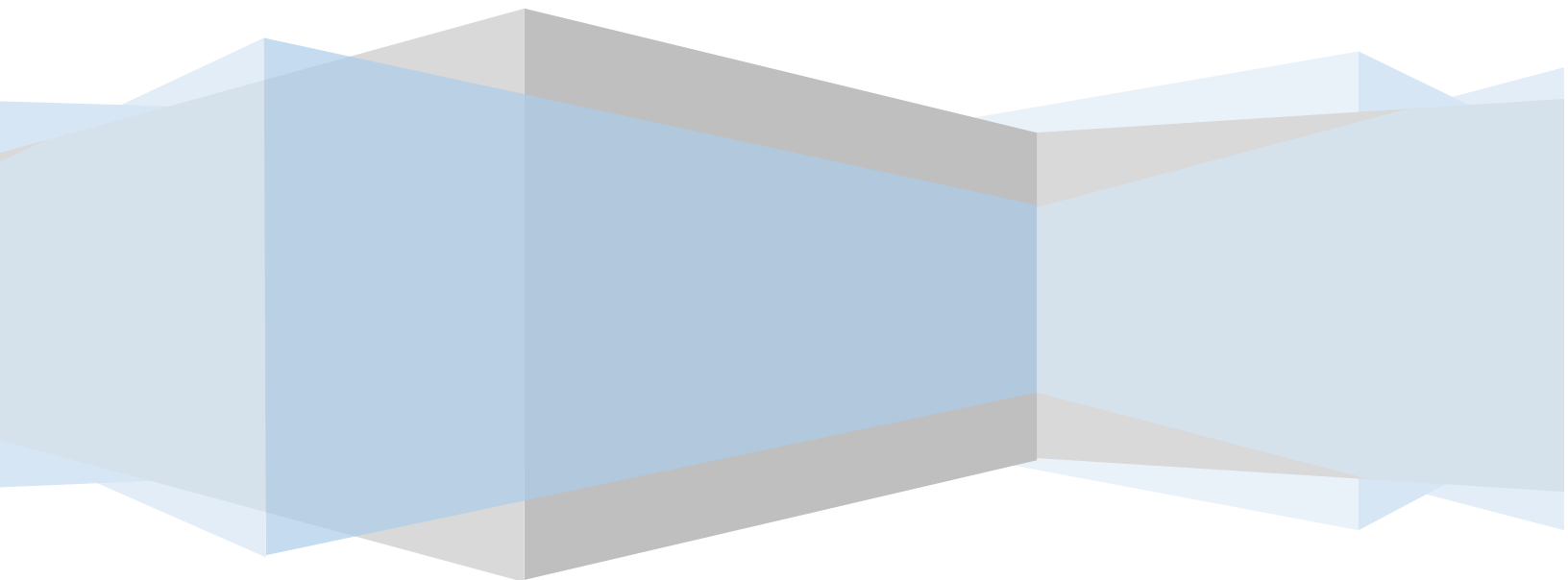


POST OPERATIONS ANALYSIS REPORT

August, 2024

CENTRAL COMMAND CENTER, C-ATFM, DELHI







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A. Executive Summary

Average Domestic air traffic has recorded an increase of 3.96% whereas the average international air traffic has increased by 0.33 % in the month of August '24 as compared to July '24.

On average, the Indian Airports in the ATFCM area saw 4531 IFR flights per day in the month of August 2024. The peak day was on 22nd August 2024 (4831 IFR flights). Thursday's were the busiest days throughout this month with an average of 4546 IFR flights per day.

Total Eighty one (81) ATFM measures were applied this month during periods of congestion at Bengaluru, Chennai, Delhi and Mumbai Airport.

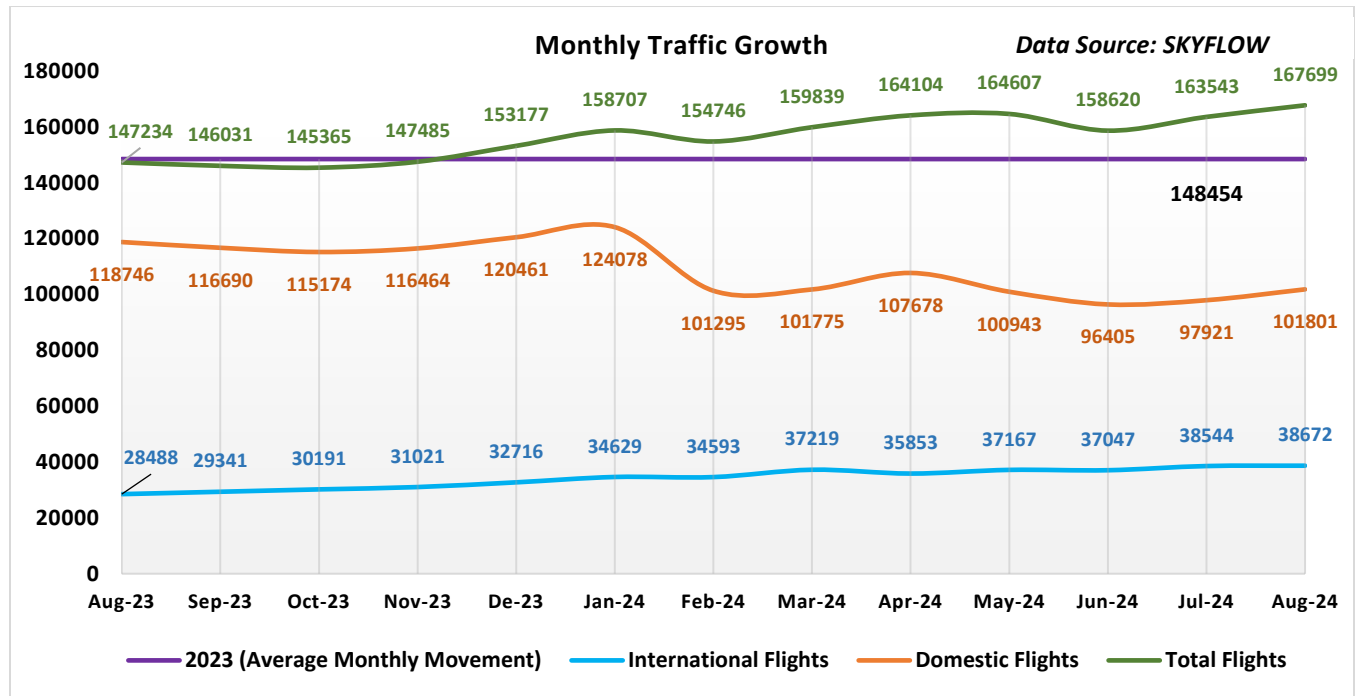


Figure 1: Monthly Traff

The graph above depicts the Domestic, International and Overflying Air traffic in Indian ATFCM Area from Feb, 2024 onwards. Before that only Domestic and International movement were depicted.



