

# FLIGHT PERFORMANCE & AVIATION ANALYTICS

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# Content

## 1. Introduction

## 2. Problem statement

- Phase-1 (SQL Analysis)
- Phase-2 (Dashboard)
- Phase-3 (Insight report)

## 3. Recommendations

## 4. Conclusion

## 5. Connect with me

# Introduction

- The Flight Analytics Project is designed to analyze **flight delays, cancellations, and airport performance** using **real-world aviation data**. Flight disruptions significantly impact **airline operations, customer satisfaction, and overall efficiency** in air travel.
- By leveraging data analytics, this project aims to **uncover key trends** and factors contributing to **delays and cancellations**, helping stakeholders **make informed decisions**.
- Through **SQL-based data extraction** and **Power BI visualizations**, we explore various aspects of flight performance, such as **on-time arrival rates, high-delay airports, and seasonal trends**. Additionally, we identify **major hub airports** based on connectivity and analyze which routes are most prone to disruptions.

# Problem Statement:

- As a Data Analyst at **AeroStat Airlines**, a global airline company that operates flights across multiple airports.
- The company is facing challenges in **flight punctuality, cancellations, route efficiency, and passenger experience**.
- My role is to analyze the dataset using **SQL queries, Power BI/Tableau** for visualization and **extract meaningful insights** for decision making.



SQL Analysis  
- MySQL



Dashboard  
- Power BI



Insight report  
-from SQL and  
Dashboard

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# SQL Analysis Using: MySQL



# Flight Delay Analysis

Calculate the **average departure** and **arrival delay** for all flights in the last 6 months.

```
SELECT
    ROUND(AVG(DEPARTURE_DELAY), 0) AS avg_departure_delay,
    ROUND(AVG(ARRIVAL_DELAY), 0) AS avg_arrival_delay
FROM
    flights
WHERE
    flights.YEAR = 2015
        AND flights.MONTH < 7;
```

## **Significance:-**

- Helps airlines understand operational performance during a specific period.
- Identifies whether delays are more common during departure or arrival.
- Can be used to improve scheduling, ground operations, or air traffic management.

# Most Frequent Routes

Identify the **top 10 most popular flight routes** based on the total number of flights.

```
SELECT  
    ORIGIN_AIRPORT,  
    DESTINATION_AIRPORT,  
    COUNT(*) AS total_flights  
FROM  
    flights  
GROUP BY ORIGIN_AIRPORT , DESTINATION_AIRPORT  
ORDER BY total_flights DESC  
LIMIT 10;
```

## *Significance:-*

- Helps airlines prioritize resources (e.g., crew, aircraft) for high-demand routes.
- Identifies popular routes for potential expansion or optimization.
- Useful for marketing and pricing strategies.

# Airline Performance Ranking

Rank airlines by their **on-time performance** (lowest average delay).

```
SELECT
    AIRLINE,
        ROUND(AVG(DEPARTURE_DELAY + ARRIVAL_DELAY),1) AS
    avg_total_delay,
        RANK() OVER (ORDER BY AVG(DEPARTURE_DELAY +
    ARRIVAL_DELAY) ASC) AS on_time_rank
FROM flights
GROUP BY AIRLINE
ORDER BY on_time_rank;
```

## **Significance:-**

- Helps passengers choose airlines with the best on-time performance.
- Enables airlines to benchmark their performance against competitors.
- Identifies areas for improvement in scheduling or operations.

# Cancellation Trends

Find the top reasons for **flight cancellations** and their **frequency**.

```
SELECT CANCELLATION_REASON, COUNT(*) AS cancellation_count  
FROM flights  
WHERE CANCELLED = 'TRUE'  
GROUP BY CANCELLATION_REASON  
ORDER BY cancellation_count DESC;
```

## Significance:-

- Helps airlines understand the primary causes of cancellations (e.g., weather, security, airline issues).
- Guides decision-making to reduce cancellations (e.g., improving maintenance, weather forecasting).
- Provides transparency to passengers about cancellation trends.

# Airport Congestion Analysis

Identify airports with the highest number of **flight departures and arrivals**.

```
SELECT
    AIRPORT,
    SUM(flights) AS total_flights
FROM (SELECT ORIGIN_AIRPORT AS AIRPORT,
    COUNT(*) AS flights
    FROM flights GROUP BY ORIGIN_AIRPORT
    UNION ALL SELECT
        DESTINATION_AIRPORT AS AIRPORT,
        COUNT(*) AS flights
        FROM flights GROUP BY DESTINATION_AIRPORT) AS
    airport_activity
GROUP BY AIRPORT ORDER BY total_flights DESC LIMIT 10;
```

## Significance:-

- Helps airports manage congestion by allocating resources (e.g., gates, staff) effectively.
- Guides airlines in selecting hubs or focus cities.
- Identifies potential bottlenecks in the air traffic network

# Weather-Related Disruptions

Analyze how weather impacts delays and cancellations.

```
SELECT  
    CANCELLATION_REASON,  
    AVG(WEATHER_DELAY) AS avg_weather_delay,  
    COUNT(*) AS weather_related_cancellations  
FROM flights  
WHERE CANCELLATION_REASON = 'B' OR WEATHER_DELAY > 0  
GROUP BY CANCELLATION_REASON;
```

## ***Significance:-***

- Helps airlines and airports prepare for weather-related disruptions (e.g., scheduling buffers, contingency plans).
- Provides insights into the frequency and severity of weather-related issues.
- Guides investments in weather forecasting and mitigation strategies.

# Flight Distance & Duration Trends

Calculate the **average flight duration** for different distance ranges.

SELECT CASE

```
WHEN DISTANCE BETWEEN 0 AND 500 THEN '0-500'  
WHEN DISTANCE BETWEEN 501 AND 1000 THEN '501-1000'  
WHEN DISTANCE BETWEEN 1001 AND 1500 THEN '1001-1500'  
WHEN DISTANCE BETWEEN 1501 AND 2000 THEN '1501-2000'  
ELSE '2000+'  
END AS distance_range,  
AVG(AIR_TIME) AS avg_flight_duration  
FROM flights  
GROUP BY distance_range ORDER BY distance_range;
```

## **Significance:-**

- Helps airlines optimize flight schedules and fuel consumption.
- Provides insights into the relationship between distance and flight duration.
- Useful for route planning and aircraft selection.

# Day-of-Week Flight Performance

Find which day of the week has the highest **on-time flight** performance.

```
SELECT  
    DAY_OF_WEEK,  
    AVG(DEPARTURE_DELAY + ARRIVAL_DELAY) AS avg_delay  
FROM flights  
GROUP BY DAY_OF_WEEK  
ORDER BY avg_delay ASC  
LIMIT 1;
```

## **Significance:-**

- Helps airlines optimize schedules for days with fewer delays.
- Guides passengers in choosing the best days to travel.
- Identifies potential operational inefficiencies on specific days.

# Seasonality in Air Traffic

Identify which months have the **highest number of flights and delays.**

```
SELECT  
    MONTH,  
    COUNT(*) AS total_flights,  
    AVG(DEPARTURE_DELAY + ARRIVAL_DELAY) AS avg_delay  
FROM flights  
GROUP BY MONTH  
ORDER BY total_flights DESC, avg_delay DESC;
```

## *Significance:-*

- Helps airlines plan for peak travel seasons (e.g., holidays, summer).
- Identifies months with higher delays for targeted improvements.
- Guides marketing and pricing strategies based on seasonal demand.

# Passenger Connectivity & Hub Efficiency

Identify which airports act as the **largest hubs** based on the number of **connecting flights**.

```
SELECT
    ORIGIN_AIRPORT AS Hub_Airport,
    COUNT(*) AS Connecting_flights
FROM flights
WHERE ORIGIN_AIRPORT IN (SELECT
    DESTINATION_AIRPORT FROM flights)
GROUP BY ORIGIN_AIRPORT
ORDER BY connecting_flights DESC LIMIT 10;
```

## *Significance:-*

- Helps airlines optimize hub operations and passenger transfer processes.
- Guides investments in airport infrastructure and services.
- Identifies key hubs for network planning and expansion..

