Week 5: Route and Airport-Level Analysis

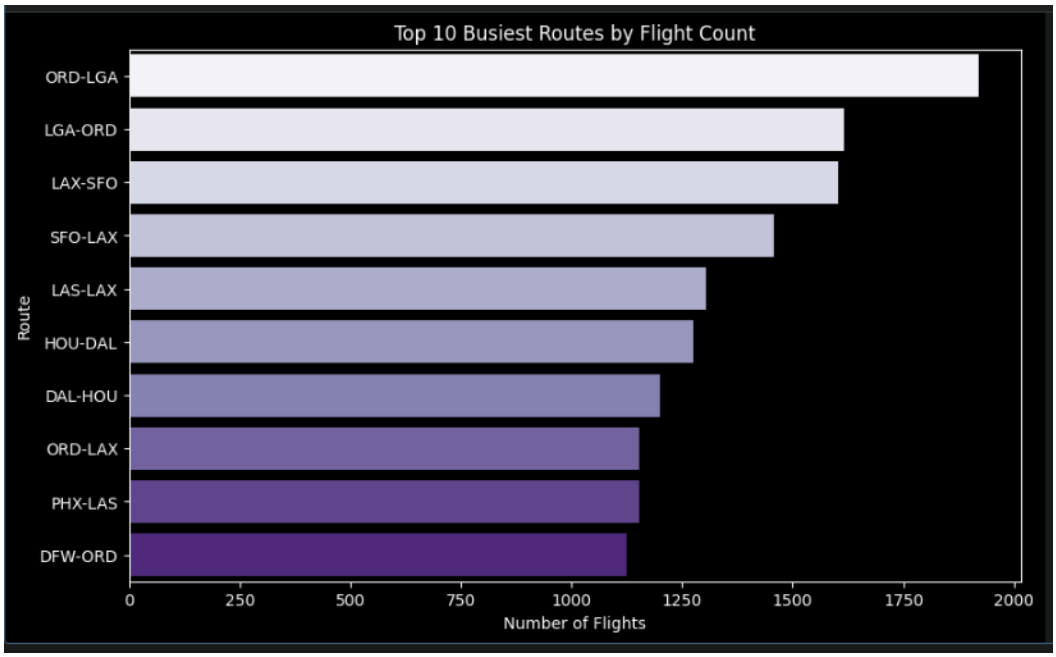
Overview

In Week 5, the analysis focused on understanding flight delays at the **route and airport level**. The main goal was to identify which airports and flight routes experience the most delays, the times and days when delays are highest, and the causes of these delays. This was done using various visualizations, including **heatmaps, bar charts, box plots, and maps**, which allowed us to examine patterns, extreme delays (outliers), and the relationship between flight volume and delays. The analysis also highlights key areas for operational improvement to reduce delays.

Insights and Measures

1. Top 10 Busiest Routes by Flight Count

Process:
A bar chart was used to show the Busiest Route.