B. Traffic Analysis

I. Air Traffic Movement at Major Airports in India

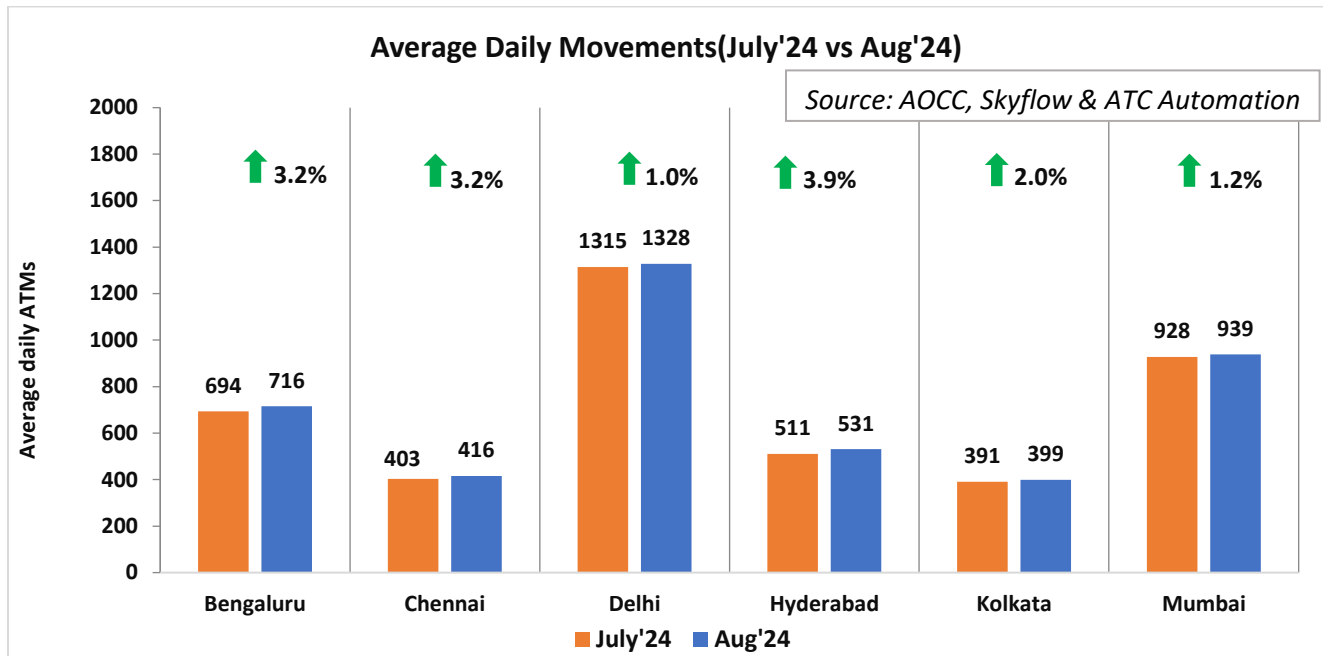


Figure 2: Average Daily Movements (July '24 vs Aug '24)

The above chart depicts the percentage change in average daily ATMs at six major Airports in August'24 as compared to the previous month July '24.

Airports\Year	Avg. Daily ATMs (YoY) for six major airports				
	Aug'20	Aug'21	Aug'22	Aug'23	Aug'24
Bengaluru	244	389	548	634	716
Chennai	119	230	349	397	416
Delhi	523	863	1179	1253	1328
Hyderabad	206	314	415	461	531
Kolkata	118	249	361	382	399
Mumbai	197	474	769	919	939



Air Traffic Movement for each day in August'24 is plotted for Delhi, Mumbai, Bengaluru and Hyderabad Airport along with the percentage change w.r.t. Avg. Daily Movements for the same month.