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# Dashboard creation

## Using:



# Flight Operations Overview



Total Flight

500K



On time performance rate

76.74%



Average arrival delay

6



Average flight duration

132



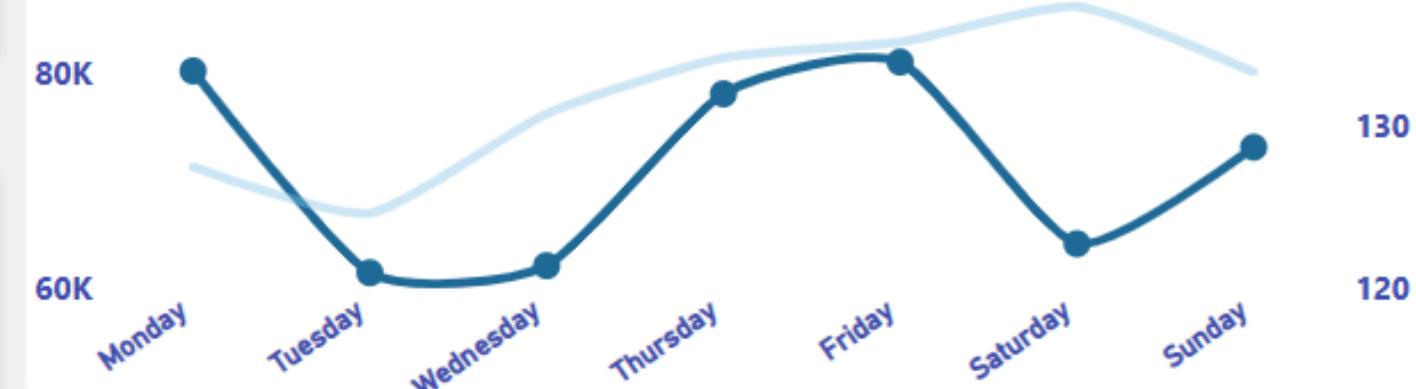
Average departure delay

10



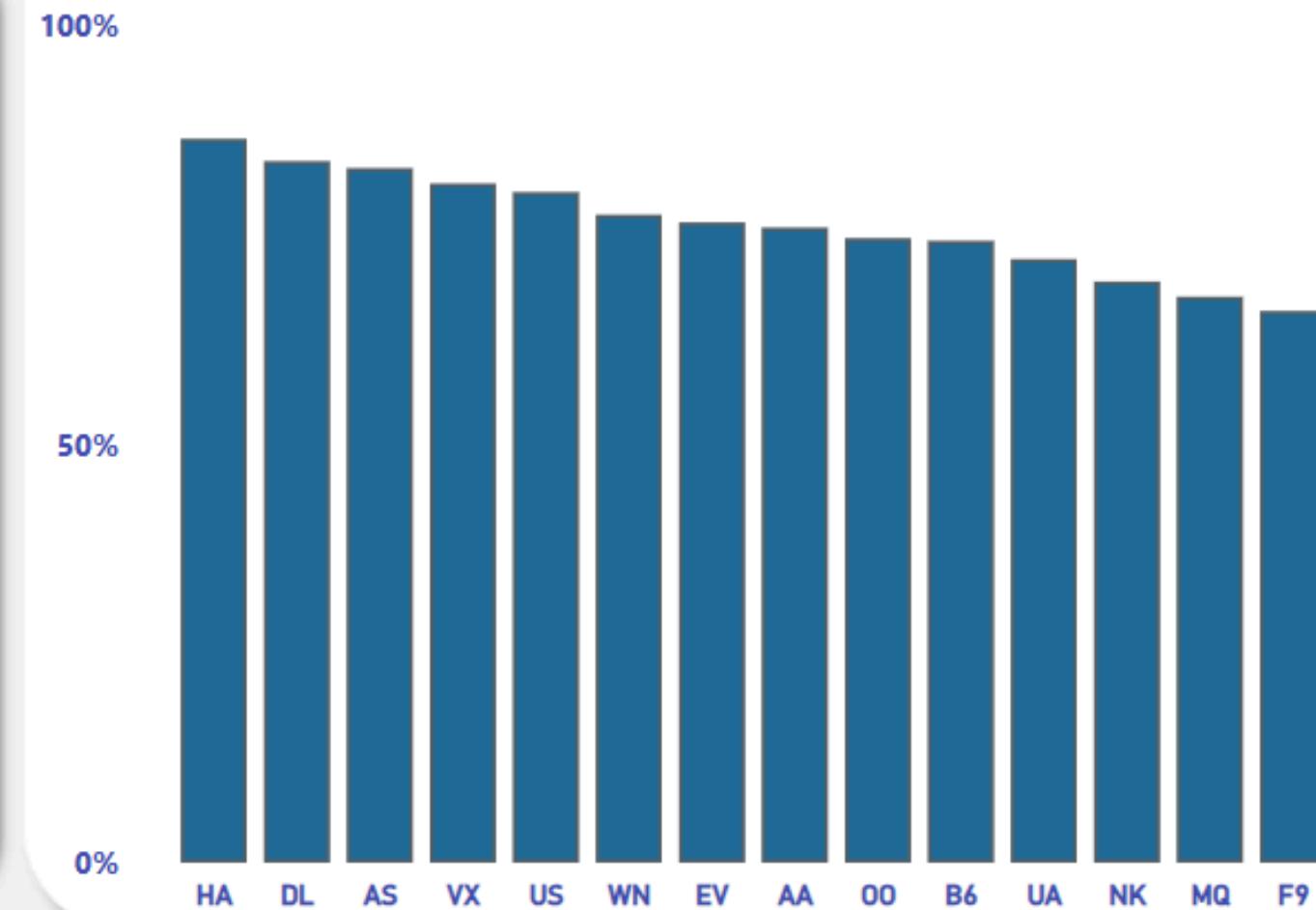
Flight count by Days of Week

Total Flights      Average Flight Duration



IATA CODE	AIRLINE	Total Flights	On-Time Performance Rate	Average Flight Duration	Average Arrival Delay	Average Departure Delay
AA	American Airlines Inc.	46950	75.9%	166	7	10.3
AS	Alaska Airlines Inc.	14149	83.0%	178	0	3.4
B6	JetBlue Airways	23062	74.3%	159	8	10.0
DL	Delta Air Lines Inc.	68555	83.8%	141	-1	6.7
EV	Atlantic Southeast Airlines	52965	76.5%	94	8	9.5
F9	Frontier Airlines Inc.	7291	65.9%	151	20	19.3
HA	Hawaiian Airlines Inc.	6858	86.5%	101	3	1.1
MQ	American Eagle Airlines Inc.	31896	67.6%	88	16	14.5
NK	Spirit Air Lines	9324	69.4%	157	12	13.7
OO	Skywest Airlines Inc.	51184	74.6%	97	11	12.0
UA	United Air Lines Inc.	40873	72.1%	186	6	13.6
US	US Airways Inc.	35591	80.1%	145	4	5.9
VX	Virgin America	5049	81.1%	202	1	6.6
WN	Southwest Airlines Co.	106252	77.4%	118	3	9.4
<b>Total</b>		<b>499999</b>	<b>76.7%</b>	<b>132</b>	<b>6</b>	<b>9.7</b>

On-Time Performance Rate by AIRLINE



# Flight Cancellation & Delay Patterns



Added an Interactive  
***Filter Panel button***  
and  
***Page navigation***  
to simplify navigation and enhance  
user experience

