Flights Delay Analysis:

Month wise
Arrival_delayed_flights, ***departure_delayed_flights***, ***Late_aircraft_delayed_flights***, ***Security_delayed_flights***, ***Weather_delayed_flights***, ***Air_system_delayed_flights***
Analysis:

Observation 1:

Delay Type	Key Trends
Arrival & Departure Delays	Peak in **June & July** (over 200K delays), lowest in **September & October**.
Late Aircraft Delays	Highest in **June (64K)**, lowest in **September & October (27K–28K)**.
Security Delays	Most severe in **June (105K)**, with a consistent pattern around ~85K for most months.
Weather Delays	Higher in **February and June**, relatively low in October (~2K).
Air System Delays	Gradual rise till June, peaking at ~58K, with dip in fall (Sep–Nov).

Observation 2:

Month	Arrival Delays	Departure Delays	Late Aircraft	Security Delays	Weather Delays	Air System Delays	Key Highlights
Jan	183,110	176,627	51,056	84,920	6,383	55,255	High delays from late aircraft & security
Feb	175,443	173,442	49,545	85,007	**8,940**	54,992	Weather delays peak here

Mar	190,133	193,817	50,278	85,326	4,510	51,885	Overall high, especially security
Apr	171,820	167,314	41,781	71,963	4,978	45,068	Slight drop in delays
May	175,178	178,856	46,904	80,424	6,259	46,740	Steady rise before peak season
Jun	**206,989**	**215,381**	**64,423**	**105,927**	**7,501**	**58,562**	**Highest across all categories**
Jul	199,717	209,619	60,227	98,137	5,601	52,710	Peak summer travel
Aug	180,891	190,840	49,376	85,412	5,823	46,755	Slight recovery from July
Sep	**133,432**	**132,591**	**27,641**	**52,118**	**3,246**	**31,843**	**Lowest delays overall**
Oct	141,250	145,102	27,843	52,477	**2,106**	32,198	Weather best managed
Nov	149,439	152,690	34,824	61,878	3,456	38,438	Moderate performance
Dec	179,494	189,339	53,055	87,284	5,913	50,380	High travel month again

Root Cause Analysis:

Category	Cause	Affected Months
Summer Travel Surge	Increased passengers, overbooked schedules	June–July
Weather Uncertainty	Fog (Feb), Sandstorms (Jun), Rain	Feb, Jun, Dec

Turnaround Delays	Aircraft not ready on time due to cascading late flights	May–Jul
Security Bottlenecks	Staffing or infrastructure strain during vacation travel	Jun–Jul, Dec
Air Traffic Overload	Congested skies and landing slots in hub airports	Mar–Jul

Analysis – Possible Causes of Delays

1. **June–July Spike (All Delay Types):**
    - **Peak travel season** due to summer vacations.
    - Increased air traffic causing **air system congestion**.
    - Aircrafts in tight schedules lead to **late aircraft delays**.
2. **Weather Delay Peaks (Feb & June):**
    - February may see **unpredictable winter storms or fog** (common in many connecting hubs).
    - June could involve **summer storms or heat waves**.
3. **Security-Related Delay Surges:**
    - High in **summer months**, correlating with increased traveler volume.
    - Possibly due to **enhanced security screenings** or staffing shortages.
4. **Low Delays in September–October:**
    - Post-summer lull in air traffic.
    - Favorable weather and **routine maintenance periods**.
    - Efficient aircraft and air system coordination.

Recommendations Part 1:

1. Flight Scheduling Improvements

- Avoid **tight turnaround times** in June–July.
- Increase **buffer time** between connecting Emirates flights.
- Schedule **non-peak travel promotions** to spread demand across months.

2. Late Aircraft Delay Reduction

- Use **predictive maintenance** using AI to prevent aircraft breakdowns.
- Maintain **reserve aircraft** to replace late arrivals.

3. Security Delay Optimisation

- Hire or reallocate **additional security staff** for summer months.
- Invest in **automated security systems** and e-gates.

4. Weather Risk Management

- Use **weather forecasting models** for better flight planning.
- Pre-position crew and resources in high-risk months.

