

Optimizing Airline Efficiency: An Exploratory Analysis of Flight Data

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Abstract

This report dissects 2019's flight cancellation trends, spotlighting operational challenges, notably for Southwest Airlines. Weather, labor disputes, and the Boeing 737 Max grounding by the FAA were key drivers. Strategic recommendations are presented to bolster airline schedule reliability and resilience.

1 Introduction

In the dynamic airspace of commercial aviation, maintaining a punctual and reliable flight schedule is pivotal for airline success. In 2019, the industry faced significant challenges, from adverse weather conditions to unexpected fleet groundings. This report delves into the cancellation trends that marked the year, focusing on Southwest Airlines. The report dissects data to discern systemic weaknesses and external factors affecting flight regularity. The ensuing insights provide a foundation for strategic enhancements in schedule optimization, fleet management, and passenger communication, aiming to fortify Southwest's operational efficiency in the face of industry-wide turbulence and specific logistical adversities.

2 Methodology

This analysis harnesses 2019 flight data from the U.S. Bureau of Transportation Statistics, focusing on cancellation patterns and delays, with a spotlight on Southwest Airlines. Initial steps involved extensive data cleaning, including handling missing values and filtering for relevant metrics such as flight dates, airlines, and reasons for cancellations. A key part of data processing was generating a 'Route' feature from 'OriginCityName' and 'DestCityName', alongside calcu-

lating specific airline cancellation rates. The methodology employed statistical tools and visualizations like bar charts, histograms, and choropleth maps to dissect cancellation trends and their causes, aiming to offer a granular understanding of operational inefficiencies and drive strategic improvements.

3 Analysis

The investigation commenced with an examination of 2019 cancellation rates across major U.S. airlines, revealing that Southwest Airlines exhibited higher cancellation rates than its competitors, including American Airlines, Delta, and Spirit Airlines. This initial finding prompted a closer scrutiny of the factors contributing to Southwest's cancellations.

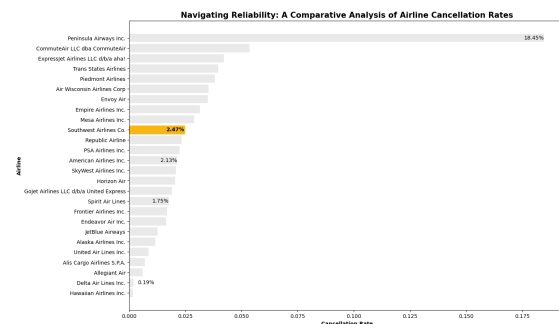


Figure 1: Analysis of Airline Cancellation Rate

Subsequent analysis focused on Southwest's cancellation reasons through a histogram, identifying significant disruptions in weeks 5, 12, and 13. Week 5's cancellations predominantly stemmed from weather-related issues, a less controllable factor. However, weeks 12 and 13 witnessed carrier-related cancellations dominating. Given the external nature of weather influences,

the analysis concentrated on carrier-related cancellations.

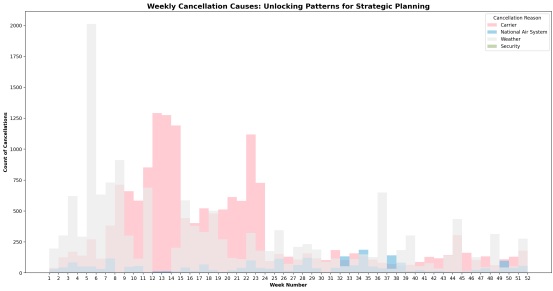


Figure 2: Weekly Cancellation Causes for Southwest

Further exploration into carrier cancellation count by week revealed that, in addition to week 5, weeks 12 and 13 experienced heightened cancellation counts. During week 8, a labor dispute between Southwest Airlines and the Aircraft Mechanics Fraternal Association (AMFA) led to significant maintenance delays. The escalation in weeks 12 and 13 was attributed to the Federal Aviation Administration's (FAA) grounding of Boeing 737 MAX 8 aircraft following two fatal crashes. As Southwest held the largest 737 MAX fleet in the U.S., the airline was compelled to undertake substantial schedule adjustments, including flight cancellations and route alterations, to mitigate passenger disruptions.

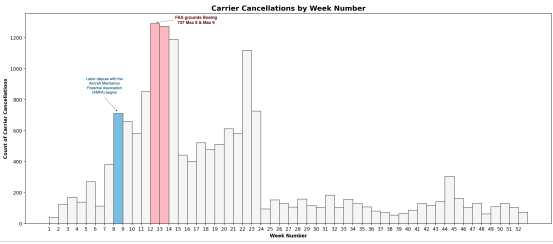


Figure 3: Carrier Cancellations by Week Number

An analysis of the most affected routes during the grounding period spotlighted "San Diego, CA - Oakland, CA", "Atlanta, GA - Houston, TX" and "Dallas, TX - Houston, TX" among the top 5 for both weeks, indicating specific operational vulnerabilities.

