Part 1: Excel Data Analysis: Manipulation, Formulas and Functions

Q1. Missing Data Handling:

- Identify and address missing data in the movie's dataset. Are there any patterns in the missing data that can be noted?

Table : flights

1. Dropped rows with very few missing values

   - **Column**: TAIL_NUMBER
   - **Missing %**: 0.65%
   - **Action**: Dropped rows
   - **Reason**: Very small percentage; doesn't affect analysis (Q11, Q22).

2. No action taken for time-related fields with conditional missing

   - **Columns**: DEPARTURE_TIME, DEPARTURE_DELAY, TAXI_OUT, WHEELS_OFF, AIR_TIME, WHEELS_ON, TAXI_IN, ARRIVAL_TIME, ARRIVAL_DELAY
   - **Missing %**: ~3.1%–3.4%
   - **Action**: No changes
   - **Reason**: These values are missing only for cancelled or diverted flights.

3. Imputed calculated column

   - **Column**: ELAPSED_TIME
     Missing %: 3.43%
   - **Action**: Imputed using formula: ARRIVAL_TIME - DEPARTURE_TIME
   - **Reason**: Logical and derivable; missing only for cancelled/diverted.

4. Skipped encoded delay reason columns with high missing

   - **Columns**:
     CANCELLATION_REASON,
     AIR_SYSTEM_DELAY,
     SECURITY_DELAY,
     AIRLINE_DELAY,
     LATE_AIRCRAFT_DELAY,

WEATHER_DELAY

- **Missing %**: ~79% to 96%
- **Action**: No changes made
- **Reason**: Encoded format and high % of nulls; not essential for main analysis.

Table : airports

Column: LATITUDE & LONGITUDE

- Missing values imputed with Web location data.

Q2. Flight Delays Analysis:

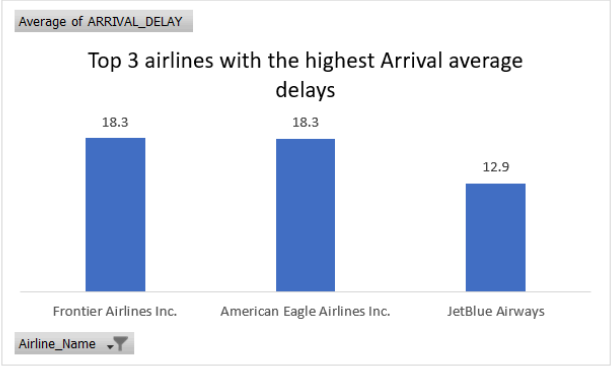
- Determine the average flight delay per airline. What are the top 3 airlines with the highest average delays?

average flight delay per airline:

Row Labels	Average of ARRIVAL_DELAY
Frontier Airlines Inc.	18.3
American Eagle Airlines Inc.	18.3
JetBlue Airways	12.9
Spirit Air Lines	9.5
Skywest Airlines Inc.	9.3
Atlantic Southeast Airlines	8.7
Virgin America	7.1
American Airlines Inc.	6.8
United Air Lines Inc.	6.5
Hawaiian Airlines Inc.	6.0
US Airways Inc.	4.1
Southwest Airlines Co.	3.0
Alaska Airlines Inc.	0.6
Delta Air Lines Inc.	0.2

top 3 airlines with the highest average delays

Row Labels	Average of ARRIVAL_DELAY
Frontier Airlines Inc.	18.3
American Eagle Airlines Inc.	18.3
JetBlue Airways	12.9



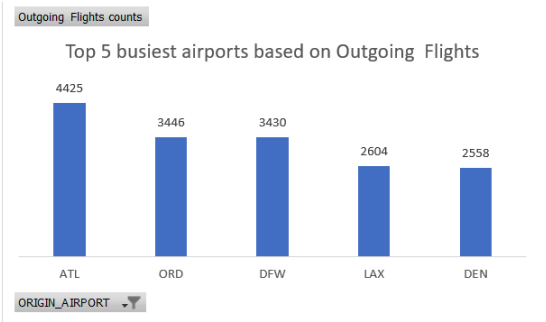
Insights:
Delta Air Lines Inc. has the least average flight delay which means it is the most punctual Airline.

Based on the flight delays analysis, the top 3 airlines with the highest average arrival delays are Frontier Airlines Inc. and American Eagle Airlines Inc., both with an average delay of 18.3 minutes, followed by JetBlue Airways with an average delay of 12.9 minutes.

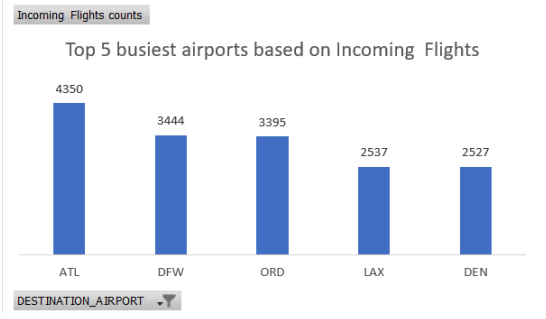
Q3. Airport Traffic Volume:

- Identify the top 5 busiest airports based on the number of incoming and outgoing flights.

AIRPORT	IATA_CODE	Outgoing Flights counts
Hartsfield-Jackson Atlanta International Airport	ATL	4425
Chicago O'Hare International Airport	ORD	3446
Dallas/Fort Worth International Airport	DFW	3430
Los Angeles International Airport	LAX	2604
Denver International Airport	DEN	2558



AIRPORT	IATA_CODE	Incoming Flights counts
Hartsfield-Jackson Atlanta International Airport	ATL	4350
Dallas/Fort Worth International Airport	DFW	3444
Chicago O'Hare International Airport	ORD	3395
Los Angeles International Airport	LAX	2537
Denver International Airport	DEN	2527



Insights:

The top 5 busiest airports by outgoing flights are Hartsfield-Jackson Atlanta (ATL), Chicago O'Hare (ORD), Dallas/Fort Worth (DFW), Los Angeles (LAX), and Denver (DEN).
For incoming flights, the top 5 are Hartsfield-Jackson Atlanta (ATL), Dallas/Fort Worth (DFW), Chicago O'Hare (ORD), Los Angeles (LAX), and Denver (DEN).

Hartsfield-Jackson Atlanta consistently ranks as the busiest airport for both incoming and outgoing flights.

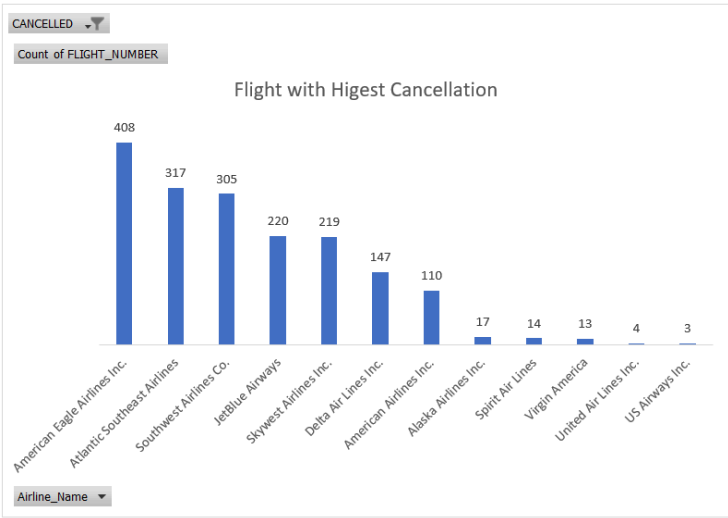
Q4 . Flight Cancellation Insights:

- Analyze the flight cancellations: Which airline has the highest cancellation rate, and what are the most common reasons for cancellations?

airline having the highest cancellation rate

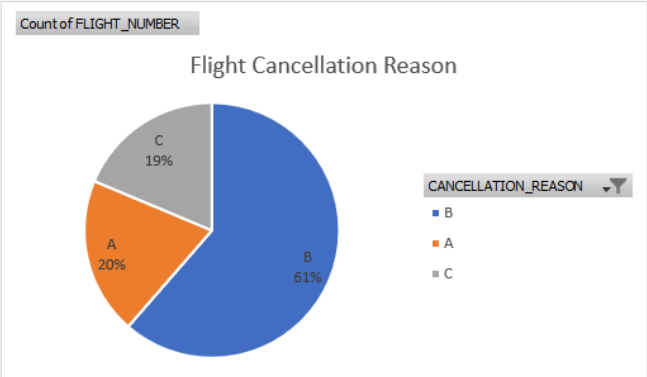
CANCELLED	1

Row Labels	Count of FLIGHT_NUMBER
American Eagle Airlines Inc.	408
Atlantic Southeast Airlines	317
Southwest Airlines Co.	305
JetBlue Airways	220
Skywest Airlines Inc.	219
Delta Air Lines Inc.	147
American Airlines Inc.	110
Alaska Airlines Inc.	17
Spirit Air Lines	14
Virgin America	13
United Air Lines Inc.	4
US Airways Inc.	3
Grand Total	**1777**



Flight Cancellation Reason

Cancellation Reason	Count of FLIGHT_NUMBER
B	1091
A	354
C	332



Insights:
American Eagle Airlines Inc. has the highest number of flight cancellations at 408.