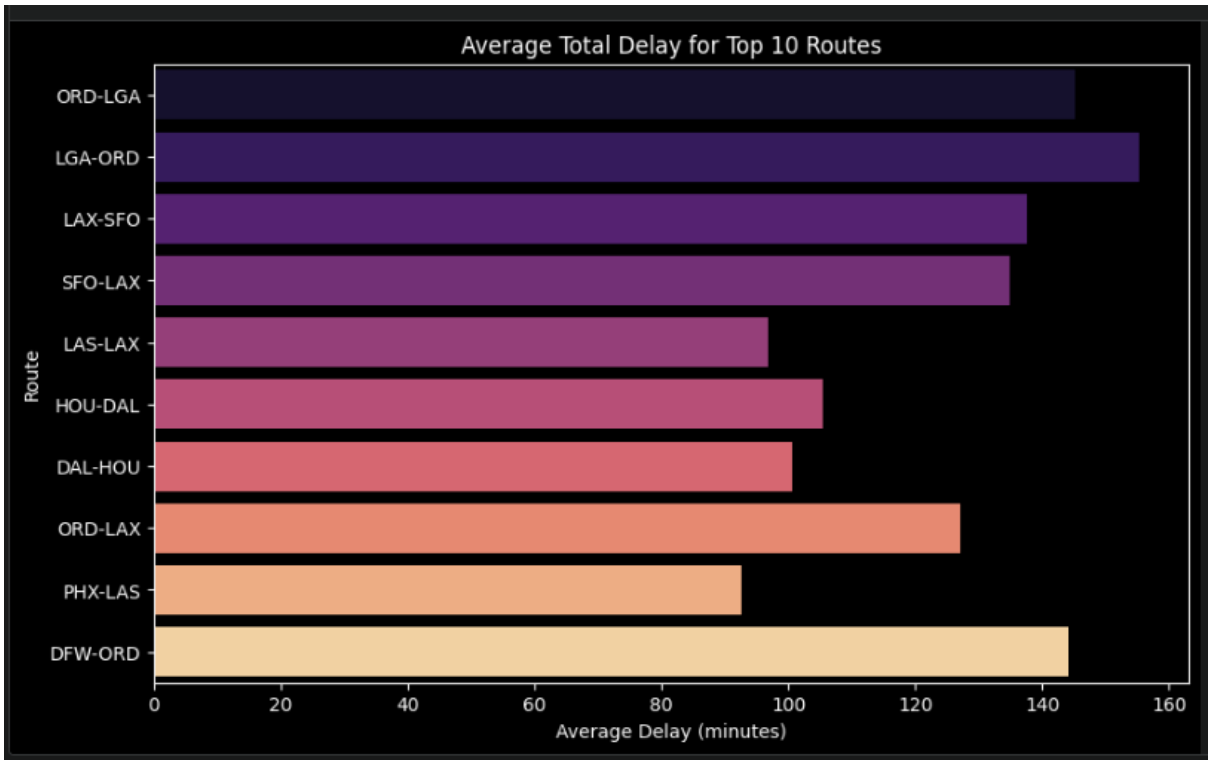


Insight:
• The ORD–LGA(Chicago O'Hare International Airport to LaGuardia Airport) route is the busiest, with nearly 2,000 flights, showing heavy traffic between Chicago and New York.
• Major city pairs like LAX–SFO(Los Angeles International Airport to San Francisco International Airport) and HOU–DAL(William P. Hobby Airport to Dallas Love Field) also dominate, highlighting strong regional and business travel demand.

Measures:
• Optimize scheduling and gate management on top routes to reduce congestion.
• Coordinate flight timings on reciprocal routes (e.g., ORD–LGA and LGA–ORD) for better efficiency.

2. Average Total Delay for Top 10 Routes

Process:
A bar chart was used to visualize the average delay for the top 10 routes.



Insight:

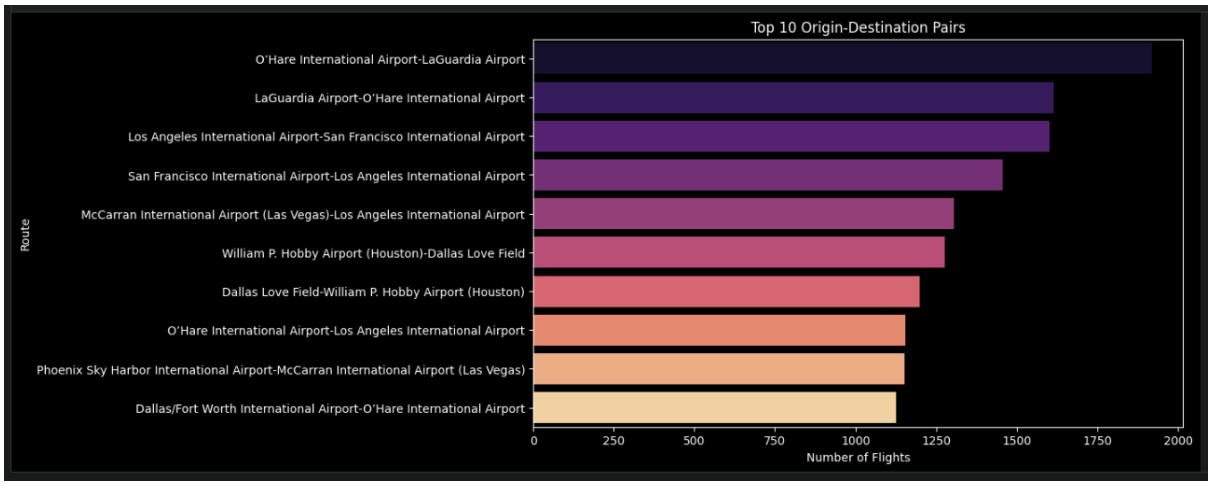
- Longest delays occur on LGA-ORD(LaGuardia Airport to Chicago O'Hare International Airport) (155 min) and ORD-LGA(Chicago O'Hare International Airport to LaGuardia Airport) (145 min).
- Delays range from 95 to 155 minutes across top routes.

Measures:

- Implement proactive monitoring on high-delay routes.
- Schedule buffer time or backup aircraft to reduce ripple effects of delays.

3. Top 10 Origin-Destination Pairs and Busiest Routes

Process:
A table and bar chart were used to rank the top 10 most-flown routes and origin-destination pairs.