Table 1: 5 Most Cancelled Routes in Week 12	
Route	Cancellation Count
San Diego, CA - Oakland, CA	11
Burbank, CA - Oakland, CA	9
Atlanta, GA - Houston, TX	8
Los Angeles, CA - Chicago, IL	8
Dallas, TX - Houston, TX	8

Table 2: 5 Most Cancelled Routes in Week 13	
Route	Cancellation Count
Houston, TX - Dallas, TX	15
Dallas, TX - Houston, TX	12
Atlanta, GA - Houston, TX	9
San Diego, CA - Oakland, CA	9
San Diego, CA - Las Vegas, NV	9

The choropleth heatmap provided a visual representation of flight volumes and cancellation rates by state, offering a broader perspective on Southwest's operational footprint and cancellation patterns across the contiguous United States.

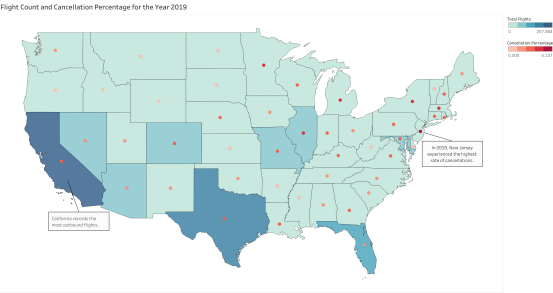


Figure 4: Flight Count & Cancellation Rates

Lastly, an examination of routes with the highest delays furnished insights into systematic delays and cancellations, highlighting potential areas for operational improvement.

Table 3: Route-Specific Delays & Cancellations			
Route	Average Departure Delay (in mins)	Average Arrival Delay (in mins)	Cancellation Percentage
Denver, CO - Newark, NJ	43.79	41.20	6.07%
Nashville, TN - Newark, NJ	30.38	26.62	3.12%
Chicago, IL- Newark, NJ	29.59	27.07	8.03%
Chicago, IL - San Francisco, CA	26.93	21.38	2.76%
Phoenix, AZ - San Francisco, CA	25.94	23.73	3.47%
New York, NY - Milwaukee, WI	25.03	23.52	4.66%
Las Vegas, NV - San Francisco, CA	24.17	22.45	2.82%
Chicago, IL - New York, NY	23.84	23.06	7.16%
Denver, CO - San Francisco, CA	23.56	20.81	2.76%
Los Angeles, CA - San Francisco, CA	22.75	19.91	10.34%

4 Recommendations

To enhance operational efficiency and reduce cancellations, the following strategies are recommended for Southwest Airlines:

- Fleet Diversification:** To mitigate risks associated with fleet groundings, diversifying the aircraft fleet will provide flexibility and resilience.
- Maintenance and Labor Relations:** Strengthening relationships with labor unions and enhancing maintenance operations can prevent disruptions. Implementing proactive maintenance scheduling and

resolving labor disputes swiftly will minimize carrier-related cancellations.

- **Route Optimization:** Analyzing the impact of the 737 MAX grounding on specific routes suggests the need for a strategic review of route profitability and reliability. Optimizing routes based on aircraft availability and demand can improve service consistency.
- **Enhanced Weather Preparedness:** Developing more robust strategies for weather-related disruptions can improve preparedness and response to adverse conditions, reducing weather-related cancellations.

Conclusion

The analysis underscores Southwest Airlines' heightened cancellation rates in 2019, attributed significantly to the Boeing 737 MAX grounding and labor disputes. These operational challenges, juxtaposed with adverse weather conditions, spotlight the airline's vulnerability to external and internal pressures. The route-specific impact analysis, particularly during critical weeks, reveals San Diego-Oakland as notably affected, emphasizing the need for strategic route and fleet management. The heatmap analysis further delineates geographical patterns in cancellations, offering a macroscopic view of operational hotspots. This comprehensive exploration not only illuminates the complexities facing Southwest but also underscores the imperative for adaptable, resilient operational strategies to mitigate future disruptions and maintain service reliability.

References

- [1] https://www.transtats.bts.gov/Tables.asp?Q0_VQ=EFD&Q0_anzr=Nv4yv0r%FDbo-gvzr%FDcr4s14zn0pr%FDQn6n&Q0_fu146_anzr=b0-gvzr
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