The most common reason is due to reason B with 61% of total flights cancelled.

Q5. Seasonal Variations in Flight Operations:

- Examine if there are seasonal patterns in flight operations. Are certain months more prone to delays or cancellations?

Month	Average of ARRIVAL_DELAY	Average of DEPARTURE_DELAY	Total_Flights	Cancelled_Flights	Cancellation_Rate
1	5.87	9.81	41731	828	0.019841365
2	6.91	10.77	27812	949	0.034121962
Grand Total	**6.28**	**10.19**	**69543**	**1777**	0.025552536

Month	Total Flights	Cancelled Flights	Cancellation Rate	Insights
January (1)	41,731	828	0.0198 (≈ **1.98%**)	Around **2 out of every 100 flights** were canceled in January.
February (2)	27,812	949	0.0341 (≈ **3.41%**)	Higher cancellation rate – **about 3.4 flights per 100** got canceled.
Grand Total	69,543	1,777	0.0255 (≈ **2.55%**)	Overall, across both months, about **2.5% of flights** were canceled.

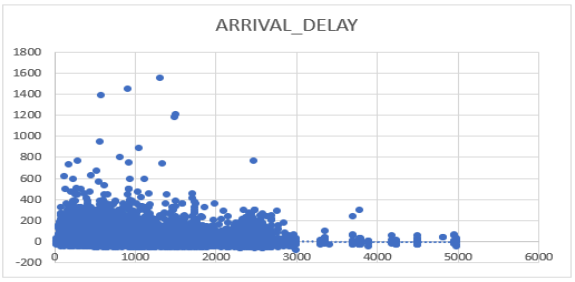
Insights: The Month 2 shows slightly higher average arrival and departure delays (6.91 and 10.77 minutes respectively) compared to Month 1 (5.87 and 9.81 minutes). Month 2 also has a higher number of cancelled flights (949) despite having fewer total flights (27812) than Month 1 (41731 total flights, 828 cancelled).

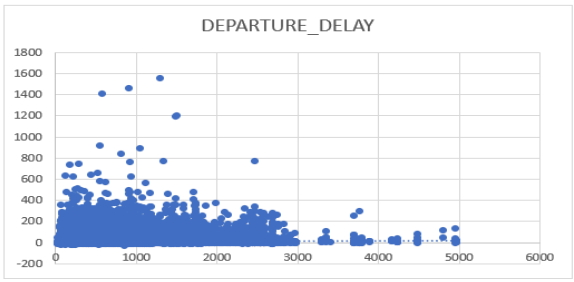
We can conclude that Month 2 experienced slightly higher average arrival and departure delays and a higher number of cancelled flights compared to Month 1.
This suggests that Month 2 is more prone to delays and cancellations based on this data.

Q6. Correlation between Distance and Delays:

- Investigate if there's a correlation between the distance of the flight and the length of delays. Use scatter plots for visualization.

DISTANCE	ARRIVAL_DELAY	DISTANCE	DEPARTURE_DELAY
813	60	813	18
261	0	261	-2
712	-15	712	-5
227	-18	227	-2
215	17	215	2
599	6	599	18
2400	-20	2400	-3
1609	-2	1609	11
109	-19	109	-4
1276	16	1276	-1
108	26	108	-8
399	-3	399	-5
1440	-7	1440	-8
349	-4	349	-2
396	61	396	66
309	71	309	11
1068	7	1068	15
100	3	100	0
337	5	337	13
190	-1	190	4
534	21	534	18
1069	85	1069	76
197	-3	197	0
775	-9	775	-4
258	-4	258	-2
1208	-12	1208	-6
1990	-13	1990	-4
2182	-13	2182	8
954	-6	954	0
258	169	258	176





Insights: The scatter plots show no strong correlation between flight distance and arrival or departure delays.

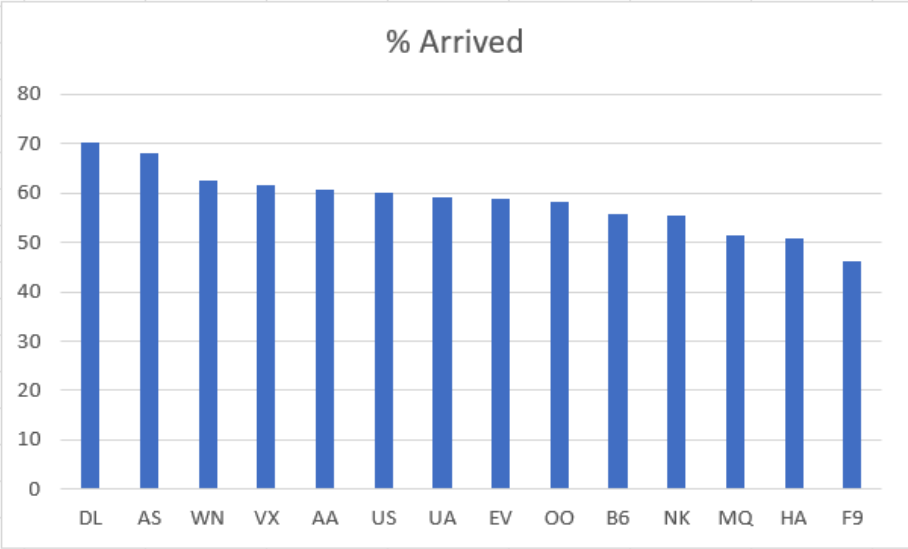
While most flights cover shorter distances and experience varied delays,

longer flights are less frequent and also show a range of delays.

Q7. Efficiency of Airlines:

- Calculate the on-time performance (percentage of flights that are not delayed) for each airline. Rank them based on this metric.

Row Label	% Arrived
DL	70.12
AS	68.21
WN	62.4
VX	61.47
AA	60.56
US	60.11
UA	59.17
EV	58.72
OO	58.19
B6	55.64
NK	55.3
MQ	51.53
HA	50.74
F9	46.29



Top Performers:

- **Delta Air Lines (DL) leads with 70.12%** on-time arrivals, suggesting efficient operations. **Alaska Airlines (AS) follows at 68.21%**, likely due to less congested regional routes (e.g., Seattle). **Southwest Airlines (WN) ranks third at 62.44%**, benefiting from its point-to-point model.

Middle Performers:

- Virgin America (VX) (61.47%), American Airlines (AA) (60.56%), US Airways (US) (60.11%), and United Airlines (UA) (59.17%) range 59-61%, impacted by busy hubs (e.g., DFW, ORD). Regional carriers ExpressJet (EV) (58.72%) and SkyWest (OO) (58.19%) face cascading delays.