Insight:

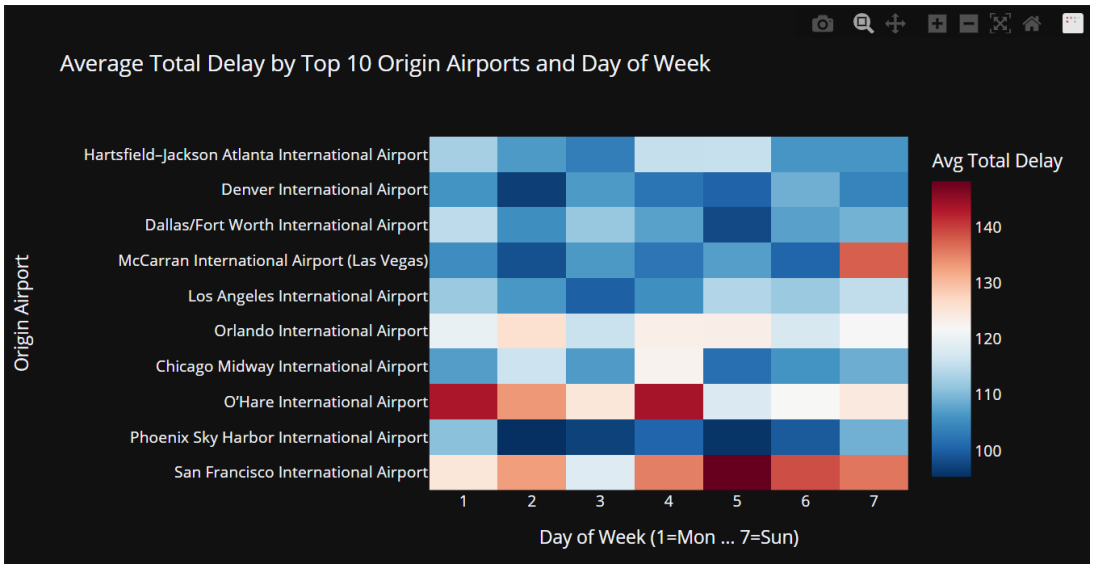
- ORD-LGA(Chicago O'Hare International Airport to LaGuardia Airport) is the most frequent route, followed by LGA-ORD.
- Other high-frequency routes include LAX-SFO(Los Angeles International Airport to San Francisco International Airport) and DFW-HOU(Dallas/Fort Worth International Airport to William P. Hobby Airport).
- The busiest routes also show **high median delays**, indicating that typical flights are often delayed.

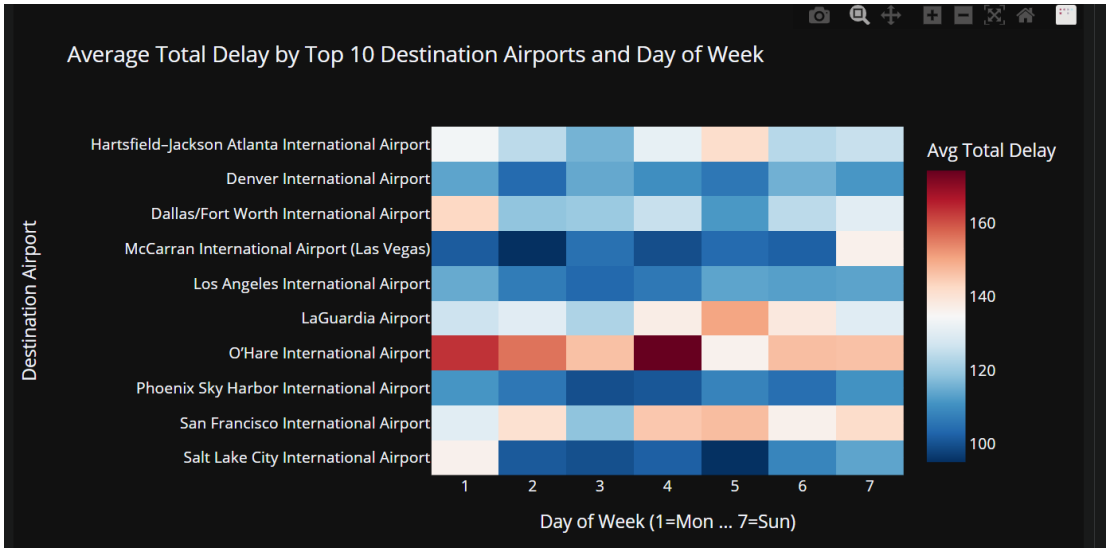
Measures:

- Prioritize resources (ground staff, gates, and crews) for busiest routes.
- Monitor aircraft rotation to prevent delays from cascading to subsequent flights.
- Implement contingency plans for extreme delays on high-frequency routes.

4. Average Total Delay by Top 10 Origin and Destination Airports and Day of Week

Process:
Heatmaps were used to show delays for departures at top airports by day of the week.