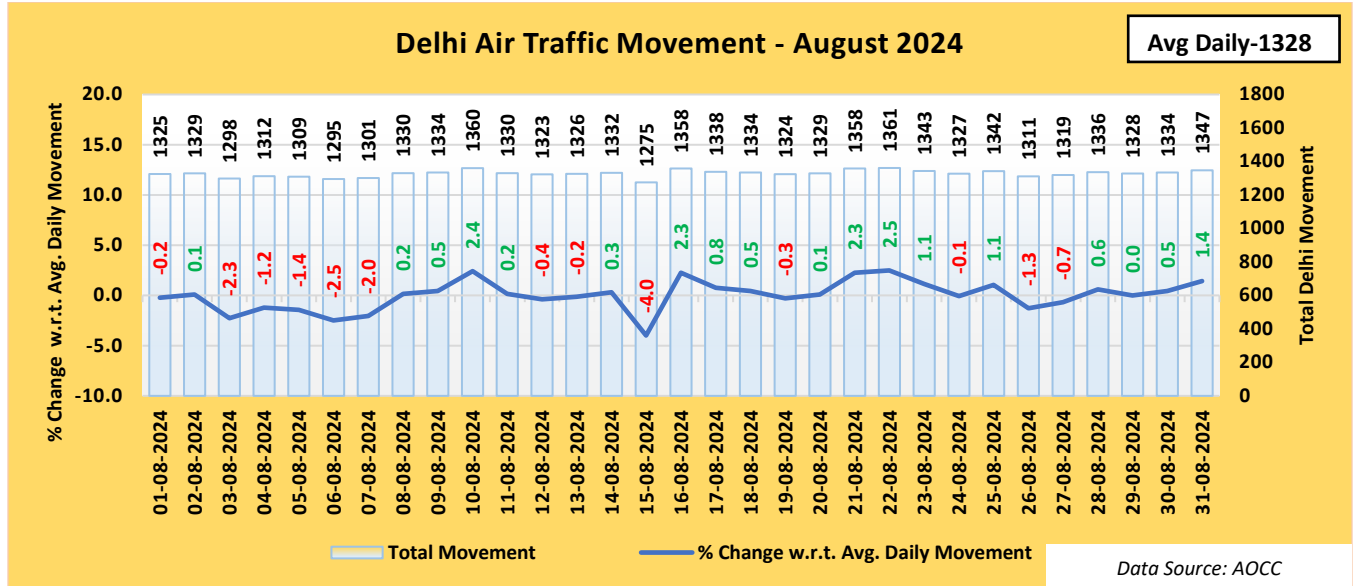


Figure 3: Air Traffic Movement for Delhi –August 2024

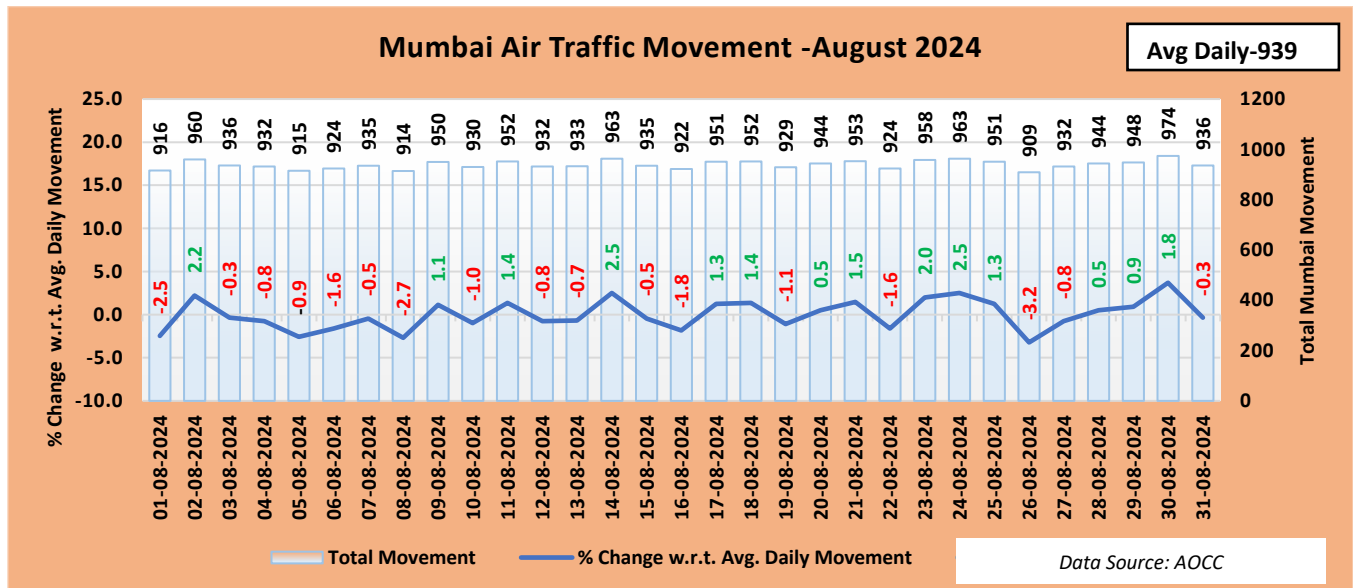


Figure 4: Air Traffic Movement for Mumbai - August 2024

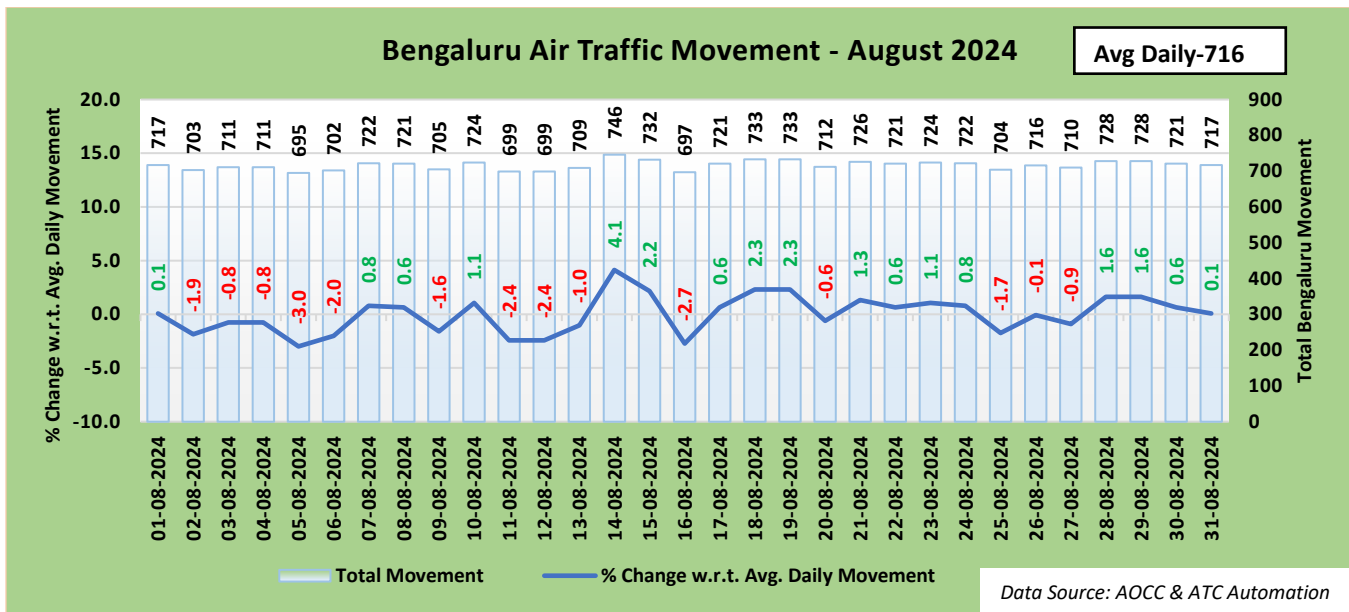


Figure 5: Air Traffic Movement for Bengaluru – August 2024

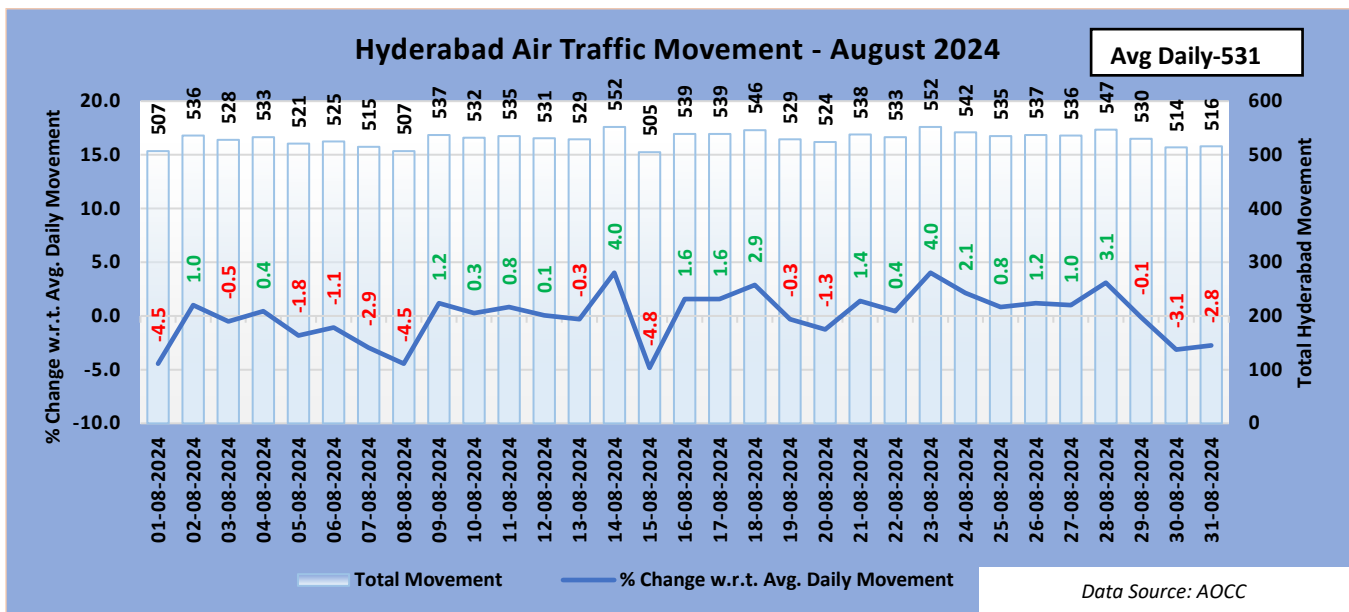


Figure 6: Air Traffic Movement for Hyderabad – August 2024

It can be concluded from the above charts that on 31st August 2024 (month end), the ATM at Delhi and Bengaluru saw an increase of 1.4% and 0.1% respectively whereas the ATM at Mumbai and Hyderabad saw a decline of 0.3% and 2.8% respectively in comparison to the average daily movement for August'24.



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 2023 and 2024 respectively. Air Traffic movement is also plotted Airline wise for the last six months for the major Scheduled Operators.

