

## Executive Summary

This comprehensive report analyzes the U.S. airline industry's performance in January 2023, focusing on flight volume, On-Time Performance (OTP), and weather-induced delays. Key findings highlight Southwest Airlines' dominance and efficient operation, despite its large volume of flights. Regional carriers like PSA Airlines demonstrate superior OTP. Early mornings and Saturdays experience the least delays, while evenings and Wednesdays are most prone to delays. Smaller airports show greater vulnerability to weather disruptions. The report recommends incorporating broader data, including aircraft age and detailed weather information, for enhanced delay prediction and operational efficiency, thereby boosting customer satisfaction and strategic planning in the airline industry.

## Introduction

The airline industry's success hinges on efficiency and punctuality. This report offers a comprehensive examination of airline operations within the U.S. for January 2023, focusing on key performance indicators such as the volume of flights, OTP, and the extent of weather-induced delays.

OTP is a crucial metric in the airline industry, representing the percentage of flights arriving within 15 minutes of their scheduled times. It is a vital indicator of an airline's operational efficiency, directly impacting customer satisfaction and competitive positioning.

## Recognizing Limitations of Data

1. **Single Month Data:** The dataset file encompasses only January 2023, however, the dataset '*OTP\_2018\_1\_to\_2023\_1.csv*' suggests 5 years of data, preventing a comprehensive annual analysis. Airline operations can vary significantly throughout the year due to factors like seasonal travel patterns, holiday periods, and economic fluctuations. Without data spanning multiple months or the entire year, it's challenging to identify long-term trends or yearly patterns. For instance, summer and winter holiday seasons typically see different travel behaviors, which can't be captured with data from just one month.
2. **Potential Misrepresentation:** Concluding annual performance based on a single month's data could lead to misrepresentations. January, often a slower travel month post-holiday season, may not accurately reflect an airline's performance during busier times. Additionally, specific events in January 2023 (like weather patterns, economic conditions, or operational changes) could have influenced the data, making it not fully representative of the airlines' typical yearly performance.

Given these limitations, the analysis provided primarily offers insights into the airlines' operational scale and efficiency for January 2023. While valuable, these insights should be considered as indicative of performance in that month, rather than extrapolated to represent an entire year. For a robust analysis, a more extensive data set covering a

longer period, detailed weather conditions, and a variety of geographical locations would be necessary. This would enable a more accurate and generalizable understanding of the various relationships including weather conditions and flight delays.

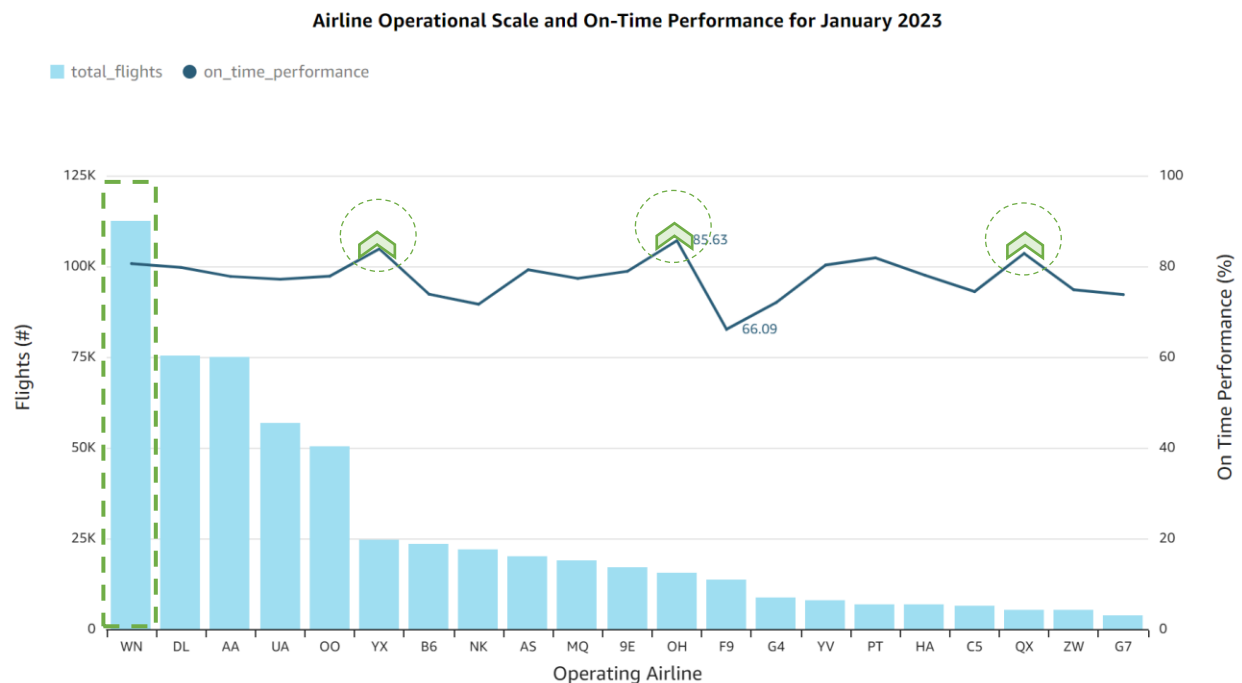
## Southwest Airlines' Market Leadership

