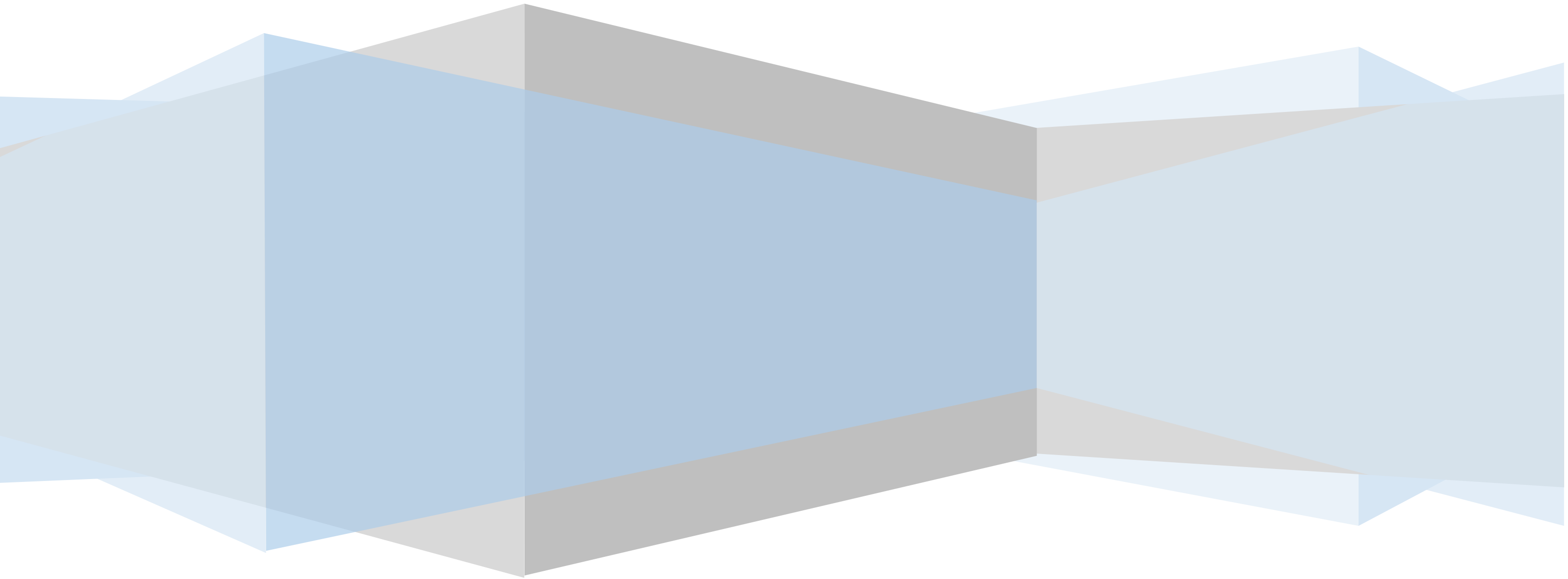
POST OPERATIONS ANALYSIS REPORT

December, 2024

CENTRAL COMMAND CENTER, C-ATFM, DELHI



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A. Executive Summary

Average Domestic air traffic has recorded a decrease of 7.0% whereas the average international air traffic has increased by 8.3 % in the month of December’24 as compared to November ’24.

On average, the Indian Airports in the ATFCM area saw 5067 IFR flights per day in the month of December 2024. The peak days were on 16th December 2024 (5321 IFR flights). Friday’s were the busiest days throughout this month with an average of 5171 IFR flights per day.

Total Sixty Five (65) ATFM measures were applied this month during periods of congestion at Bengaluru, Chennai, Delhi and Mumbai Airport.

