

# Flight Delay Analysis

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## **Problem Statement:**

To analyze the various causes of flight delay and propose suitable solutions

## **Abstract:**

This report investigates the causes and patterns of flight delays using a comprehensive dataset detailing various factors related to air travel. The analysis aims to uncover key insights that contribute to flight delays and offer actionable recommendations for mitigating such delays.

## **Introduction:**

Flight delays are a common issue in the aviation industry, impacting airlines, passengers, and airport operations. Understanding the underlying causes and identifying trends can help reduce delays, enhance customer satisfaction, and improve airline efficiency. This report presents a thorough analysis of flight delays, leveraging data visualization and statistical techniques.

## **Data set Description:**

1. DayOfWeek → 1 (Monday) - 7 (Sunday)
2. Date → Scheduled date

3. DepTime → Actual departure time (local, hhmm)
4. ArrTime → Actual arrival time (local, hhmm)
5. CRSArrTime → Scheduled arrival time (local, hhmm)
6. UniqueCarrier → Unique carrier code
7. Airline → Airline company
8. FlightNum → flight number
9. TailNum → plane tail number
10. ActualElapsedTime → Actual time an airplane spends in the air(in minutes) with TaxiIn/Out
11. CRSElapsedTime → CRS Elapsed Time of Flight (estimated elapse time), in minutes
12. AirTime → Flight Time (in minutes)
13. ArrDelay → Difference in minutes between scheduled and actual arrival time
14. Origin → Origin IATA(International Air Transport Association) airport code
15. Org\_Airport → Origin Airport Name
16. Dest → Destination IATA code
17. Dest\_Airport → Destination Airport Name
18. Distance → Distance between airports (miles)
19. TaxiIn → Wheels down and arrival at the destination airport gate, in minutes
20. TaxiOut → The time elapsed between departure from the origin airport gate and wheels off, in minutes
21. Cancelled → Was the flight canceled?
22. CancellationCode → Reason for cancellation
23. Diverted → 1 = yes, 0 = no
24. CarrierDelay → Flight delay due to carrier(e.g. maintenance or crew problems, aircraft cleaning, fueling, etc), 0 = No, yes = (in minutes)
25. WeatherDelay → Flight delay due to weather, 0 = No, yes = (in minutes)

26. **NASDelay** → Flight delay by NSA(National Aviation System), 0 = No, yes = (in minutes)
27. **SecurityDelay** → Flight delay by this reason, 0 = No, yes = (in minutes)
28. **LateAircraftDelay** → Flight delay by this reason, 0 = No, yes = (in minutes)

## **Scope of the Analysis:**

The scope of this analysis includes:

- **Evaluating Key Variables:** Analyzing variables such as day of the week, airline, and flight distance to determine their impact on flight delays.
- **Exploring Delay Causes:** Investigating various types of delays, including carrier, weather, NAS, security, and late aircraft delays, to understand their prevalence and contributing factors.
- **Temporal Analysis:** Assessing how delays vary over different times of the day and across the week.
- **Correlation Analysis:** Using statistical methods like Pearson correlation to identify relationships between flight schedule details and delay durations.
- **Visual Representation:** Creating visualizations in Tableau to highlight trends, distributions, and significant insights.
- **Recommendations:** Providing actionable strategies based on findings to help mitigate flight delays.

## **Questions:**

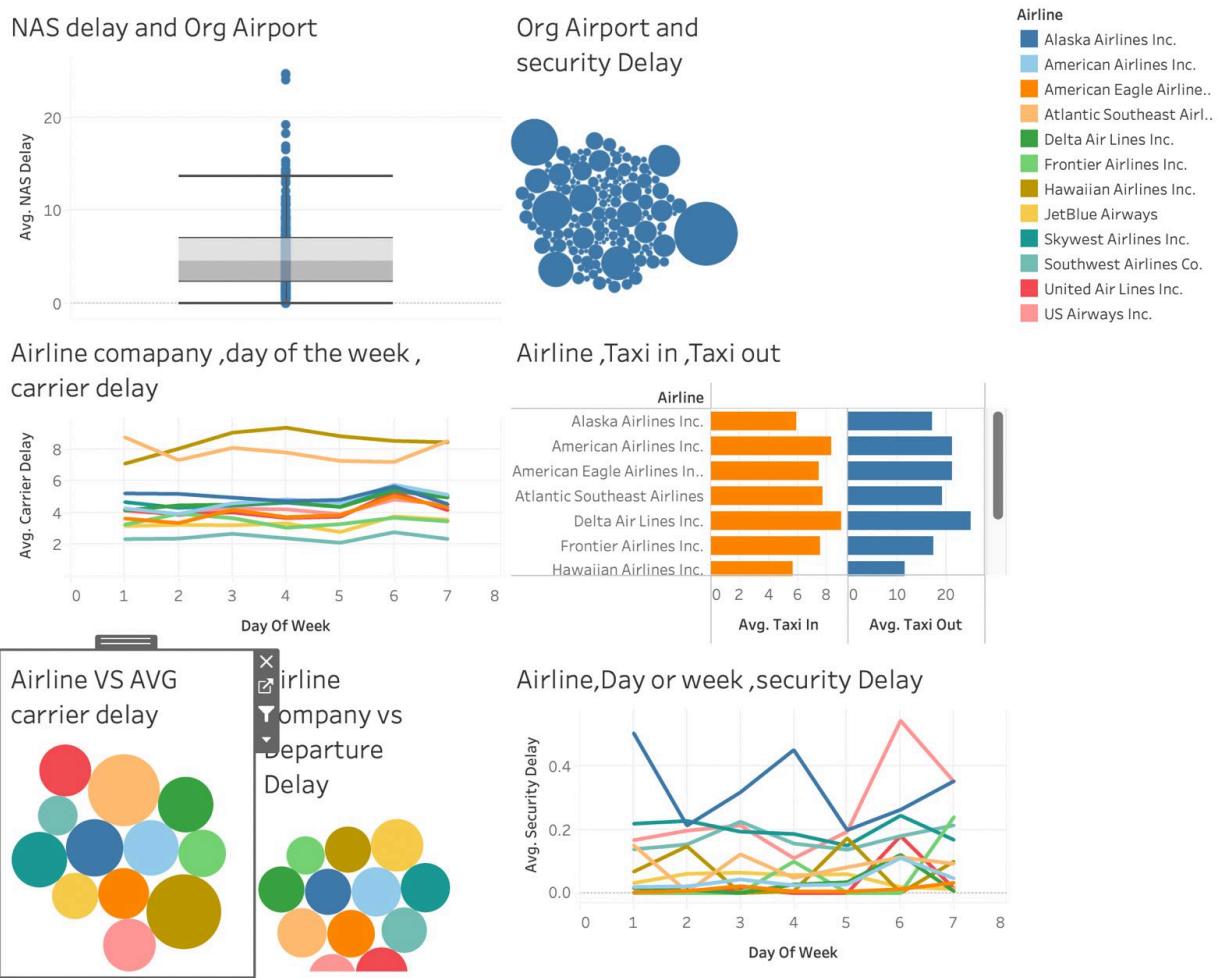
- What are the major causes of flight delay?
- What is the interrelation of types of flight delays?
- Which airline company provides the best services?

