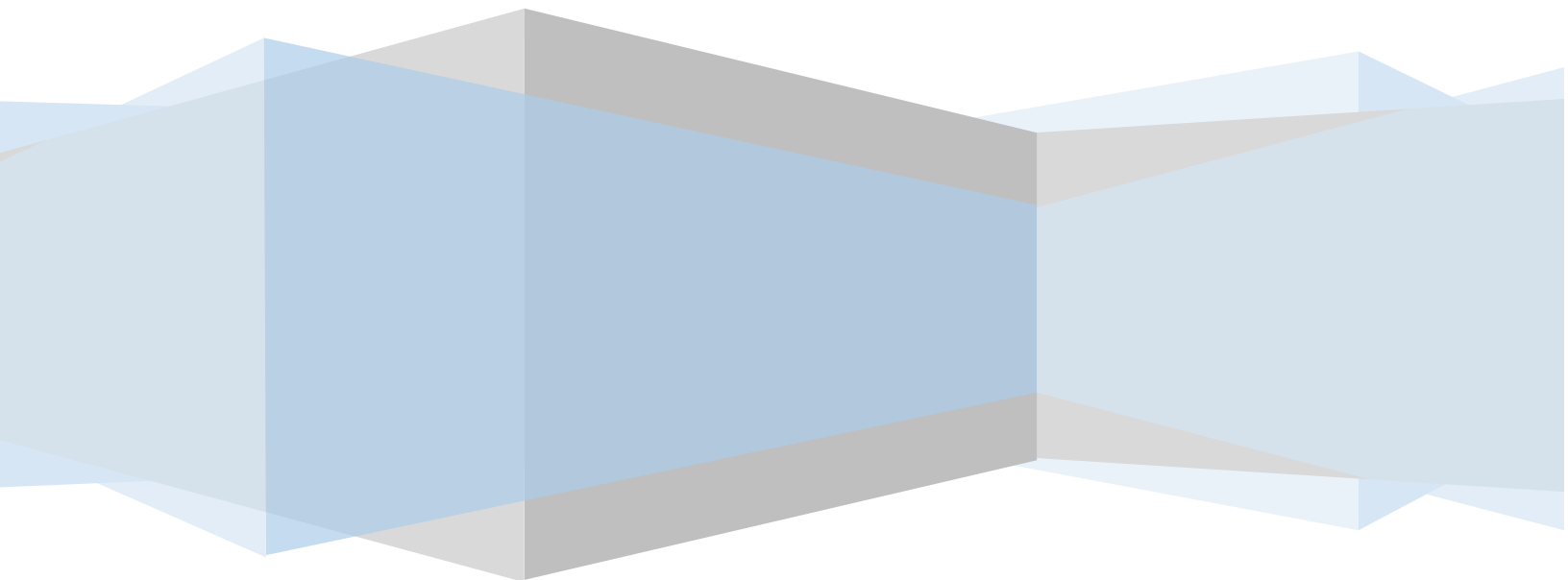


POST OPERATIONS ANALYSIS REPORT

August, 2023

CENTRAL COMMAND CENTER, C-ATFM, DELHI







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A. Executive Summary

Average Domestic air traffic has recorded a decrease of 2.5% whereas the average international air traffic has increased by 3.6% in the month of Aug'23 as compared to July'23.

On average, the Indian Airports in the ATFCM area saw 4874 IFR flights per day in the month of August 2023. The peak day was on 11th August 2023 (5026 IFR flights). Friday's were the busiest days throughout this month with an average of 4972 domestic IFR flights per day.

Total Twenty one (21) ATFM measures were applied this month during periods of congestion at Delhi, Chennai and Mumbai Airport.

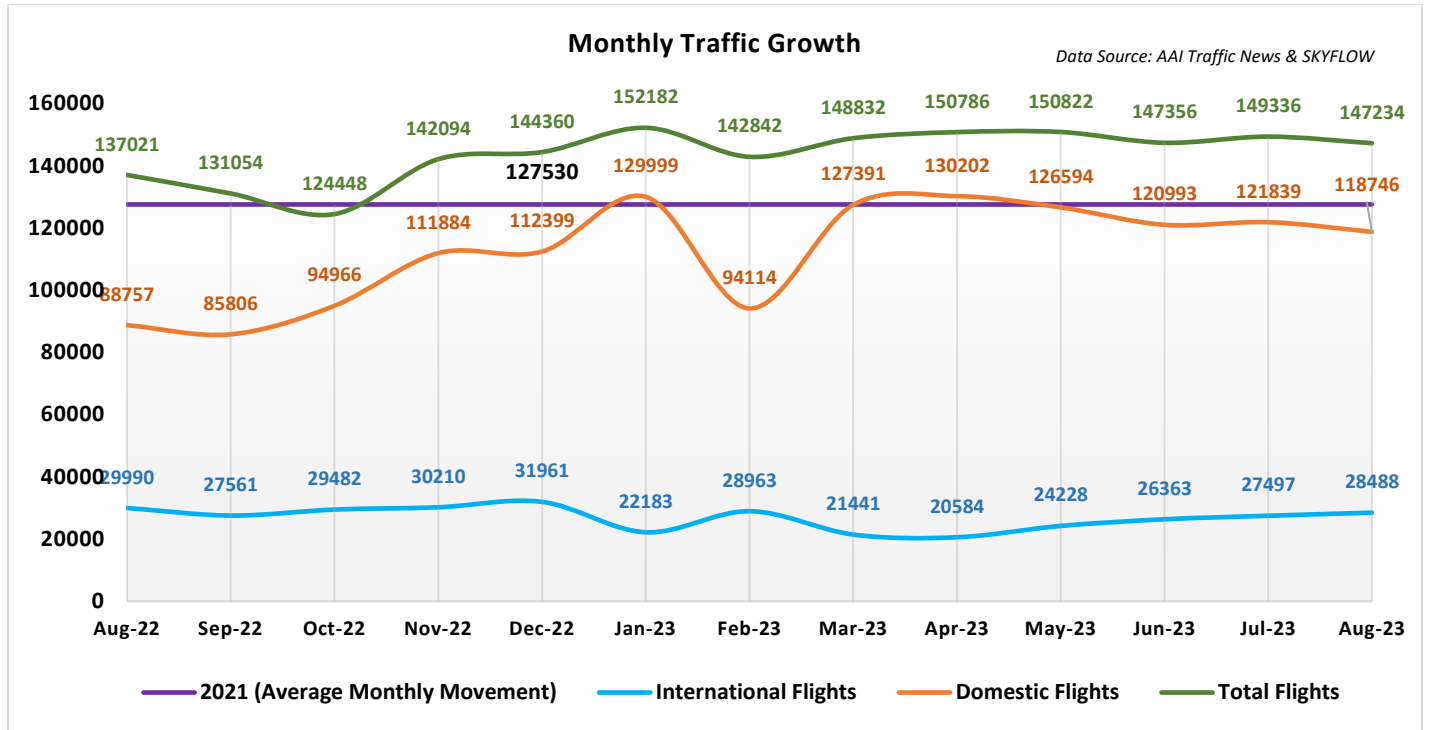


Figure 1: Monthly Traffic Growth

The graph above depicts the Domestic and international Air traffic in Indian ATFCM Area during the last 13 months (Aug'2022 to Aug'2023).