## Filter panel

Airline

All

Day name

All

Origin Airport

All

Destination Airport

All

City

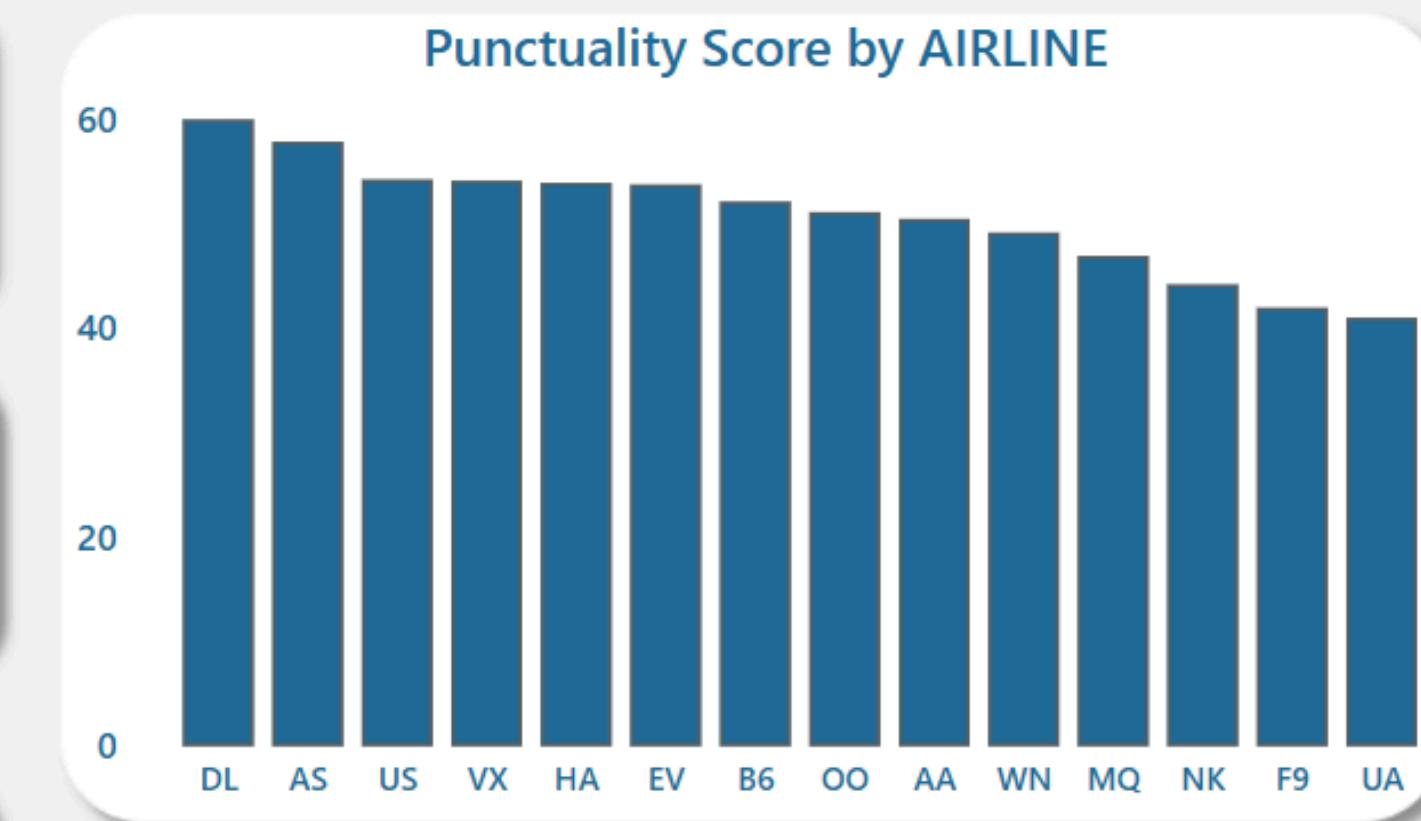
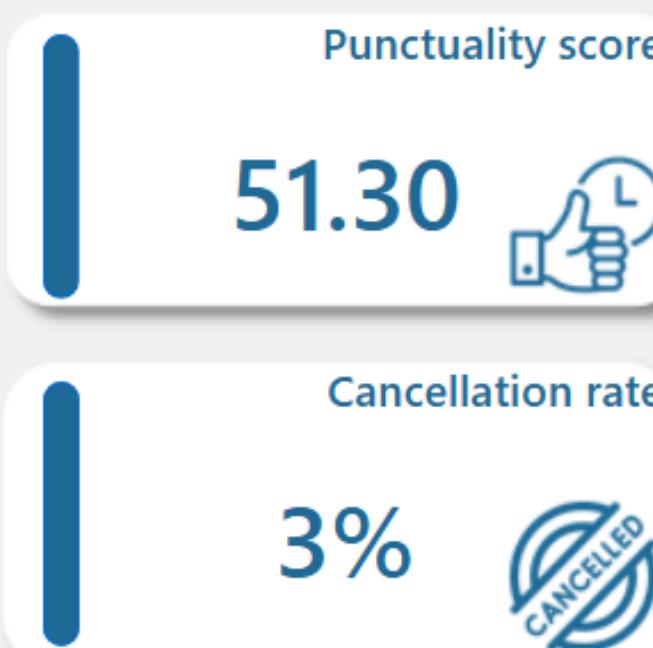
All

State

All

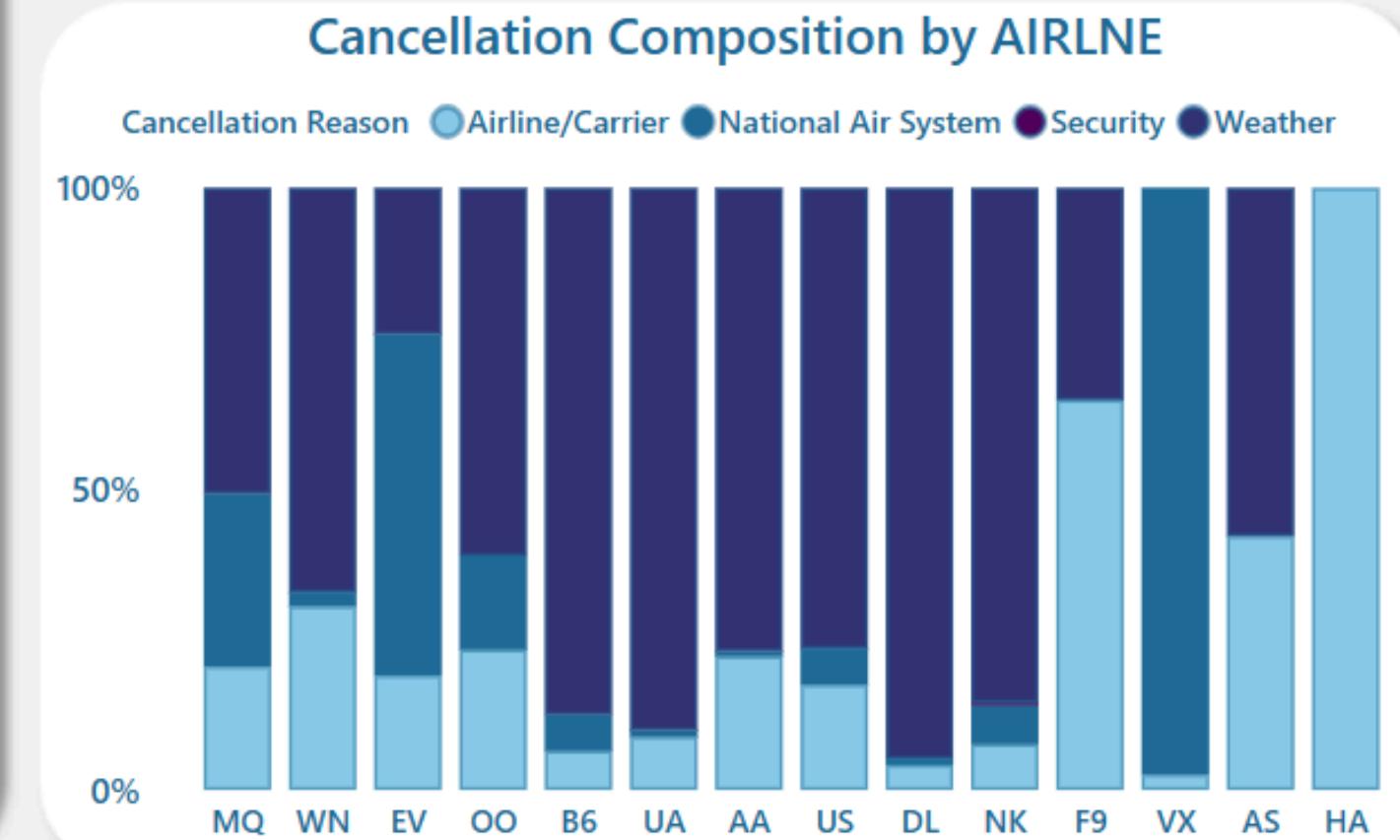
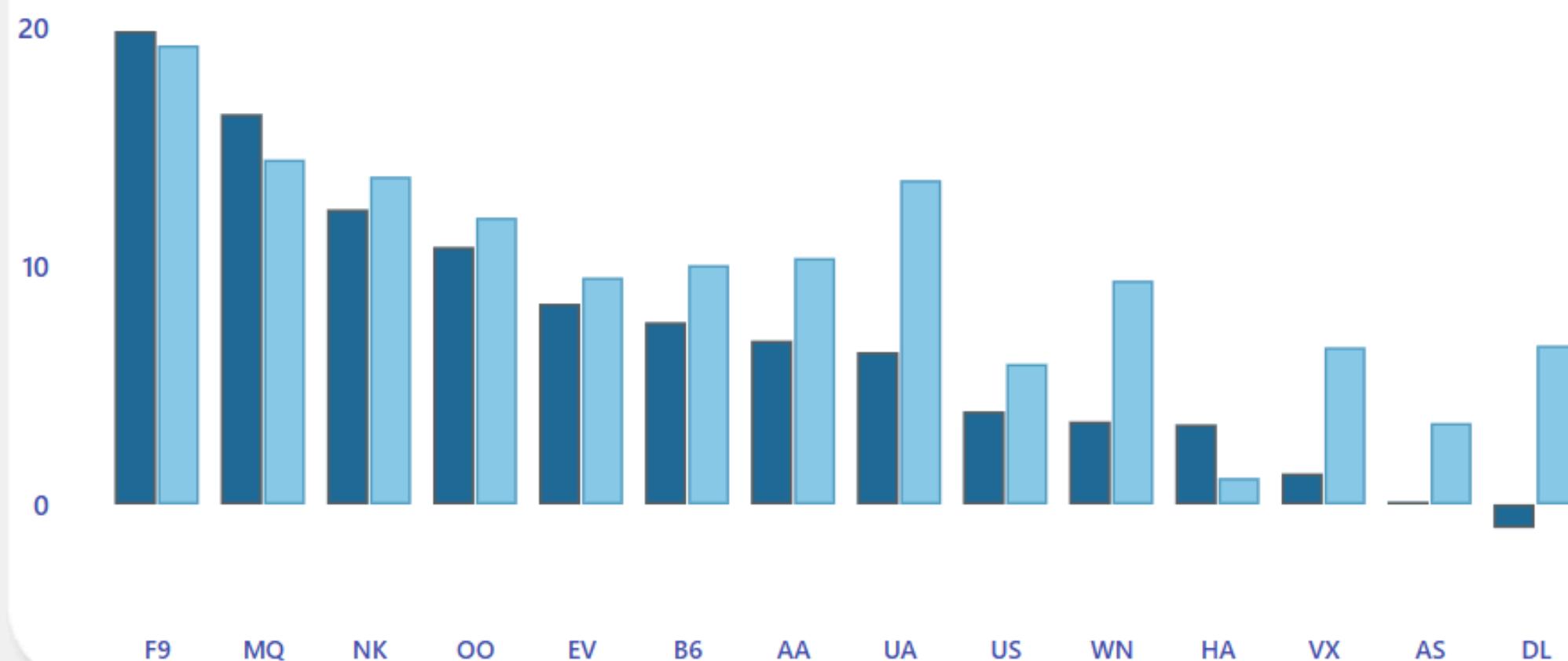