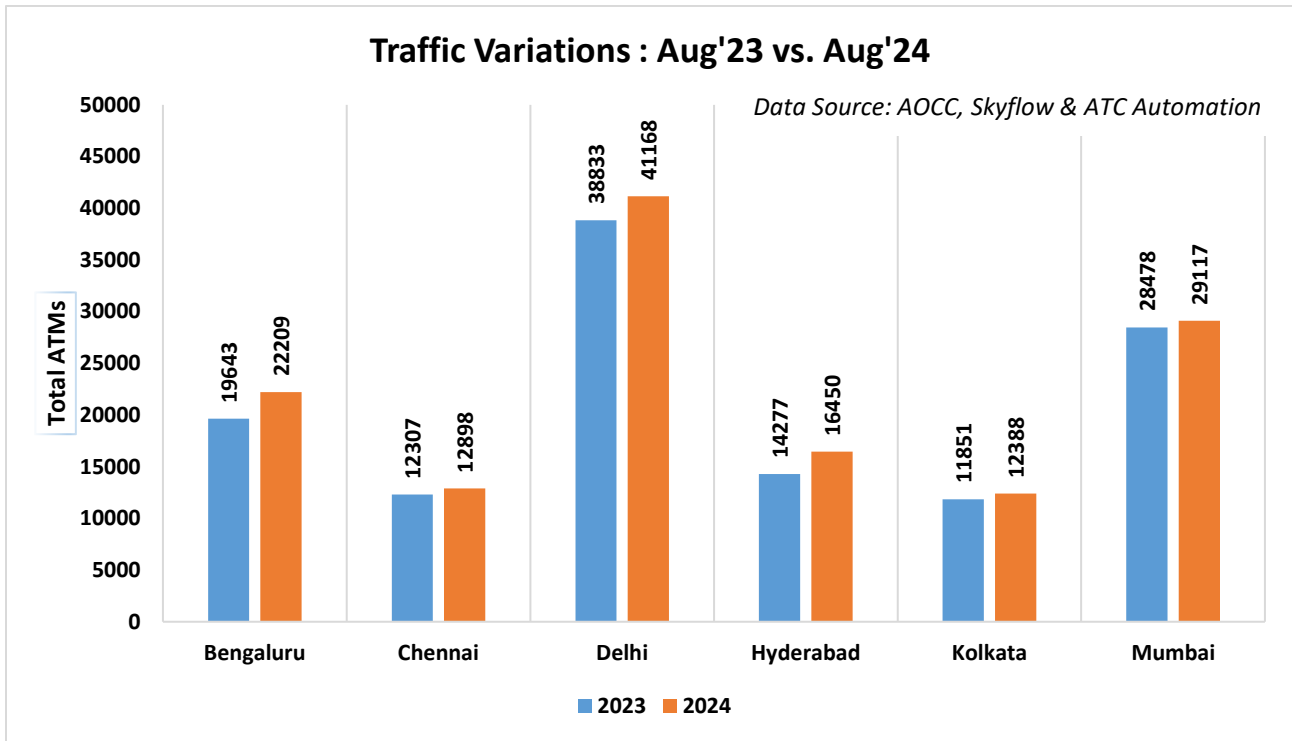


Figure 7: Traffic Variation (YoY)



III. Flight Operations – Airlinewise

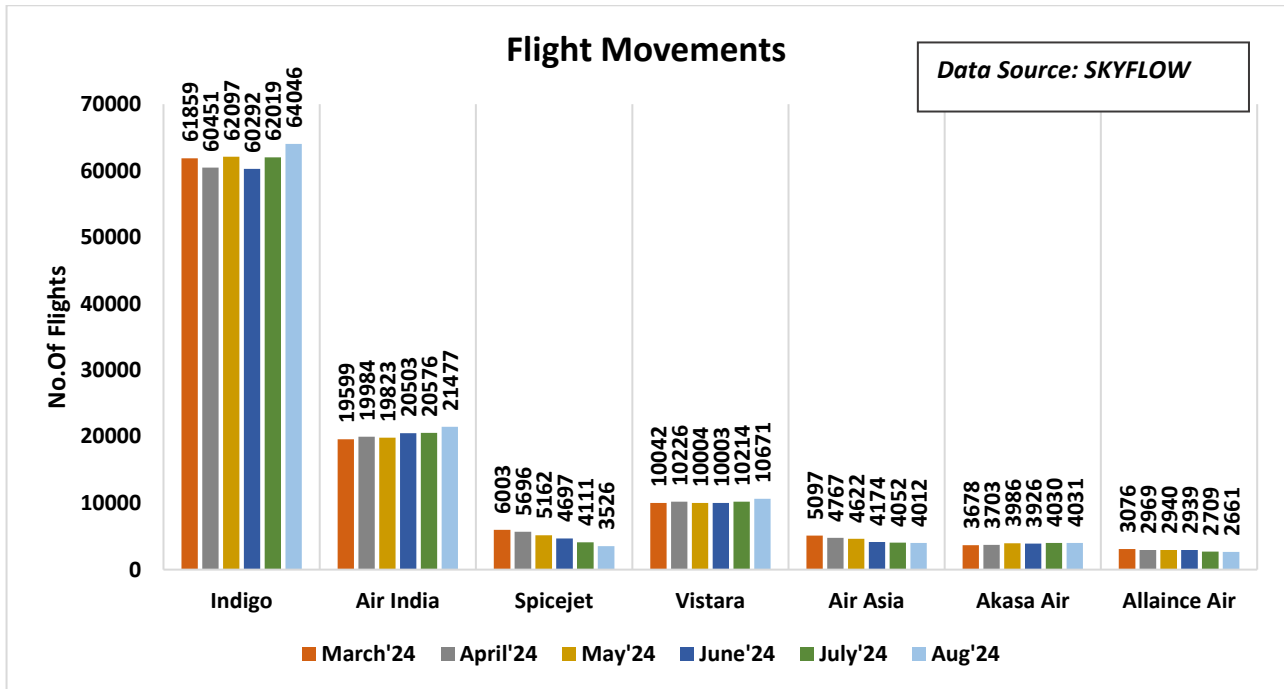


Figure 8: Flight Movements –Airlinewise

Inference:

1. Indigo, Air India, Vistara and Akasa airlines have recorded an increase in the monthly average (31 days) Flight movement in August'24 as compared to July '24 while Spicejet, Alliance air and Air Asia airlines have recorded a decline during the same period.



C. ATFM Post Operations – CDM Analysis

I. Introduction

Analysis Period 1st – 31st August 24

Back Ground During the above mentioned period, **Seven (07)** ATFM measure was applied for **Bengaluru Airport**, **Four (04)** ATFM measures were applied for **Chennai Airport**, **Thirteen (13)** ATFM measures were applied for **Delhi Airport** and **Fifty seven (57)** ATFM measures were applied for **Mumbai Airport** due to the following reasons as illustrated in the bar chart below:-

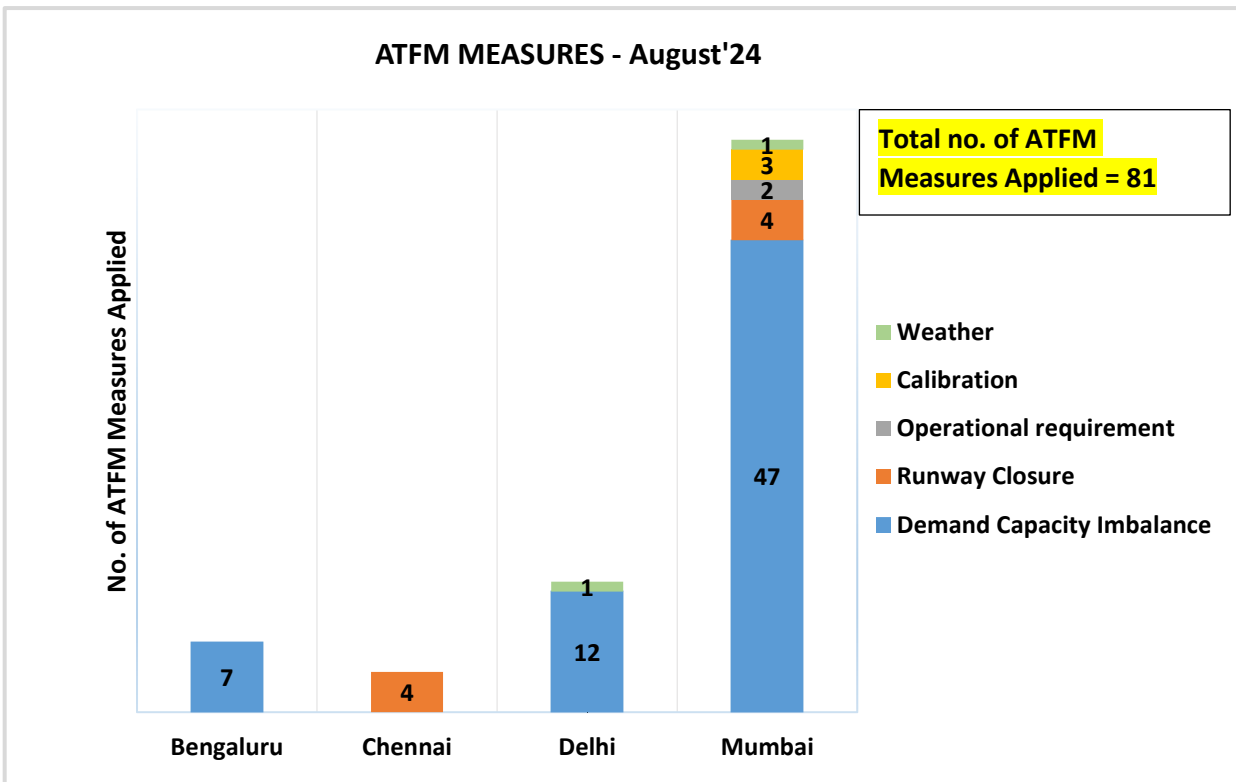


Figure 9: ATFM Measures –Aug'24



II. ATFM Measures Overview

Constrained Airport	Bengaluru	Chennai	Delhi	Mumbai
Number of ATFM measures applied	7	4	13	57
Average ATFM Ground delay(in min) due to measures*	19.6	18.5	20.8	33.2
Maximum ATFM Ground delay(in min) due to measures	59	44	58	125
% Compliance	86.7	86.8	83.2	84.2