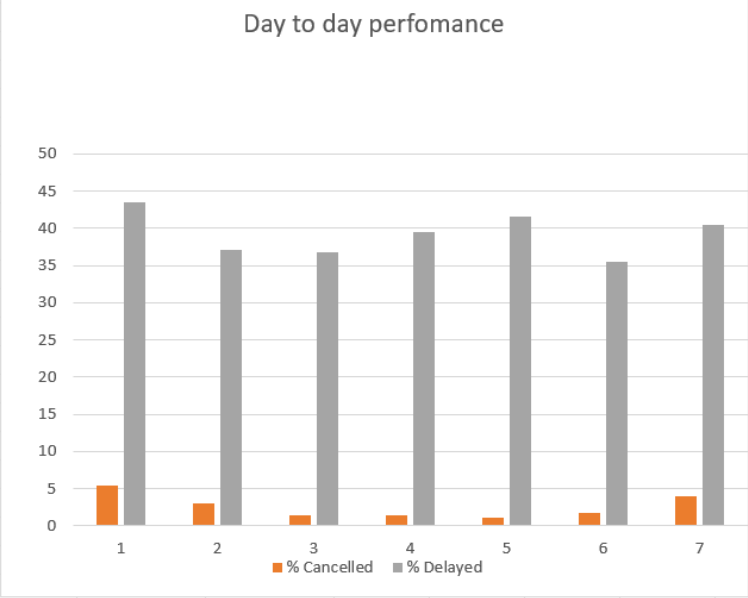
Low Performers:

- **Frontier Airlines (F9) is lowest at** 46.29%, likely due to tight schedules. **Hawaiian Airlines (HA) (50.74%)** struggles despite accurate durations, possibly from inter-island challenges. Envoy Air (MQ) (51.53%) and Spirit Airlines (NK) (55.53%) lag, affected by mainline dependency and minimal buffers.

Q8. Impact of Day of Week on Flight Operations:

- Assess how flight operations (delays, cancellations) vary by the day of the week.

Day of the Week	% Cancelled	% Delayed
1	5.41	43.41
2	3.11	37.14
3	1.41	36.78
4	1.48	39.46
5	1.09	41.62
6	1.77	35.47
7	4.07	40.4



Highest Cancellation Rate:

- **Day 1 (Monday)** with **5.41%**.
- Likely due to higher operational volume at the start of the week.

Lowest Cancellation Rates:

- **Day 5 (Friday)**: **1.09%**
- **Day 3 (Wednesday)**: **1.41%**

Highest Delay Rate:

- **Day 5 (Friday)**: **41.62**
- Followed by **Day 1 (Monday)**: **43.41%**

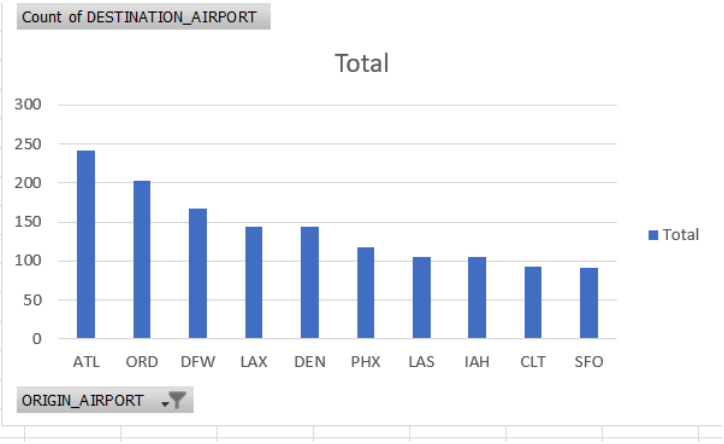
Lowest Delay Rate:

- **Day 6 (Saturday)**: **35.47%**
- Suggests smoother operations on weekends.

Q9. Analysis of Airport Connectivity:

- Which airports serve as the most significant hubs in terms of connectivity (most destinations served)?

Row Labels	Count of DESTINATION_AIRPORT
ATL	241
ORD	203
DFW	167
LAX	144
DEN	144
PHX	117
LAS	105
IAH	105
CLT	93
SFO	92
Grand Total	**1411**



Top 3 Most Connected Airports:

1. **ATL (Atlanta)** – **241** destinations
   ➤ **Most significant hub**, indicating its major role in the national network.

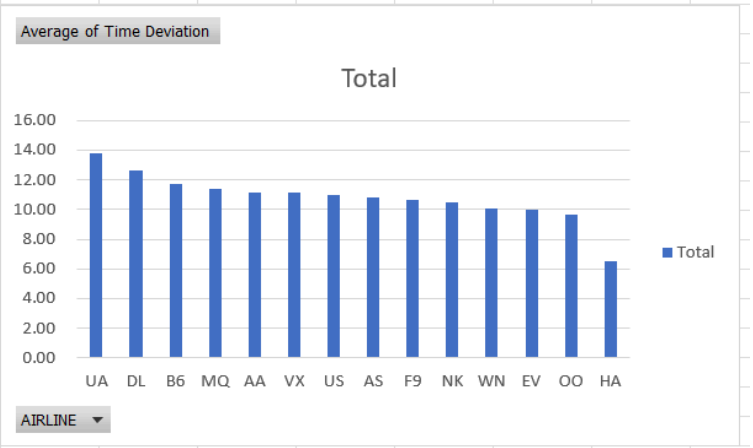
2. **ORD (Chicago O'Hare)** – **203** destinations
   ➤ Another **critical hub** with extensive reach across regions.

3. **DFW (Dallas/Fort Worth)** – **167** destinations
   ➤ Strong central U.S. connectivity

Q10. Flight Duration Accuracy:

- Compare the scheduled flight duration versus the actual flight duration. Which airlines have the most and least deviation?

Row Labels	Average of Time Deviation
UA	13.75
DL	12.60
B6	11.71
MQ	11.36
AA	11.17
VX	11.15
US	10.97
AS	10.83
F9	10.61
NK	10.49
WN	10.08
EV	10.00
OO	9.63
HA	6.52



Airlines with Most Deviation:

1. **UA (United Airlines) – 13.75 mins avg. deviation**
   ➤ Highest deviation; may indicate frequent schedule mismatch or variable conditions.

2. **DL (Delta) – 12.60 mins**
   ➤ Second highest; potential for optimization in schedule planning.

3. **B6 (JetBlue) – 11.71 mins**

Airlines with Least Deviation:

1. **HA (Hawaiian Airlines) – 6.52 mins**
   ➤ Most **consistent** in aligning scheduled and actual flight durations.

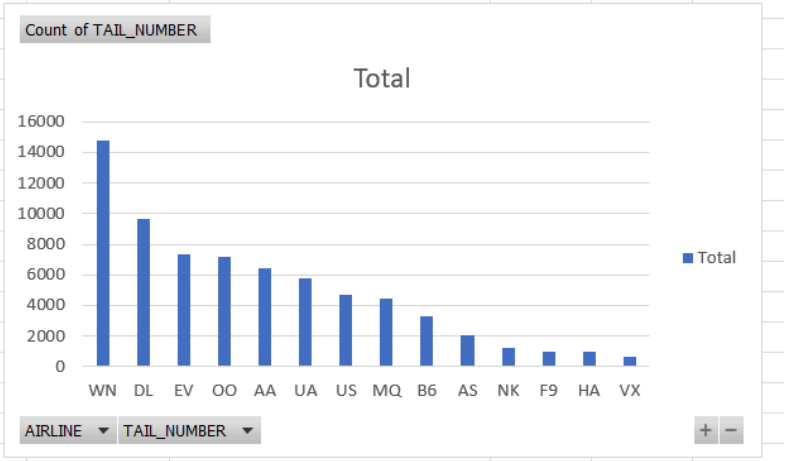
2. **OO (SkyWest) – 9.63 mins**

3. **EV (ExpressJet) – 10.00 mins**

Q11. Airline Fleet Utilization:

- Based on the tail numbers, determine which airline has the highest number of flights per aircraft, indicating fleet utilization.

Row Labels	Count of TAIL_NUMBER
WN	14787
DL	9619
EV	7376
OO	7196
AA	6465
UA	5777
US	4715
MQ	4473
B6	3282
AS	2032
NK	1264
F9	970
HA	946
VX	641
Grand Total	69543



Highest Fleet Utilization:

1. **WN (Southwest Airlines) – 14,787 flights**
   ➤ Significantly higher than others → strong fleet efficiency and high aircraft usage.

2. **DL (Delta Airlines) – 9,619 flights**
   ➤ Second-highest; large fleet, well-utilized.

3. **EV (ExpressJet) – 7,376 flights**

Lowest Fleet Utilization:

1. **VX (Virgin America) – 641 flights**
   ➤ Indicates either limited operations or fewer active aircraft.