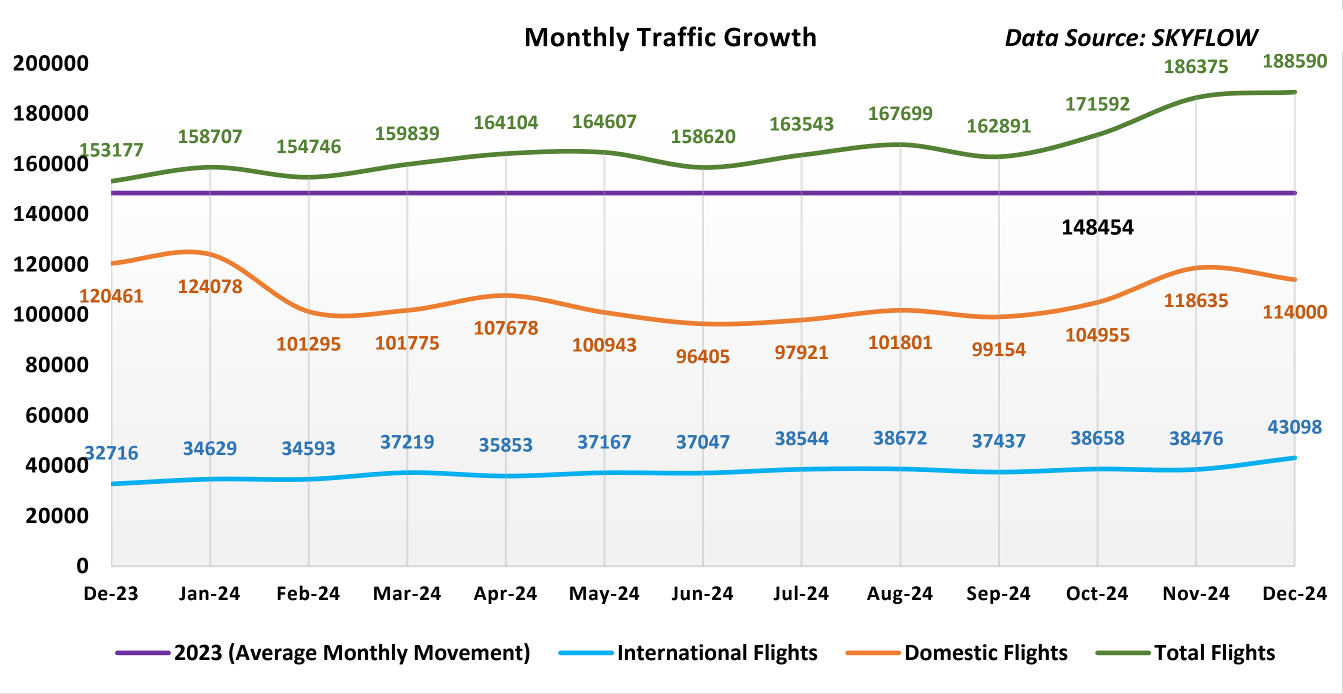


Figure 1: Monthly Traffic Growth

The graph above depicts the Domestic, International and Overflying Air traffic in Indian ATFCM Area during the last 13 months (December’23 to December’24).