Insight:

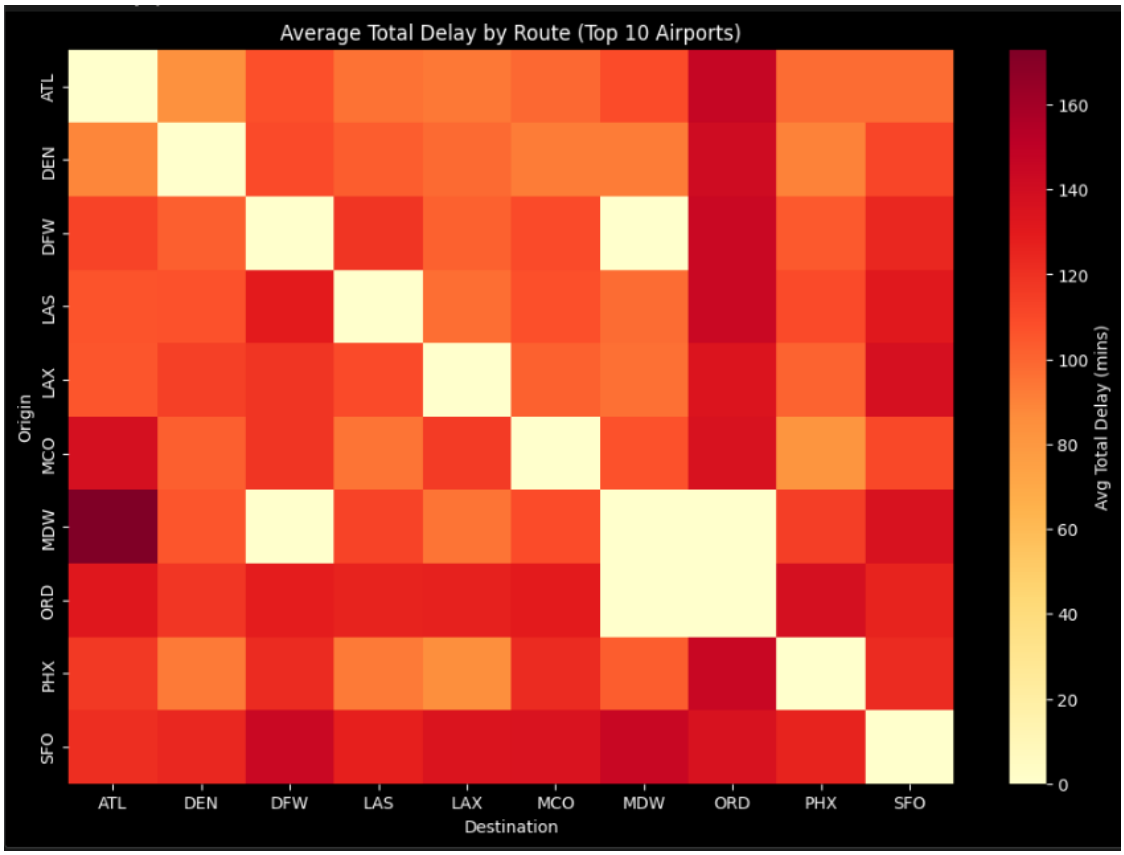
- LAS(Harry Reid International Airport) has highest delays on Sunday (Day 7), while ORD(Chicago O'Hare International Airport) shows high delays on Monday and Thursday.
- Delay patterns vary across the week.

Measures:

- Increase staffing and gate readiness on high-delay days.
- Review weekly schedules to redistribute flights and reduce peak congestion.

5. Average Total Delay by Route (Top 10 Airports)

Process:
A heatmap was created showing average delays for flights between the top 10 airports. Dark red represented long delays, light yellow represented short delays.



Insight:

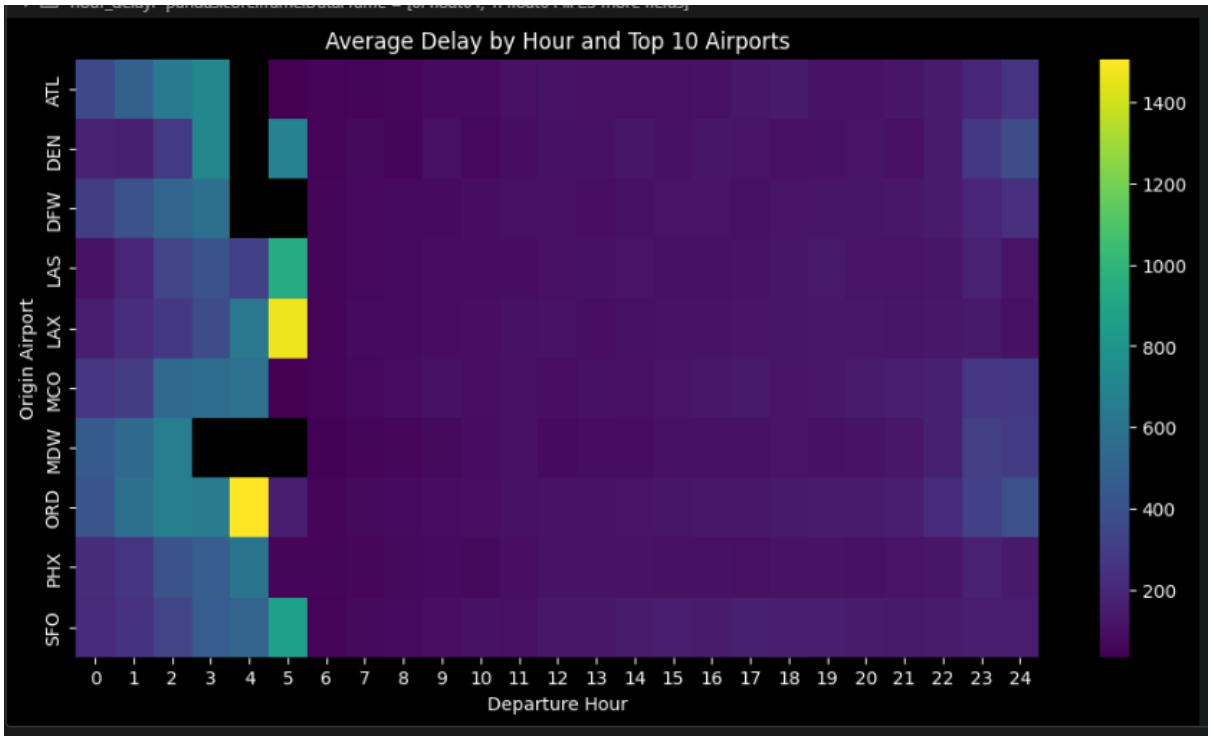
- Longest delays occur on high-traffic routes such as MDW-ATL(Chicago Midway International Airport to Hartsfield–Jackson Atlanta International Airport) and ATL-ORD(Hartsfield–Jackson Atlanta International Airport to Chicago O'Hare International Airport).
- Some routes, like ORD-MDW(Chicago O'Hare International Airport to Chicago Midway International Airport) and PHX-SFO(Phoenix Sky Harbor International Airport to San Francisco International Airport), experience minimal delays.