B. Traffic Analysis

I. Air Traffic Movement at Major Airports in India

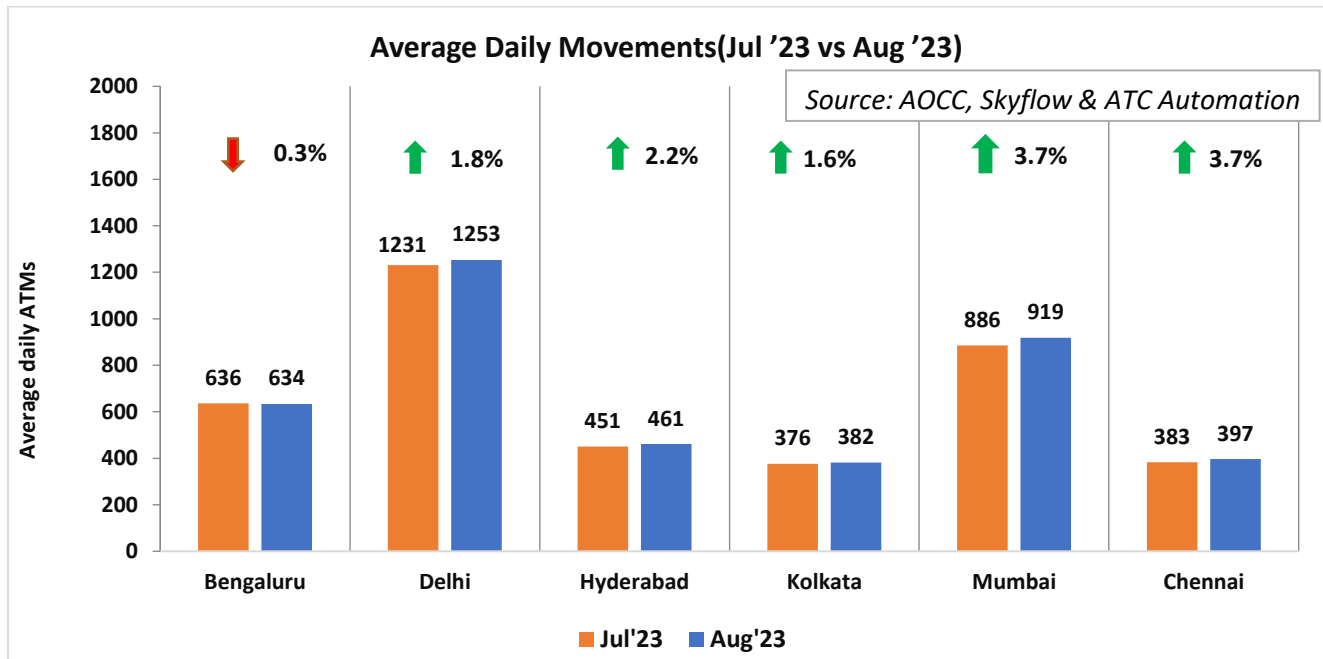


Figure 2: Average Daily Movements (July '23 vs Aug '23)

The above chart depicts the percentage change in average daily ATMs at six major Airports in Aug'23 as compared to the previous month (July'23).

Airports\Year	Avg. Daily ATMs (YoY) for six major airports				
	Aug'19	Aug'20	Aug'21	Aug'22	Aug'23
Bengaluru	623	244	389	548	634
Delhi	1296	523	863	1179	1253
Hyderabad	479	206	314	415	461
Kolkata	444	118	249	361	382
Mumbai	875	197	474	769	919
Chennai	470	119	230	349	397



Air Traffic Movement for each day in Aug'23 is plotted for Delhi, Mumbai, Bengaluru and Hyderabad Airport along with the percentage change w.r.t. Avg. Daily Movement for the same month.

