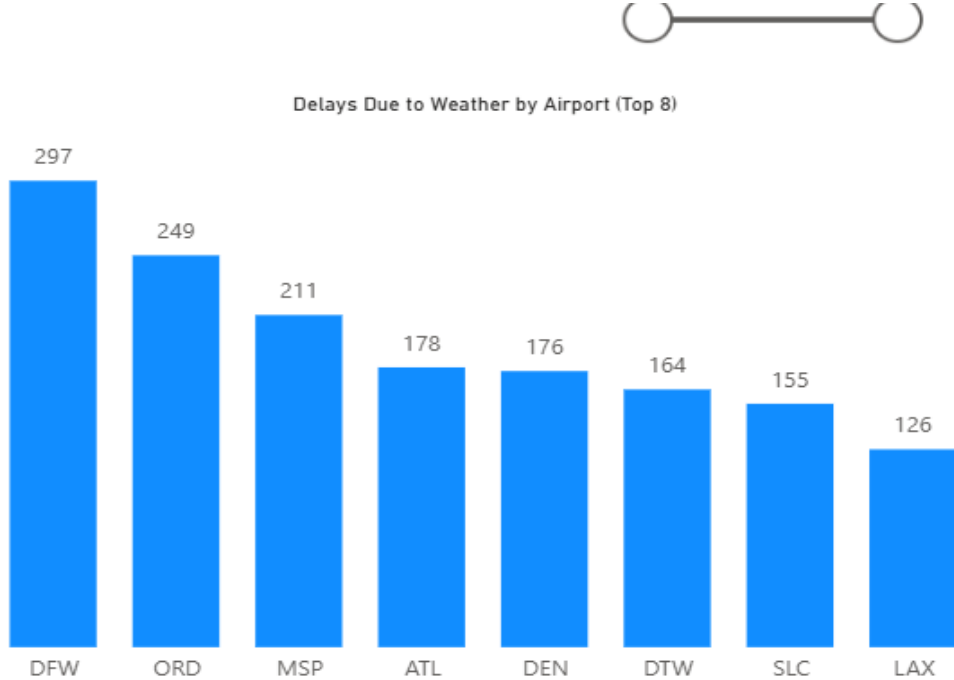- **Diversion rate:** 49.38%

Allegiant Air
- **On-time performance:** 79.22%
- **Cancellation rate:** 4.61%
- **Diversion rate:** 16.98%

SkyWest leads in punctuality but shows a **high diversion rate**, suggesting possible rerouting issues.

Allegiant balances moderate punctuality with **lower cancellation and diversion rates**.

🌧 **Delays Due to Weather by Airport**
Dallas Fort Worth (DFW): 297 delays — *most affected by weather*
Chicago O'Hare (ORD): 249 delays
Marcos Paz Airfield: 211 delays
  ◆ These airports experience the **highest frequency of weather-related delays**
  ◆ Suggests potential **regional climate challenges** or **weather management inefficiencies**

Airline Delay Analysis

Airline Delay Breakdown by Cause					
Carrier Name	Carrier's Reasons	Late Aircraft	Security Breach	Weather	N. A. Systems
Southwest Airlines Co.	11,403.04	13,003.82	112.72	189.03	5,869.44
SkyWest Airlines Inc.	8,228.43	6,970.44	44.60	1,454.02	3,976.49
American Airlines Inc.	6,203.86	5,564.38	51.04	390.83	6,733.80
Delta Air Lines Inc.	5,985.01	4,341.45	22.42	570.48	7,943.48
JetBlue Airways	3,587.45	3,340.13	19.48	120.85	3,295.12
United Air Lines Inc.	3,291.67	4,112.23	0.96	338.73	5,754.49
Mesa Airlines Inc.	1,922.93	2,681.60	15.05	227.38	1,511.99
PSA Airlines Inc.	1,881.44	3,063.85	18.01	145.11	2,053.51
Republic Airline	1,844.76	2,540.32	19.69	201.05	3,326.25
Envoy Air	1,647.72	2,906.13	19.22	457.59	3,039.35
Endeavor Air Inc.	1,621.39	2,045.83	4.92	195.01	1,992.92
Alaska Airlines Inc.	1,574.97	1,975.05	46.05	117.06	2,580.90
Spirit Air Lines	1,185.55	1,077.48	56.89	114.08	2,586.04
Frontier Airlines Inc.	1,110.39	1,207.36	0.00	38.85	1,297.47
Allegiant Air	837.58	1,400.99	23.40	185.11	1,032.99
Hawaiian Airlines Inc.	739.39	251.43	4.61	19.77	16.78
ExpressJet Airlines LLC	640.84	903.68	0.00	59.48	1,090.03

Delay Causes by Airline – Key Highlights

Southwest Airlines Co. reports the **highest delay counts** among all carriers.