Measures:

- Target high-delay routes for operational improvements, such as prioritizing timely departures.
- Monitor aircraft rotation to prevent Late Aircraft Delays along busy routes.
- Adjust flight schedules to spread flights more evenly during the day.

6. Average Delay by Hour and Top 10 Airports

Process:
A heatmap was created showing average flight delays at the top 10 busiest airports by departure hour (0–24). The color scale ranged from dark (short delays) to bright yellow (long delays).



Insight:

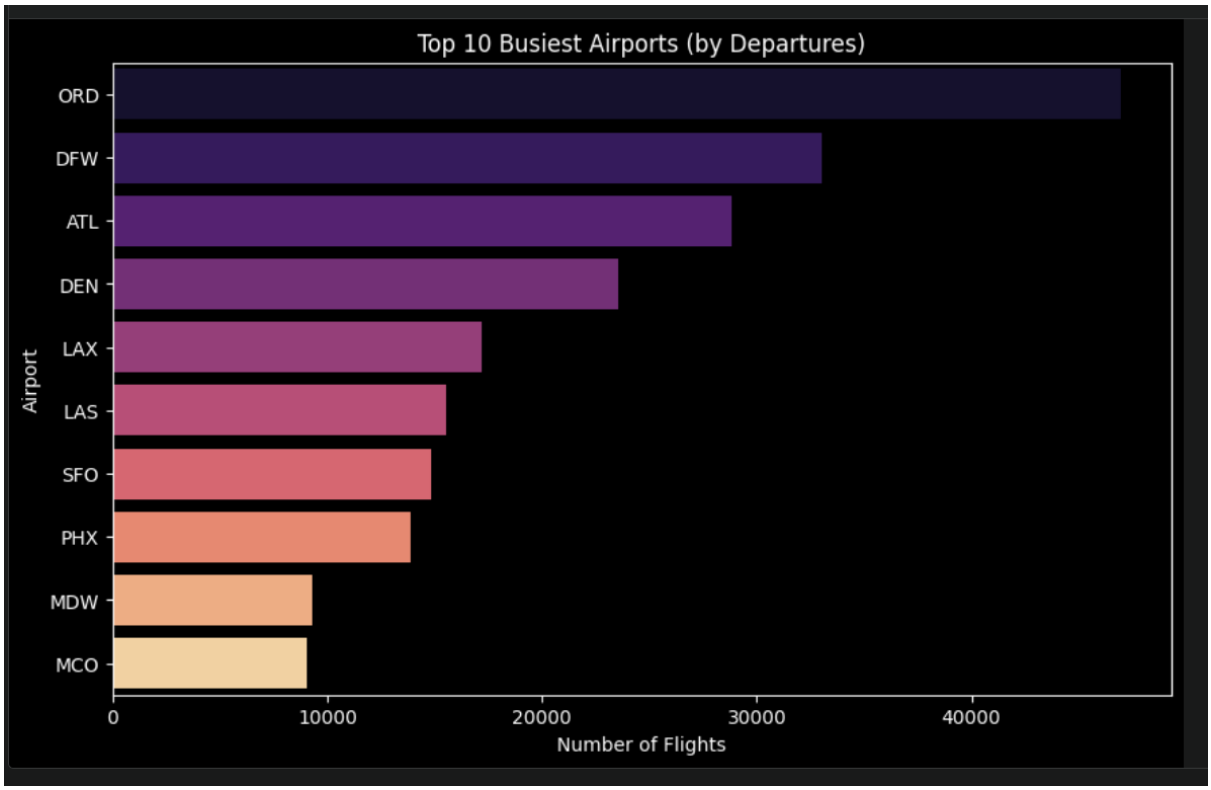
- The longest delays occur very early in the morning (4–6 AM) at ORD (Chicago O'Hare), LAX (Los Angeles), and LAS(Las Vegas).
- Delays are highest in the first few hours of the day and drop significantly during the main day, showing that early flights are more prone to problems.
- Large black blocks indicate hours with very few or no flights.