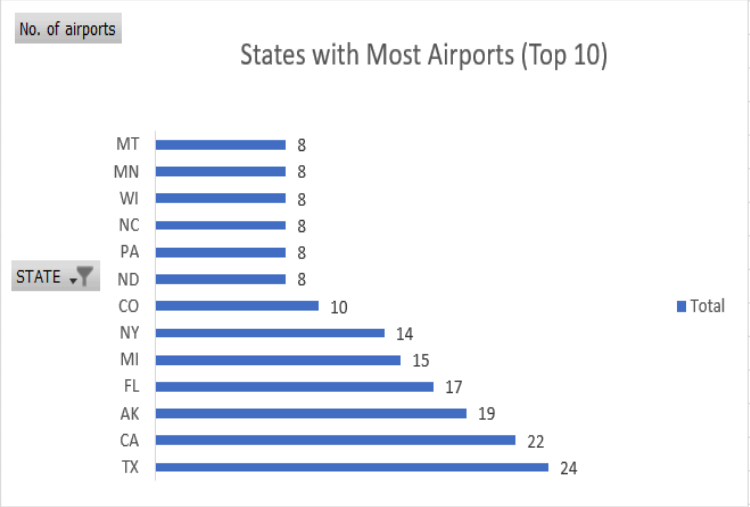
2. **HA (Hawaiian Airlines) – 946 flights**

3. **F9 (Frontier Airlines) – 970 flights**

Q12. Airport Geographical Analysis:

Using latitude and longitude data, analyze the geographical distribution of airports. Which states or regions have the highest concentration of airports?

States	No. of airports
TX	24
CA	22
AK	19
FL	17
MI	15
NY	14
CO	10
ND	8
PA	8
NC	8
WI	8
MN	8
MT	8
Grand Tot	169



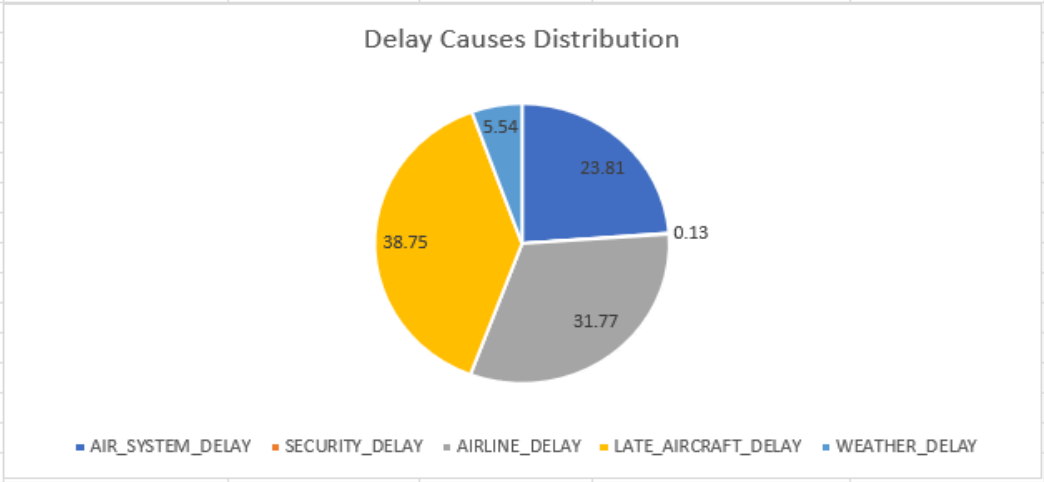
Airport Geographical Analysis – Insights

- Geographical distribution was analyzed using latitude and longitude data combined with state information.
- Texas (TX) has the highest number of airports (24), followed by California (CA) (22) and Alaska (AK) (19).
- Florida (FL), Michigan (MI), and New York (NY) also show high airport density with 17, 15, and 14 airports respectively.
- Colorado (CO) has 10 airports, while ND, PA, NC, WI, MN, and MT each have 8.
- These top states represent key aviation hubs and regions with high transportation needs or geographic coverage.
- The concentration reflects factors such as state size, population, tourism activity, and regional accessibility.

Q13. Delayed Flights and Delay Types Analysis:

For flights that are delayed, break down the delay types (airline, weather, security, etc.) and analyze their proportions.

AIR_SYSTEM_DELAY	SECURITY_DELAY	AIRLINE_DELAY	LATE_AIRCRAFT_DELAY	WEATHER_DELAY
0.238139599	0.001313604	0.317663279	0.387486774	0.055396745
23.81	0.13	31.77	38.75	5.54



Delayed Flights and Delay Types Analysis – Insights

- The delay causes were analyzed by categorizing them into five major types: Airline, Late Aircraft, Air System, Weather, and Security.
- The highest contributor to delays is Late Aircraft, accounting for 38.75% of total delay time.
- Airline-related delays are the second highest, making up 31.77% of the total.
- Air System delays contribute 23.81%, showing a significant operational impact.
- Weather delays represent 5.54%, indicating a relatively lower but still notable impact.
- Security delays are minimal, contributing only 0.13% to total delays.
- This breakdown highlights that operational and scheduling inefficiencies (Airline + Late Aircraft = ~70.5%) are the primary reasons for flight delays, while external factors like weather and security contribute far less.

Q14. Long-Haul vs Short-Haul Operations:

Compare the operational metrics (delays, cancellations) between long-haul and short-haul flights for different airlines.

CANCELLED 1	Number of Flights Cancelled
AA	**110**
Long	2
Short	108
AS	**17**
Short	17
B6	**220**
Short	220
DL	**147**
Short	147
EV	**317**
Short	317
MQ	**408**
Short	408
NK	**14**
Short	14
OO	**219**
Short	219
UA	**4**
Short	4
US	**3**
Short	3
VX	**13**
Short	13
WN	**305**
Short	305
Grand Total	**1777**

IS_DELAYED 1	Number of Flights Delayed
AA	**2550**
Long	11
Short	2539
AS	**646**
Short	646
B6	**1456**
Short	1456
DL	**2874**
Long	5
Short	2869
EV	**3045**
Short	3045
F9	**521**
Short	521
HA	**466**
Long	4
Short	462
MQ	**2168**
Short	2168
NK	**565**
Short	565
OO	**3009**
Short	3009
UA	**2359**
Long	17
Short	2342
US	**1881**
Short	1881
VX	**247**
Short	247
WN	**5560**
Short	5560
Grand Total	**27347**

Insights – Cancelled Flights

- A total of 1,777 flights were cancelled.

- Only 2 flights (0.11%) were long-haul, both from American Airlines (AA).
- The remaining 1,775 cancellations (99.89%) were short-haul flights.
- Airlines with the highest short-haul cancellations:
  - Mesa Airlines (MQ) – 408
  - ExpressJet (EV) – 317
  - Southwest (WN) – 305
  - JetBlue (B6) – 220

Insights – Delayed Flights

- A total of **27,347 flights** were delayed.
- Only **37 delays (0.14%)** were **long-haul** flights.
- **27,310 delays (99.86%)** were from **short-haul** operations.
- Long-haul delays occurred mostly in:
  - **American Airlines (AA)** – 11
  - **United Airlines (UA)** – 17
  - **Delta Airlines (DL)** – 5
  - **Hawaiian Airlines (HA)** – 4
- Airlines with the highest short-haul delays:
  - **Southwest (WN)** – 5,560
  - **Delta (DL)** – 2,869
  - **American Airlines (AA)** – 2,539
  - **JetBlue (B6)** – 1,456

Q15. Pivot Analysis of Flights Data:

- Use pivot tables to summarize key operational metrics (like average delay, number of flights, cancellations) by airline and airport.