> **Late aircraft arrival:** 13,003 delays
> **Carrier-related issues:** 11,403 delays
> **NAS delays:** 5,869 delays
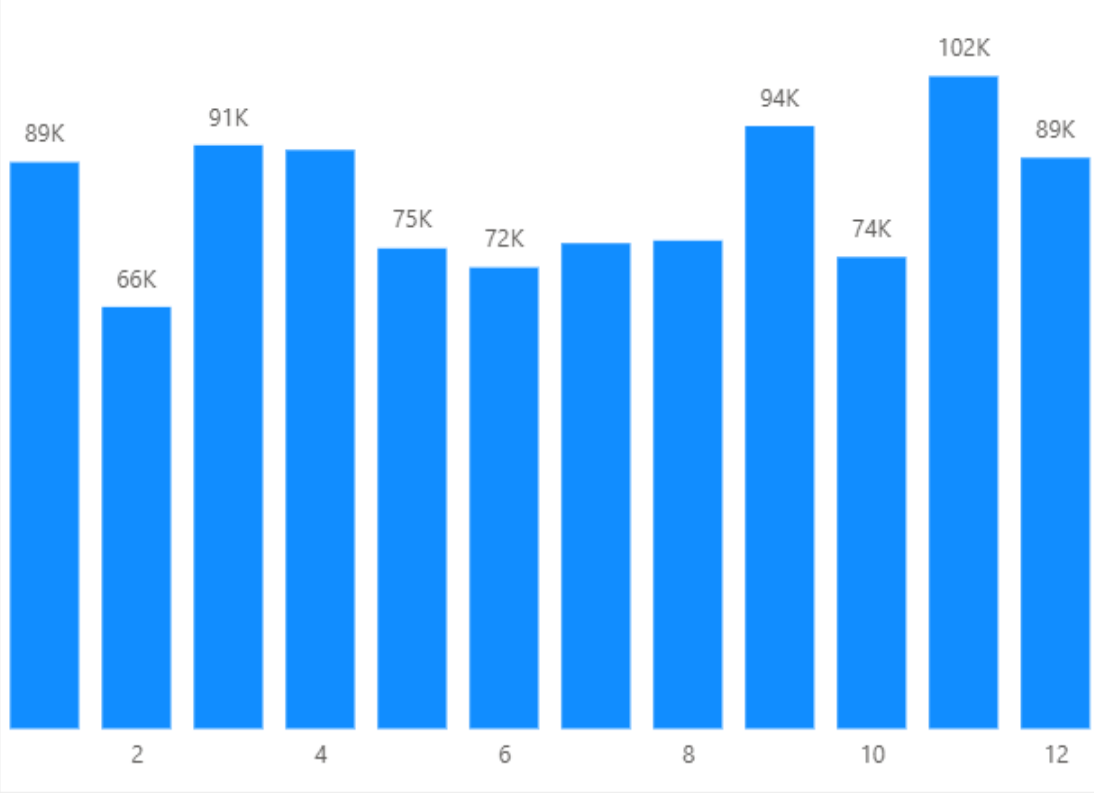> **Weather-related:** 189 delays
> **Security delays:** 113 occurrences

SkyWest Airlines Inc. and **American Airlines Inc.** follow in delay frequency.

Majority of delays are operational (carrier & late aircraft), not external (weather/security).

Indicates potential **internal inefficiencies** in scheduling, fleet, or turnaround management.

Flights Arrival by Month

Bar chart values by month: 89K, 66K, 91K, (next), 75K, 72K, (next), (next), 94K, 74K, 102K, 89K