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

Total Arrivals	5707
Total International Arrivals(exempted)	1153
Total affected flights in scenario (Domestic Arrivals)	4554
Total Domestic Arrivals with zero ATFM delay	335
Total Domestic Arrivals with ATFM delay	4219

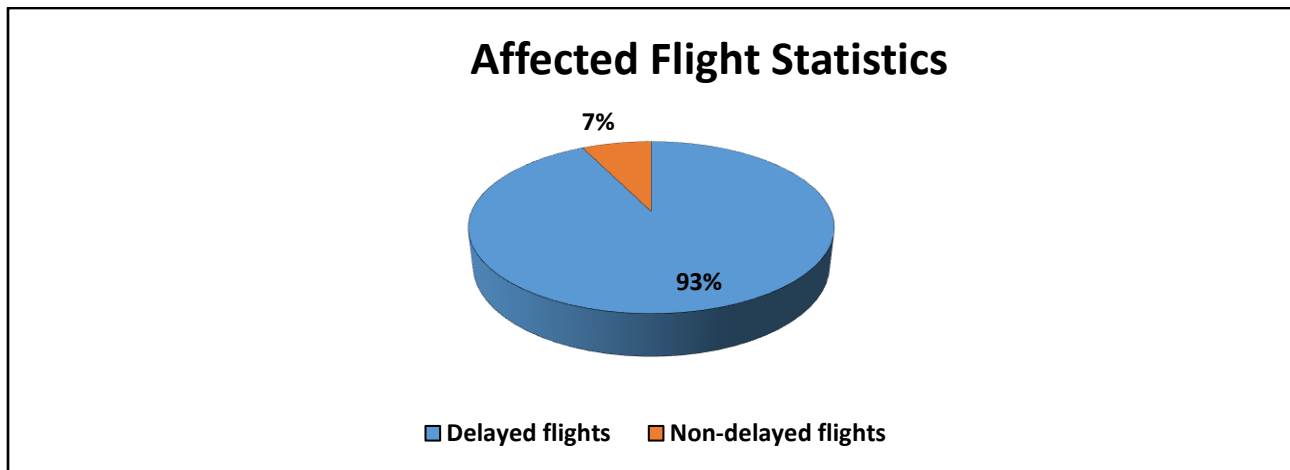


Figure 10: Affected Flight Statistics –Aug'24



III. Overall Compliance

Total arrivals	5707
Domestic arrivals	4554
Flights with complete data (ATOT)	4452
Flights with incomplete data	28
Flights Not Operated	74
Compliant*	3747
Non-Compliant	705

*Total No. of Revised CTOTs issued = 1451 (Compliance calculation for flights which were issued revised CTOT is w.r.t. new CTOT issued)

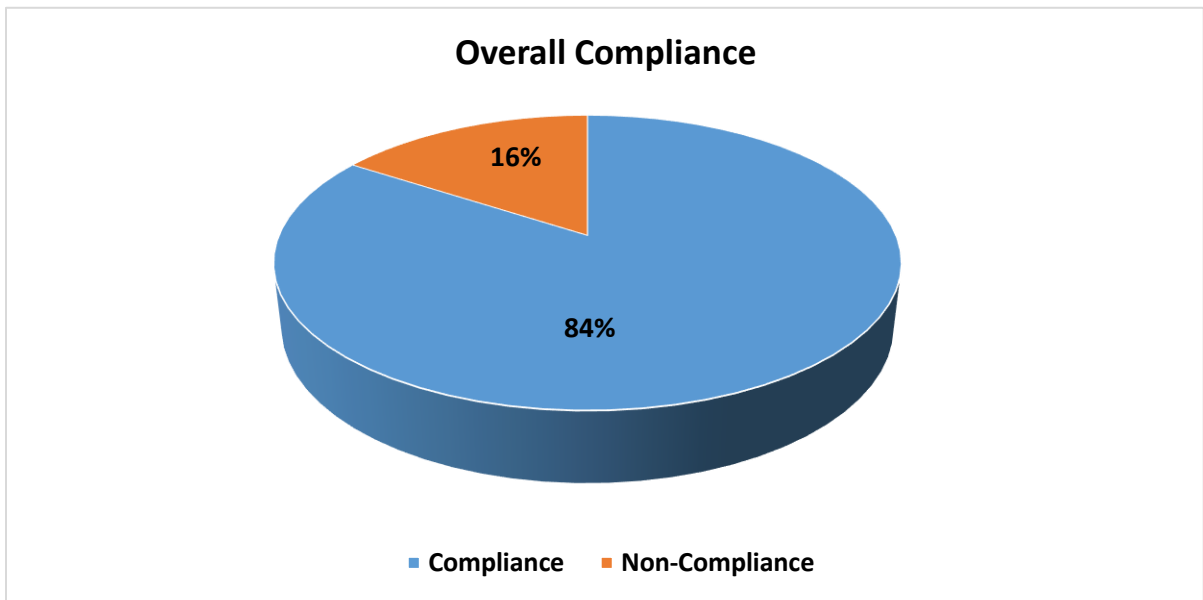


Figure 11: Overall Compliance – Aug'24

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

Out of the total domestic arrivals with complete data in the CDM scenario, 84% arrivals are compliant.