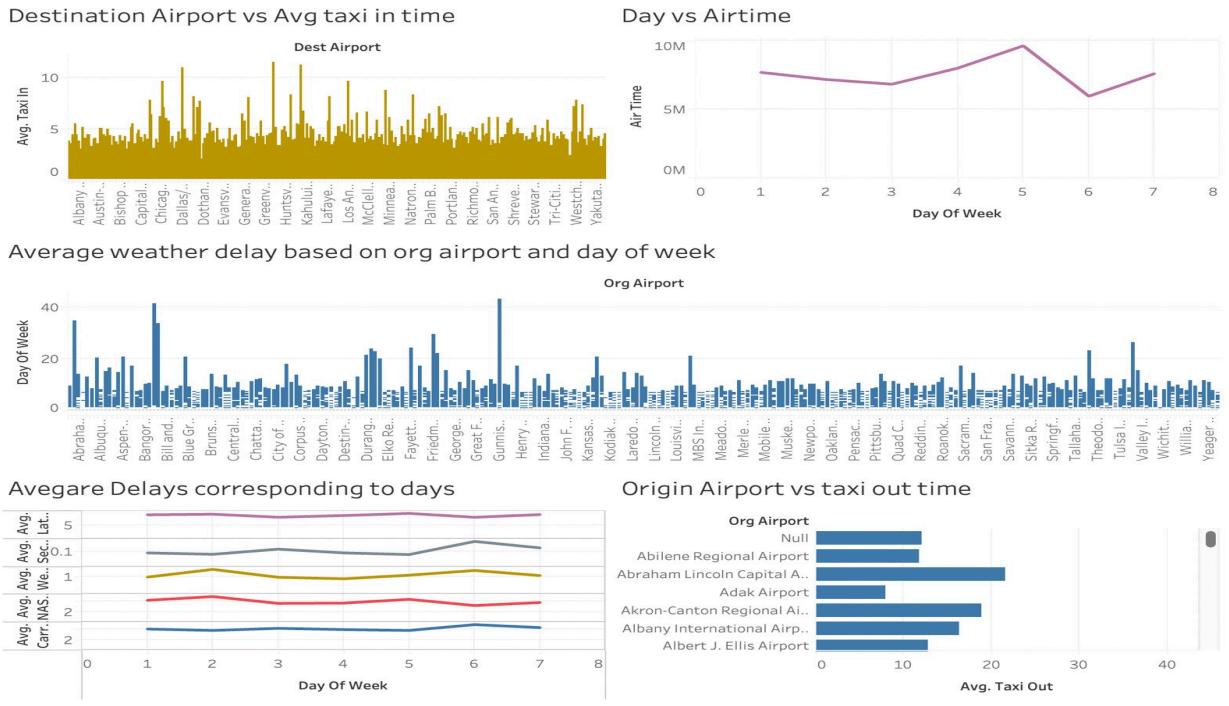
- Which are the busy days of the week and why?
- What is the relation of taxi in and taxi out time wrt airports?
- How do weather delays vary by day of the week and origin of the airport?

### **Flow of Analysis:**

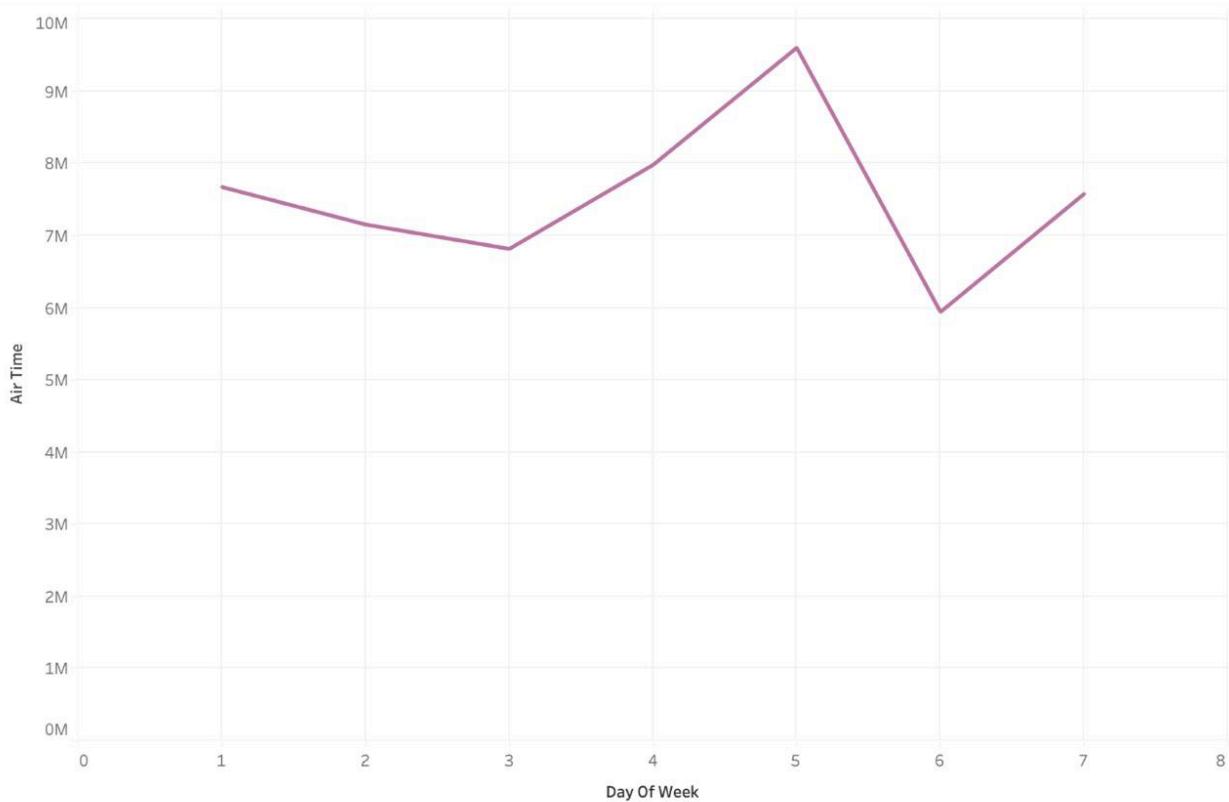
- Handling missing values
- Removing errors
- Min max normalization
- Scaling
- Pearson Correlation
- Analysis in Tableau