Measures:

- Adjust early morning schedules at high-delay airports to reduce congestion.
- Increase staffing and ground support for early morning flights of the day.
- Add buffer time between early departures to prevent Late Aircraft Delays from cascading.

7. Top 10 Busiest Airports (by Departures)

Process:
A bar chart was used to rank airports as busiest based on the number of departing flights.



Insight:

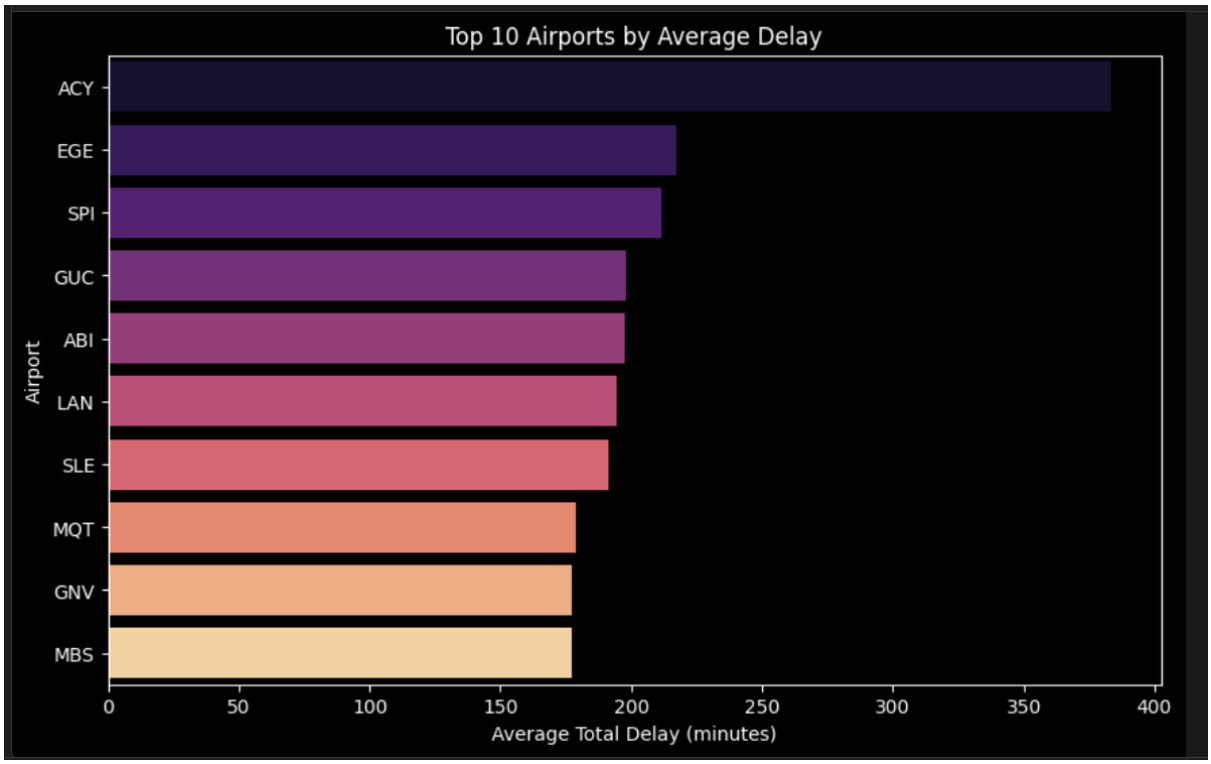
- ORD(Chicago O'Hare International Airport) is the busiest (~45,000 departures), followed by DFW(Dallas/Fort Worth International Airport) (~32,000) and ATL(Hartsfield–Jackson Atlanta International Airport) (~30,000).
- These airports are major hubs, where small disruptions can quickly lead to large-scale delays.

Measures:

- Focus operational improvements on major hubs to ensure high-volume flights are on time.
- Optimize turnaround times and gate assignments to reduce congestion during peak hours.

8. Top 10 Airports by Average Delay

Process:
A bar chart was used to show the average delay per airport.