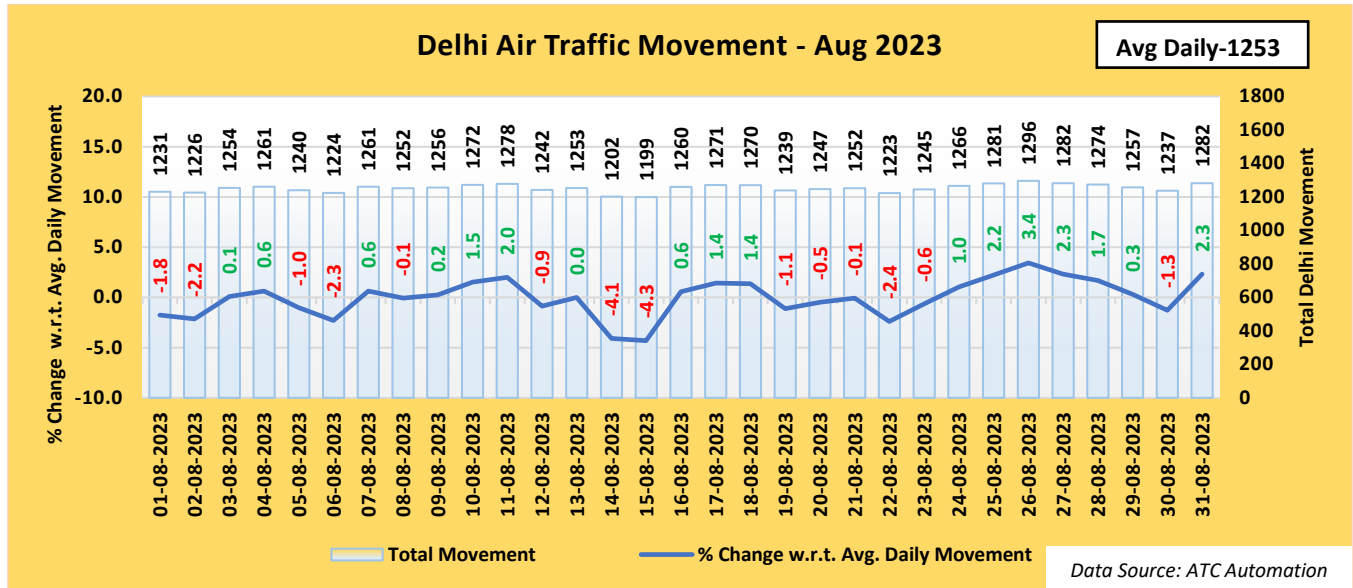


Figure 3: Air Traffic Movement for Delhi –Aug 2023

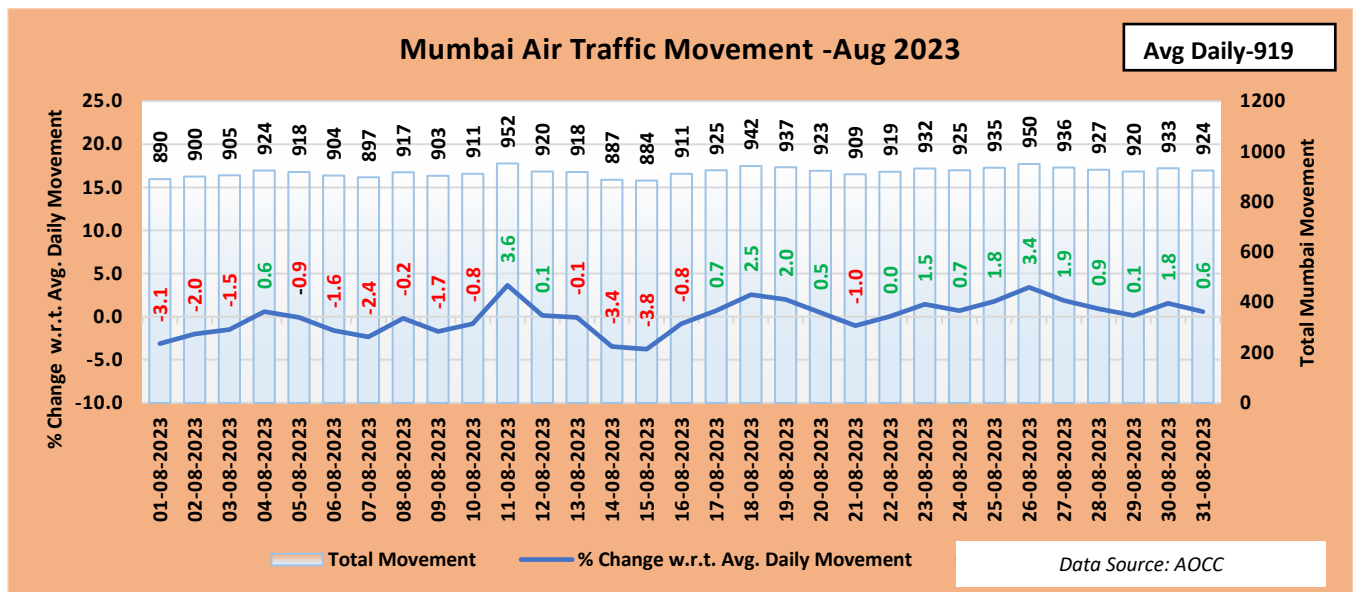


Figure 4: Air Traffic Movement for Mumbai - Aug 2023

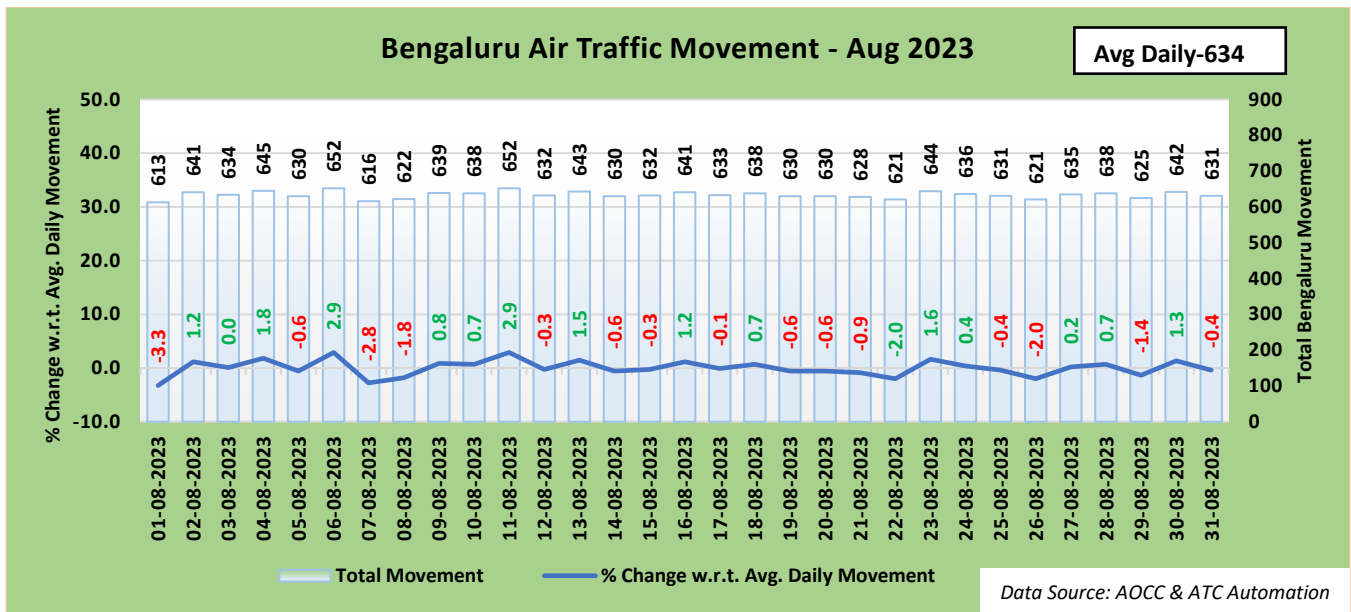


Figure 5: Air Traffic Movement for Bengaluru – Aug 2023

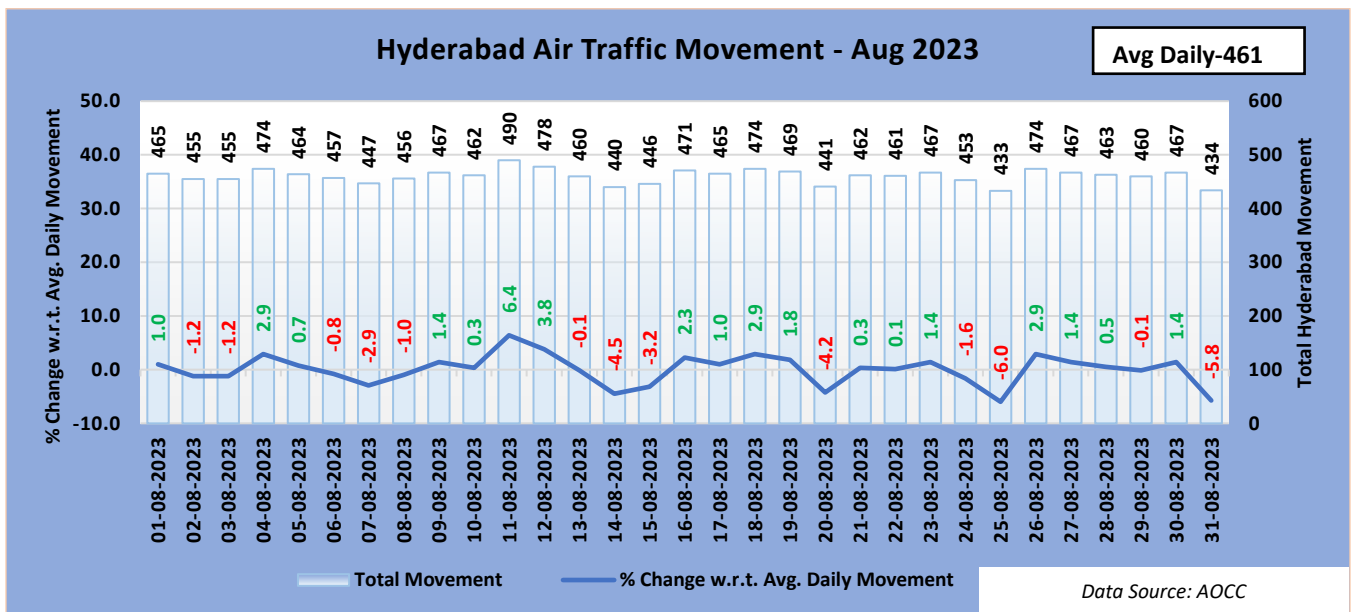


Figure 6: Air Traffic Movement for Hyderabad - Aug 2023

It can be concluded from the above charts that on 31st Aug 2023(month end), the ATMs at Bengaluru and Hyderabad saw a decline of 0.4% and 5.8% respectively whereas ATMs at Delhi and Mumbai saw an increase of 2.3% and 0.6% respectively in comparison to the average daily movement for Aug'23.



II. Comparison of total ATMs (YoY) and Monthwise

The total Air traffic movement(ATMs) including Passenger and other flights such as Cargo flights, International scheduled, International non-scheduled, Domestic scheduled, Domestic non-scheduled, Air taxi & commercial business flights at six major Indian Airports namely Delhi, Mumbai, Bengaluru, Hyderabad, Kolkata and Chennai is plotted for the month of August for two consecutive years 2022 and 2023 respectively. Air Traffic movement is also plotted Airline wise for the last six months for the major Scheduled Operators.

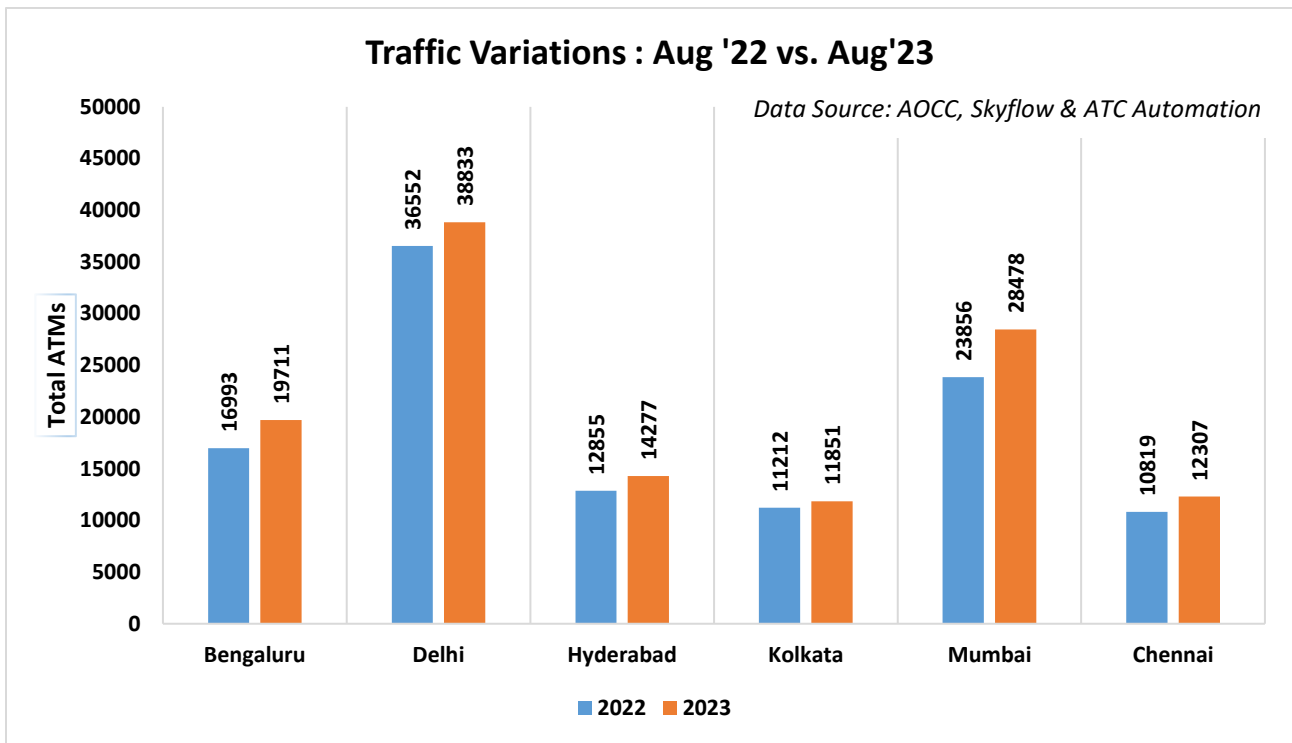


Figure 7: Traffic Variation (YoY)



