Analysis of Flight Delay Trends in the Airline Industry:Statistical Analysis Report

ABSTRACT

The report analyzes the distribution for flight delays within the airline industry and analyzes airline delays at different times of the week and day, as well as for different flight durations. It is noteworthy that the periods of time with the highest frequency of delays were Wednesdays and afternoons, with medium-haul flights exhibiting the most significant delay rates. Furthermore, it was disclosed that WN Airlines exhibited the highest percentage of delays compared to all other airlines.

1 INTRODUCTION

Flight delays have significant economic and operational consequences for the airline industry, impacting passenger satisfaction and operational efficiency. First, the report explores an in-depth analysis of flight delay trends to discover essential patterns that could provide helpful insights for improving management strategies. Second, by organizing flights into different categories based on distance and examining delay routines throughout the week and day the study offers a thorough insight into the factors affecting flight delays. In addition, the report compares delay rates among different airlines and gives insights into their respective punctuality performances.

2 DATASET DESCRIPTION

This dataset provides a complete basis for studying airline delay trends throughout different durations, hours of day, days of the week, and airlines. The wide range of elements considered allows for an in-depth analysis of the factors impacting flight timing and operational efficiency in the airline sector.

3 DATA ANALYSIS

3.1 Task 1

To examine the distribution of flight delays across different flight duration categories: short-haul, medium-haul, and long-haul.

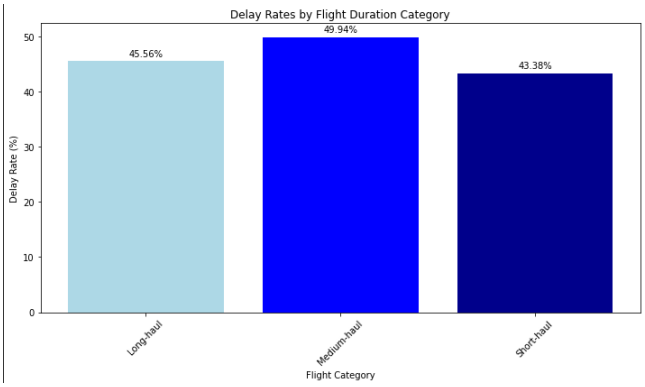

Figure 1: Delay Rates by Flight Duration Category

According to the Figure 1 The most substantial delay rates with 49.94% of flights were delayed are experienced by planes scheduled for medium-haul routes, possibly due to the complexity of operations for flights of this duration, including airspace congestion, aircraft turnaround times, and operational delays. Although long-distance flights have the second-highest rate 45.56% of delays, they are less influenced by rapid turnaround times and may instead be affected by more complex logistical requirements and international considerations and Short-haul flights have the lowest rate 43.38% of delays, which may be related to their increased regularity and flexibility in scheduling, allowing for more effective recovery procedures in the event of delays.

3.2 Task 2

A detailed investigation of the patterns delays throughout different days of the week and hours of the day. Airports and airlines must understand these trends to manage their flight schedules and enhance operational efficiency properly.According to the dataset study, the length of time that flights are delayed varies significantly according to the day of the week and the time of day.

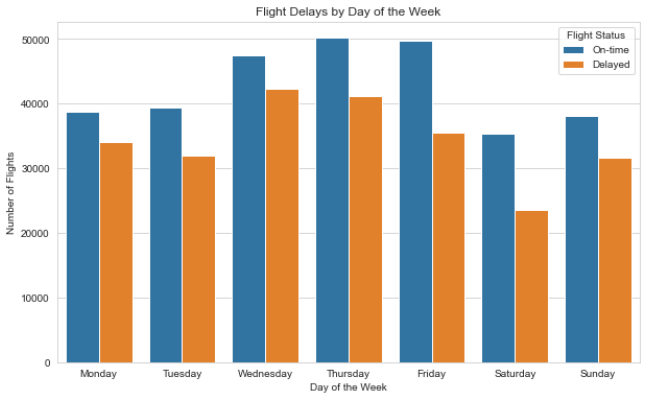

Figure 2: Flight Delays by Day of the Week

Days of the Week: From Figure 2 The most significant proportion of observed delays is on Wednesday, at around 47.08Delays are also expected on Mondays and Sundays, with 46.76% and 45.35%, respectively. The tendency toward timeliness is evident as the week advances, with Saturday having the lowest delay rate at 40.06%.