- Of the 21 airlines, Southwest Airlines (WN) significantly outperformed its competitors with 112,430 flights making up 20% of total flights, ~1.5x more than Delta Air Lines (DL) and American Airlines (AA) with 75,174 and 74,999 flights, respectively.
- The distinct operational scales may reflect different market strategies - WN's high volume is due to more focus on widespread coverage and lower-cost offerings, while others like DL and AA focus on higher-value services.

## On-Time Performance Insights

On-time performance is a critical factor for customer satisfaction and can be a competitive advantage, especially for business travelers and time-sensitive itineraries.

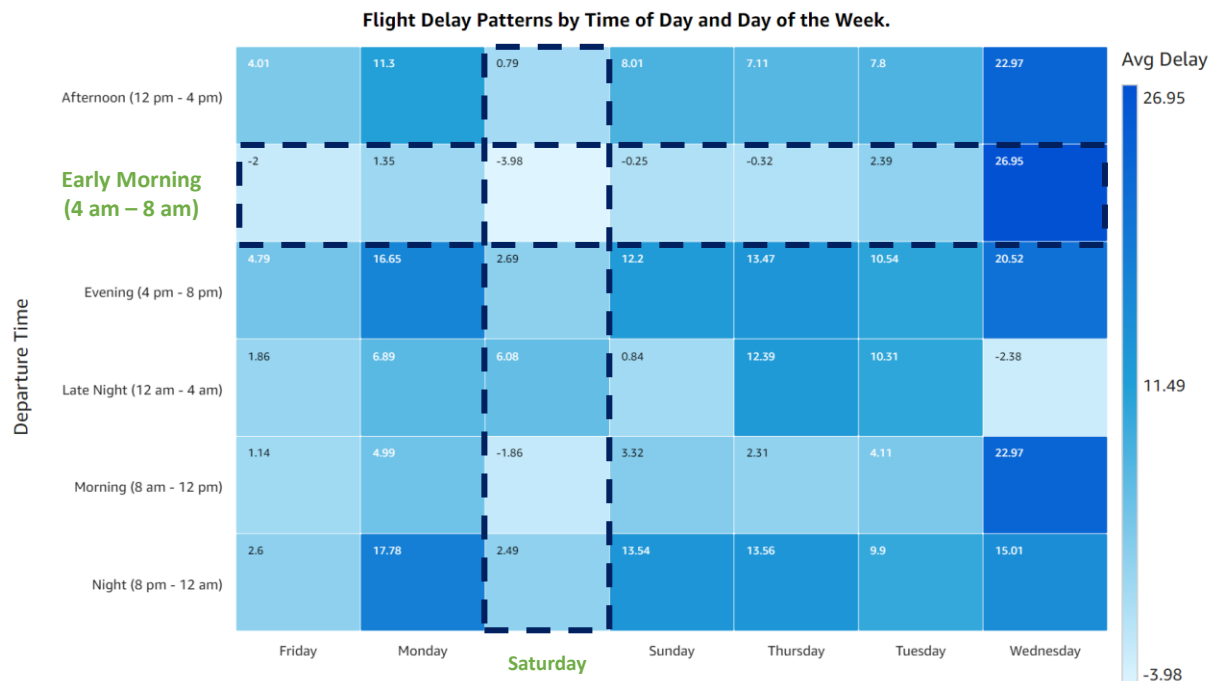
- **Regional Carriers' Excellence:** PSA Airlines (OH), Republic Airways (YX), and Horizon Air (QX) led in on-time performance with 85.63%, 83.82%, and 82.82% respectively, highlighting their operational efficiency.
- **Southwest's Operational Efficiency:** Despite its volume, Southwest Airlines maintained an ~81% on-time performance, slightly higher than Delta Air Lines (DL) and American Airlines (AA) which operate at ~50% of Southwest's volume, indicative of robust operational management.