x-axis labels: 2, 4, 6, 8, 10, 12
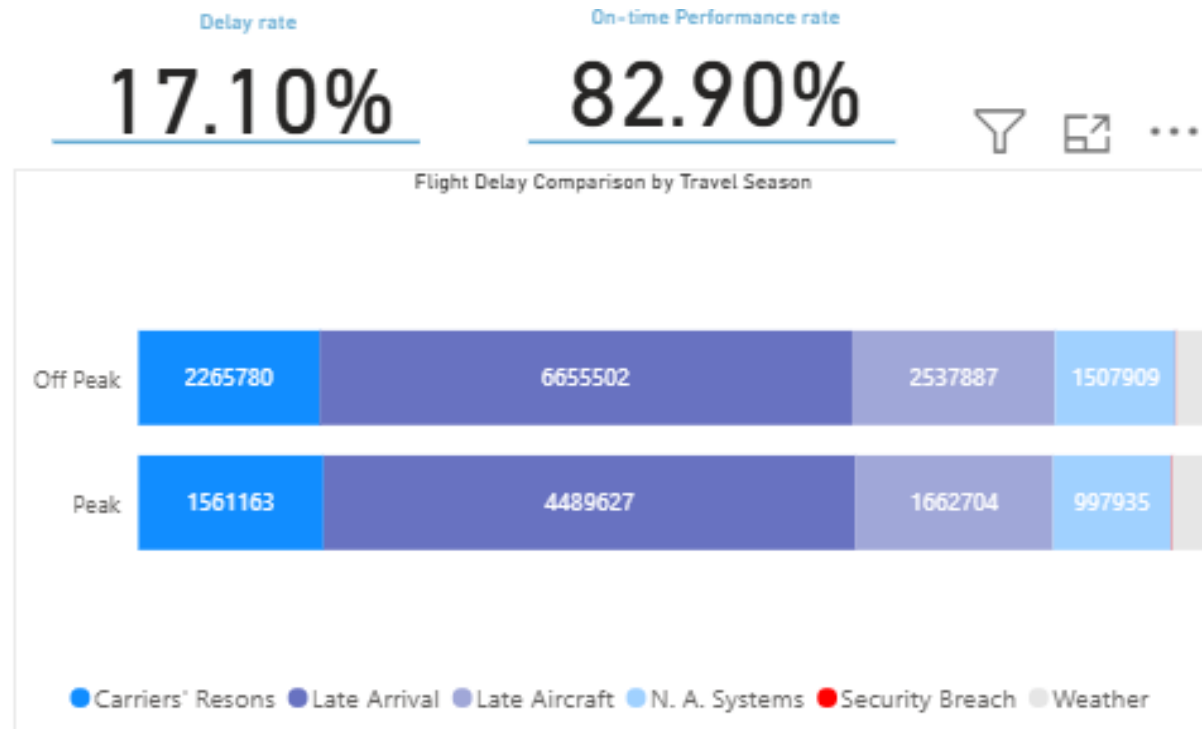
Flight Arrivals by Month
November: Highest arrivals — **102,000 flights**
September: 94,000 flights
March: 91,000 flights
November leads in flight volume, possibly due to peak travel periods or seasonal demand.

Airline Delay Analysis

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Flight Delay Comparison by Travel Season

Off Peak	2265780	6655502	2537887	1507909
Peak	1561163	4489627	1662704	997935

● Carriers' Resons ● Late Arrival ● Late Aircraft ● N. A. Systems ● Security Breach ● Weather

Delay Minutes by Airport Region

27bn (36.59%)

47bn (63.41%)

Airport... ● Inland ● Coastal

Delays Due to Weather (Minutes) by Airport Region

246K (41.36%)

348K (58.64%)