# Airline Performance Comparison



Average Arrival Delay and Average Departure Delay by AIRLINE

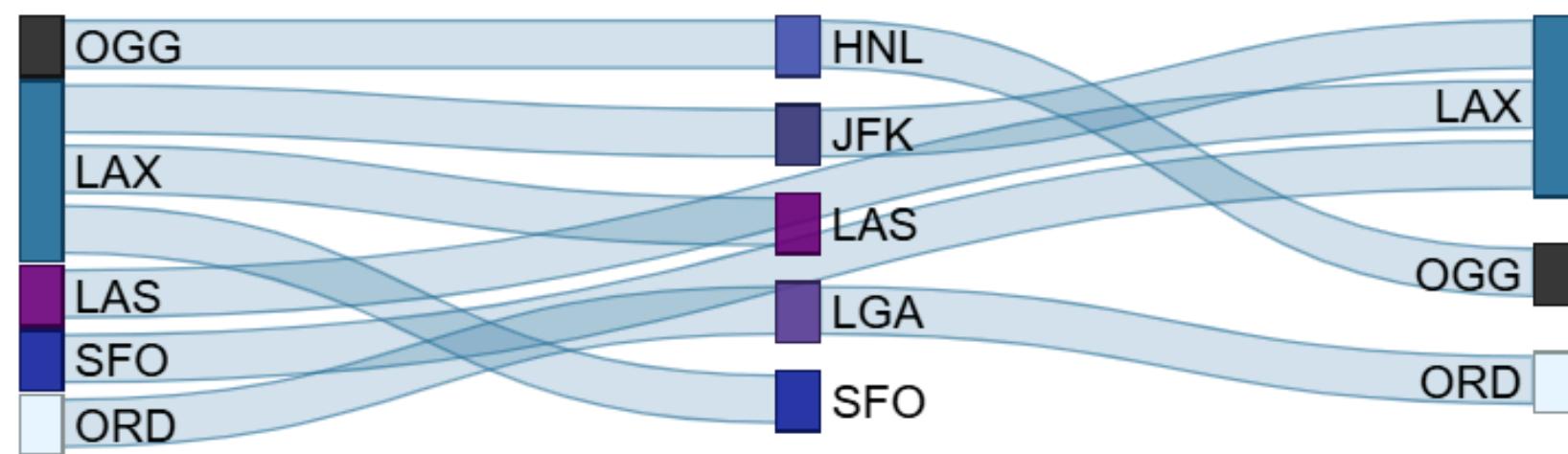
● Average Arrival Delay ● Average Departure Delay