Average_delayed	Total_Cancellation	Number_Airline
0.393238716	1777	69543

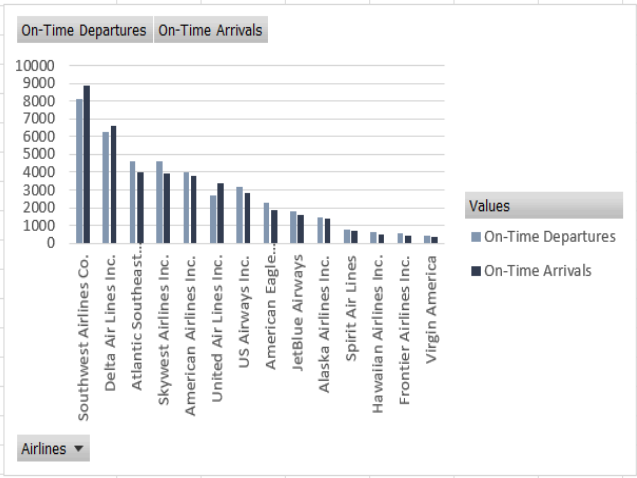
Pivot Analysis of Flights Data – Insights

- The average delay rate across all flights is 39.32%, meaning nearly 4 out of every 10 flights experienced a delay.
- A total of 1,777 flights were cancelled, representing a 2.56% cancellation rate out of 69,543 total flights.
- The dataset covers operations from multiple airlines, offering a comprehensive view of performance across different routes and airports.
- This pivot analysis helps identify key operational bottlenecks and supports the development of targeted strategies to reduce delays and cancellations.

Q16. Data Integration for Comprehensive Insights:

Merge data from the "airlines.csv" and "flights.csv" to provide enhanced insights, such as correlating airline names with operational metrics. Analyze the merged data to determine the overall on-time performance of each airline, considering both arrival and departure delays.

Row Labels	On-Time Departures	On-Time Arrivals
Southwest Airlines Co.	8120	8884
Delta Air Lines Inc.	6247	6582
Atlantic Southeast Airlines	4636	3998
Skywest Airlines Inc.	4627	3939
American Airlines Inc.	4002	3791
United Air Lines Inc.	2667	3396
US Airways Inc.	3156	2821
American Eagle Airlines Inc.	2261	1886
JetBlue Airways	1769	1603
Alaska Airlines Inc.	1475	1362
Spirit Air Lines	756	684
Hawaiian Airlines Inc.	625	480
Frontier Airlines Inc.	536	447
Virgin America	389	381
Grand Total	**41266**	**40254**



Data Integration for Comprehensive Insights - Insights

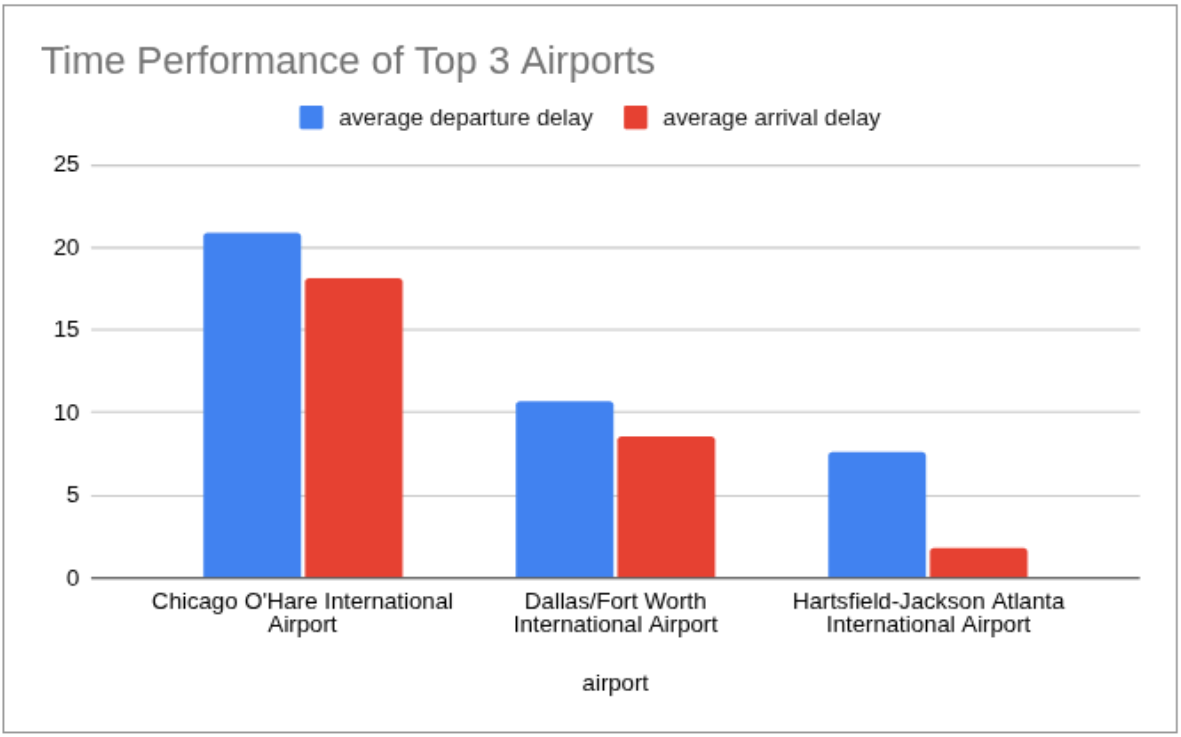
- Merging **airlines.csv** with **flights.csv** enabled a detailed analysis of on-time performance by airline.
- Out of all flights, 41,266 departed and 40,254 arrived on time, showcasing overall operational efficiency.
- Southwest Airlines led in punctuality with 8,120 on-time departures and 8,884 on-time arrivals, followed by Delta and Atlantic Southeast.
- Other strong performers include SkyWest, American, and United, each maintaining high on-time records.
- This integrated view helps identify reliable carriers and supports strategies to enhance flight performance and service quality.

Q17. Airport Operations and Connectivity Assessment:

- Combine the "flights.csv" dataset with the "airports.csv" based on airport codes. Use the merged dataset to identify the top 3 airports in terms of flight connectivity (number of unique destinations served) and analyze their average delay times (both departure and arrival).

Top 3 Airports

airport	destinations_served
Hartsfield-Jackson Atlanta International Airport	156
Chicago O'Hare International Airport	147
Dallas/Fort Worth International Airport	145



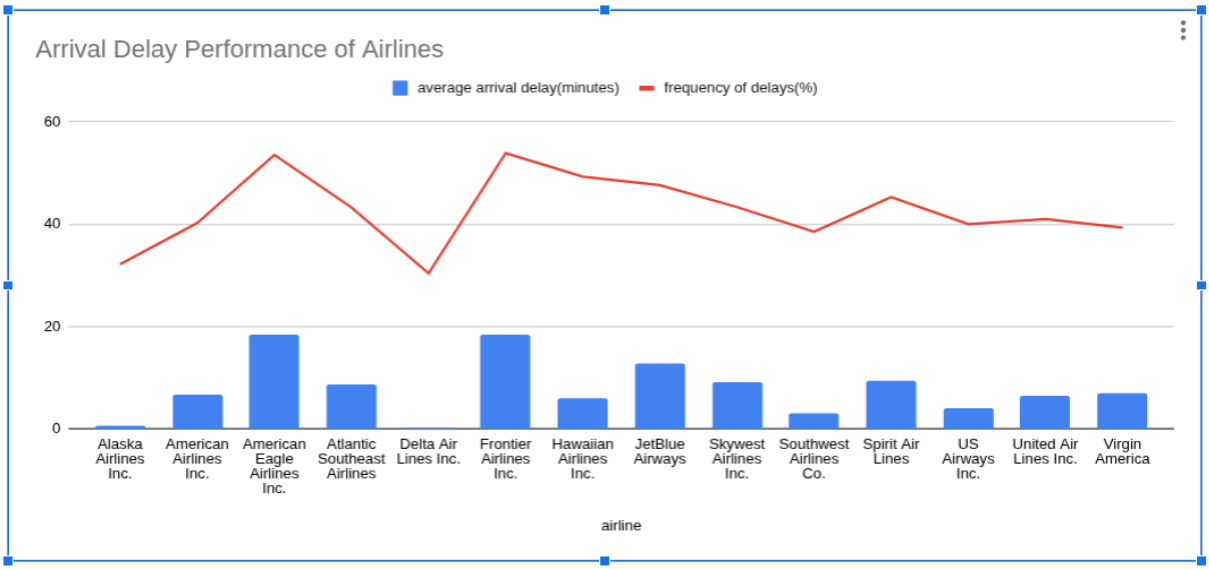
Insights:

The top 3 airports by flight connectivity are Hartsfield-Jackson Atlanta International Airport, Chicago O'Hare International Airport and Dallas/Fort Worth International Airport. In terms of time performance, in both departure and arrival delay, the 1st place goes to Hartsfield-Jackson Atlanta International Airport, 2nd to Dallas/Fort Worth International Airport and 3rd to Chicago O'Hare International Airport.