III. Flight Operations – Airlinewise

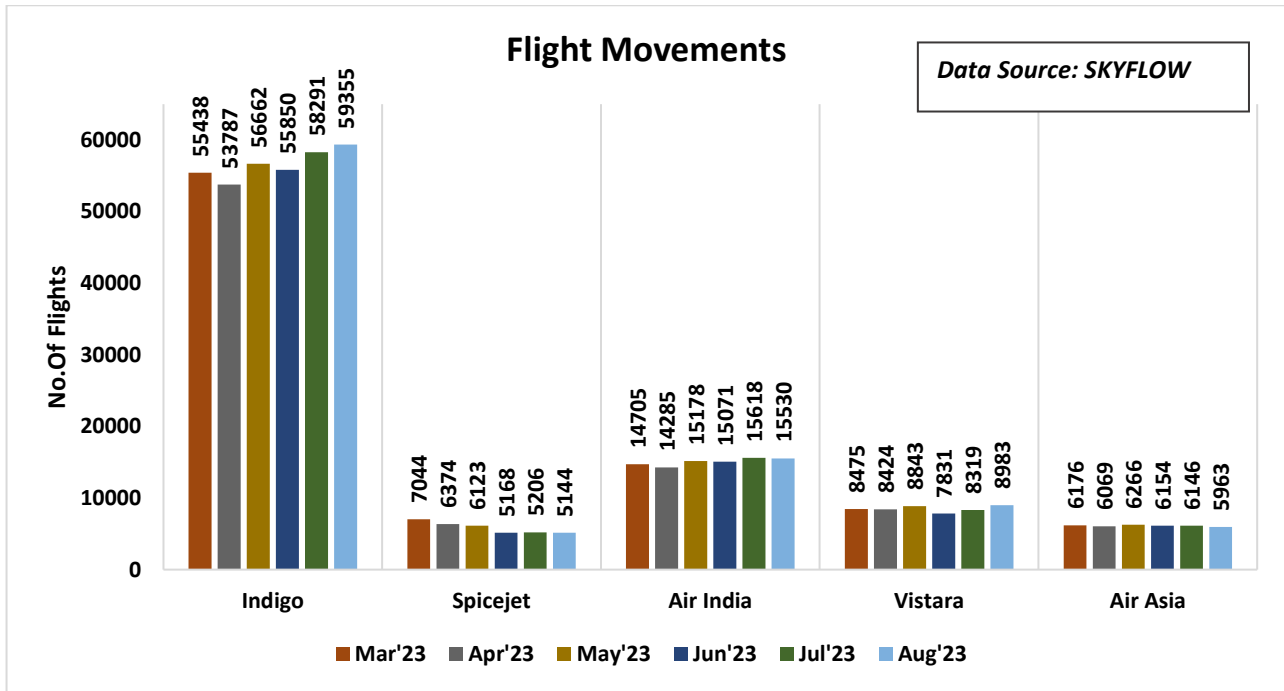


Figure 8: Flight Movements –Airlinewise

Inference:

1. Indigo and Vistara Airlines have recorded an increase in the monthly average Flight movement in August '23 as compared to July'23 while Spicejet, Air India and Air Asia Airlines have recorded a decline during the same period. Go first Airline has stopped operations from 3rd May 2023.



C. ATFM Post Operations – CDM Analysis

I. Introduction

Analysis Period 1st – 31st August 23

Back Ground During the above mentioned period, **Four (04)** ATFM measures were applied for **Delhi Airport**, **Seven (07)** ATFM measures were applied for **Chennai Airport** and **Ten (10)** ATFM measures were applied for **Mumbai Airport** due to the following reasons as illustrated in the bar chart below:–

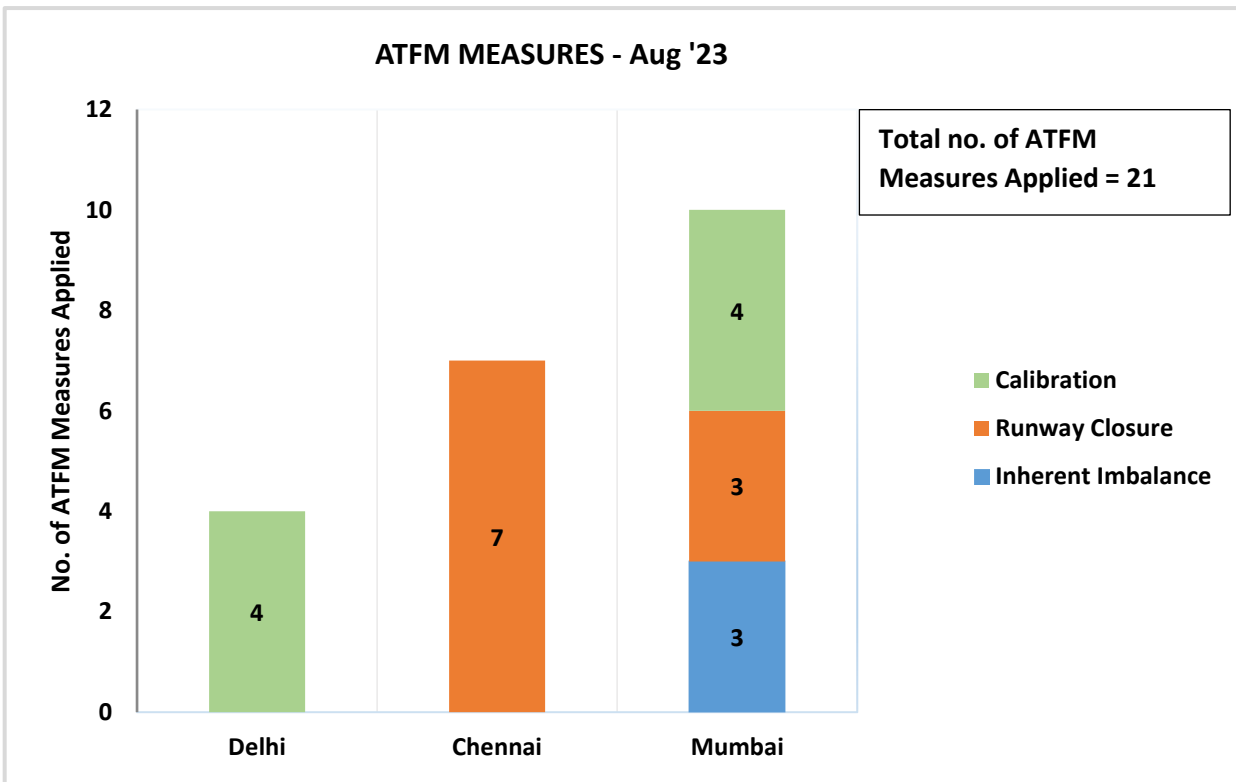


Figure 9: ATFM Measures –Aug '23



II. ATFM Measures Overview

Constrained Airport	Delhi	Mumbai	Chennai
Number of ATFM measures applied	4	10	7
Average ATFM Ground delay(in min) due to measures*	13.5	18.2	19.3
Maximum ATFM Ground delay(in min) due to measures	48	83	35
% Compliance	75.4	83.3	79.5

Note: * *Average ATFM Delay* = $\frac{\text{Total ATFM Delay}}{\text{Total Domestic Arrivals}}$

Total Arrivals	879
Total International Arrivals(exempted)	143
Total affected flights in scenario (Domestic Arrivals)	736
Total Domestic Arrivals with zero ATFM delay	57
Total Domestic Arrivals with ATFM delay	679