# Route & Airport Analytics



Traffic flow between major hubs



Flights on Busiest Airport

183K



Airport Congestion index

7.88

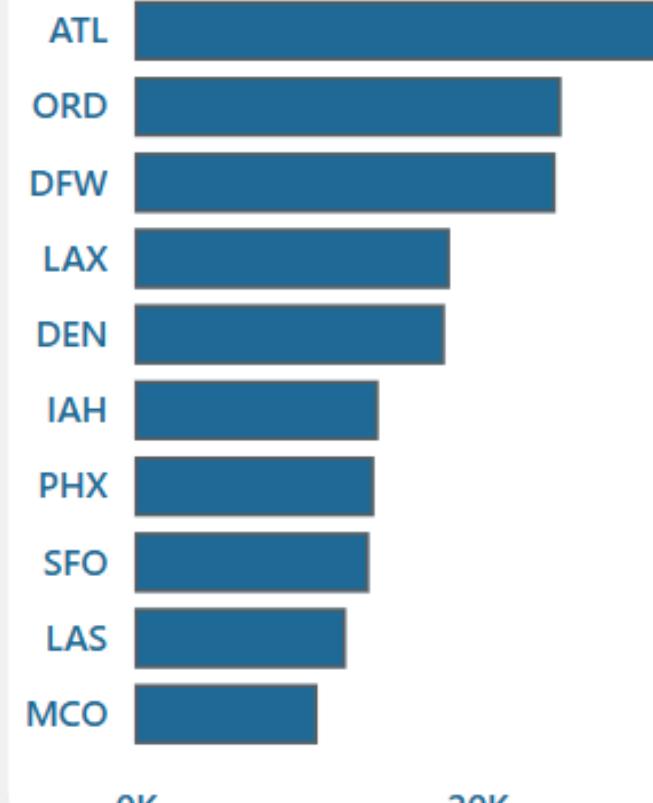


Average Flight delay

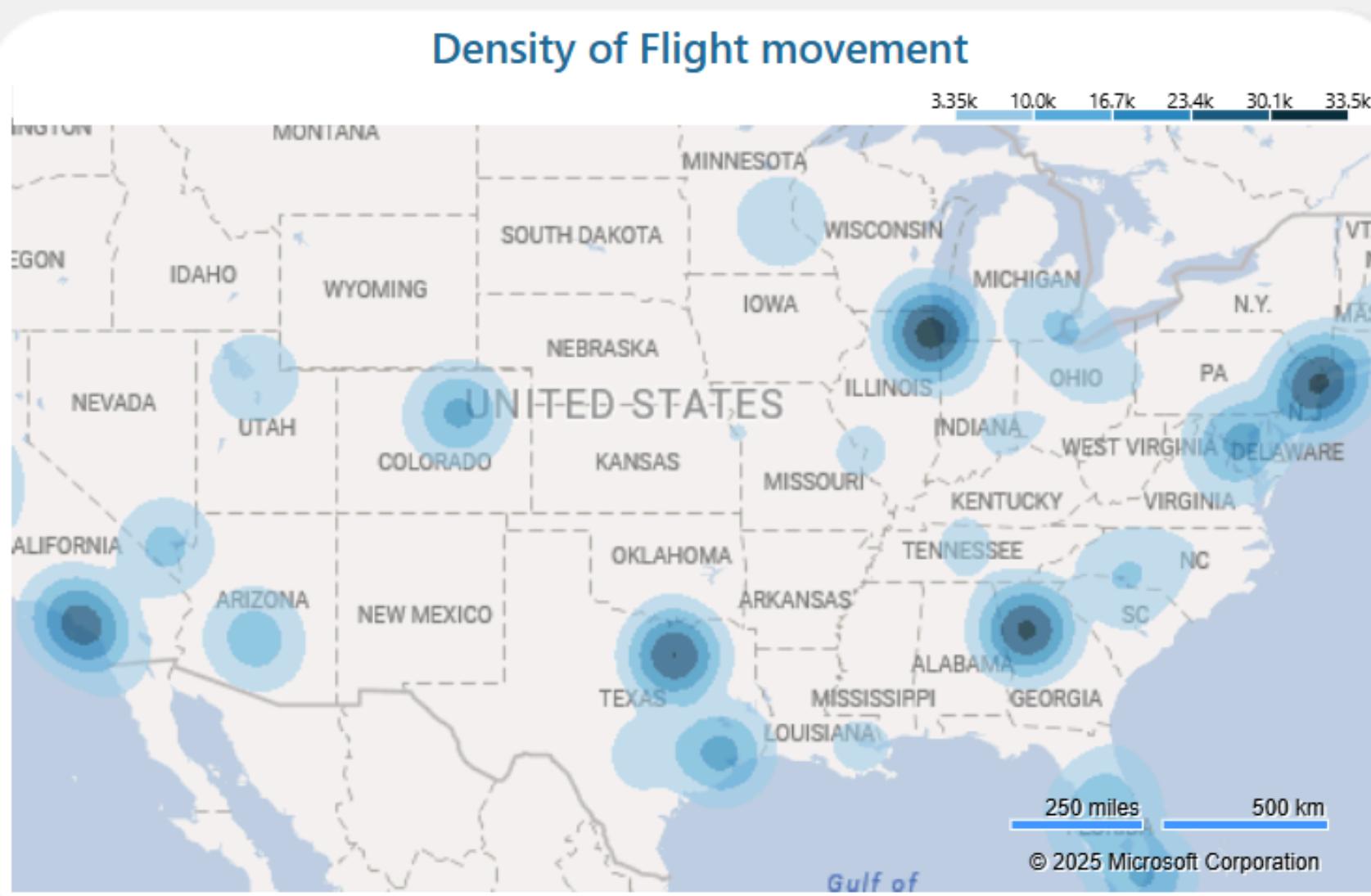
16



Top 10 Busiest Airports



Density of Flight movement



Delay Trend