## Best Time of Day and Day of the Week Minimize Delays

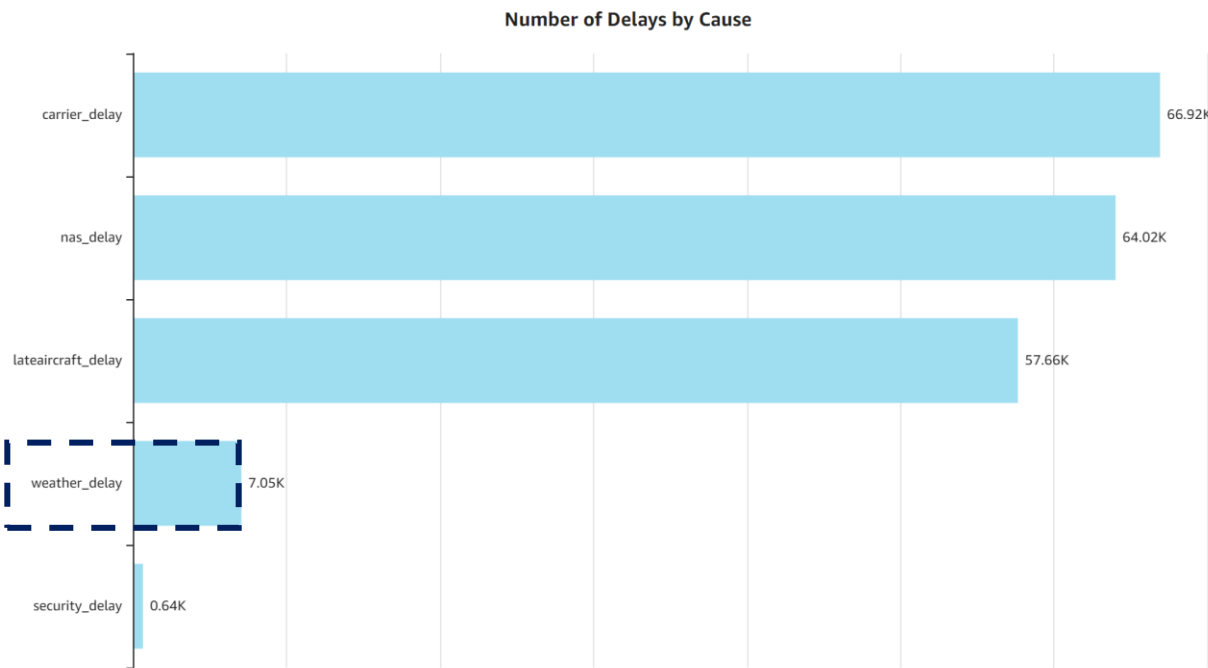
- **Least Delayed Time and Day:** Early morning flights (4 am - 8 am) experienced the lowest delay rate, with only 14.81% of flights being delayed with an average delay of 3 minutes. Saturday surprisingly had a negative total delay, indicating overall fewer delays with a delay rate of 15.32%, which is relatively lower compared to other days.
- **Most Delayed Time and Day:** Evening flights (4 pm - 8 pm) had the highest delay rate at 26.23%, suggesting that as the day progresses, the likelihood of delays increases, possibly due to the accumulation of earlier delays and increased air traffic. Wednesday experienced the highest average delay (22 minutes) and the highest delay rate (32.08%).