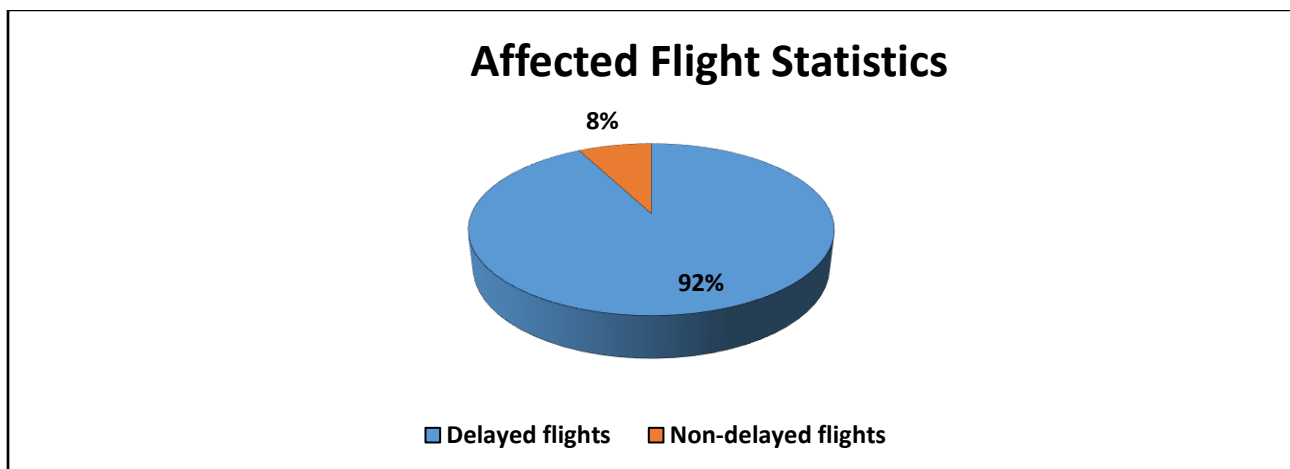


Figure 10: Affected Flight Statistics –Aug'23



III. Overall Compliance

Total arrivals	879
Domestic arrivals	736
Flights with complete data (ATOT)	719
Flights with incomplete data	03
Flights Not Operated	14
Compliant*	578
Non-Compliant	141

*Total No. of Revised CTOTs issued = 153 (Compliance calculation for flights which were issued revised CTOT is w.r.t. new CTOT issued)

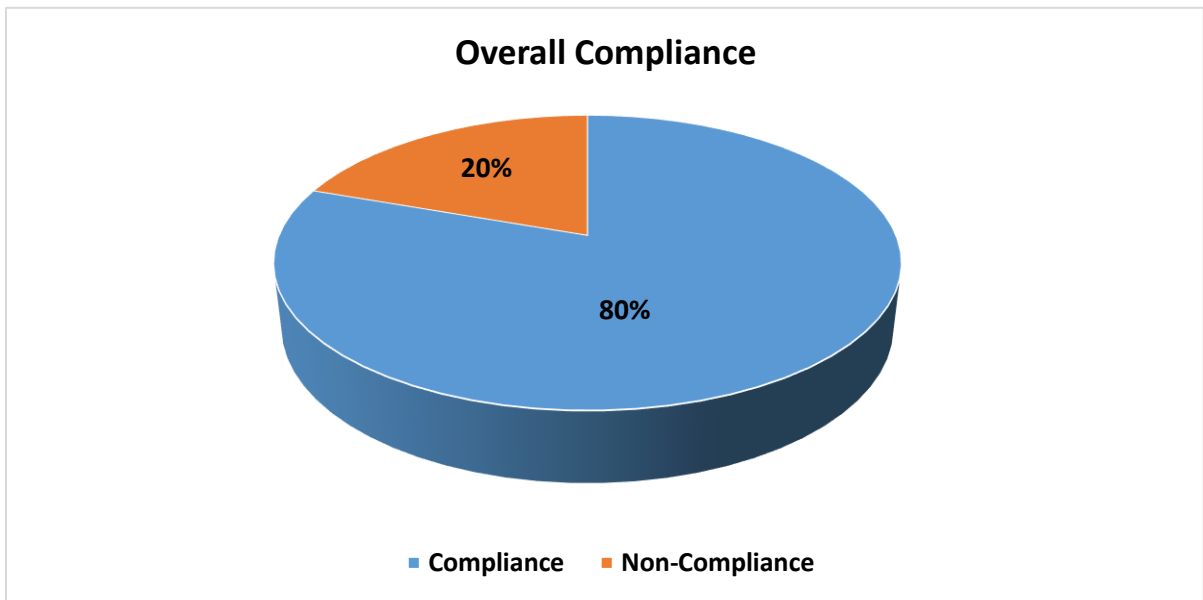


Figure 11: Overall Compliance – Aug'23

NOTE: Flights with required data (i.e. ATOT) are only considered for compliance measurement

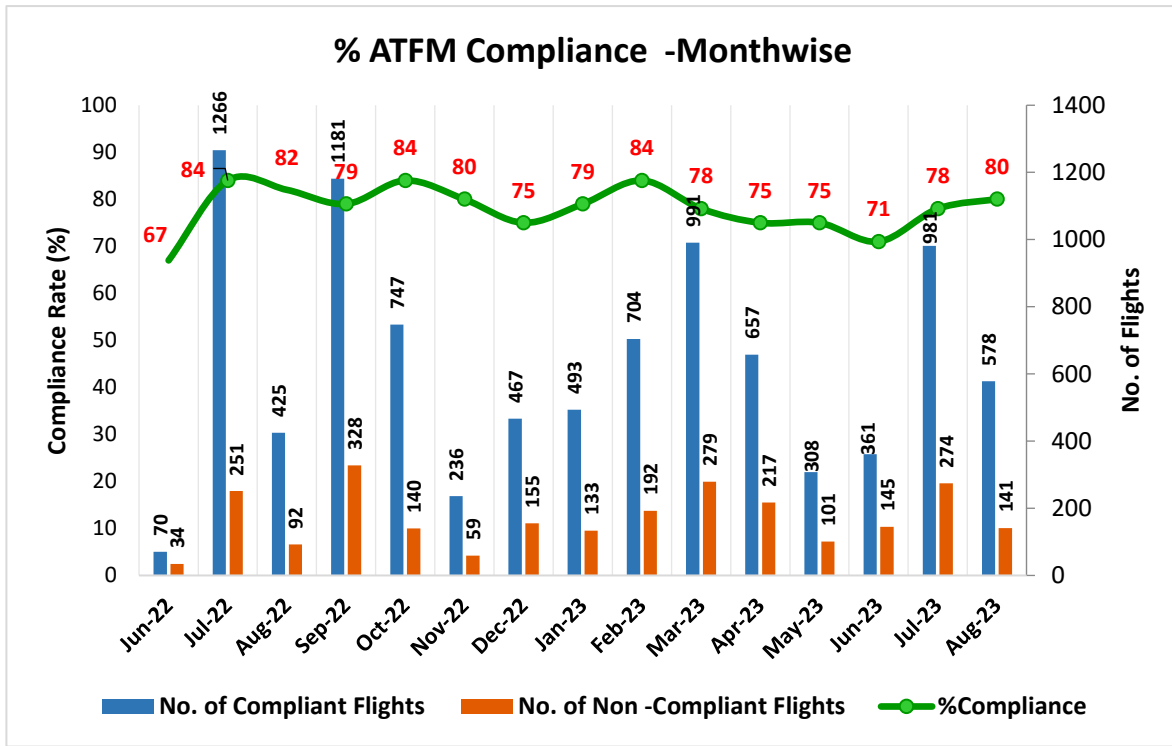


Figure 12: Compliance(Monthwise)

Inference

1. Out of the total arrivals captured(879 flights) during the CDM scenario for the constrained Airports, 83.7% of flights i.e. domestic arrivals(736 flights) were candidates for ground delay(participating).
2. Out of these Domestic Arrivals, 92.3% (679 flights) are assigned ATFM ground delay.
3. Out of the total arrivals captured(879 flights) to the constrained Airport during the ATFM scenario, only 77.2% of flights(679 flights) were assigned ATFM Ground Delay.