Insight:

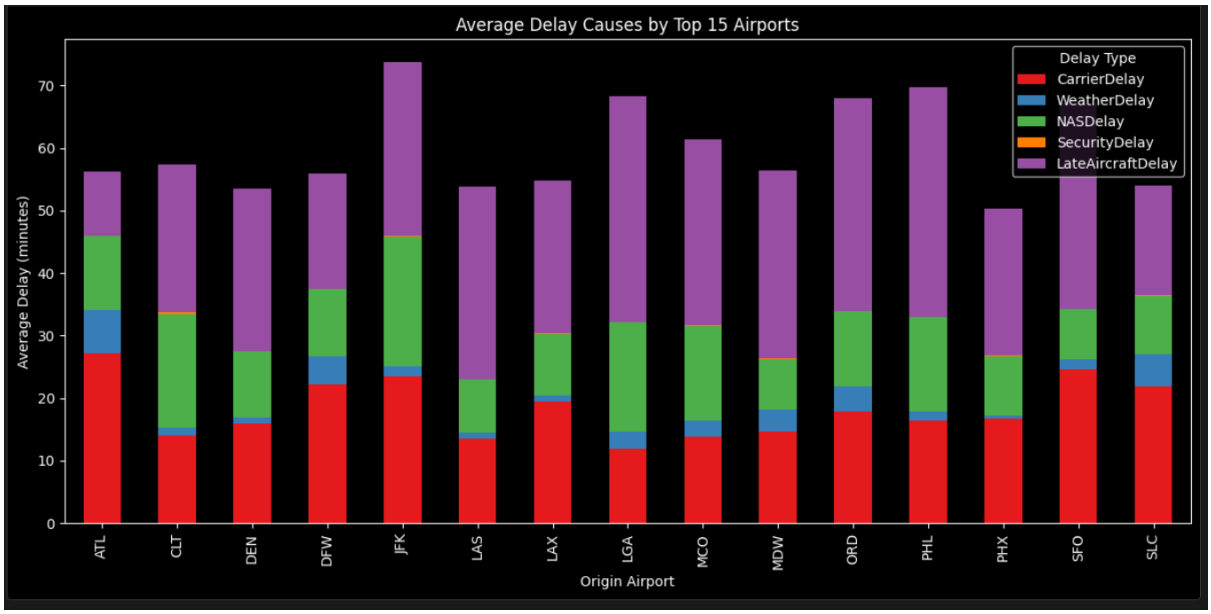
- ACY (Atlantic City) has the highest average delay (~380 min), followed by EGE(Eagle County Regional Airport) (~200 min) and SPI(Abraham Lincoln Capital Airport) (~200 min).
- Smaller airports tend to have higher delays, while larger hubs generally have moderate delays.

Measures:

- Investigate operational inefficiencies at small, high-delay airports.
- Provide targeted support for these airports (crew planning, maintenance).

9. Average Delay Causes by Top 15 Airports

Process:
Stacked bar charts were created to show the contribution of different delay types (Late Aircraft, Carrier, NAS, Weather, Security) for top airports.



Insight:

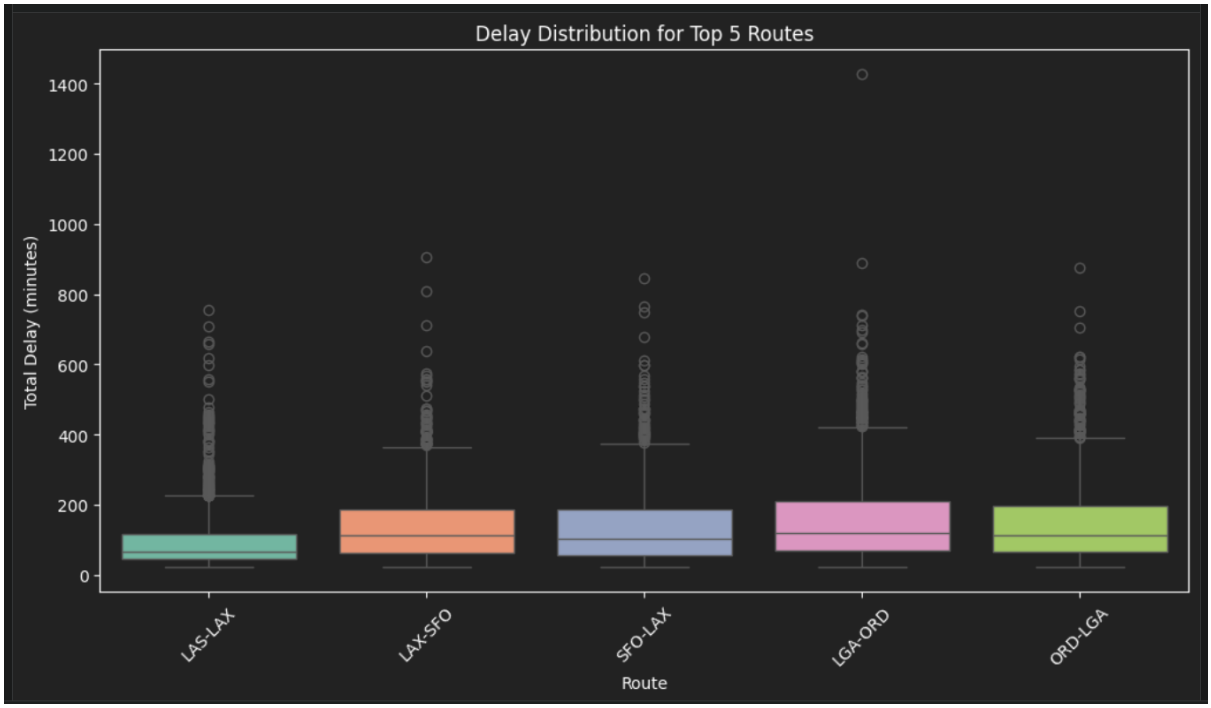
- Late Aircraft Delay is the largest contributor for nearly all airports.
- Carrier Delay is the second-largest, particularly at ATL(Hartsfield–Jackson Atlanta International Airport), DFW(Dallas/Fort Worth International Airport), and PHX(Phoenix Sky Harbor International Airport).
- JFK(John F. Kennedy International Airport) has the highest total delay, with large contributions from Late Aircraft, Carrier, and NAS Delays.