### **Tableau Analysis:**





## 1. Day vs Airtime:

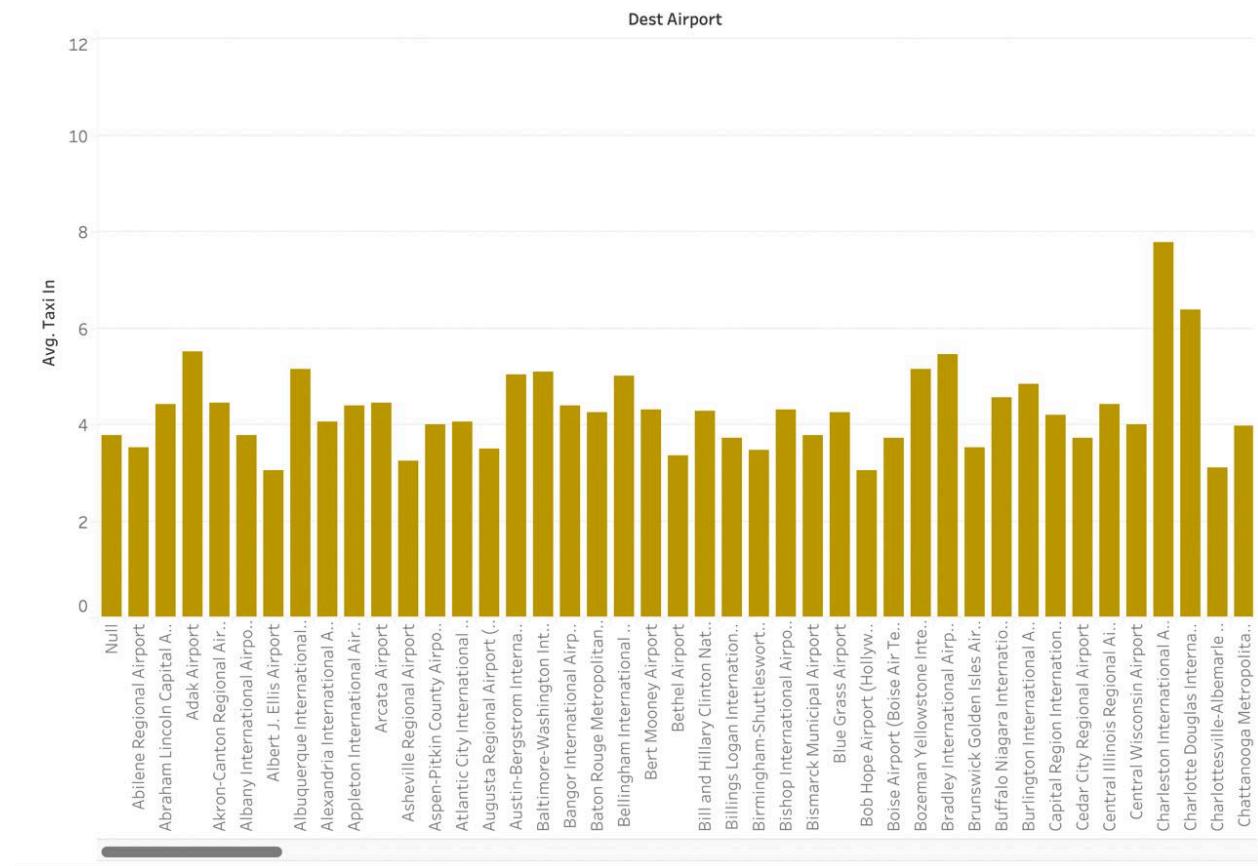


Description: This line chart shows total airtime for flights across each day of the week.

Insights: Some days have notably higher total airtime, possibly indicating higher flight volumes or longer flight distances.

Recommendations: Allocate additional resources and staff on high airtime days to manage increased operations smoothly. Airlines may consider adjusting schedules to optimize demand-based efficiency.

