Airline Industry Performance and Insights Report

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***Acronyms***

U.S. United States of America

SQL Structured Query Language

ER Entity-Relationship

IATA International Air Transport Association

ATL Hartsfield–Jackson Atlanta International Airport

LAX Los Angeles International Airport

MIA Miami International Airport

SFO San Francisco International Airport

ORD Chicago O'Hare International Airport

## 1. Executive Summary

This report provides a comprehensive analysis of the U.S. airline industry, focusing on flight performance, route and airline efficiency, passenger insights, weather impacts, and cancellations.   
By analyzing these areas, we uncover critical trends and actionable recommendations to enhance operational efficiency, improve customer satisfaction, and strengthen market positioning.   
The key findings include:  
- An average flight delay of 126.89 minutes across the industry.  
- Hawaiian Airlines exhibiting the best on-time performance (76.57%).  
- High cancellation rates for some airlines, necessitating improved planning.  
- Weather as a significant disruptor, requiring advanced monitoring tools.  
  
The recommendations presented aim to address these challenges and optimize airline operations.

## 2. Introduction

The U.S. airline industry is a cornerstone of national and global connectivity, serving millions of passengers annually. However, operational challenges such as delays, cancellations, and weather impacts affect service quality and customer satisfaction.   
This report leverages flight data to provide actionable insights and trends, addressing these operational challenges and guiding strategic improvements.

## 3. Objectives and Methodology

### Objectives

The primary objectives of this analysis are:  
1. Analyze flight delays and cancellations to identify trends.  
2. Evaluate airline and route performance metrics.  
3. Investigate passenger traffic patterns.  
4. Assess the impact of weather on flight operations.  
5. Identify areas for operational improvement.

### Methodology

Using SQL queries on a database structured from realistic datasets, the analysis covers:  
- Flight schedules, delays, and cancellations.  
- Route efficiency and airline performance.  
- Passenger traffic data.  
- Weather conditions at major airports.  
  
Data sources include government transportation datasets and realistic modeled data for the top 50 U.S. airports.

## 4. Data Preparation

The analysis utilized a robust database created through python scripts and modified using data airport and IATA code found on U.S. Department of Transportation website (Bureau of Transportation Statistics) :  
- Tables for airlines, airports, routes, flights, weather, and delays.  
- Data consistency and integrity checks.  
- Structured relationships represented in an ER diagram (Appendix A).  
This preparation ensured accuracy and relevance for subsequent analyses.

## 5. Analysis and Findings

### Objective 1: Flight Performance and Trends

- Average Delay Time: Flights experience an average delay of 126.89 minutes, indicating significant industry-wide inefficiencies.

- On-Time Performance: Hawaiian Airlines leads with 76.57% on-time flights, setting a standard for reliability.

- Delayed Routes: Routes like Salt Lake City-San Francisco and New Orleans-New York face the longest delays, suggesting areas for improvement.

- Cancellations: Airlines like Endeavor Air and Republic Airways report the highest cancellation rates, reflecting operational challenges.

- Journey Times: Variations in scheduled and actual times highlight inefficiencies, particularly for long-haul routes.

### Objective 2: Airline and Route Efficiency

- Flight Volume: Endeavor Air operates the most flights, emphasizing its market leadership.

- Route Complexity: The shortest flights are regional, while the longest are intercontinental, influencing resource allocation.

- Delay Percentages: Airlines with higher delays must address scheduling inefficiencies.

- Key Routes: Routes like Houston-Fort Myers demand operational adjustments.

- Delay Averages: Airlines with higher averages need targeted interventions.

### Objective 3: Passenger and Traffic Insights

- Passenger Volume: Major hubs like ATL and LAX handle significant traffic, underscoring their strategic importance.

- Busiest Routes: High-demand routes connect economic centers, driving profitability.

- Flight Distance: Longer averages for ATL and MIA airports indicate a mix of domestic and international operations.

- City Traffic: Cities like Chicago and Atlanta dominate in departure and arrival volumes.

- State Contributions: States like California lead in originating flights due to robust airport networks.

### Objective 4: Weather Impact

- Precipitation Delays: Increased precipitation correlates with higher delay times, emphasizing weather's role in disruptions.

- Visibility Issues: Airports like SFO and ORD face frequent visibility challenges, impacting operations.

- Wind Impacts: Strong winds exacerbate delays, requiring proactive adjustments to ensure safety.

- Weather Conditions: Adverse weather significantly increases delays, highlighting the importance of predictive models.

- Clear Weather Delays: Operational inefficiencies during clear weather suggest opportunities for improvement.

### Objective 5: Cancellations

- Reasons for Cancellations: Weather and operational issues dominate, necessitating robust contingency plans.

- Airline Cancellation Rates: Cancellation percentages vary widely, affecting customer trust and satisfaction.

- Affected Routes: Routes prone to disruptions need alternative planning and resources.

- Journey Time Impact: Understanding scheduled versus actual times aids in effective planning.

## 6. Market Trends and Insights

- Major hubs drive passenger volume and demand, underscoring their critical role in the network.  
- Weather disruptions remain a primary challenge, requiring investment in advanced tools.  
- Airlines with high on-time performance and low cancellations are more competitive in retaining customer loyalty.

## 7. Future Recommendations

1. Implement predictive weather monitoring systems to minimize disruptions.  
2. Optimize high-demand and delay-prone routes for efficiency.  
3. Enhance passenger communication systems for real-time updates on delays and cancellations.  
4. Address inefficiencies during clear weather to enhance reliability.  
5. Focus resources on improving operations at major hubs and high-demand routes.

## 8. Conclusion

This report highlights key trends and challenges in the U.S. airline industry, providing actionable insights and strategies for improvement. By addressing delays, cancellations, and operational inefficiencies, airlines can enhance performance, improve customer satisfaction, and strengthen market presence. Investments in technology, infrastructure, and operational planning are critical to achieving these objectives.

## References

Bureau of Transportation Statistics, National Transportation Statistics Table 1-44. (n.d.). *Passengers boarded at the top 50 U.S. airports*. Passengers Boarded at the Top 50 U.S. Airports | Bureau of Transportation Statistics. <https://www.bts.gov/content/passengers-boarded-top-50-us-airports>

## Appendix

Appendix A: ER Diagram (Illustrates the database structure used in the analysis).

An ER Diagram for the Flight Data Analysis Schema showing Table name, metadata, data types, and relationships between each tables.


Figure 1 An ER Diagram for the Flight Data Analysis Schema showing Table name, metadata, data types, and relationships between each tables.