Q18.Flight Delay Impact Analysis:

- Calculate the cumulative impact of delays for each airline. Consider both the frequency of delays and the average delay time. How do these factors combine to affect overall airline performance?

airline	average arrival delay(minutes)	frequency of delay(%)
Alaska Airlines Inc.	0.6	32.17
American Airlines Inc.	6.8	40.21
American Eagle Airlines Inc.	18.3	53.48
Atlantic Southeast Airlines	8.7	43.23
Delta Air Lines Inc.	0.2	30.39
Frontier Airlines Inc.	18.3	53.82
Hawaiian Airlines Inc.	6	49.26
JetBlue Airways	12.9	47.6
Skywest Airlines Inc.	9.3	43.31
Southwest Airlines Co.	3	38.49
Spirit Air Lines	9.5	45.24
US Airways Inc.	4.1	40
United Air Lines Inc.	6.5	40.99
Virgin America	7.1	39.33



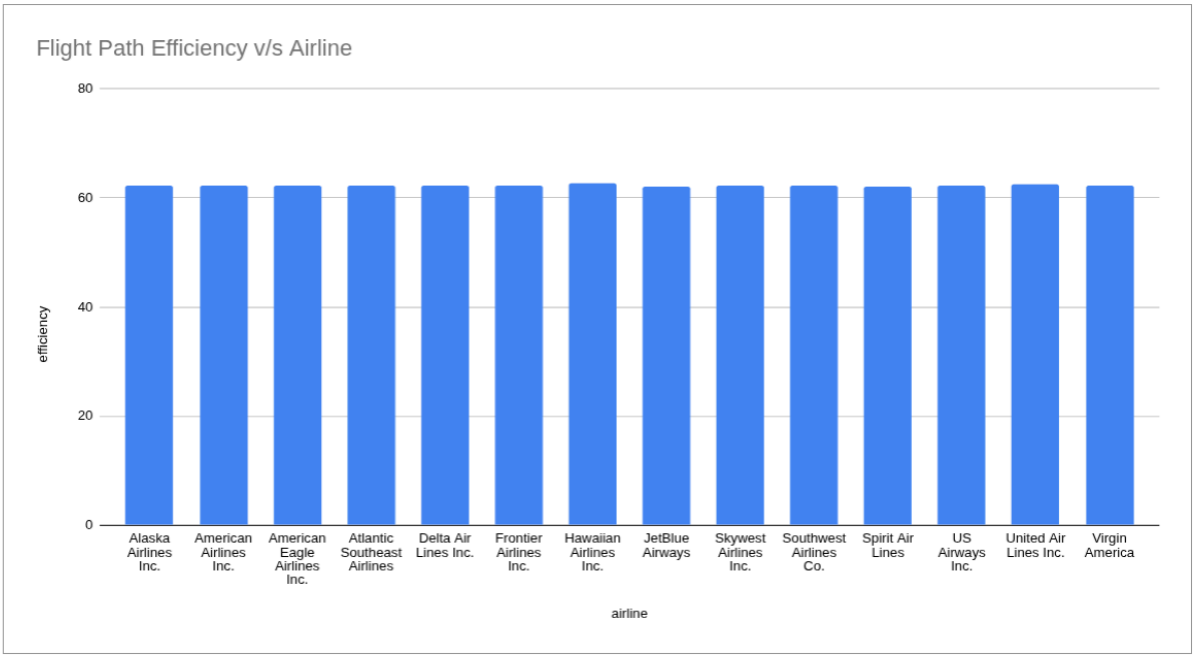
Insights:

Over all the airlines, it is seen that as the frequency of delays increases, the average arrival delay also increases. Alaska Airlines Inc. and Delta Air Lines Inc. are perfectly punctual. American Eagle Airlines Inc. and Frontier Airlines Inc. have the worst performance.

Q19.Optimal Flight Path Efficiency Assessment:

- Using the distance data from "flights.csv" and geographical coordinates from "airports.csv", calculate the efficiency of various flight paths. Determine if there are significant differences in the efficiency of flights (measured as a ratio of actual flight time to the shortest possible time based on distance) for different airlines or types of aircraft (identified by tail number).

airline	efficiency
Alaska Airlines Inc.	62.19
American Airlines Inc.	62.2
American Eagle Airlines Inc.	62.17
Atlantic Southeast Airlines	62.17
Delta Air Lines Inc.	62.19
Frontier Airlines Inc.	62.17
Hawaiian Airlines Inc.	62.69
JetBlue Airways	62.13
Skywest Airlines Inc.	62.18
Southwest Airlines Co.	62.18
Spirit Air Lines	62.14
US Airways Inc.	62.18
United Air Lines Inc.	62.55
Virgin America	62.25



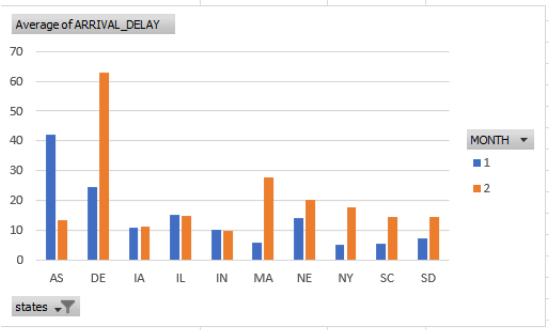
Insights:

There are no significant differences in flight path efficiency across different airlines.

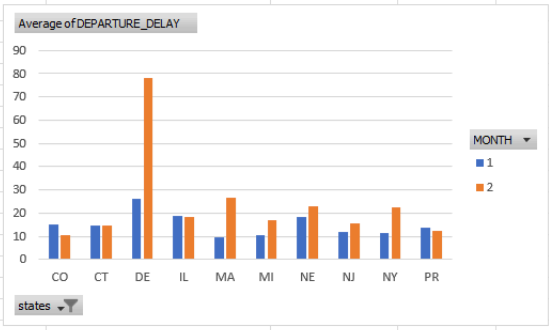
Q20. Airport Performance and Environmental Factors Correlation:

- Investigate if there's a correlation between airport performance (in terms of delays) and environmental factors like location (latitude and longitude from "airports.csv") and time of year (seasonal weather conditions). Are certain airports more prone to delays due to their geographical location and the associated weather patterns?

Average of ARRIVAL_DELAY	Column Labels	
States	1	2
AS	42	13.5
DE	24.66666667	63
IA	10.82113821	11.3608247
IL	15.19895483	14.8533724
IN	10.18148148	10.0674157
MA	5.948824343	27.7844037
NE	14.18902439	20.2941176
NY	5.121479845	17.7993605
SC	5.700534759	14.6350365
SD	7.338235294	14.5849057



Average of DEPARTURE_DELAY	Column Labels	
Row Labels	1	2
CO	15.23618383	10.392638
CT	14.82550336	14.81
DE	26.33333333	78
IL	18.66008935	18.3099004
MA	9.565698479	26.610984
MI	10.41818182	16.8343465
NE	18.48780488	22.8921569
NJ	11.78712221	15.7587477
NY	11.48241758	22.2242618
PR	13.50232558	12.2428571



Arrival Delay Insights (Left Table & Chart):

1. **DE (Delaware)** shows the **highest average arrival delays**:
    - Month 1: **24.67 mins**
    - Month 2: **63 mins** → **Significant spike**, likely weather-related or operational.
2. **MA (Massachusetts)** and **NE (Nebraska)** show a **large increase in Month 2**:
    - MA: from **5.95** → **27.78 mins**
    - NE: from **14.19** → **20.29 mins**
3. **AS (American Samoa)** shows a sharp **decrease** from **42** → **13.5 mins** — could indicate a resolution of earlier disruptions.

4. **Most states** show a **moderate increase** from Month 1 to Month 2, likely due to seasonal weather effects.

Departure Delay Insights (Right Table & Chart):

1. **DE (Delaware)** again stands out:
    - Month 1: **26.33 mins**
    - Month 2: **78 mins** → **Highest among all states**.