## 2. Destination Airport vs Avg Taxi In Time:

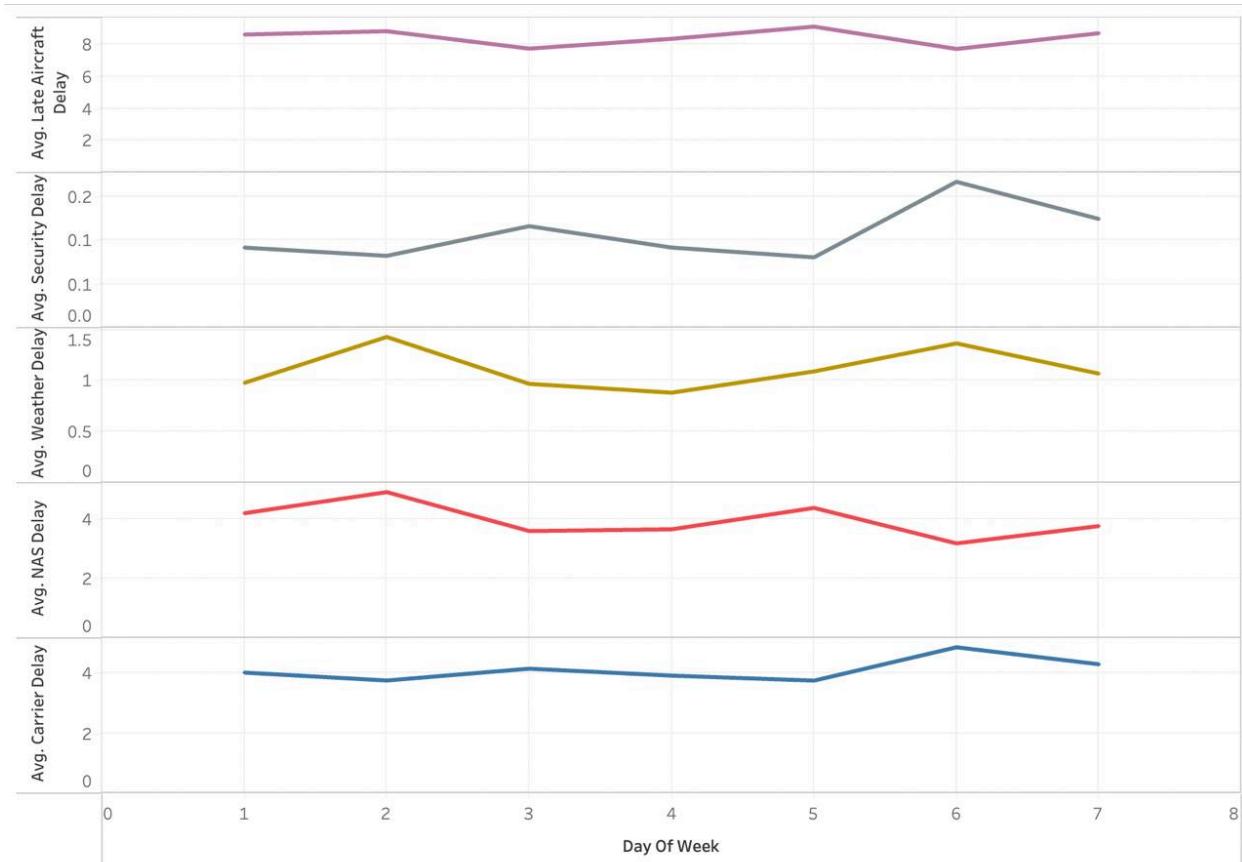


Description: Compares destination airports by their average taxi-in times, identifying locations with longer taxi-in durations.

Insights: Certain airports experience prolonged taxi-in times, which may suggest congestion or gate availability issues upon arrival.

Recommendations: Airports with high taxi-in times should streamline ground operations, improve gate management, or expand ground crew resources to reduce delays.

### 3. Average Delays Corresponding to Days:

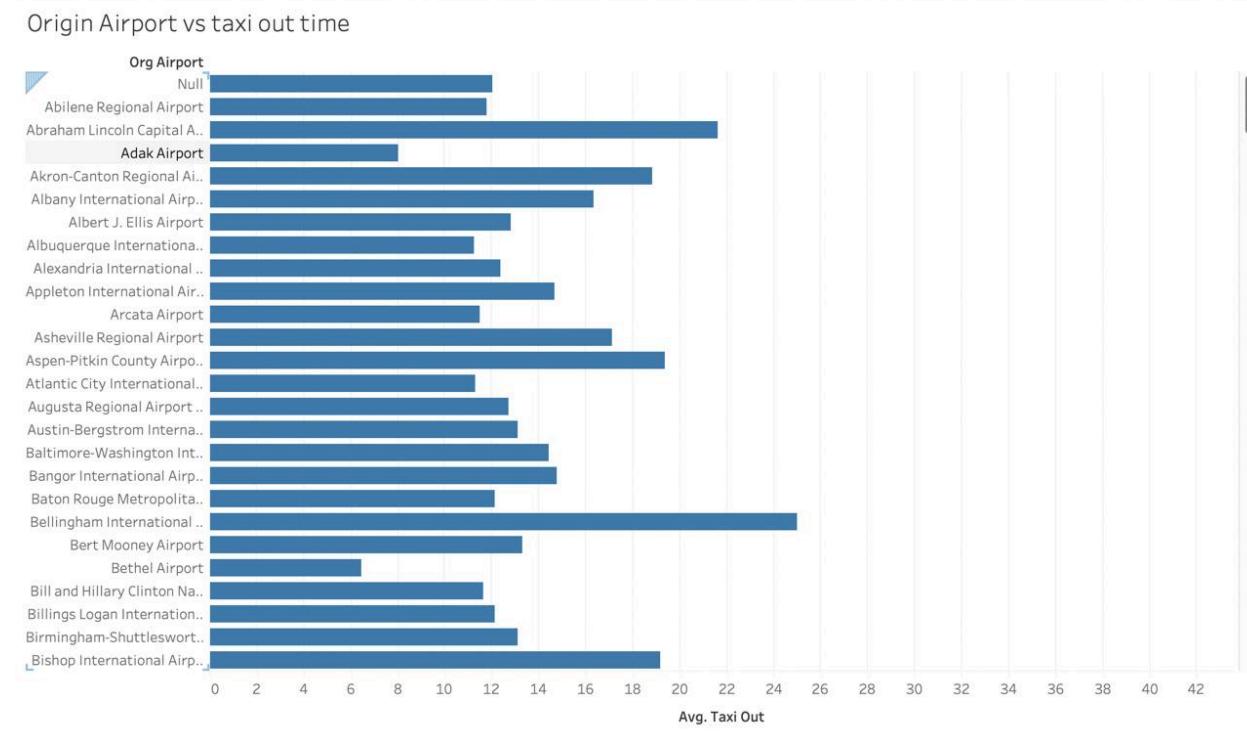


Description: Displays the average delay times across different days of the week.

Insights: Some days consistently experience higher delays, indicating peak times or operational challenges.

**Recommendations:** Increase ground support and add flight buffers on high-delay days to improve on-time performance and reduce congestion.