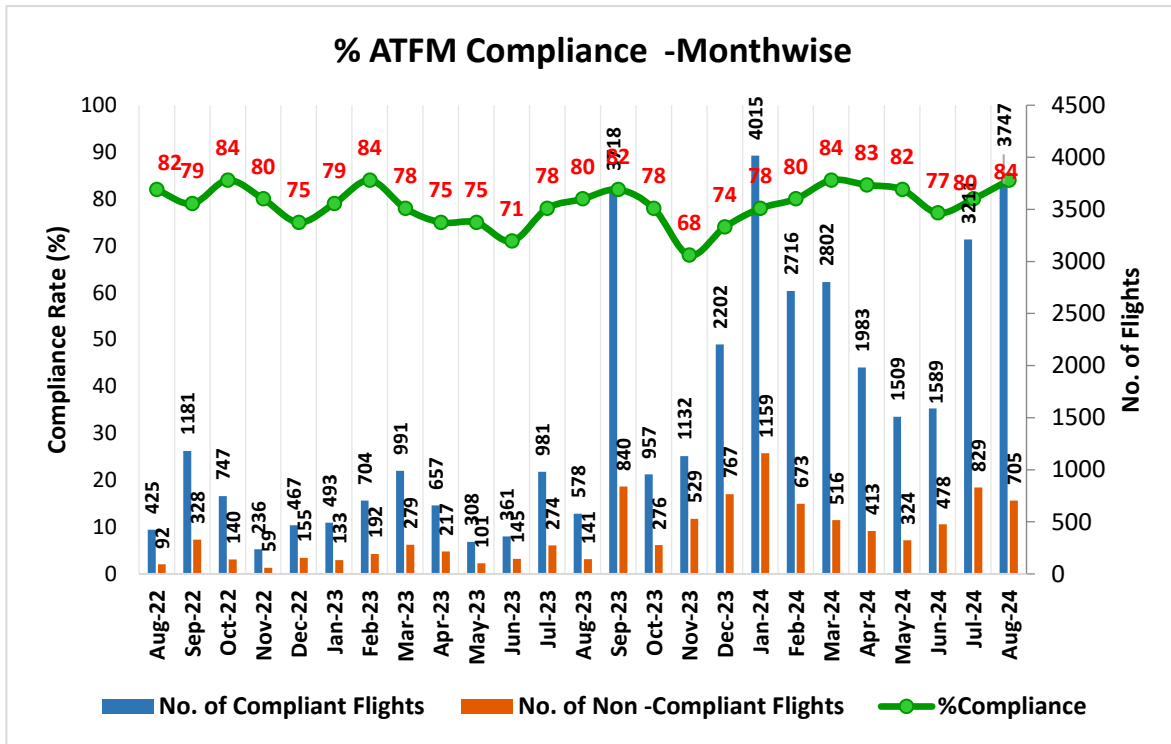


Figure 12: Compliance(Monthwise)

Inference

1. Out of the total arrivals captured(5707 flights) during the CDM scenario for the constrained Airports, 79.8% of flights i.e. domestic arrivals(4554flights) were candidates for ground delay(participating).
2. Out of these Domestic Arrivals(4554), 92.6% (4219 flights) are assigned ATFM ground delay.
3. Out of the total arrivals captured(5707 flights) to the constrained Airport during the ATFM scenario, only 73.9% of flights(4219 flights) were assigned ATFM Ground Delay.



IV. CTOT Compliance rate – Airportwise

MUMBAI FIR (82%)*	Compliant	Non Compliant	% Compliant
Ahmedabad	154	19	89%
Aurangabad	25	7	78%
Mumbai	106	24	82%
Vadodara	34	9	79%
Bhopal	49	7	88%
Bhavnagar	2	2	50%
Diu	7	1	88%
Hirasar, Rajkot	30	8	79%
Indore	77	22	78%
Jabalpur	8	3	73%
Jalgaon	7	2	78%
Jamnagar	11	6	65%
Kandla	3	1	75%
Kohlapur	6	0	100%
Keshod	1	1	50%
Nagpur	78	11	88%
Ozar	1	1	50%
Pune	47	21	69%
Shirdi	9	0	100%
Surat	12	8	60%
Udaipur	34	6	85%
KOLKATA FIR (83%)*	Compliant	Non Compliant	% Compliant
Prayagraj	15	4	79%
Agartala	5	0	100%
Ayodhya	21	4	84%
Bagdogra	30	9	77%
Shillong	1	0	100%
Varanasi	59	18	77%
Bhubaneswar	80	13	86%
Kolkata	184	39	83%
Chakeri	8	4	67%
Durgapur	4	0	100%



Darbhanga	5	1	83%
Gorakhpur	11	5	69%
Guwahati	56	12	82%
Gaya	2	0	100%
Hollongi	0	1	0%
Jharsuguda	4	0	100%
Jamshedpur	1	0	100%
Khajuraho	1	0	100%
Aizawl	2	0	100%
Dibrugarh	4	1	80%
Patna	64	10	86%
Ranchi	30	4	88%
Raigarh	0	1	0%
Raipur	50	5	91%
DELHI FIR (82%)*	Compliant	Non Compliant	% Compliant
Agra	3	0	100%
Amritsar	8	7	53%
Adampur	1	0	100%
Bikaner	0	2	0%
Bhuntar	2	1	67%
Bathinda	1	0	100%
Bareilly	1	1	50%
Chandigarh	55	17	76%
Dehradun	35	9	80%
Delhi	549	97	85%
Hindon	0	1	0%
Gaggal	1	1	50%
Gwalior	6	2	75%
Jodhpur	7	1	88%
Jaipur	82	17	83%
Jaisalmer	0	1	0%
Jammu	12	4	75%
Leh	11	4	73%
Lucknow	97	16	86%
Narnaul	1	0	100%
Pantnagar	2	2	50%
Srinagar	67	22	75%



CHENNAI FIR (88%)*	Compliant	Non Compliant	% Compliant
HAL Bangalore	2	3	40%
Bengaluru	327	49	87%
Belagaum	4	1	80%
Bidar	1	0	100%
Vijayawada	30	8	79%
Coimbatore	86	8	91%
Kochi	122	9	93%
Calicut	6	0	100%
MOPA Goa	112	16	88%
Gulbarga	1	1	50%
Goa	147	25	85%
Hubli	13	2	87%
Shamsabad, Hyderabad	241	27	90%
Begumpet Hyderabad	5	1	83%
Kannur	7	0	100%
Madurai	25	1	96%
Mangalore	38	8	83%
Chennai	214	34	86%
Nanded	0	1	0%
Port Blair	3	0	100%
Rajahmundry	1	0	100%
Sindhudurg	2	2	50%
Sulur	2	1	67%
Tuticorin	0	1	0%
Tirupati	1	0	100%
Tiruchirappally	6	1	86%
Thiruvananthapuram	51	4	93%
Visakhapatnam	21	6	78%

*FIR wise compliance rate (decimals rounded off to nearest integer value).

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(84%) for the month are highlighted in red.



V. CTOT Compliance rate – Airlinewise (Kindly take a look and think how to reduce Non-Compliance)

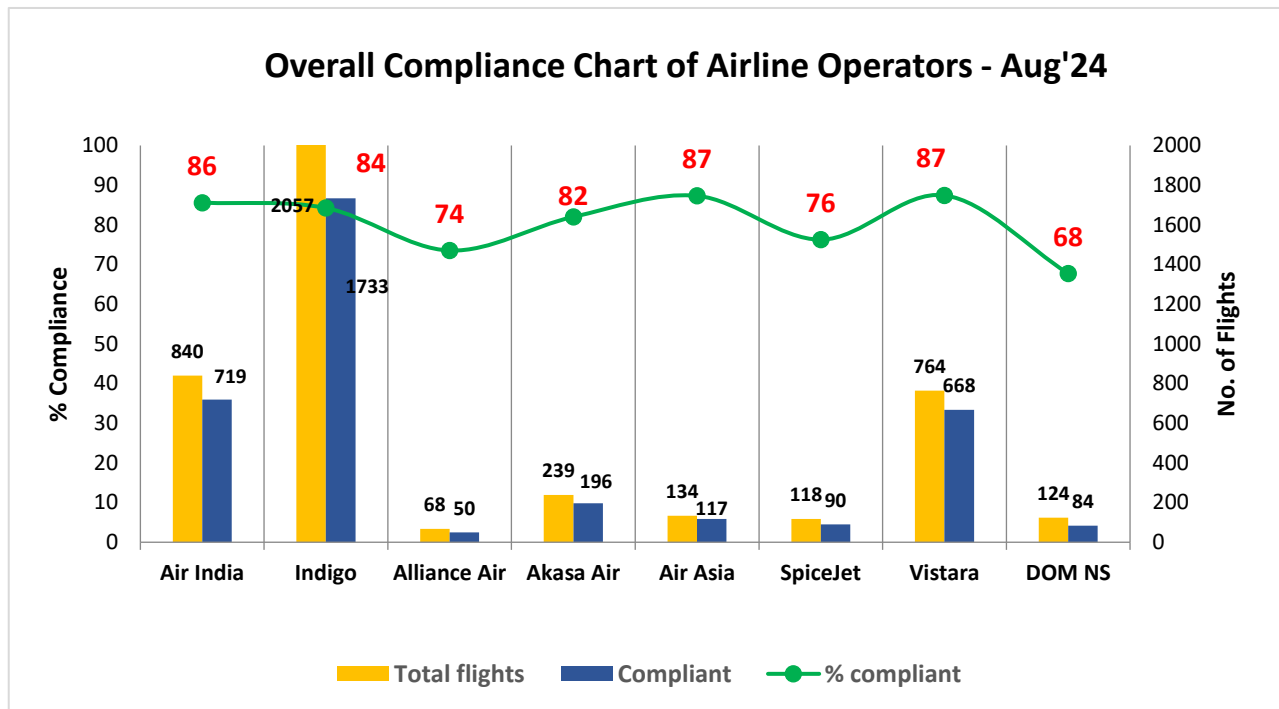


Figure 13: Airline wise Compliance –Aug'24

Inference

1. Chennai region record the highest compliance of 84% whereas Mumbai region has the lowest percentage compliance of 81.5~82%.
2. Air India, Indigo, Air Asia and Vistara Airlines have a CTOT compliance higher than the average recorded compliance for the month of August'24.