B. Traffic Analysis

I. Air Traffic Movement at Major Airports in India

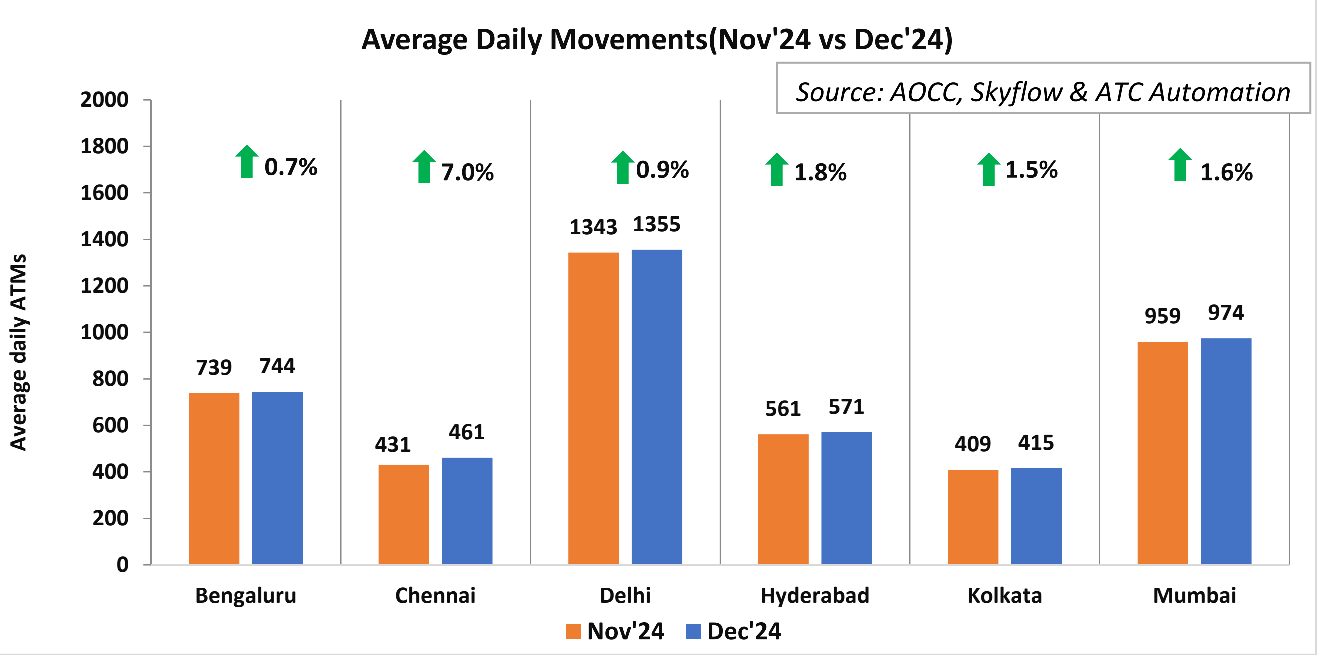
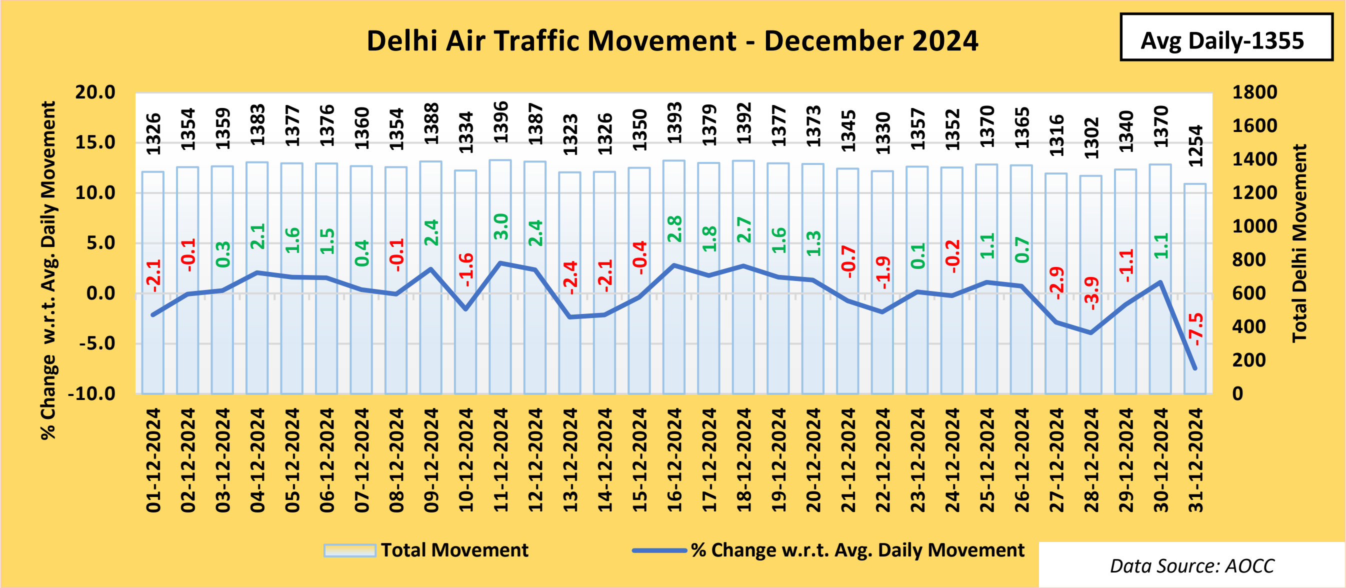