#### 4. Origin Airport vs Taxi Out Time:

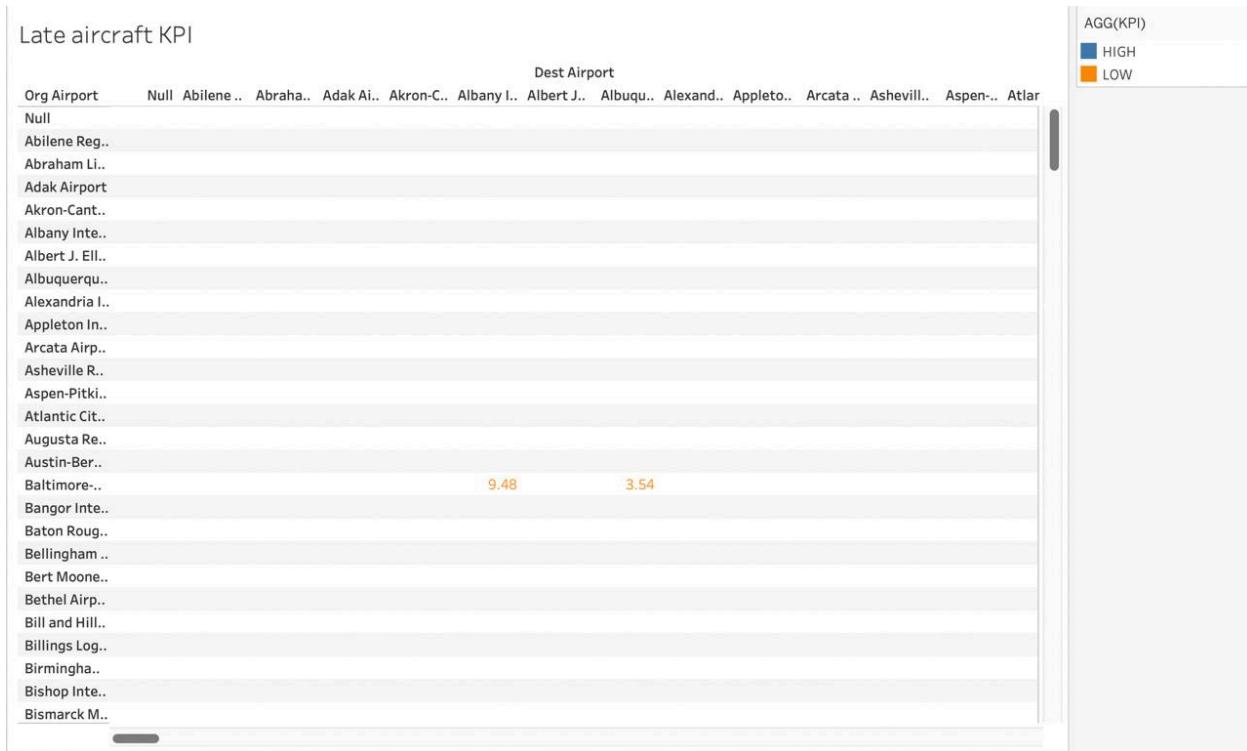


**Description:** This visualization shows taxi-out times across origin airports, highlighting where departures are delayed on the ground.

**Insights:** Some airports have longer taxi-out times, possibly due to congestion on runways or departure processes.

**Recommendations:** Airports with higher taxi-out times should evaluate departure processes and consider staggered flight timings to reduce congestion.

#### 5. Late Aircraft KPI:

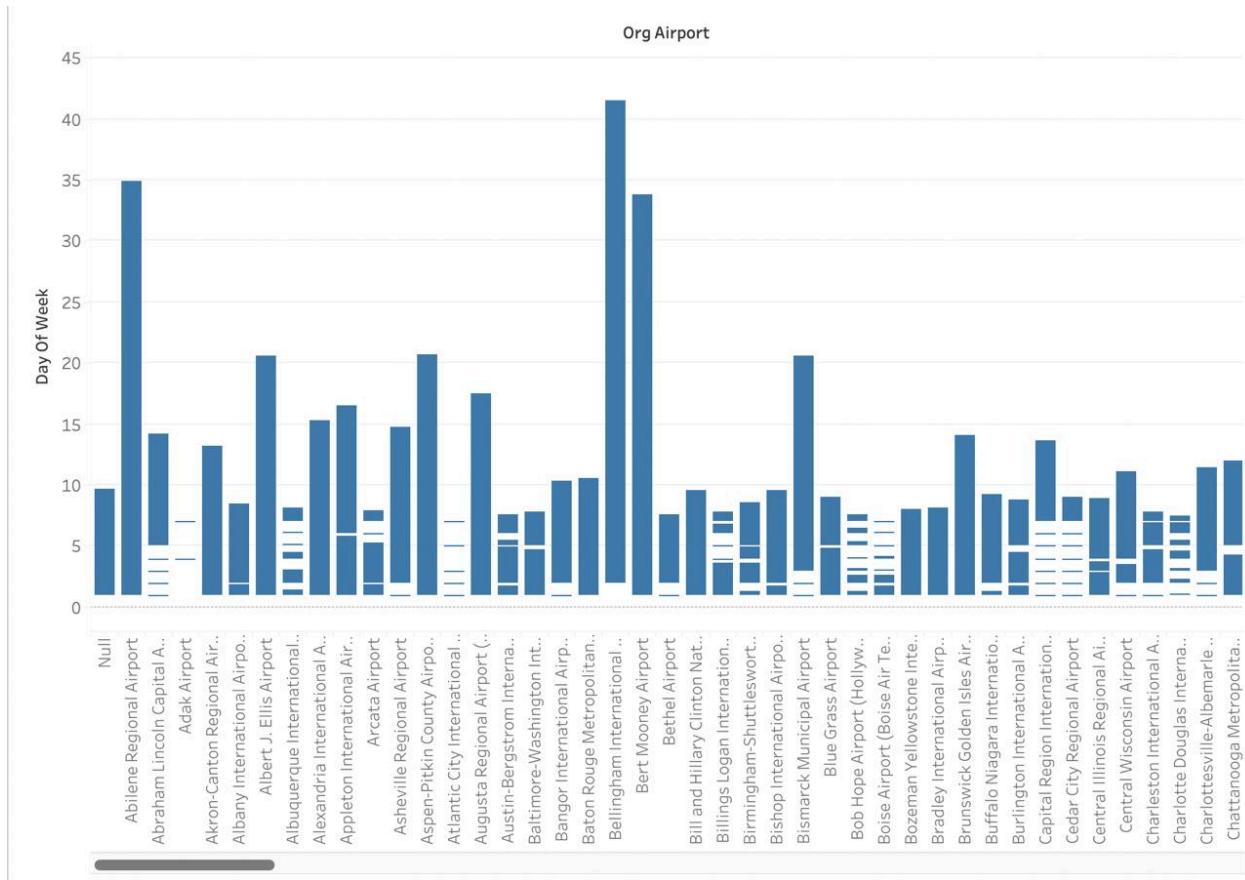


Description: Key Performance Indicator (KPI) visualization that highlights flights impacted by late-arriving aircraft.