VI. Reason For Non Compliance

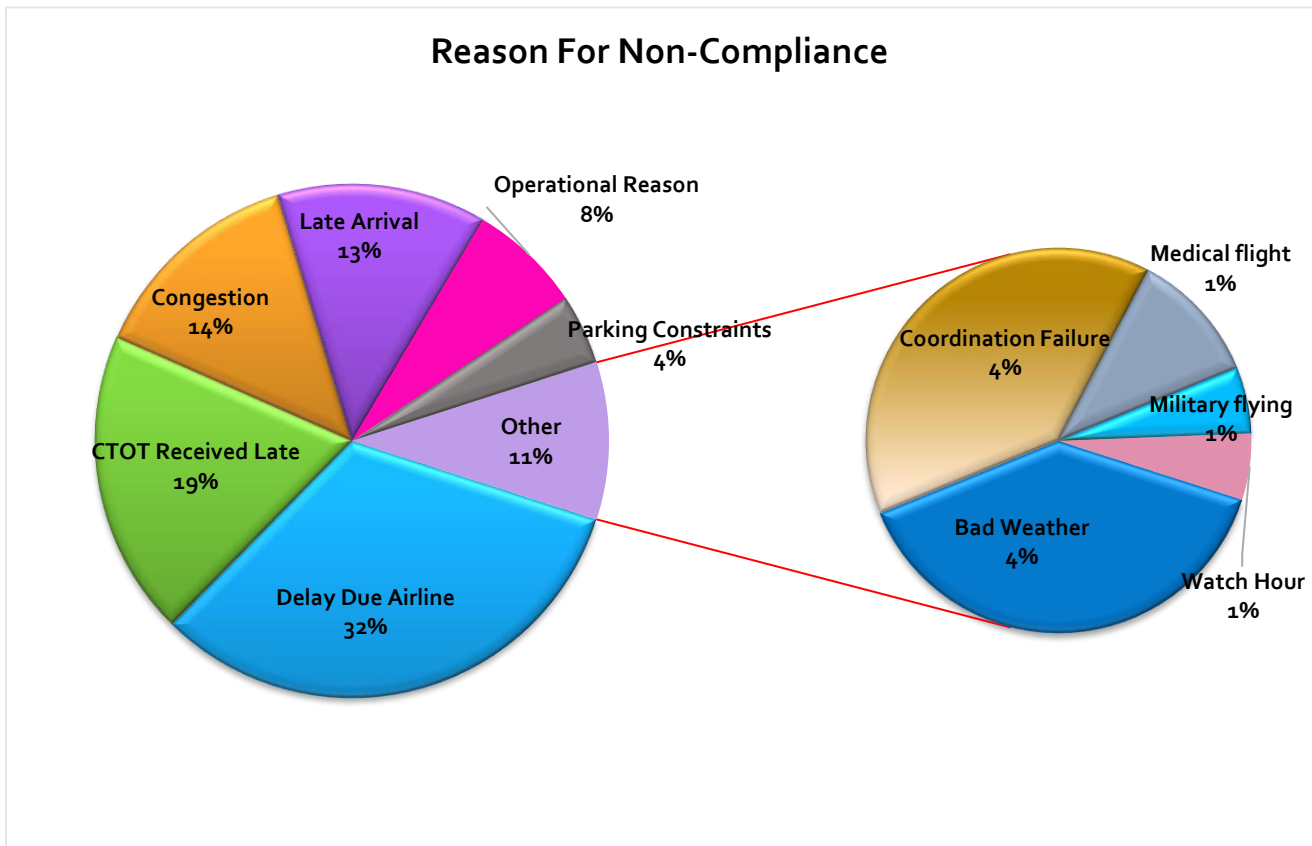


Figure 14: Reason for Non-Compliance as provided by FMPs

Inference:

- 32 % of CTOT Non- Compliance was reported by concerned FMPs to be due to delay by Airlines.
- 19 % 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.
- 14 % of the CTOT Non- compliance was reported to congestion at airports while 13% non -compliance was due to late arrival from previous station. Updated EOBTs of such flights was not available to 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 Bengaluru, Chennai, Delhi and Mumbai was 9.0, 9.6, 8.3 and 11.8 minutes respectively.