5. Air System Congestion Mitigation

- Collaborate with **air traffic control authorities** for route deconfliction.
- Stagger Emirates flight departure/arrival times at congested airports.

Recommendations Based on Root Cause Analysis:

Short-Term Fixes

1. **Increase turnaround buffer** (especially May–Aug).

2. **Deploy mobile security checkpoints** during peak times.
3. **Pre-position aircrafts & crews** in strategic locations before summer rush.
4. **Increase automated screening systems** to reduce security processing time.

Mid-to-Long-Term Strategies

- **AI-driven delay prediction** using historic + weather data.
- **Collaboration with ATC** to pre-plan optimal flight paths in busy months.
- **Dynamic fleet scheduling**: prioritize backup aircraft availability during June–July.
- **Passenger communication automation** to manage expectations in high-delay months.

Flights Cancellation Analysis:

Based on : 1
Origin_airport, Destination_airport, Cancellation, Cancellation_reason Wise

And
Origin_airport_name, Destination_airport_name, Cancelled_flights_count Wise

Overall Observations

- **High Cancellation Routes:**
    - **`Baltimore-Washington Intl`** to **`Albany Intl`**, **`Albuquerque Intl Sunport`**, and **`Austin-Bergstrom Intl`** have cancellations above **600+** combined for reasons A, B, and C.
- **Consistent Cancellation Across Routes:**

    - Many destinations from Baltimore and Charlotte have 3 cancellation reasons (A, B, C) with similar counts, showing a pattern.

- **Most Affected Airport:**

    - **`Baltimore-Washington International Airport`** appears the most across the dataset, indicating high traffic and possibly operational stress.

Reason Code Analysis

Cancellation Reasons:

- **A** = Carrier Issues (e.g., staffing, scheduling, mechanical)
- **B** = Weather
- **C** = National Air System (NAS) delays (e.g., air traffic control, airport ops)

Reason Code	Total Cancellations	% Share	Key Observations
A	High (~35–40%)	🔧	Frequent in major hubs and high-frequency routes. Could reflect airline internal issues.
B	Moderate (~30–35%)	🌧️	Mostly weather-prone regions (Northeast, Midwest, etc.)
C	Moderate (~25–30%)	🛫	Indicates nationwide airspace and airport system inefficiencies

Route-Level Cancellation Summary

Top 5 most canceled **origin–destination** routes (by total count):

Origin	Destination	A	B	C	Total
Baltimore-Washington Intl	Albany Intl	245	238	234	**717**
Baltimore-Washington Intl	Albuquerque Intl Sunport	220	209	204	**633**
Baltimore-Washington Intl	Austin-Bergstrom Intl	204	182	177	**563**
Baltimore-Washington Intl	Bill and Hillary Clinton Airport	156	146	146	**448**
Baltimore-Washington Intl	Birmingham Intl	145	142	–	**287**

Optimization Suggestions:

A. Carrier-Based (Reason A):

- Investigate internal **staffing, fleet rotation**, and **maintenance schedules**.
- Introduce **dynamic crew assignment models** using AI optimization.
- Encourage **cross-airport equipment pooling** in peak seasons.

B. Weather-Based (Reason B):

- Enhance **weather-prediction-integrated scheduling**.
- Diversify routes with **alternate airport landings** in weather-prone areas.
- Offer **seasonal route flexibility**—reduce flights during storm-prone months.

C. Airspace/System-Based (Reason C):

- Coordinate with **ATC (Air Traffic Control)** for **better slot management**.
- Explore **non-peak hour** scheduling to reduce NAS congestion.
- Increase **coordination with the FAA** for high-density corridor relief.

5. Additional Recommendations

- **Use Machine Learning** to predict and preempt cancellations based on:
    - Weather forecasts
    - Flight traffic
    - Crew availability
    - Airport delays
- **Introduce Passenger Alerts**:
    - Notify passengers in advance with incentives for rescheduling on high-risk flights.
- **Airport Collaboration**:
    - Work with hub airports to improve turnaround times, ground handling efficiency, and gate allocations.