2. **MA, MI, and NY** see **notable increases** in Month 2:
    - MA: **9.57** → **26.61 mins**
    - MI: **10.42** → **16.83 mins**
    - NY: **11.48** → **22.22 mins**

3. **Some states** (e.g., CO, CT, PR) show **stable or reduced** delays — indicating possibly better operational management or less weather impact.

Overall Patterns & Trends:

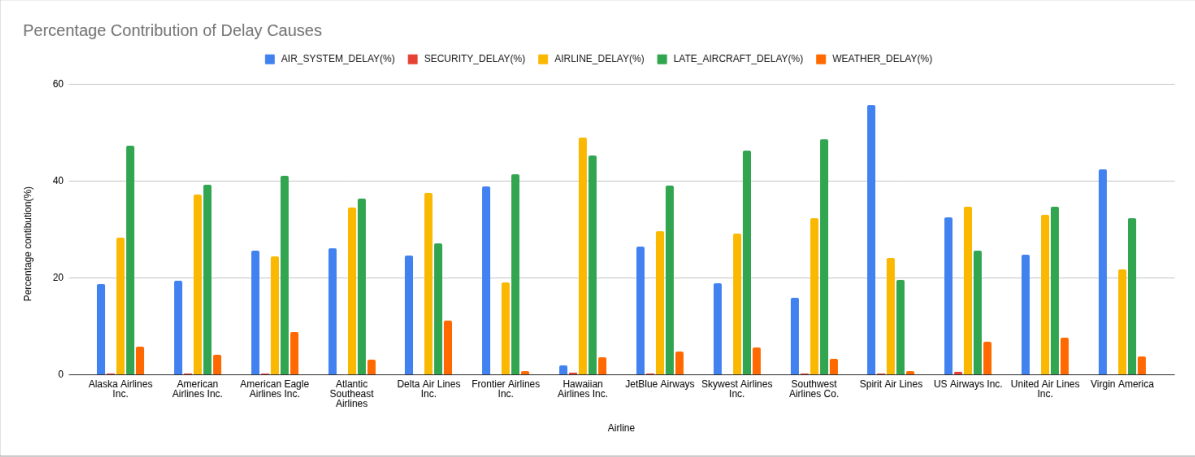
- **DE** is consistently the **worst-performing state** in both arrival and departure delays across both months.
- **Winter effects** in **Month 2** (likely February) seem to drive up delays in **northern and eastern states** (MA, NY, NE, DE).
- **Southern or less impacted states** (e.g., AS, SC, CO) show **lower or improving** delay averages.

Q21. Complex Delay Cause Analysis:

- Use nested functions to analyze the primary cause of delays for each airline. Determine if the predominant cause of delay (like airline delay, weather delay, security delay) varies by airline and time of day.

PERCENTAGE CONTRIBUTION OF DELAYS

AIRLINE	AIR_SYSTEM_DELAY(%)	SECURITY_DELAY(%)	AIRLINE_DELAY(%)	LATE_AIRCRAFT_DELAY(%)	WEATHER_DELAY(%)
Alaska Airlines Inc.	18.61	0.17	28.28	47.2	5.74
American Airlines Inc.	19.36	0.22	37.25	39.19	3.98
American Eagle Airlines Inc.	25.64	0.21	24.41	41.06	8.68
Atlantic Southeast Airlines	26.09	0	34.51	36.35	3.05
Delta Air Lines Inc.	24.48	0.06	37.43	27.01	11.02
Frontier Airlines Inc.	38.83	0	19.01	41.45	0.72
Hawaiian Airlines Inc.	1.79	0.36	49.02	45.29	3.54
JetBlue Airways	26.46	0.19	29.64	39.05	4.66
Skywest Airlines Inc.	18.88	0.03	29.18	46.31	5.6
Southwest Airlines Co.	15.81	0.17	32.29	48.55	3.17
Spirit Air Lines	55.6	0.14	24.1	19.54	0.62
US Airways Inc.	32.42	0.53	34.72	25.65	6.69
United Air Lines Inc.	24.71	0	32.99	34.73	7.56
Virgin America	42.44	0	21.62	32.22	3.72



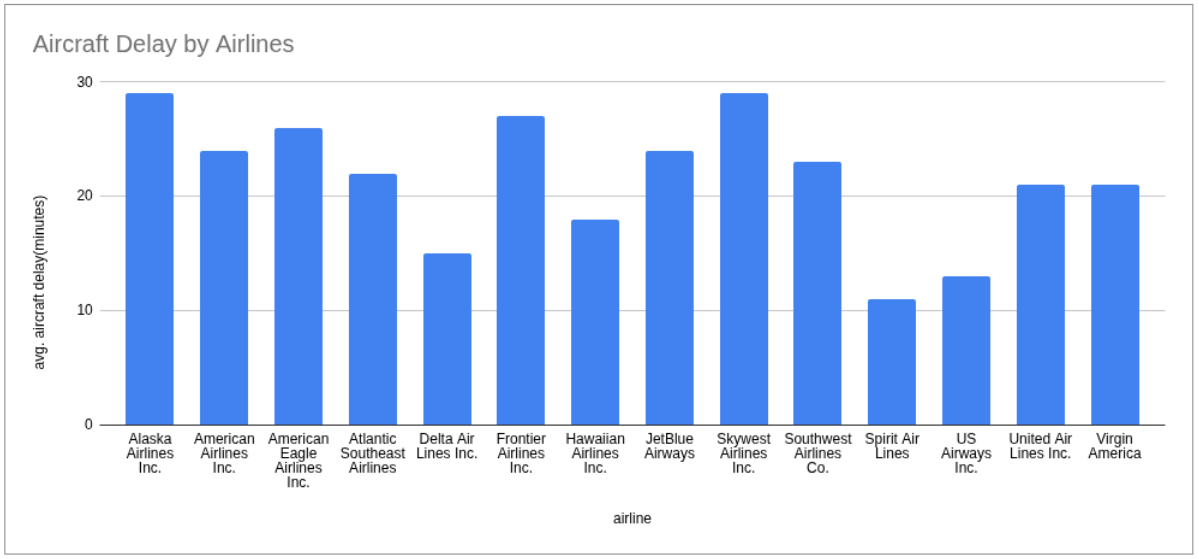
Insights:

For the majority of airlines, the predominant cause of delay is late aircraft.

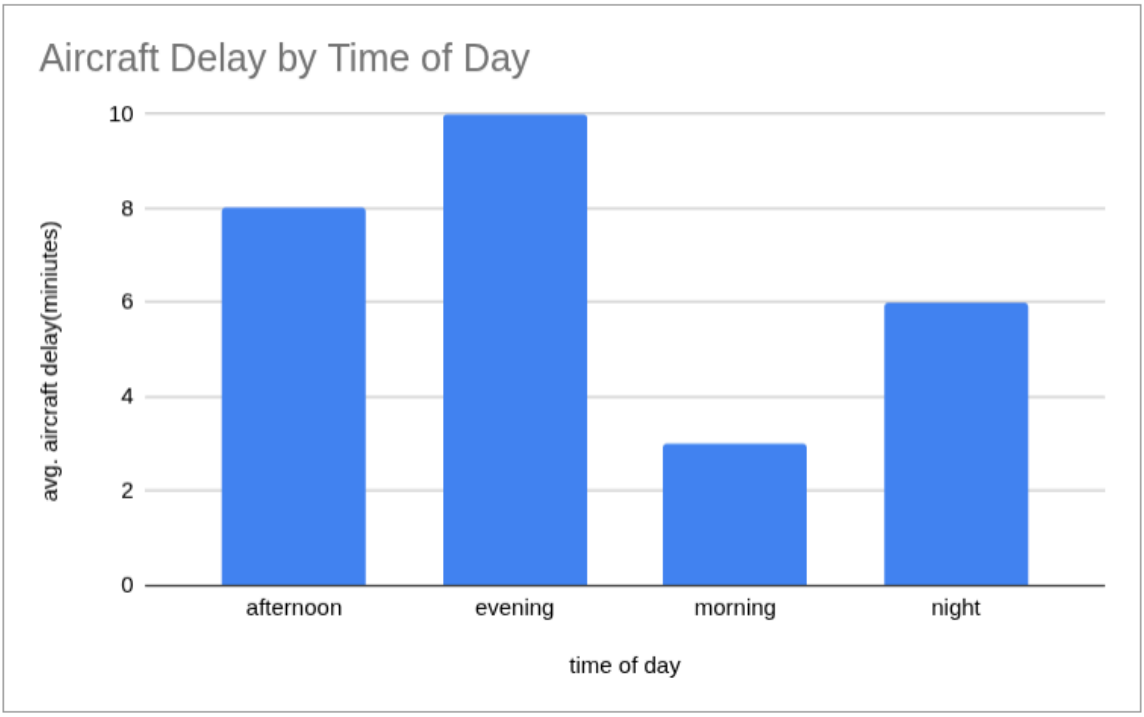
The airlines Alaska Airlines, Skywest Airlines and American Eagle Airlines have the highest aircraft delay. The airlines Spirit Airlines, US Airways and Delta Airlines have the lowest aircraft delay.