Passengers looking to minimize delays should consider early morning flights, especially on Saturday, and avoid evening flights, particularly on Tuesdays. Additional data would be required to understand the impact of operational challenges for airlines in managing delays as the day progresses and the influence of factors like airport congestion, scheduling practices, and demand patterns. For airlines, understanding these patterns can aid in optimizing schedules and improving overall operational efficiency.



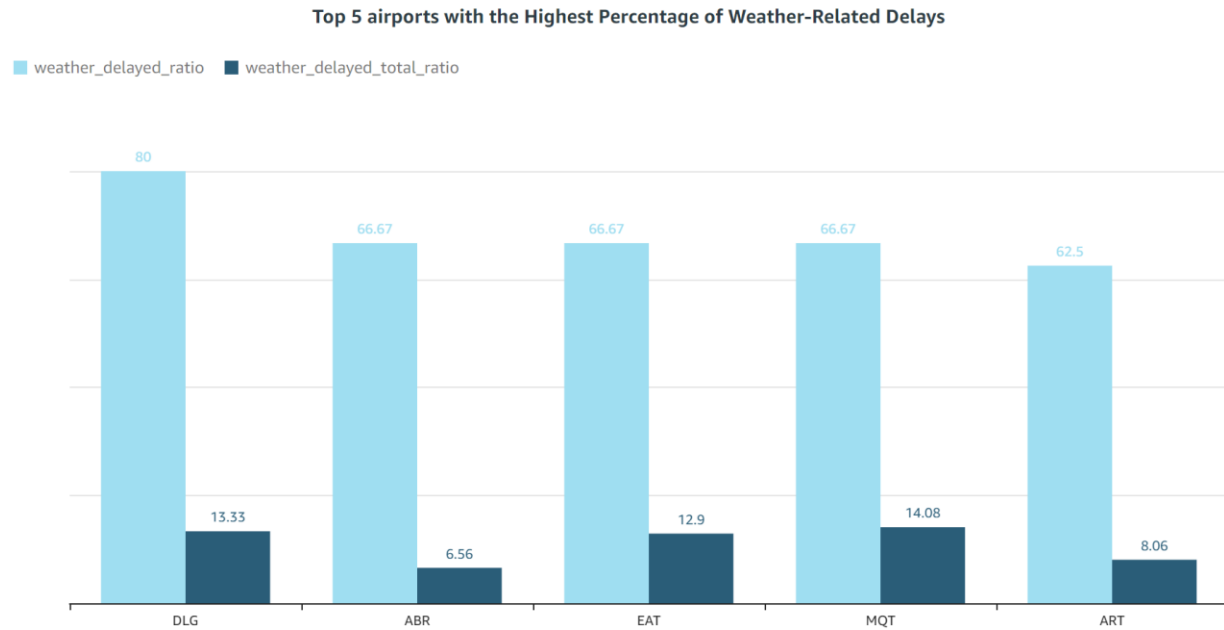
Weather-Related Delays and Airport Performance

Flight delays are categorized into Carrier Delays (related to airline operations), Weather Delays (due to adverse weather conditions), NAS Delays (involving the broader aviation system), Security Delays (caused by security issues), and Late Aircraft Delays (resulting from delayed incoming aircraft). These categories help in identifying the causes of flight delays and improving operational efficiency in the airline industry.



In January 2023, ~22% (124,293) of the flights were delayed, indicating a significant portion of flights impacted by various factors. Around 6% (7,049) of all delays were influenced by weather, with 2% being directly attributed to adverse weather conditions. This demonstrates that while weather is a significant factor, it's not the predominant cause of delays in the overall delay landscape.