IV. CTOT Compliance rate – Airportwise

MUMBAI FIR (81%)*	Compliant	Non Compliant	% Compliant
Ahmedabad	15	2	88%
Aurangabad	1	0	100%
Mumbai	17	6	74%
Vadodara	8	0	100%
Bhopal	8	1	89%
Diu	0	1	0%
Indore	10	1	91%
Jabalpur	1	2	33%
Jamnagar	3	1	75%
Kandla	5	0	100%
Maharashtra	1	0	100%
Keshod	0	1	0%
Mundra	0	1	0%
Nagpur	5	0	100%
Pune	3	1	75%
Rajkot	4	1	80%
Shirdi	5	1	83%
Udaipur	5	2	71%
KOLKATA FIR (84%)*	Compliant	Non Compliant	% Compliant
Prayagraj	6	0	100%
Siliguri	12	1	92%
Varanasi	14	0	100%
Bhubaneswar	15	1	94%
Kolkata	18	5	78%
Chakeri	0	4	0%
Durgapur	0	1	0%
Darbhanga	0	1	0%
Deoghar	0	1	0%
Gorakhpur	1	0	100%
Guwahati	13	4	76%
Imphal	1	1	50%
Aizawl	0	1	0%
Dibrugarh	1	0	100%



Dimapur	1	0	100%
Patna	11	1	92%
Ranchi	7	0	100%
Raipur	5	0	100%
Tezpur	1	0	100%
DELHI FIR (74%)*	Compliant	Non Compliant	% Compliant
Agra	0	1	0%
Amritsar	4	1	80%
Bareilly	2	1	67%
Chandigarh	10	1	91%
Dehradun	1	2	33%
Delhi	57	12	83%
Kangra	4	0	100%
Gwalior	2	2	50%
Jodhpur	6	7	46%
Jaipur	16	6	73%
Jammu	11	0	100%
Leh	7	6	54%
Lucknow	10	5	67%
Shimla	1	0	100%
Srinagar	16	8	67%
CHENNAI FIR (83%)*	Compliant	Non Compliant	% Compliant
Hal Bangalore	1	1	50%
Bangalore	43	9	83%
Vijayawada	1	0	100%
Coimbatore	17	0	100%
Kochi	21	2	91%
Calicut	1	0	100%
MOPA Goa	12	3	80%
Goa	20	12	63%
Hubli	5	0	100%
Hyderabad	39	5	89%
Begumpet Hyderabad	1	0	100%
Jakkur	0	1	0%



Kannur	2	0	100%
Kurnool	3	1	75%
Madurai	8	0	100%
Mangalore	3	1	75%
Chennai	24	3	89%
Port Blair	2	3	40%
Sindhudurg	1	2	33%
Tuticorin	5	2	71%
Thiruvananthapuram	20	1	95%
Visakhapatnam	5	1	83%

**FIR wise compliance rate*

Note: The above list contains only those airports which had flights to the Constrained Airport and are affected by ATFM measures.

Airports with % compliance less than the average compliance(80%) for the month are highlighted in red.



V. CTOT Compliance rate – Airline wise

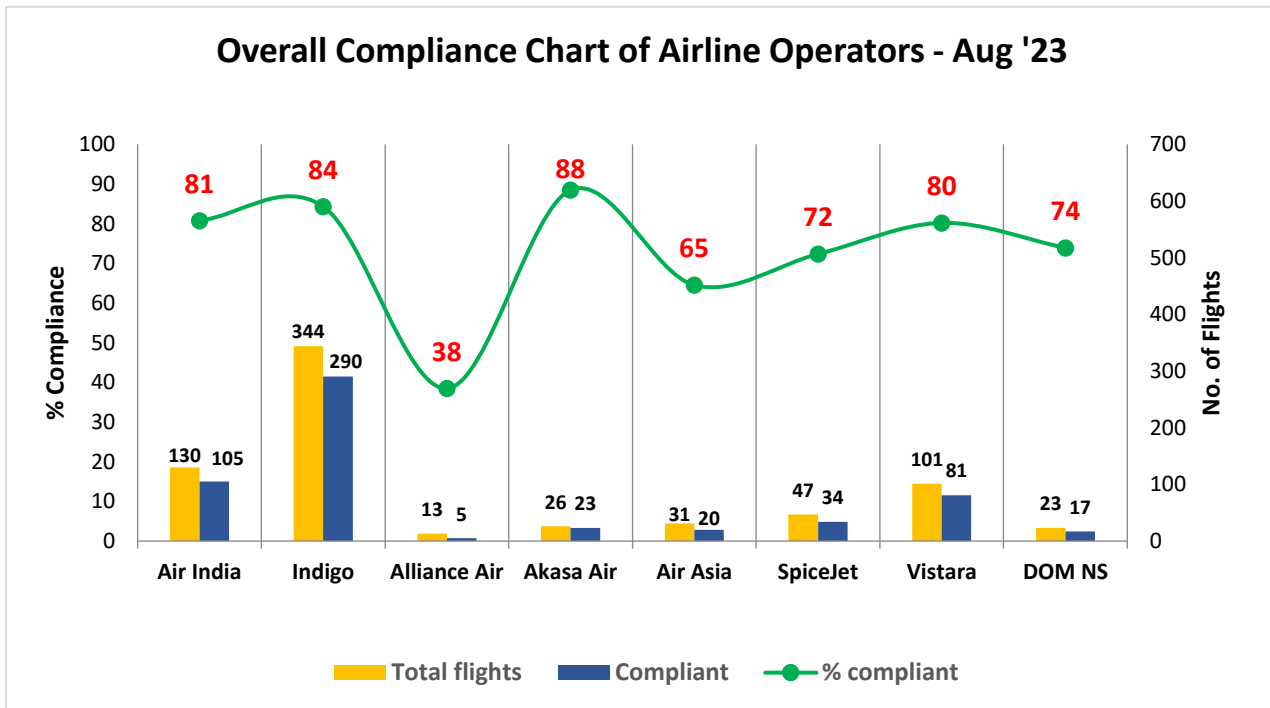


Figure 13: Airline wise Compliance –Aug'23

Inference

1. Out of the total domestic arrivals with complete data in the CDM scenario, 80% arrivals are compliant.
2. Kolkata region has the highest compliance rate of 83.5% whereas Delhi region has the lowest compliance rate of 74%.
3. Air India, Indigo and Akasa Air have a CTOT compliance higher than the average recorded compliance for the month of Aug '23.

VI. Reason For Non Compliance

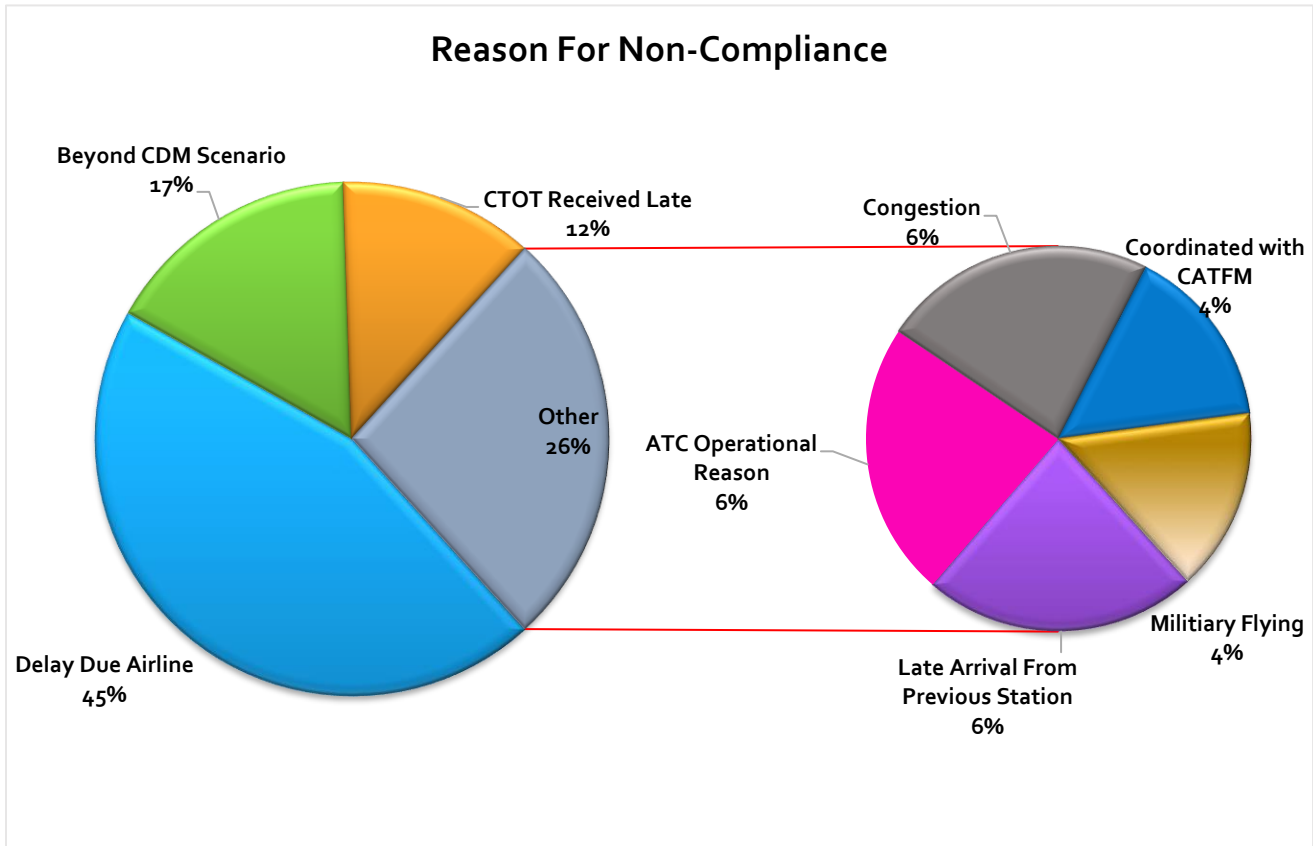


Figure 14: Reason for Non-Compliance as provided by FMPs

Inference:

1. 45 % of CTOT Non- Compliance was reported by concerned FMPs to be due to delay by Airlines.
2. 17 % of flights captured during the ATFM measures did not operate during the scheduled flight plan timings resulting in under utilization of the constrained Airport.
3. 12% of the CTOT Non- compliance was reported by concerned FMPs to be due to late receipt of CTOTs and by the time the aircraft had already initiated pushed back or startup.
4. 6% of the CTOT Non- compliance was reported to be due to late arrival from previous station. Updated EOBTs of such flights was not available with ATFM unit leading to wastage of unused slots.