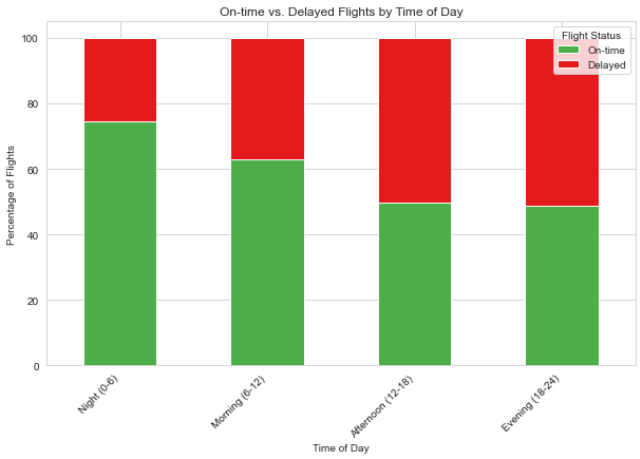

Figure 3: On-time vs. Delayed Flights by Time of Day

Times of the Day: From Figure 3 Flights departing in the afternoon had the largest rate of delays, 50.67 %. Like morning flights, evening flights have a delay percentage of 49.85 %. With a delay percentage of 44.46%, night flights have a moderate amount of delays. There is a good beginning to the day regarding timeliness, as evidenced by the fact that morning flights have the lowest delay percentage, 36.08%. The proportion of delays is highest during the middle of the week , notably on Wednesday, which may be connected to a culmination of operational activities and air traffic. The domino effect of earlier delays during the day may be responsible for increased delays during the afternoon and evening. This might be attributed to the congestion at airports during peak operation hours. On the other hand, the lower delay rates on Saturdays and during the early hours may be due to less air traffic and the absence of cumulative delays from flights that occurred in the past.

3.3 Task 3

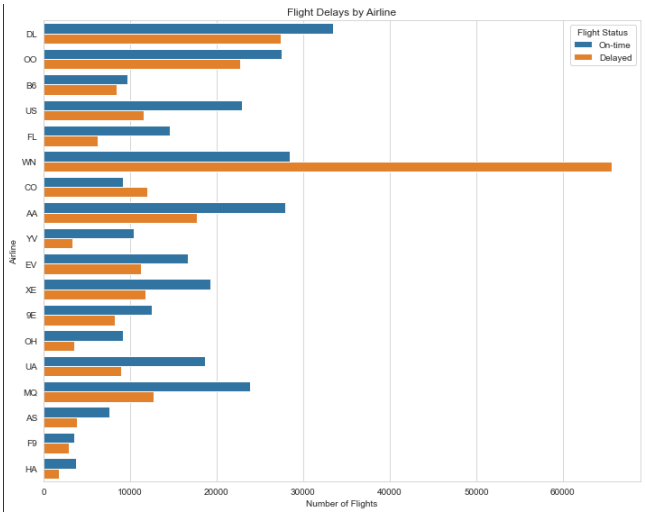

Figure 4: Flight Delays by Airline

The distribution of delayed flights among different airlines in Figure 4 provides a clear view of the performance variance in terms of flight punctuality: (WN)Airlines shows the highest delays proportion, accounting for 65657 flights approximately 69.78% of its total delays, closely followed by (CO) with 11957 flights delay for percentage of 56.62%. On the other hand, (YV) Airlines has the lowest delay with 3334 flights and with only 24.29% of its flights experiencing delays. Additionally, (OH) and (FL) Airlines have lower delay percentages, indicating a higher punctuality level.

3.4 Task 4

Airline	Total Flights	On-time Flights	Delayed Flights	Delayed Percentage
WN	94,097	28,440	65,657	69.78
CO	21,118	9,161	11,957	56.62
B6	18,112	9,653	8,459	46.70
OO	50,254	27,494	22,760	45.29
DL	60,940	33,488	27,452	45.05
F9	6,456	3,557	2,899	44.90
9E	20,686	12,460	8,226	39.77
AA	45,656	27,920	17,736	38.85
XE	31,126	19,331	11,795	37.89
EV	27,983	16,728	11,255	40.22
MQ	36,604	23,862	12,742	34.81
AS	11,471	7,579	3,892	33.93
US	34,500	22,909	11,591	33.60
UA	27,619	18,673	8,946	32.39
HA	5,578	3,792	1,786	32.02
FL	20,827	14,552	6,275	30.13
OH	12,630	9,128	3,502	27.73
YV	13,725	10,391	3,334	24.29

Table 1: Flight punctuality data by airline.

Within the dataset scope and the provided Tables 1 conclude that WN has the highest proportion of delayed flights compared to other airlines, presenting an area ripe for further investigation into the causes and potential strategies for mitigation.Delving deeper into WN Airlines delay patterns:

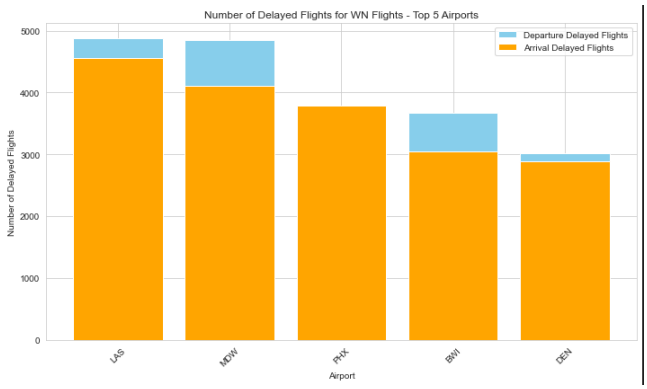

Figure 5: Number of Delayed Flights for WN Flights - Top 5 Airports

First the Figure 5 bar graph and heatmaps Figure 6 and Figure 7 present a comprehensive view of the frequency and timing of delays. The bar chart indicates that departure delays are more common than arrival delays at the top five airports. The departure

procedures at LAS airport show a particularly stark difference, indicating potential operational issues.