Aircrafts have the highest delay in the evening and lowest delay in the morning.

airline	avg. aircraft delay(minutes)
Alaska Airlines Inc.	29
American Airlines Inc.	24
American Eagle Airlines Inc.	26
Atlantic Southeast Airlines	22
Delta Air Lines Inc.	15
Frontier Airlines Inc.	27
Hawaiian Airlines Inc.	18
JetBlue Airways	24
Skywest Airlines Inc.	29
Southwest Airlines Co.	23
Spirit Air Lines	11
US Airways Inc.	13
United Air Lines Inc.	21
Virgin America	21



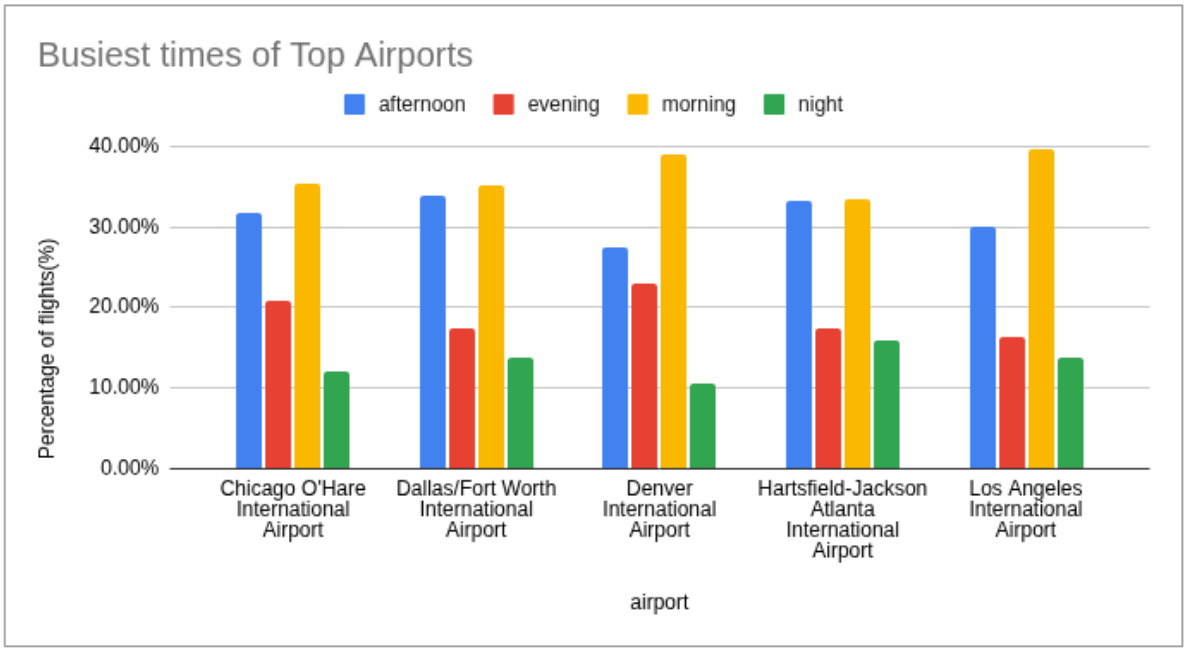
time of day	avg. aircraft delay(miniutes)
afternoon	8
evening	10
morning	3
night	6



Q22. Analysis of Flight Frequency and Peak Hours:

- Analyze the flight frequencies to determine the peak operating hours for major airports. (Use a combination of Excel functions to categorize flights into different time slots (e.g., morning, afternoon, evening, night) and calculate the number of flights in each slot for the top 5 busiest airports.)

A	B	C	D	E
COUNT of SCHEDULED_DEPARTURE	*TIME_SLOT*			
ORIGIN_AIRPORT	afternoon	evening	morning	night
Chicago O'Hare International Airport	31.75%	20.86%	35.29%	12.10%
Dallas/Fort Worth International Airport	33.82%	17.41%	35.07%	13.70%
Denver International Airport	27.44%	23.03%	38.98%	10.56%
Hartsfield-Jackson Atlanta International Airport	33.20%	17.40%	33.40%	16.00%
Los Angeles International Airport	30.11%	16.36%	39.71%	13.82%



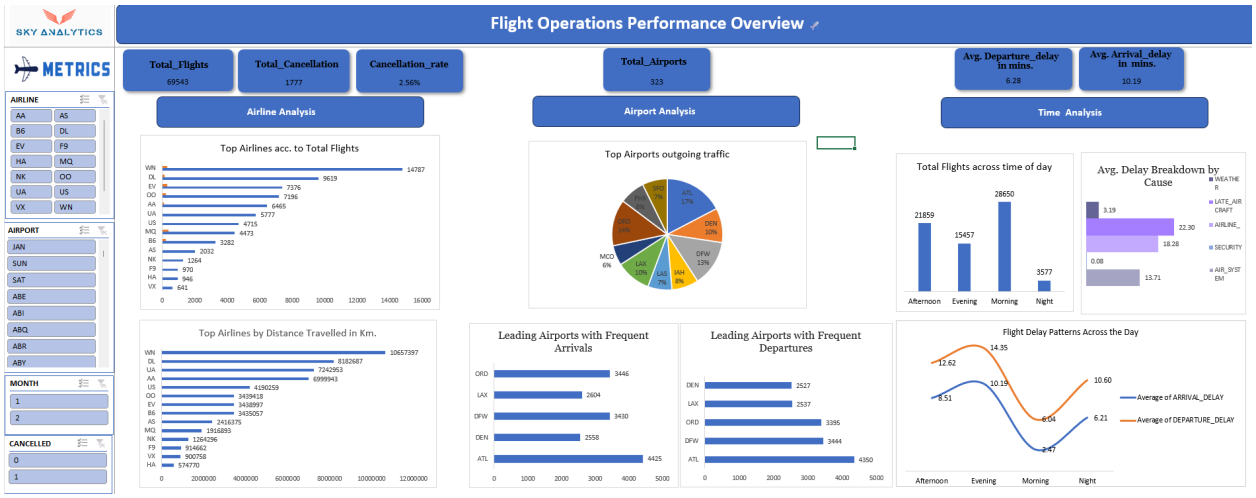
Insights:

Morning is the busiest time for airports. The next busiest time for airports is afternoon. Nights show the lowest flight activity in airports followed by evenings. Evenings still have a considerable amount of flights.

Part 2: Building an Excel Dashboard

Dashboard:

Dashboard file: Sky Analytics Excel Dashboard.xlsx



✈️ Key Operational Insights from the Sky Analytics Dashboard

- Total of 69,543 flights operated across 322 airports.
- 2.56% of flights were canceled (1,777 cancellations).
- Morning flights dominate (28,648), with the least delays — ideal for on-time travel.
- Evening flights experience the highest delays (Dep: 14.36 min, Arr: 10.2 min).
- Top airports by activity: ATL, ORD, DFW, LAX, and DEN.
- Main causes of delays: Late aircraft (22.3 min) and airline issues (18.3 min).
- Filters available for airline, month, and cancellation status to explore specific trends.

Conclusion:

Sky Analytics paints a clear picture of flight performance—mornings take off smoothly with minimal delays, while evenings face turbulence in punctuality. Major hubs like ATL and ORD dominate the skies, but delays caused by late aircraft and airline issues remain key challenges. With these insights, airlines can fine-tune schedules, streamline operations, and ensure a smoother journey for every passenger.