Departure Delay

5M

Arrival Delay

3M

Late aircraft...

2M

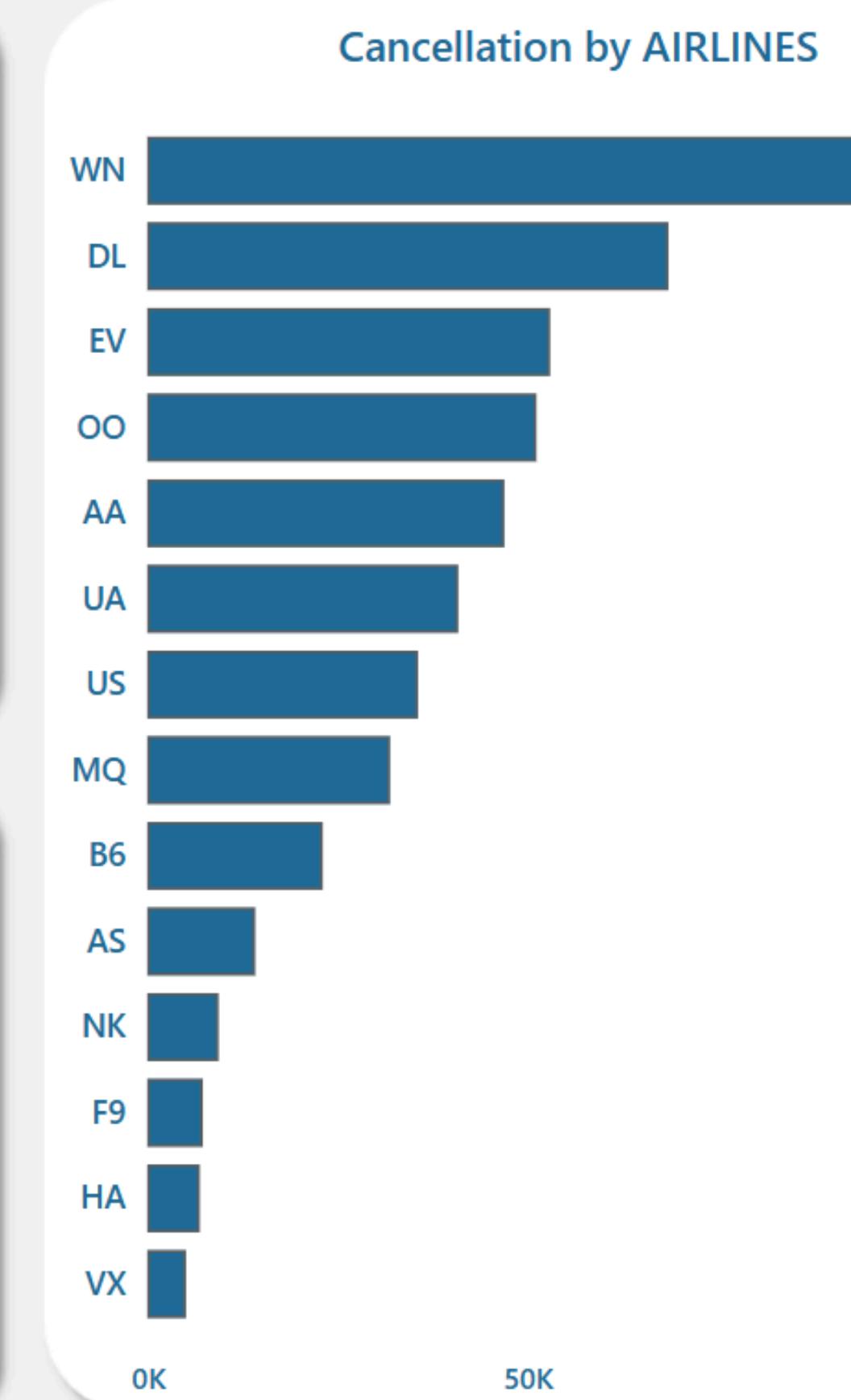
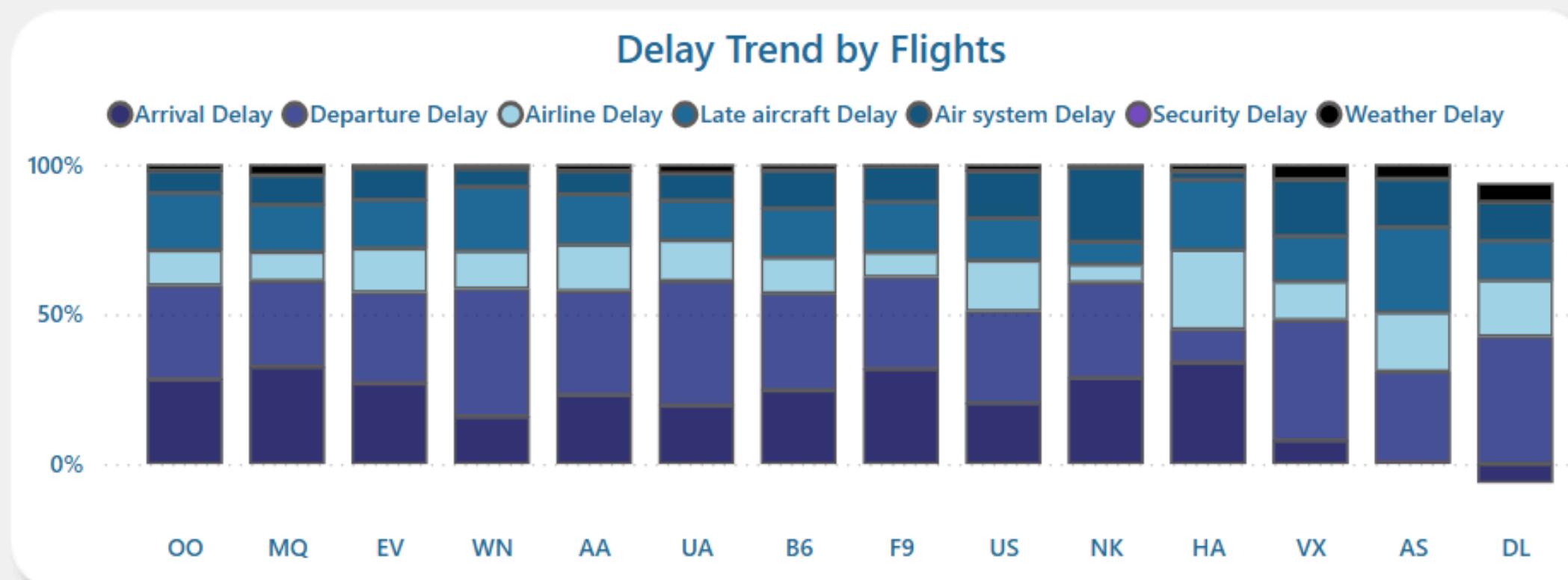
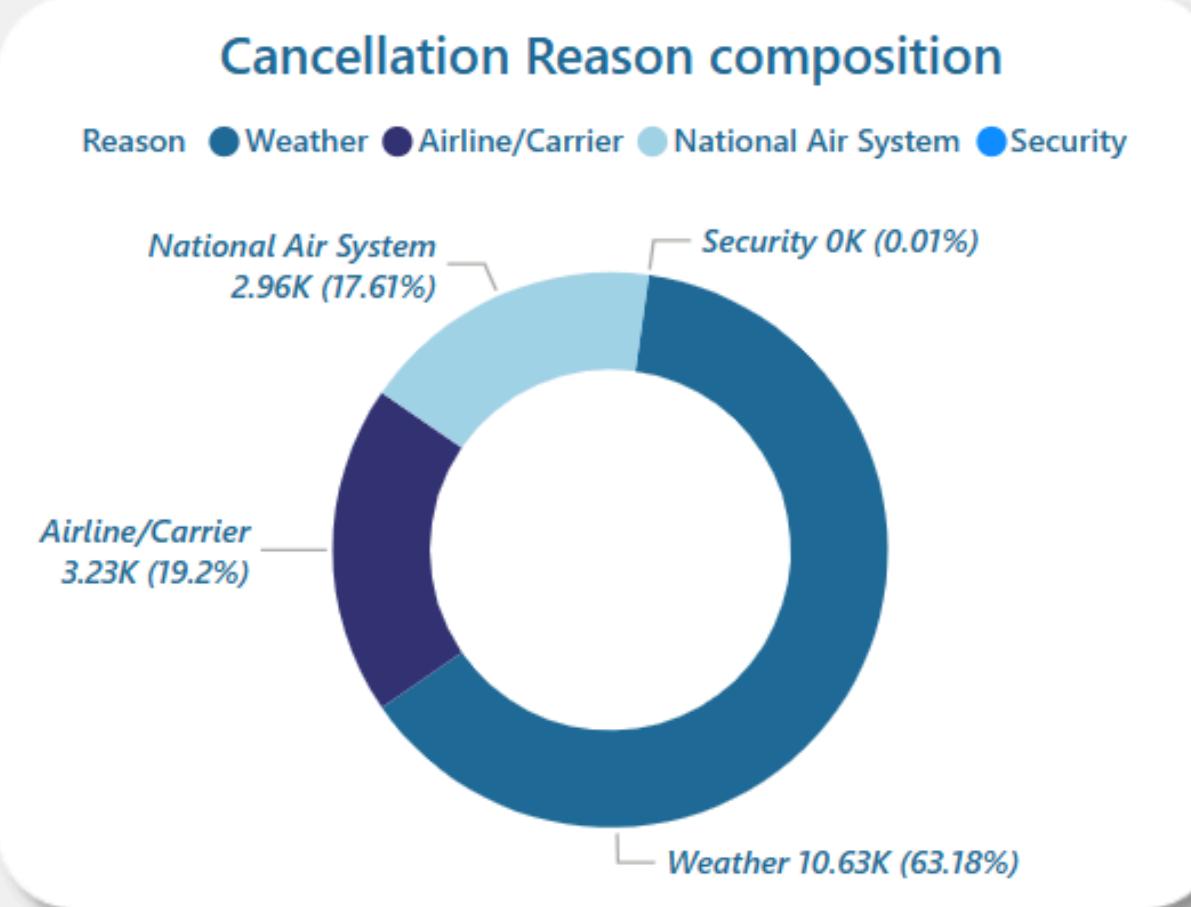
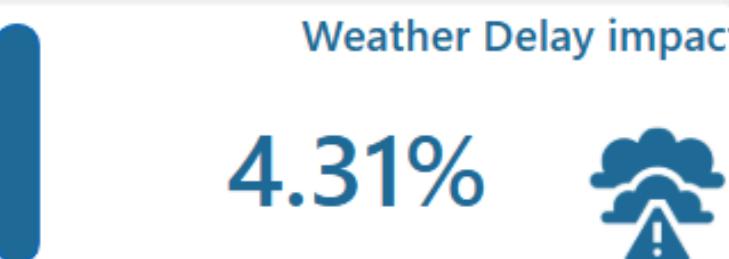
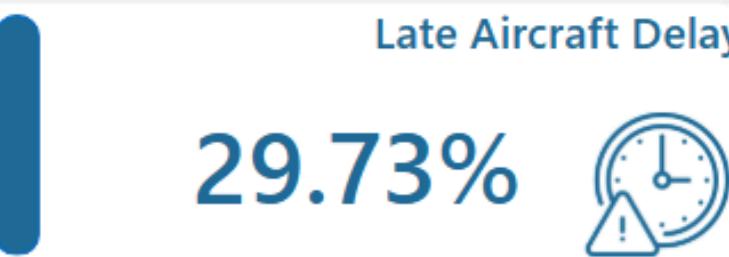
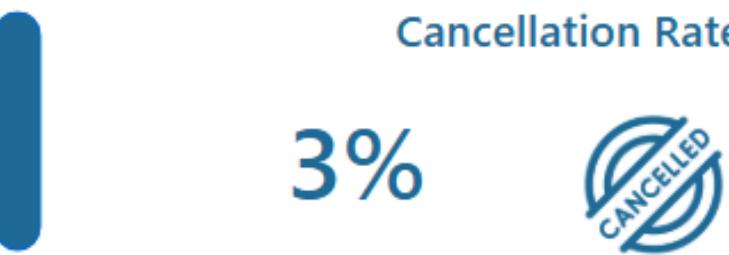
Airline Delay