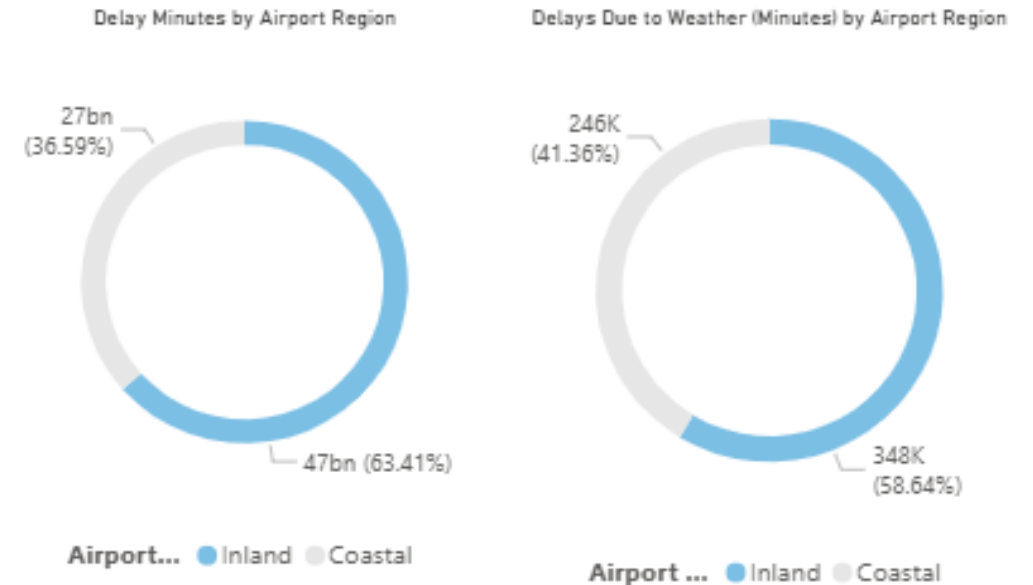Airport ... ● Inland ● Coastal

Flight Delays by Season
Delays vary slightly across seasons, with no extreme spikes.
- **Off-peak seasons** (e.g., late winter, early fall) show **higher overall delay counts** across all major causes.
- Indicates **resource optimization or demand imbalance** during quieter travel periods.

Understanding seasonal patterns can guide **better staffing and scheduling strategies**.

Delay Distribution by Airport Region
Total Delay by Minutes
- 🏔️ Inland airports: **63.41%**
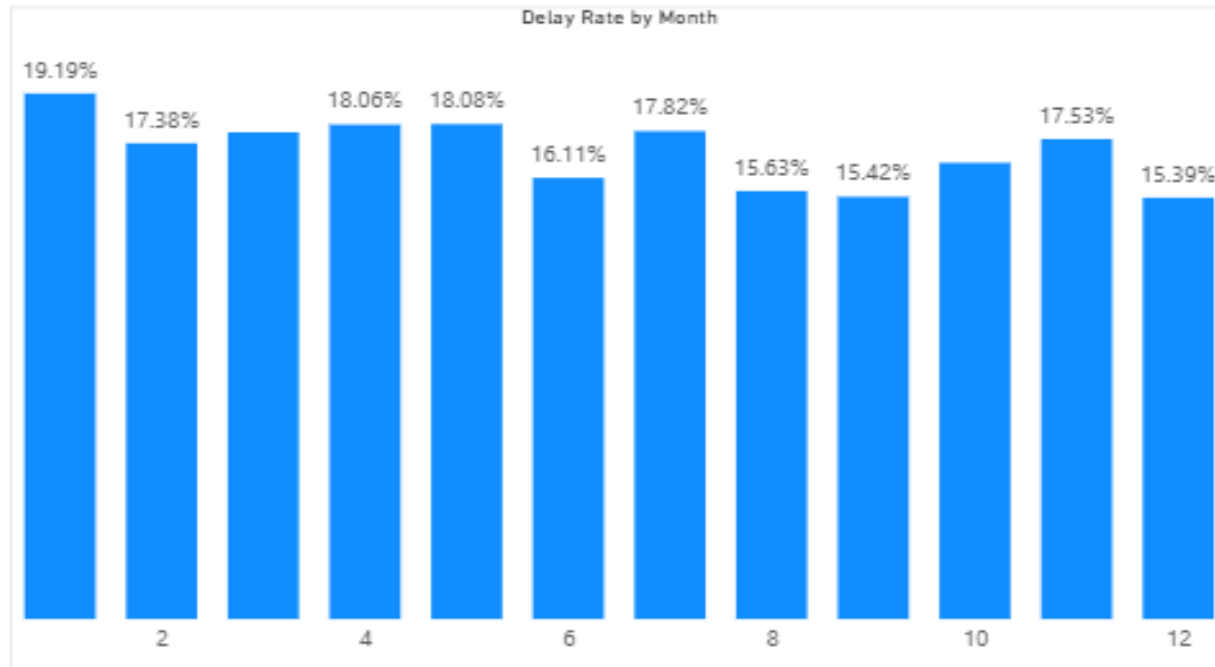- 🌊 Coastal airports: **36.59%**

Delays Due to Weather
- 🏔️ Inland: **58.64%**
- 🌊 Coastal: **41.36%**

Inland airports experience **significantly higher delays**, both in total minutes and weather-related causes — possibly due to geographic or infrastructural factors.