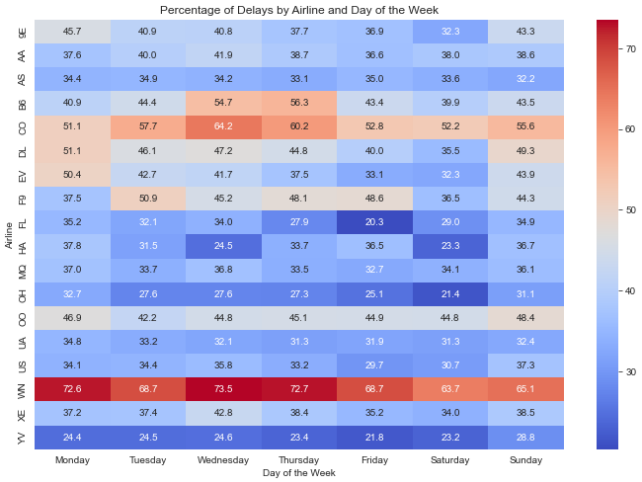

Figure 6: Percentage of Delays by Airline and Day of the Week

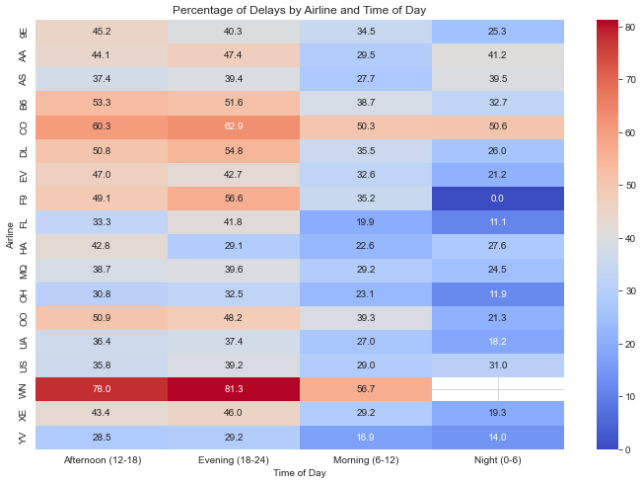

Figure 7: Percentage of Delays by Airline and Time of Day

Secound from the 6 and Figure 7 Heatmap analysis confirms that WN consistently experiences significant delay percentages throughout the week, peaking from Tuesday to Thursday and during the afternoon to evening hours, potentially due to increased traffic and complex scheduling. Based on these trends, it seems that WN operations are having significant issues that warrant a full review of scheduling, staffing, and airport processes, especially during peak operational periods. A detailed examination of WN's operational practices, along with external factors such as weather conditions, air traffic control, and airport congestion, is recommended to devise and implement strategies aimed at reducing delays and boosting overall efficiency.

4 DISCUSSION

Flight Duration Categories and Delay Trends: Medium-haul flights have the highest delay rates at 49.94%. These delays are caused by various factors such as complexities in operations, airspace congestion, and turnaround times. Long-haul flights face various challenges, including logistical requirements and international considerations, which can lead to delays. Short-haul flights offer the lowest delay rate at 43.38%, which can be linked to their flexible scheduling and ability to recover back quickly from any delays.

Day of the Week and Time of the Day Patterns: Midweek is when delays peak with Wednesday having the most significant percentage of delays (47.08%). As the weekend approaches, the pattern weakens and with Saturday seeing the lowest percentage of delays. In terms of daily trends, the flights in the afternoon had the highest rates of delays, which may indicate a cascade of delays from earlier in the day. There are often fewer flight delays during the night and early morning, which suggests less air traffic and operational difficulties.

Major differences in delay rates were found across airlines, with WN Airlines having the largest proportion of delays at around 69.78%. The investigation reveals that operational inefficiencies, particularly in departure processes, might contribute to these delays. A deeper look into WN Airlines' delay patterns using bar graphs and heatmaps shows that departure delays, particularly at LAS airport, and peak delay periods from Tuesday to Thursday and from afternoon to evening hours, are areas that require immediate action.

5 CONCLUSION

The report explains the elements of flight delays within the airline sector with underscoring the necessity for focused operational modifications. As result delays are more common on medium-haul flights, midweek days, and afternoons. WN Airlines is notable within the airline industry due to its elevated delay rates, warranting a comprehensive examination of its scheduling, staffing, and airport operations.Use an integrated strategy that includes flight schedule optimization, operational efficiency improvements, and improvements in airport operations. Airlines and airports may efficiently reduce delays by concentrating on five particular areas, which will increase customer happiness and improve operational efficiency.

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