From a passenger perspective, arrival delays might be more relevant, as they affect the final arrival time. Delays at the destination reflect the impact of weather on the arrival time. The analysis indicated that smaller airports, like Dillingham Airport (DLG) in Alaska (30 total flights) and Sawyer International Airport (MQT) in Michigan (71 total flights), experienced a higher ratio of weather-related delays in comparison to larger hubs. For example, at DLG, 80% of delayed flights faced were weather-related and 67% at MQT. This contrasts with major airports such as Hartsfield-Jackson Atlanta International Airport (ATL) (26,662 total flights) and Chicago O'Hare International Airport (ORD) (23,156 total flights), where weather-related delays constituted a smaller proportion of total delays - 6.32% and 6.26%, respectively. This disparity highlights the increased vulnerability of smaller airports to weather disruptions, possibly due to factors like less robust infrastructure and local geographical or climatic conditions.



These percentages are substantial when considering the overall operations at these airports, underscoring the heightened vulnerability of smaller airports to weather disruptions. While the January 2023 data may offer insights into how weather-related factors contribute to flight delays during that specific month, it's not sufficient to comprehensively predict the impact of weather on plane delays throughout the year.

The analysis of weather-related delays at destination airports for January 2023 reveals the following top 5 airports with the highest percentage of weather-related delays:

- Dillingham Airport (DLG) in Dillingham:**
  - Total Flights: 30 | Delayed Flights: 5
  - Weather Delayed Flights: 4 (13.33% of total flights)
- Aberdeen Regional Airport (ABR) in South Dakota:**
  - Total Flights: 61 | Delayed Flights: 6
  - Weather Delayed Flights: 4 (6.56% of total flights)
- Pangborn Memorial Airport (EAT) in Wenatchee:**
  - Total Flights: 31 | Delayed Flights: 6
  - Weather Delayed Flights: 4 (12.90% of total flights)
- Sawyer International Airport (MQT) in Marquette:**
  - Total Flights: 71 | Delayed Flights: 15
  - Weather Delayed Flights: 10 (14.08% of total flights)
- Watertown International Airport (ART) in New York:**
  - Total Flights: 62 | Delayed Flights: 8
  - Weather Delayed Flights: 5 (8.06% of total flights)

## **Age of Aircraft, Capacity Utilization, and Predicting Delays**

The following analysis could enhance operational strategies for airline fleet management and delay predictions but has encountered limitations. The current dataset, while informative about general operational patterns and delays, does not encompass essential details like aircraft age and specific weather conditions. This limits our ability to draw a direct correlation between aircraft age and the nature and frequency of delays, hindering our understanding of whether delays are primarily mechanical or operational.

Additionally, the absence of detailed weather data, such as precipitation levels and temperature, restricts our insight into how weather elements specifically impact flight punctuality. The analysis is further constrained by its limited scope, covering only a short timeframe and lacking geographical diversity. This limitation hinders our capacity to assess the broader, seasonal impacts of weather on flight operations, essential for strategic planning and passenger communication.

To address these gaps and enhance our operational efficiency and customer satisfaction, we would require a comprehensive dataset that includes detailed weather metrics and aircraft age information. Such data, spanning diverse geographical regions and extended periods, would enable us to predict and mitigate delays, plan routes effectively, and make informed decisions on fleet management and infrastructure development.

## **Conclusion**

In conclusion, this analysis of the U.S. airline industry for January 2023 demonstrates the operational strengths of major and regional carriers, with Southwest Airlines and airlines like PSA Airlines (OH) showcasing efficiency and punctuality despite varying operational scales. The study highlights the impact of factors like time of day, day of the week, and airport size on delay rates, with smaller airports being more susceptible to weather-related disruptions. Interestingly, while weather is a significant factor in flight delays, it is not the predominant cause in the overall delay landscape. This insight, along with the limitations of the current dataset, underscores the need for incorporating more comprehensive data, including detailed weather conditions and aircraft age. Such an expanded dataset would enable a more accurate prediction of delays and provide crucial insights for optimizing operational efficiency, particularly for smaller airports and regional airlines, ultimately enhancing customer satisfaction and aiding strategic airline industry planning.