Insights: Flights that depend on late-arriving aircraft face cascading delays, impacting schedules throughout the day.

Recommendations: Airlines should add buffer times between connecting flights or have backup aircraft ready for high-frequency routes to minimize delay impacts.

## 6. Average Weather Delay Based on Org Airport and Day of Week:



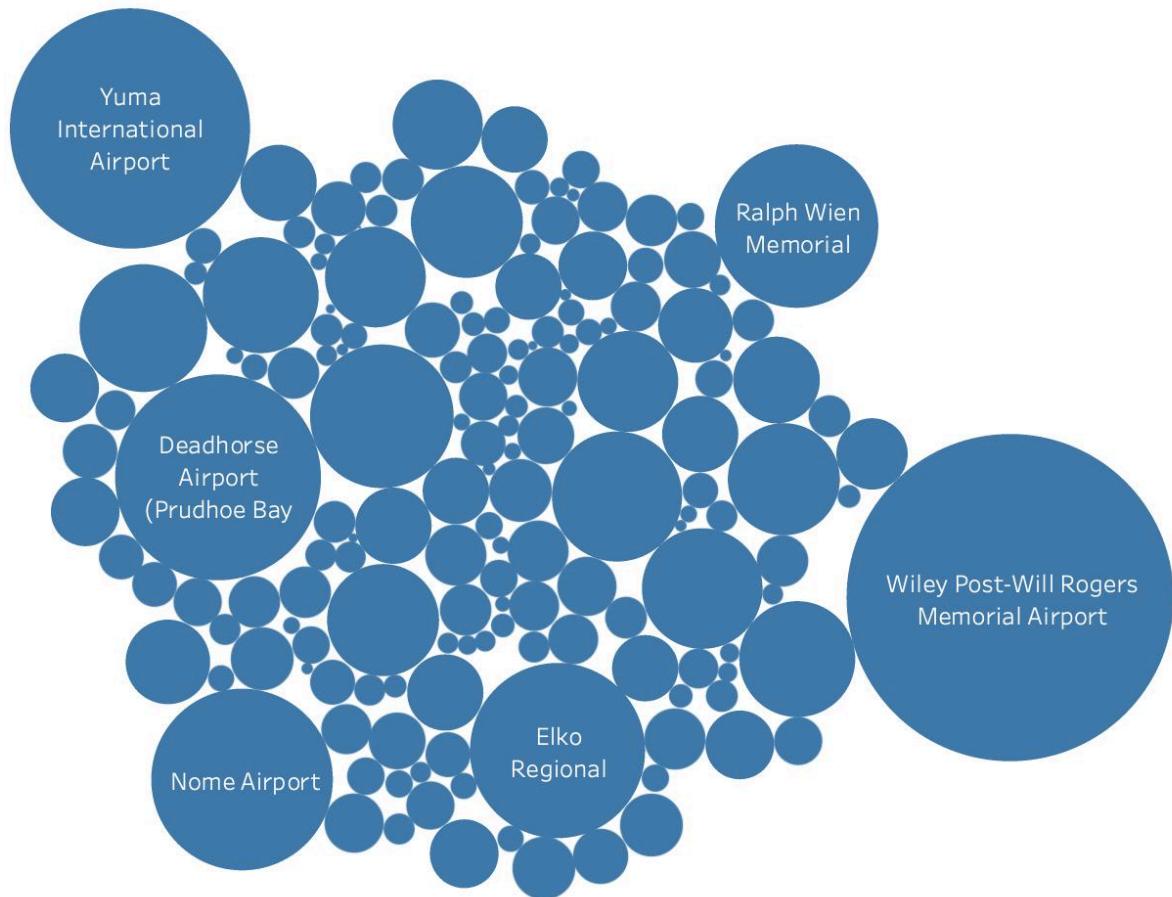
Description: Illustrates average weather-related delays across origin airports and days of the week.

Insights: Weather delays are higher at certain airports and on specific days, likely due to seasonal weather patterns.

Recommendations: Prepare contingency plans for airports frequently affected by weather delays, such as increasing buffers and exploring rerouting options on bad weather days.

## 7. Org Airport and Security Delay:

## Org Airport and security Delay



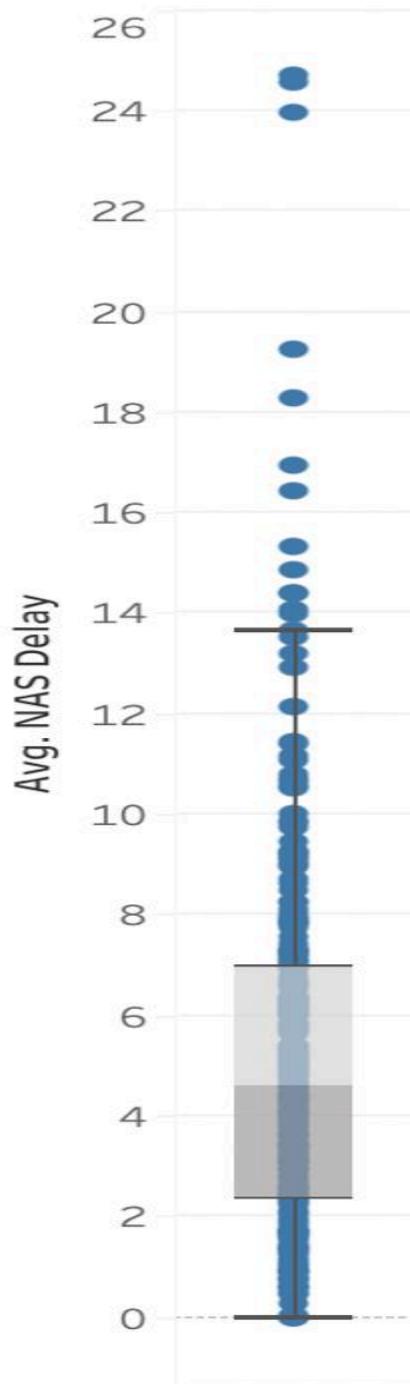
Description: This sheet shows security delays across origin airports, revealing potential bottlenecks in security processes.