Measures:

- Improve flight rotation and turnaround efficiency to reduce Late Aircraft Delays.
- Strengthen airline operations (crew, maintenance) to reduce Carrier Delays.
- Invest in NAS systems to minimize airspace-related delays at busy airports.

10. Delay Distribution for Top 5 Routes

Process:
Box plots were used to analyze the spread of delays on the top 5 busiest routes.



Insight:

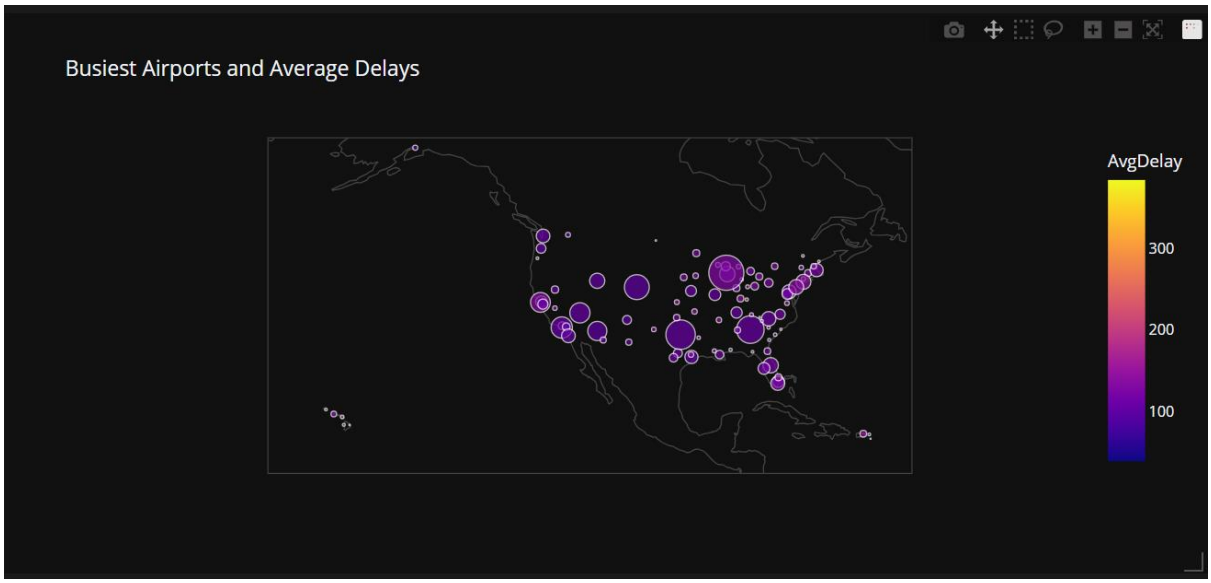
- Median delays for busiest routes are around 100–125 minutes.
- LAS-LAX(Harry Reid International Airport to Los Angeles International Airport) has lower median delays and smaller variation.
- Extreme outliers exist on all routes, with delays over 23 hours (LGA-ORD).

Measures:

- Focus improvement efforts on top delayed routes.
- Implement alert systems for flights approaching extreme delays.
- Schedule buffer flights or backup aircraft to recover from major delays.

11. Busiest Airports and Average Delays (Geographical Map)

Process:
A map visualized airport location, flight volume (circle size), and average delay (color).



Insight:

- Largest airports are clustered in Eastern and Midwestern US.
- East Coast and Midwest airports generally have higher average delays.
- West Coast airports usually have lower delays, though some exceptions exist.

Conclusion:

Overall, the route and airport-level analysis shows that flight delays are most severe during early morning hours, at specific high-traffic airports, and along major routes such as O'Hare–LaGuardia. Late Aircraft and Carrier Delays continue to be the biggest contributors. By improving scheduling, increasing early-morning staffing, and focusing on operational efficiency at key airports and routes, airlines can greatly reduce total delay times and improve on-time performance.