Airline Delay Analysis

Delay Rate by Month

19.19% | 17.38% | 18.06% | 18.08% | 16.11% | 17.82% | 15.63% | 15.42% | 17.53% | 15.39%

On-Time Performance Leaders: Top 7 Airlines

BFM — PGV — RIW — GUM — CSG — ALS — CDC

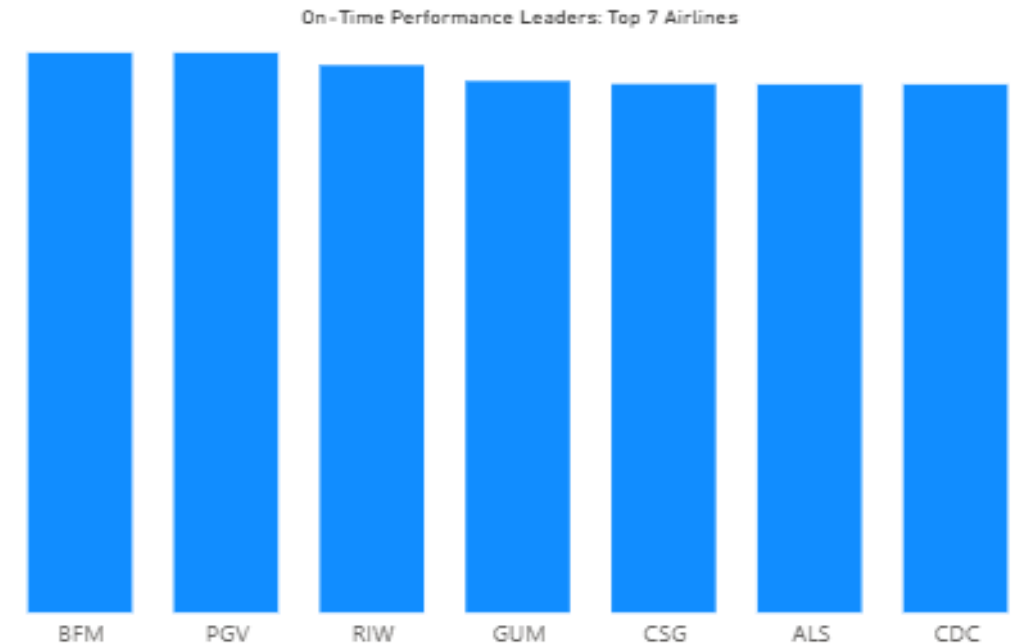**Flight Delays by Month (Top 3)**
January: 19.19%
May: 18.08%
April: 18.06%
🟡 These months reflect the **highest delay rates**, potentially linked to:
❄️ **January** – Winter weather disruptions
🌸 **April–May** – Spring travel peaks and transitional weather patterns

Top Performers by Rating (Low Volume, High Performance)
Frontier Airlines Inc.
Pitt-Greenville Airport
Central Wyoming Regional Airport
◆ These entities achieved the **highest performance ratings**
◆ However, they recorded **low flight arrival counts**
➡️ High efficiency may be influenced by **lower traffic volume**, enabling better control over operations and fewer delays.

Recommendations

- **Actionable Insights for Stakeholders**

For Airlines

Benchmark against top performers achieving 80%+ on-time performance

Implement seasonal staffing strategies for peak delay months (Jan-Feb)

Focus on controllable delays: carrier-related and late aircraft issues

Develop proactive weather contingency plans for weather-prone routes

For Airports

Enhance capacity management during peak travel periods

Implement regional coordination for weather delay mitigation

Invest in infrastructure to address capacity constraints

Optimize ground operations to reduce turnaround times

For Regulatory Bodies

Establish performance standards based on 17.10% delay rate baseline

Implement enhanced oversight during peak delay periods

Invest in National Aviation System infrastructure improvements

Facilitate best practice sharing among high-performing carriers

Airline Delay Analysis

- **Areas for Operational Improvement**

Immediate Actions (0-6 months)

Target underperforming airlines with focused improvement plans

Implement enhanced weather monitoring and response systems

Develop comprehensive winter operations strategies

Establish real-time delay tracking and response mechanisms

Medium-term Initiatives (6-18 months)

Balance flight volumes with operational capacity during peak periods

Establish collaborative delay management across airport regions

Implement predictive analytics for proactive delay management

Enhance operational efficiency through targeted staff training

Performance Targets

Short-term: Reduce delay rate from 17.10% to 15% within 12 months

Long-term: Establish 12% delay rate as industry standard

Airline Delay Analysis

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Summary of Key Takeaways:

Industry performance baseline - establishing the 17.10% delay rate and 82.90% on-time performance as benchmarks

Critical delay drivers - weather dominance and carrier-related improvement opportunities

Performance insights - gaps between carriers and geographic impacts

Actionable opportunities - immediate steps for improvement

Future Analysis Opportunities:

Enhanced data integration - expanding data sources for deeper insights

Advanced analytics - implementing predictive modeling and machine learning

Expanded scope - broadening analysis to international operations and new technologies

Strategic planning - developing industry-wide improvement frameworks

Stakeholder engagement - creating collaborative improvement systems