Insights: Some airports experience significant security delays, which can affect overall on-time performance.

Recommendations: Increase staffing or optimize security layouts at high-delay airports to streamline security processes and reduce passenger wait times.

## 8. NAS Delay and Org Airport:

NAS delay and Org Airport



Description: Shows delays related to the National Airspace System (NAS) by origin airport.

Insights: NAS-related delays are concentrated at certain airports, indicating air traffic control or airspace management issues.

Recommendations: Collaborate with air traffic management to optimize scheduling and reduce congestion at high-delay airports, especially during peak travel hours.

## 9. Airline vs Avg Carrier Delay:

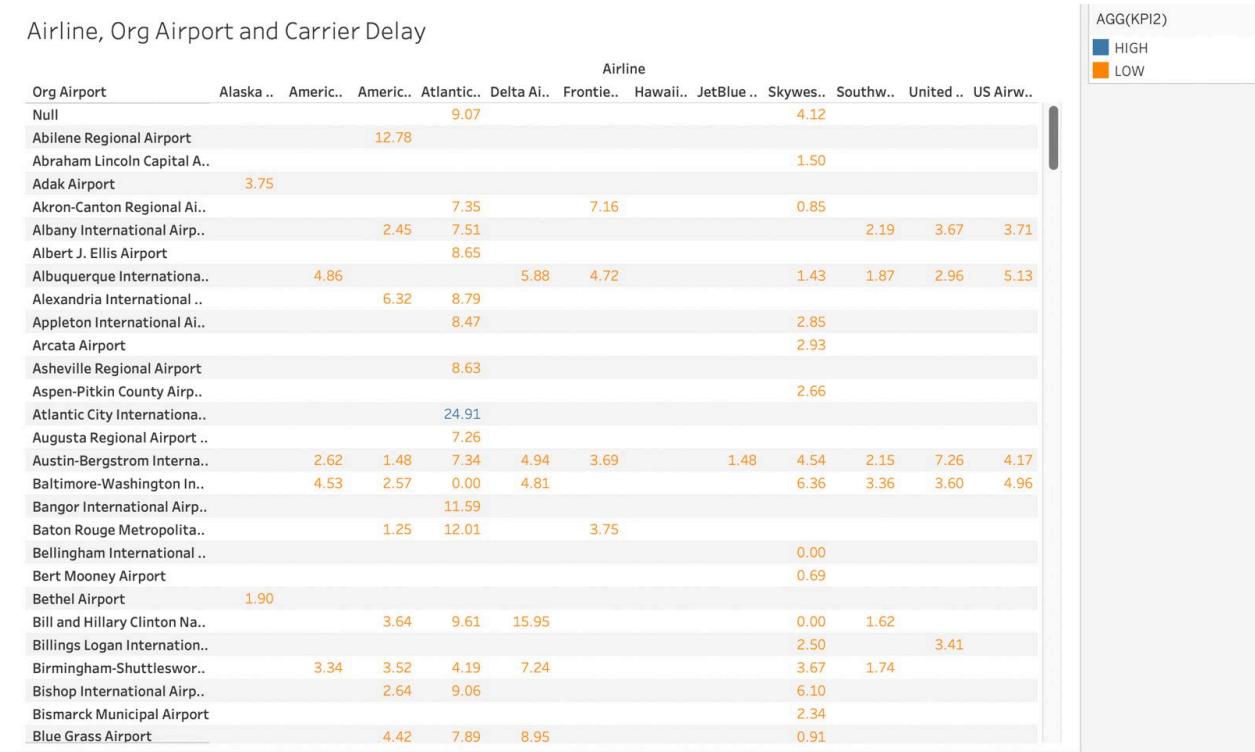


Description: Compares average carrier delays for different airlines.

Insights: Some airlines have higher carrier delays, which could be attributed to operational inefficiencies or scheduling challenges.

Recommendations: Airlines with high carrier delays should review internal operations, such as maintenance schedules and crew rotations, to improve reliability.