2M

Air system Delay

1M

# Flight Cancellation & Delay Patterns



# Passenger Experience & Service Quality



Customer's Satisfaction score

94



Missed connection rate

8.32%

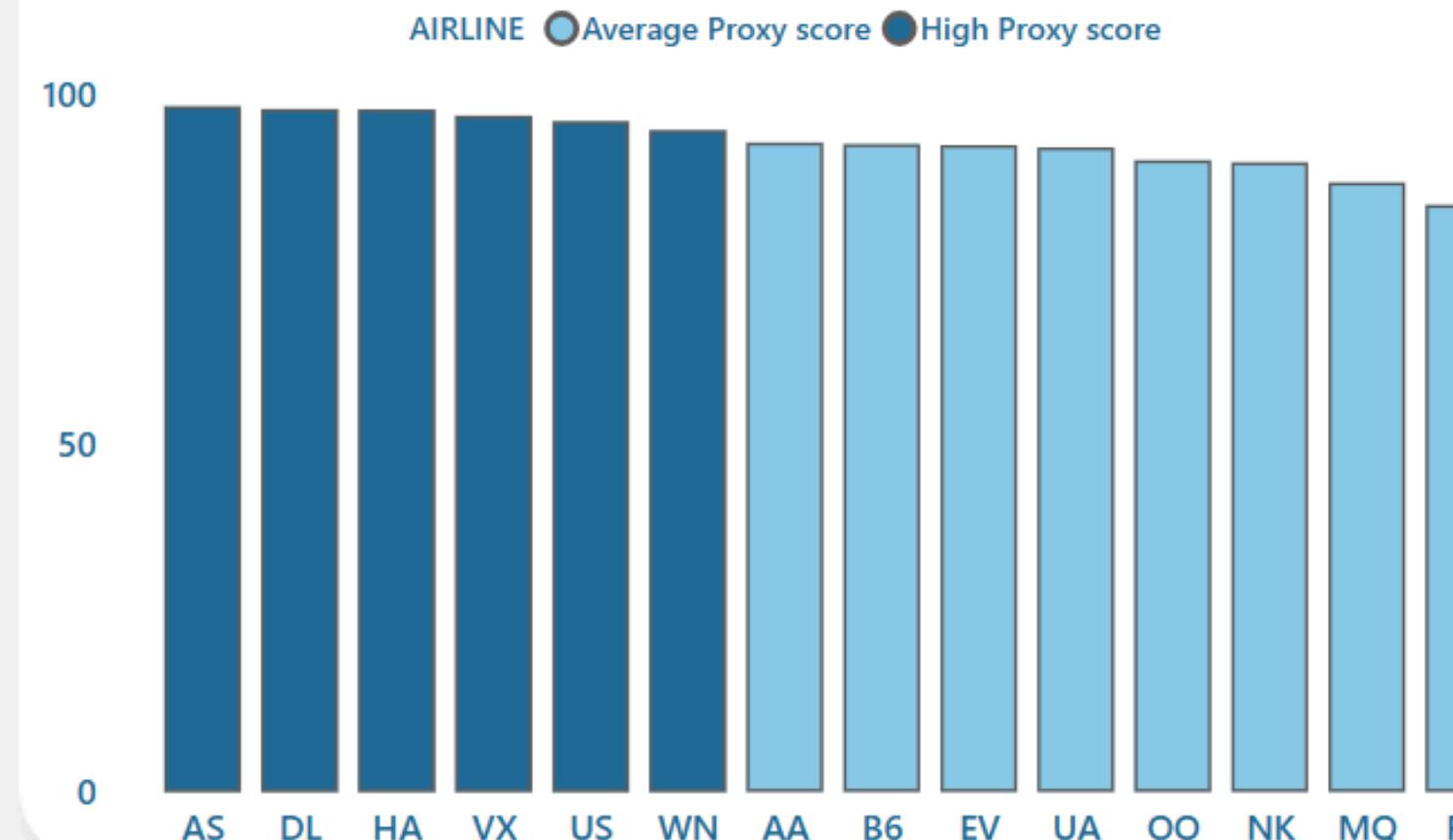


Delay Recovery Effectiveness

38.27%

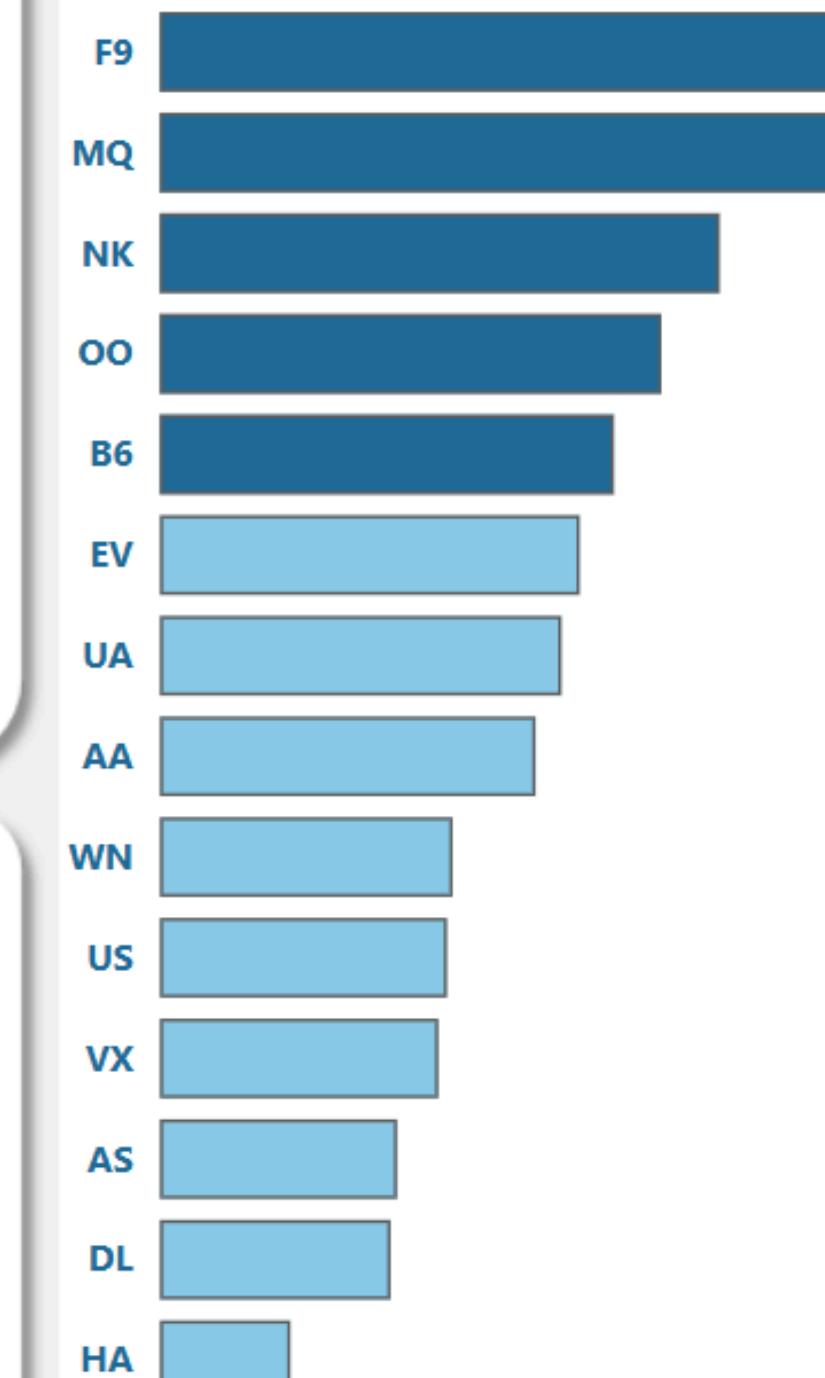


Customer Satisfaction Proxy Score by AIRLINE

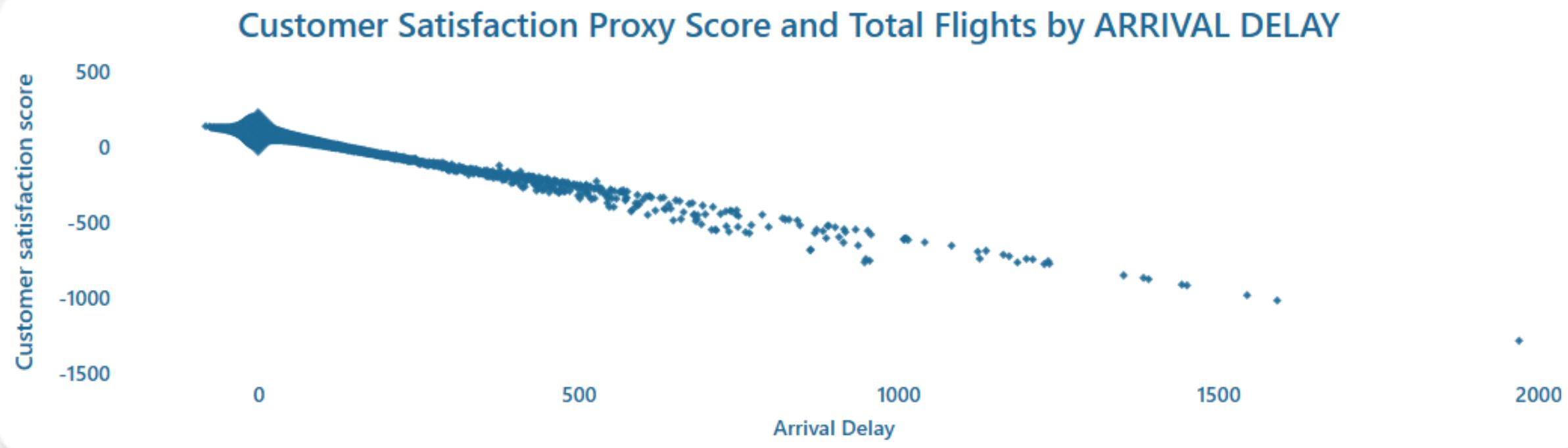


Missed Connections Rate by AIRLINE

AIRLINE ● High missed connection ● Low missed connection



Customer Satisfaction Proxy Score and Total Flights by ARRIVAL DELAY



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# **Insight report**

**-for SQL analysis  
and Dashboard**



# SQL Analysis

## Flight Delay Analysis

- The **average departure delay (15 minutes)** is slightly higher than the **average arrival delay (13 minutes)**, indicating some recovery in-flight but still a significant delay impact.

## Most Frequent Routes

- LAX-JFK** is the most popular route with **118 flights**, followed closely by **JFK-LAX (116)**, indicating heavy two-way traffic. Major hubs like **LAX and SFO** dominate the busiest routes.

## Airline Performance Ranking

- VX** has the **best on-time performance** with the **lowest average delay (5.0 mins)**, while **F9 ranks worst** with an average delay of 54.8 mins, indicating significant performance gaps among airlines.