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

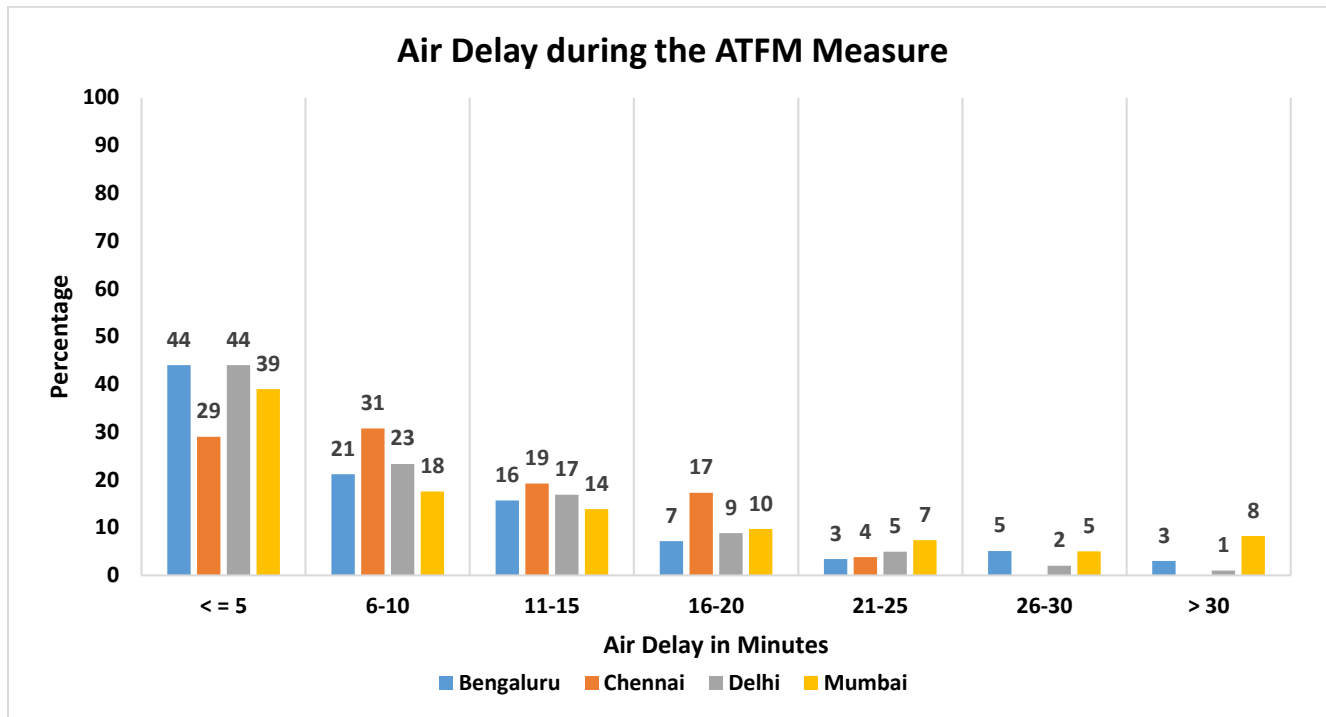


Figure 15: Air Delay distribution during the CDM period

Inference

- 65% of domestic arriving flights to Bengaluru had an Air delay of equal to or less than 10 minutes during the CDM period.
- 60% of domestic arriving flights to Chennai had an Air delay of equal to or less than 10 minutes during the CDM period.
- 67% of domestic arriving flights to Delhi had an Air delay of equal to or less than 10 minutes during the CDM period.
- 57% of domestic arriving flights to Mumbai had an Air delay of equal to or less than 10 minutes during the CDM period.



VIII. 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)= 50280 mins

Total Air Delay (with no ATFM measures) = 112506 mins

Reduction in Air delay due to ATFM measures= (112506-50280) = **62226 mins**

Fuel Saving Calculation:

Total Fuel saved during the ATFM Measure: **35,69,286.22 Kg**

Total reduction in CO₂ emission : 3.16(KgCO₂/kg fuel)* 35,69,286.22 Kg = 1,12,78,944.46 Kg

**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 2024

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 FPL 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 –

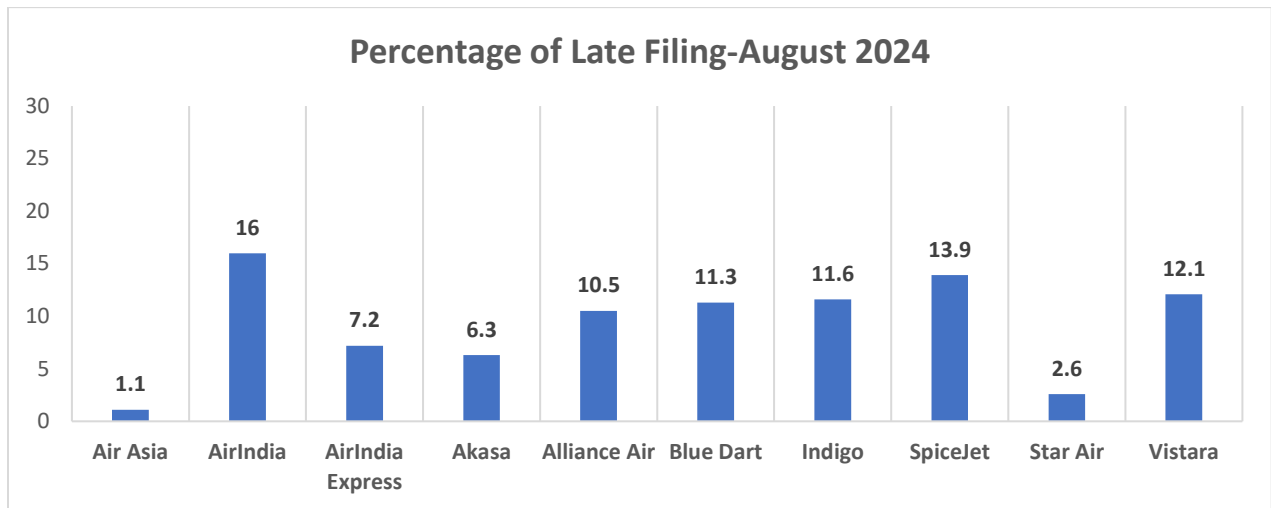
- a) Flight plans shall be submitted at least 3 hours before the estimated off block time (EOBT);
- b) The window for filing FPL is between 3 Hours and 120 Hours (Five days) before the EOBT. Earlier filing of FPL will give a realistic demand data to the CCC and hence the requirement of ATFM measures 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;”

I. 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 2024 to 31st August 2024. The purpose of the analysis is to monitor the compliance with provisions of AIP India, section 4, ENR 1.9 regarding Flight Planning requirements in context of the 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.

Table Below Shows the depiction of Flight Plan filed in contravention of AIP INDIA, ENR 9.1 by airlines as a percentage of total Flight Plan filed.



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

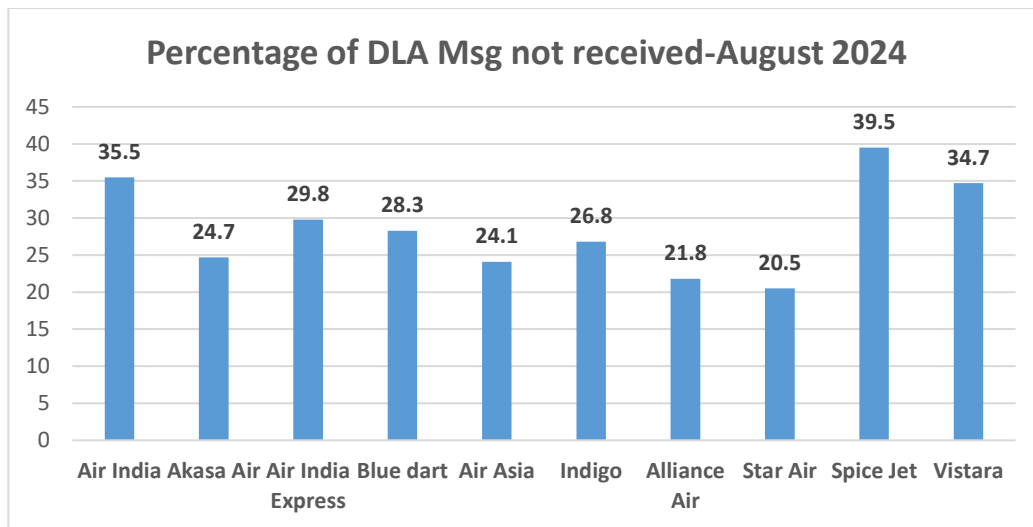
Name of Airline	Late Filed FPL	Total No. Of FPL	% Delayed Filing
Air Asia	47	4084	1.1
AirIndia	1209	7526	16
AirIndia Express	1081	14940	7.2
Akasa	255	4041	6.3
Alliance Air	290	2744	10.5
Blue Dart	76	672	11.3
Indigo	7514	64582	11.6
SpiceJet	535	3834	13.9
Star Air	32	1204	2.6
Vistara	1304	10698	12.1
Total no. of FPLs for Scheduled Airlines	12343	114325	10.8

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

The Table below lists number of flights for which no DLA message was received in August 2024. **{{EOBT of original FPL}- (ATOT received)} > 30 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	4547	12781	35.5
Akasa Air	874	3528	24.7
Air India Express	1735	5824	29.8
Blue dart	171	604	28.3
Air Asia	785	3249	24.1
Indigo	14043	52391	26.8
Alliance Air	371	1700	21.8
Star Air	107	520	20.5
Spice Jet	1196	3024	39.5
Vistara	3221	9270	34.7



- C. For analysis of non-receipt of CNL (cancel) messages for August 2024, annulled FPLs were considered for which no CNL/DEP/DLA messages were received. A FPL gets annulled in 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 2024:



Name of Airline	CNL message not received	No. of flights annulled
Air India	44	59
Akasa Air	8	8
Air India Express	79	81
Blue dart	4	4
Air Asia	39	41
Indigo	197	201
Alliance Air	266	266
Star Air	54	55
Spice Jet	175	181
Vistara	75	77

-End of Report-