## 10. Airline vs Org Airport & Carrier Delay:

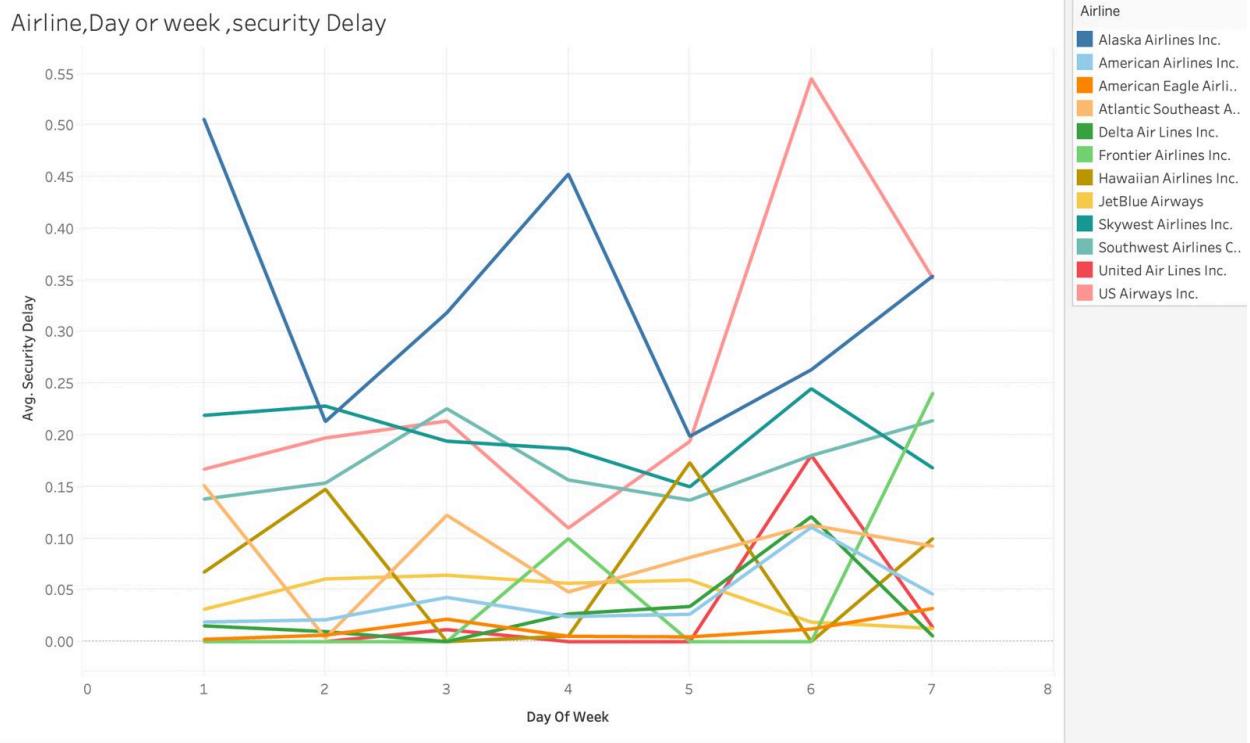


Description: Analyzes how carrier delays vary by airline and origin airport.

Insights: Certain airport-airline combinations are more prone to delays, suggesting specific operational challenges.

Recommendations: Airlines should work closely with high-delay airports to address bottlenecks and potentially adjust schedules to account for delays.

## 11. Airline, Day of Week, Security Delay:



Description: Analyzes security delays by airline and day of the week.

Insights: Security delays vary between airlines and days, suggesting that some airlines face more challenges during peak security hours.

Recommendations: Adjust security staffing and streamline processes on high-delay days and for airlines with consistent security issues.

## 12. Airline Company vs Departure Delay:

## Airline Company vs Departure Delay

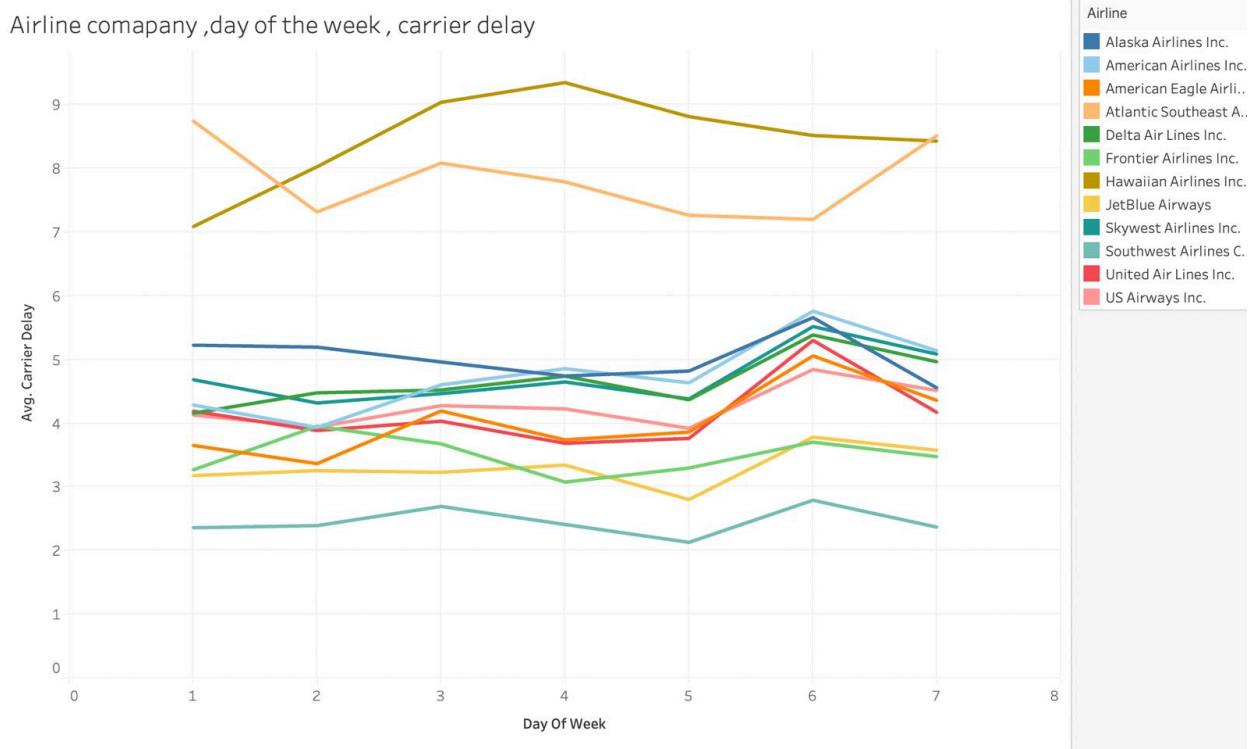


Description: Compares departure delays across different airlines.

Insights: Some airlines experience longer departure delays, often due to ground handling inefficiencies.

Recommendations: Airlines with high departure delays should optimize boarding, loading, and refueling processes to reduce delays and improve turnaround times.

### 13. Airline Company, Day of the Week, Carrier Delay:



Description: Shows carrier delays across airlines and days of the week.

Insights: Certain days present operational challenges for specific airlines, leading to higher delays.

Recommendations: Airlines should optimize crew and maintenance schedules on high-delay days to improve punctuality and reduce delays.

### 14. Airline, Taxi In, Taxi Out:



Description: Compares taxi-in and taxi-out times for different airlines, offering insights into ground operations.

Insights: Variations in taxi times across airlines may reflect ground handling efficiency differences or airport congestion.

Recommendations: Airlines with high taxi times should work with airport ground crews to streamline operations, especially during peak hours, to reduce turnaround time.

## Conclusion:

In conclusion, this analysis of flight delays reveals several actionable insights for improving airline and airport operations. High delay days, frequent taxi-out and taxi-in delays, and variations across airlines and airports indicate specific operational challenges that can be addressed. To reduce delays, airports can streamline ground handling, optimize gate assignments, and enhance security processes during peak times. Airlines can improve scheduling buffers, allocate backup aircraft, and refine crew and maintenance schedules. Additionally,

implementing contingency plans for weather-prone airports and coordinating with air traffic control to minimize NAS-related delays can significantly improve on-time performance. Together, these recommendations offer a path to enhancing efficiency, reliability, and passenger satisfaction across the airline industry.

Dataset:

<https://www.kaggle.com/datasets/undersc0re/flight-delay-and-causes>