## Cancellation Trends

- Reason "B"** is the **leading cause** of flight cancellations (**551 occurrences**), followed by "A" (380) and "C" (207), indicating a need to address the primary cancellation factor.

## Airport Congestion Analysis

- Atlanta (ATL)** has the highest flight activity (**5,891 flights**), followed by **Dallas/Fort Worth (DFW)** and **Chicago O'Hare (ORD)**, highlighting these as key hubs for air traffic.

## Weather-Related Disruptions

- Weather-related cancellations (**B**) are significant (**551**), and unknown reasons have the highest average weather delay (29.76 minutes).

## Flight Distance & Duration Trends

- As expected, average flight duration increases with distance. Short-haul flights (**0-500 miles**) take ~**50.86 minutes**, while long-haul flights (**2000+ miles**) take ~**305.39 minutes**, showing a near-linear relationship between distance and air time.

## Day-of-Week Flight Performance

- Day 4 (Thursday) has the lowest average delay (**14.44 minutes**), indicating it has the best on-time flight performance compared to other days of the week.

## Seasonality in Air Traffic

- January (Month 1) has the highest number of flights (**49,999**) and an average delay of **28.48 minutes**, indicating high air traffic volume and significant delays.

## Airport Congestion Analysis

- Weather-related cancellations (**B**) are significant (**551**), and unknown reasons have the highest average weather delay (29.76 minutes).

# Flight Operations

## Overview

### Flight Volume & Duration:

- Around **500K** flights with an average duration of **132** minutes.

### Delays & On-Time Performance:

- Avg. departure delay: **9.74** minutes; avg. arrival delay: **6.01** minutes (showing good delay recovery).
- Overall on-time rate: **77%**
  - Top performers:
    - Hawaiian (**86%**)
    - Delta (**84%**)
    - Alaska (**83%**)
  - **Frontier (66%)** has the **lowest on-time rate** and highest delays (**19+ minutes**).

### Airline Trends:

- **Delta** leads in flights (**68,555**) with **strong punctuality**.
- **American Airlines** operates **46,950** flights with **moderate delays**.

### Day-wise Trends:

- Flights peak on **Fridays**
- Drop by **Tuesday**
- Flight durations stay consistent.

# Airline Performance

## Comparison

### **Overall Performance:**

- Average delay: **15.76** minutes
- Cancellation rate: **3.36%**
- Punctuality score: **51.30**

### **Top & Bottom Performers:**

- **Delta (DL)** leads in punctuality
- followed by **Alaska (AS)** and **US Airways (US)**.
- **Frontier (F9)** and **United (UA)** have the lowest punctuality scores and the highest delays (**20+ minutes**).

### **Cancellation Trends:**

- **Frontier (F9)** and **Alaska (AS)** show higher cancellation rates.
- **Delta (DL)** and **Hawaiian (HA)** maintain low cancellations and strong punctuality.

### **Delay Patterns:**

- **Frontier (F9)** and **American Eagle (MQ)** have the longest arrival and departure delays.
- **Hawaiian (HA)** and **Virgin America (VX)** consistently experience minimal delays.

# Route & Airport Analytics

## Airport Congestion & Flight Volume:

- Congestion Index: **15.76** indicates moderate congestion across major hubs.

## Busiest Origin Airports:

- **Atlanta (ATL)** leads with **31,332** flights,
- followed by **Chicago O'Hare (ORD)** and **Dallas-Fort Worth (DFW)**.

## Frequent Flight Routes:

- Top routes:
  - **JFK–LAX** and **LAX–JFK** are the busiest routes (**over 1,200 flights each**).
- Other high-traffic routes include:
  - **LAX–SFO (1,172 flights)**
  - **LAS–LAX (1,018 flights)**.
  - **HNL–OGG** is the most frequent inter-island route (**874 flights**).

## Traffic Flow & Geographic Spread:

- Major traffic flows concentrate between coastal hubs (**LAX, JFK, ORD**).
- The network shows dense coverage in the **continental U.S.** with **notable Hawaiian connectivity**.

# Flight Cancellation & Delay Patterns

## **Overall Delay & Cancellation Trends:**

- Total Delay: **4 million minutes** of total delay.
- Cancellation Rate: **3.36%**
  - **airline/carrier** issues as the leading cause.

## **Primary Delay Reasons:**

- Late Aircraft Delays: Highest contributor at **29.73%**.
- Weather Delays: Account for **4.31%**
  - peaking midweek (**Wednesday**)
  - Lowest on (**Friday**).

## **Airline-Specific Delay Patterns:**

- Certain airlines (**MQ, B6, US**) show higher proportions of **late aircraft** and **carrier-related delays**.
- **Weather** and **security-related delays** are comparatively minimal across airlines.

# Passenger Experience & Service Quality.

## **Overall Passenger Experience:**

- Customer Satisfaction Proxy Score: **High** at **94**
  - **Indicating generally positive passenger experience.**
- Missed Connections Rate: **Moderate** at **8.32%**
- Delay Recovery Effectiveness: Stands at **38.27%**
  - **Highlighting moderate recovery from delays.**

## **Airline-wise Performance:**

- **AS, DL and HA** airlines lead in both **customer satisfaction** and **connectivity efficiency**.
- **F9** consistently performs **lower in satisfaction and connectivity metrics**.

## **Delay Impact on Satisfaction:**

- A clear **negative correlation** between **arrival delays** and **customer satisfaction**
- **Higher delays result in reduced satisfaction.**

# Recommendation

## Reduce Flight Cancellations

- **Problem:**
  - **Weather (B) and airline issues (A)** are the top reasons for cancellations, leading to operational inefficiencies and customer dissatisfaction.
- **Recommendation:**
  - **Invest in Weather Forecasting:** Partner with advanced weather forecasting services to anticipate disruptions and adjust schedules proactively.
  - **Improve Maintenance and Crew Scheduling:** Address airline-related cancellations by optimizing maintenance schedules and ensuring adequate crew availability.

## Optimize Operations at Busiest Airports

- **Problem:**
  - High-traffic airports like **ATL, DFW, and ORD** experience congestion, leading to delays and operational bottlenecks.
- **Recommendation:**
  - **Infrastructure Upgrades:** Invest in **additional runways, gates, and ground support** equipment to handle peak traffic.
  - **Advanced Scheduling:** Use AI-driven scheduling tools to optimize flight operations and reduce congestion.

## Improve On-Time Performance

- **Problem:**
  - Delays, especially **departure delays**, are **higher than arrival delays**, indicating inefficiencies in pre-flight processes.
- **Recommendation:**
  - **Streamline Turnaround Processes:** Optimize aircraft turnaround times by **improving ground operations** and reducing boarding delays.
  - **Focus on High-Delay Airlines:** Target airlines with higher delays (e.g., **Frontier, Spirit**) for operational improvements.

## Enhance Customer Satisfaction

- **Problem:**
  - Airlines with lower customer satisfaction scores (e.g., Frontier, Spirit) need to improve their service quality.
- **Recommendation:**
  - **Upgrade In-Flight Services:** Enhance in-flight amenities, entertainment, and comfort to improve the passenger experience.
  - **Proactive Communication:** Provide timely updates and compensation during delays or cancellations to build trust and loyalty.

# Conclusion

The flight analytics dashboard provides valuable insights into flight delays, cancellations, and airport performance. Key findings include:

- **Flight Duration Trends:** Longer flight distances correlate with increased flight durations, with flights over **2000** miles averaging the highest duration (~**305 minutes**).
- **Best On-Time Performance:** Flights on Day 4 (**likely Wednesday**) experience the least delays (~**14 minutes**), making it the best day for on-time travel.
- **Peak Travel & Delay Periods:** January has the highest number of flights (49,999), with an average delay of **28** minutes, indicating potential seasonal congestion.
- **Major Hub Airports:** **Atlanta (ATL)**, **Dallas (DFW)**, and **Chicago (ORD)** serve as the top connecting hubs, highlighting their significance in flight networks.

This dashboard enables better decision-making for airlines, passengers, and airport management by identifying efficiency trends and areas for improvement in flight operations.

# **Thank you!**

## **Connect with me**

I value and welcome your insights regarding this project and am always open to any suggestions. Let's connect and discuss further here...

**Gmail**

**LinkedIn**

**Github**

A photograph taken from an airplane window, looking out over a vast expanse of white, fluffy clouds against a clear blue sky. The airplane's wing is visible in the upper right corner, extending from the center towards the bottom right. The wing is dark grey with a red vertical stabilizer at the end. A thin white line of text is overlaid on the image, positioned near the wing.

*"To most people, the sky is the limit.  
To those who love aviation, the sky is home."*