VII. Air Delay during the CDM Scenario period

Average Air Delay to domestic arrivals* within the CDM Scenario period for Delhi, Mumbai and Chennai was 9.4, 17.6 and 6.0 minutes respectively.

**Note: Only calculated for domestic arrivals with both ATOT and ALDT information*

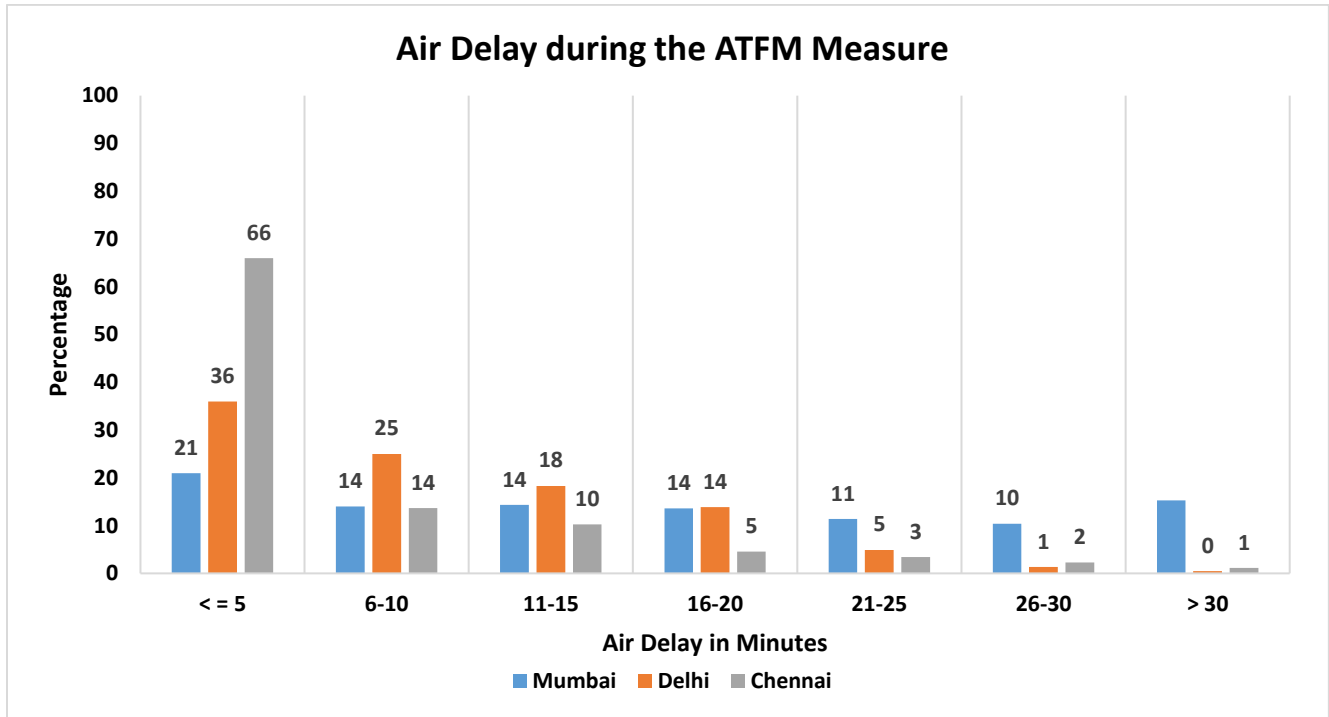


Figure 15: Air Delay distribution during the CDM period

Inference

1. 35% of domestic arriving flights to Mumbai had an Air delay of equal to or less than 10 minutes during the CDM period.
2. 61% of domestic arriving flights to Delhi had an Air delay of equal to or less than 10 minutes during the CDM period.
3. 80% of domestic arriving flights to Chennai had an Air delay of equal to or less than 10 minutes during the CDM period.



Tangible Benefits due to ATFM Measures

A modest attempt is made to find out the tangible benefit of ATFM measures applied.

Assumptions:

- When ATFM measures are not in force, all flights take off at their ETOT where Estimated take off time(ETOT)= Estimated off block time(EOBT) + default taxi time
- All flights have an Estimated elapsed time(EET) as calculated by SKYFLOW using the Flight Plan information and Basic Aircraft data.

Methodology:

Air delay (with ATFM measures in force) is calculated during the period when ATFM measures are in force by summing the air delay for all the flights landing at constrained Airport.

i.e. **Total Air Delay = \sum (Actual Flying time – SKYFLOW calculated EET)**

Air delay (with no ATFM measures) is calculated as the sum of Air delay for all the flights during the above said period with no ATFM measures in place and the air delay for each flight is the difference in its ideal landing time and its ideal estimated landing time.

Total Air Delay (with no ATFM measures) = \sum (Ideal LDT - Ideal ELDT)

*Ideal LDT is taken by assuming every flight is landing at a specified interval based on the Arrival acceptance rate(AAR) defined,

*Ideal ELDT = ETOT + SKYFLOW calculated Flying time

Fuel Saving Calculation :

Great Circle Distance(GCD)* was calculated for all the arrivals during the ATFM Measure from the point of origin to destination. Assuming Airbus 320 as reference aircraft for flights (flight distance equal to or less than 3000 nm) and B777 for international flights (flight distance more than 3000nm):

Fuel consumption (Kgs / nm) for each affected flight in the scenario was then calculated using the Reference document: ICAO Carbon emissions calculator methodology, version10, Appendix C: ICAO Fuel Consumption Table.

The Fuel consumed per minute(Kg/min) was calculated for each affected flight.



Total Air Delay(with ATFM Measures)= 9547 mins

Total Air Delay (with no ATFM measures) = 17038 mins

Reduction in Air delay due to ATFM measures= (17038-9547) = **7491 mins**

Fuel Saving Calculation:

Total Fuel saved during the ATFM Measure: **4,12,217.33 Kg**

Total reduction in CO₂ emission : 3.16(KgCO₂/kg fuel)* 4,12,217.33 Kg = 13,02,606.75Kg

**GCD (Great Circle Distance): The distance between origin and destination airports is derived from latitude and longitude coordinates originally obtained from ICAO Location Indicators database.*

3.16 = constant representing the number of tonnes of CO₂ produced by burning a tonne of aviation fuel.



D. Glossary

ATFM Parameters	Definition
<i>Affected Flight statistics</i>	An insight of participating traffic in the scenario i.e. ratio of the domestic arrivals to the constrained airport affected by ATFM measures (assigned delay by the Ground Delay Program) to the domestic arrivals not affected by ATFM measures (not assigned any delay) within the CDM scenario.
ATFM Ground delay	ATFM ground delay defined as CTOT-ETOT (Calculated take off time – Estimated take off time)
<i>Average ATFM delay</i>	$\frac{\text{Total monthly ATFM delay (in minutes)}}{\text{Total Domestic Arrivals}}$
<i>Maximum ATFM delay</i>	Maximum ATFM delay (in minutes) assigned in the month
<i>Overall compliance rate</i>	Defined as monthly ATFM departure slot adherence rate of regulated flights. Flights having ATOT within the ATFM Slot Tolerance Window (STW) of minus 5 to plus 10 minutes of CTOTs, are considered as compliant flights
<i>CTOT Compliance rate of Airline operators</i>	An overview of CTOT compliance rate of various Airline operators
<i>CTOT Compliance rate of Airports within different Regions</i>	An overview of CTOT compliance rate of Airports within 4 FIRs
Air delay statistics	<p>Air delay defined as difference between AET & EET, where AET (actual elapsed time) can be obtained from (ALDT-ATOT) and estimated elapsed time (EET) can be obtained from FPL/RPL or (CLDT-CTOT). Therefore, Air delay = AET-EET</p> <p>Average Air Delay is calculated as:</p> $\text{Average Air Delay} = \frac{\text{Total Air Delay to domestic arrivals (with values greater than zero)}}{\text{Total Domestic Arrivals}}$ <p>CLDT: Calculated Landing Time CTOT: Calculated Take off Time ALDT: Actual Landing Time ATOT: Actual Take off Time</p>



Annexure-A

Compliance by Airlines with Flight Planning Requirements of Common Business Rules(CBR)- August 2023



I. Introduction:

Accurate and timely input in respect of flight intent is paramount to the correct traffic demand projection and eventually effective ATFM implementation. FPLs remain the main source of tactical demand prediction for ATFM systems. Early filing of error free Flight plan helps in improving the lead time required for ATFM measures and reduces the number of unexpected flights(pop-up). This in turn, helps in improving the accuracy of demand-capacity imbalance prediction and optimizes slot utilization.

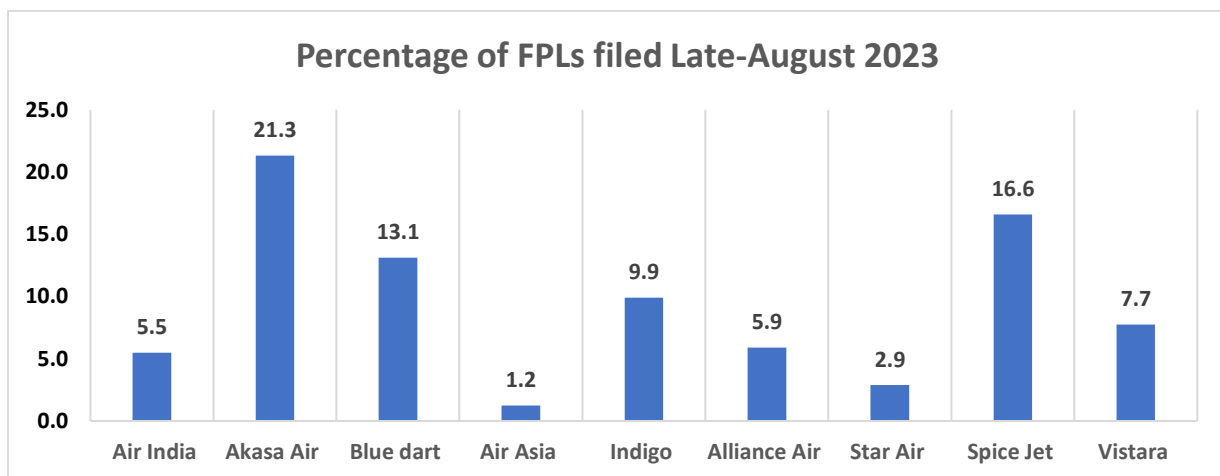
AIP India, ENR 1.9 section 4 on Flight Planning in the context of ATFM recommends Flight Planning requirements for all Airline Operators –

- “a) Flight plans shall be submitted at least 3 hours before the estimated off block time (EOBT);
- b) The window for filing FPL is between 3 Hours and 120 Hours (Five days) before the EOBT. Earlier filing of FPL will give a realistic demand data to the CCC and hence the requirement of ATFM measures can be identified early for better planning. Late filing of a flight plan will lead to inaccuracies in predicting the demand and may lead to undesirable delay;”

II. Analysis

- A. An analysis has been conducted to find out the difference between the flight plan filing time and filed EOBT for all the FPLs received at ATFM system from 1st August 2023 to 31st August 2023. The purpose of the analysis is to monitor the compliance with the provisions of AIP India, section 4, ENR 1.9 regarding Flight Planning requirements in the context of ATFM.

This flight plan filing requirement has been reiterated through the recently agreed ATFM common business rules (CBR) document and is recognized as a metrics to be monitored regularly for any improvement.





The table below lists the number of filed flight plans (FPLs) filed with less than 3 Hours prior to EOBT:

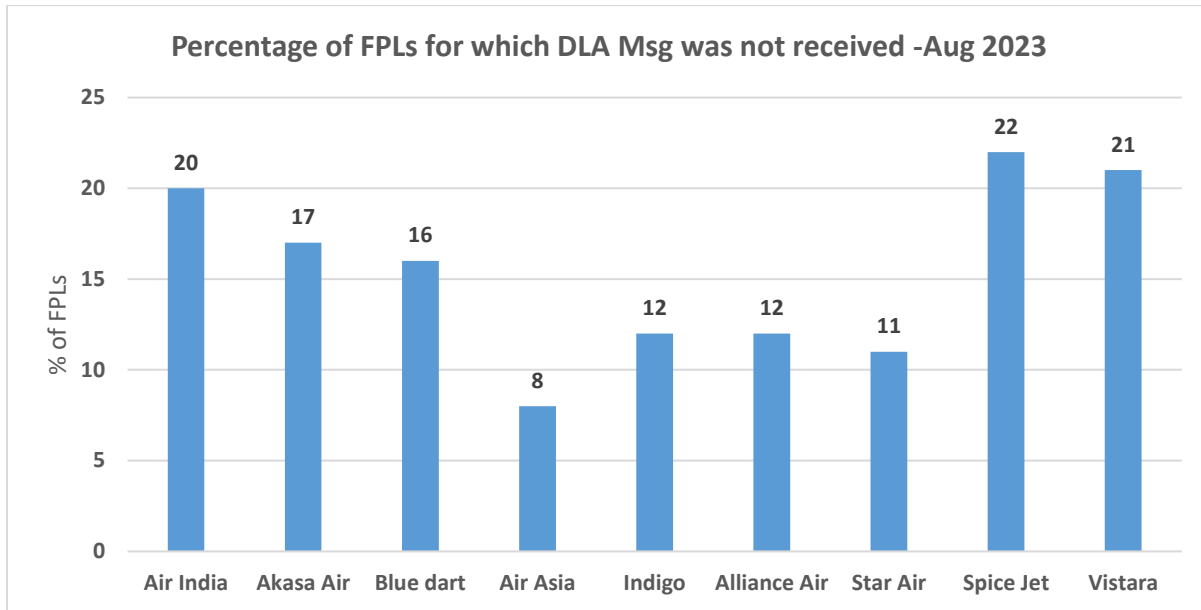
Name of Airline	Number of FPL filed late	Total No. Of FPL	% Delayed Filing
Air India	728	13253	5.5
Akasa Air	737	3455	21.3
Blue Dart	69	526	13.1
Air Asia	74	5938	1.2
Indigo	5744	57949	9.9
Alliance Air	189	3197	5.9
Star Air	22	741	2.9
Spice Jet	886	5336	16.6
Vistara	674	8707	7.7
Total no. of FPLs for Scheduled Airlines	9123	99102	9.2

- B. The analysis of non-receipt of DLA (Delay) messages for flight plans filed was also conducted. The EOBT of FPL received was compared with Actual Take off time (ATOT) received through DEP(Departure)messages. Thus, only those FPLs were considered for the analysis for which DEP messages were available and no associated DLA messages was received.

The Table below lists number of flights (Airlines wise) for which no DLA message was received in August 2023

Analysing for each flight: $\{(EOBT \text{ of original FPL}) - (ATOT \text{ received})\} > 30 \text{ minutes}$

Name of Airline	DLA Message not received	Total No. of flights considered for analysis	% of flights for which no DLA message was received
Air India	1982	10111	20
Akasa Air	485	2780	17
Blue Dart	79	480	16
Air Asia	387	5003	8
Indigo	5402	45956	12
Alliance Air	243	1952	12
Star Air	43	378	11
Spice Jet	806	3741	22
Vistara	1536	7448	21



- C. For analysis of non-receipt of CNL (cancel) messages for August 2023, annulled FPLs were considered for which no CNL/DEP/DLA messages were received. A FPL gets annulled in the SKYFLOW system, if it doesn't get activated through Dep message /surveillance data/ manual activation by FMP within a defined system parameter.

The table below lists the number of Flights for which no CNL Msg. was received in August 2023:

Name of Airline	CNL message not received	No. of annulled FPLs
Air India	85	86
Akasa Air	9	10
Blue Dart	5	5
Air Asia	17	18
Indigo	310	319
Alliance Air	234	237
Star Air	11	12
Spice Jet	120	127
Vistara	14	14

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