Figure 2: Average Daily Movements (Nov ’24 vs Dec ’24)

The above chart depicts the percentage change in average daily ATMs at six major Airports in December’24 as compared to the previous month November ’24.

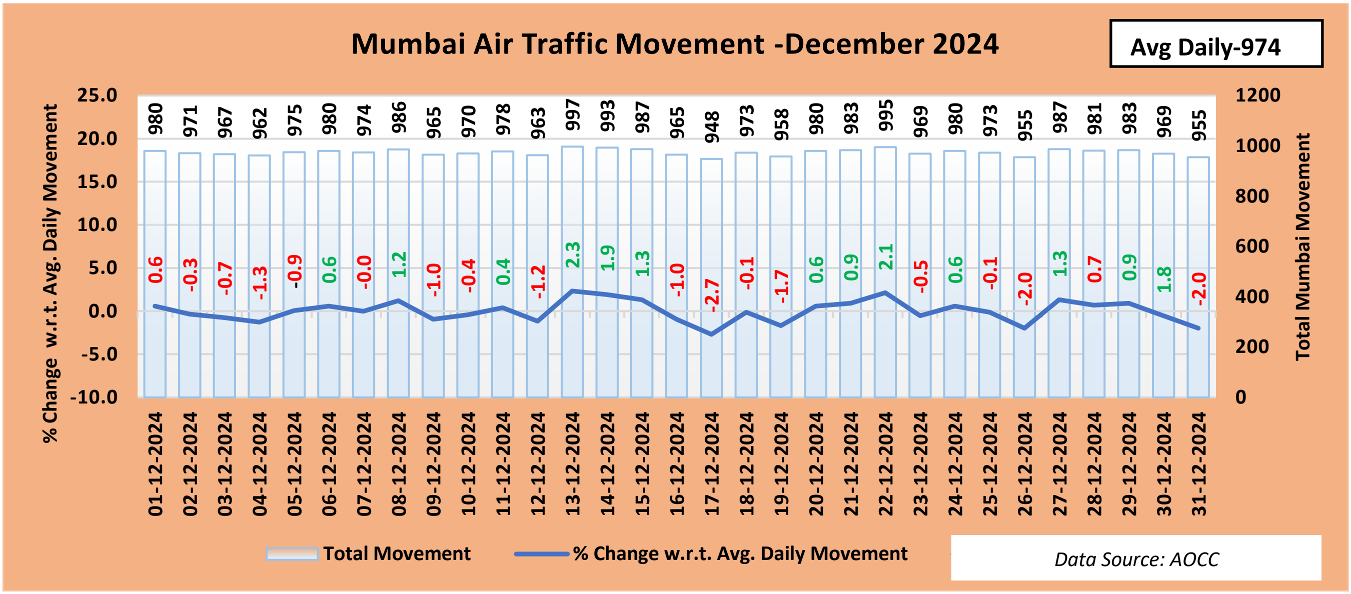
Airports\Year	Avg. Daily ATMs (YoY) for six major airports				
	Dec’20	Dec’21	Dec’22	Dec’23	Dec’24
Bengaluru	469	566	656	699	744
Chennai	283	342	350	387	461
Delhi	894	1247	1287	1287	1355
Hyderabad	351	388	444	491	571
Kolkata	294	382	385	394	415
Mumbai	523	765	887	958	974

Air Traffic Movement for each day in December'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.



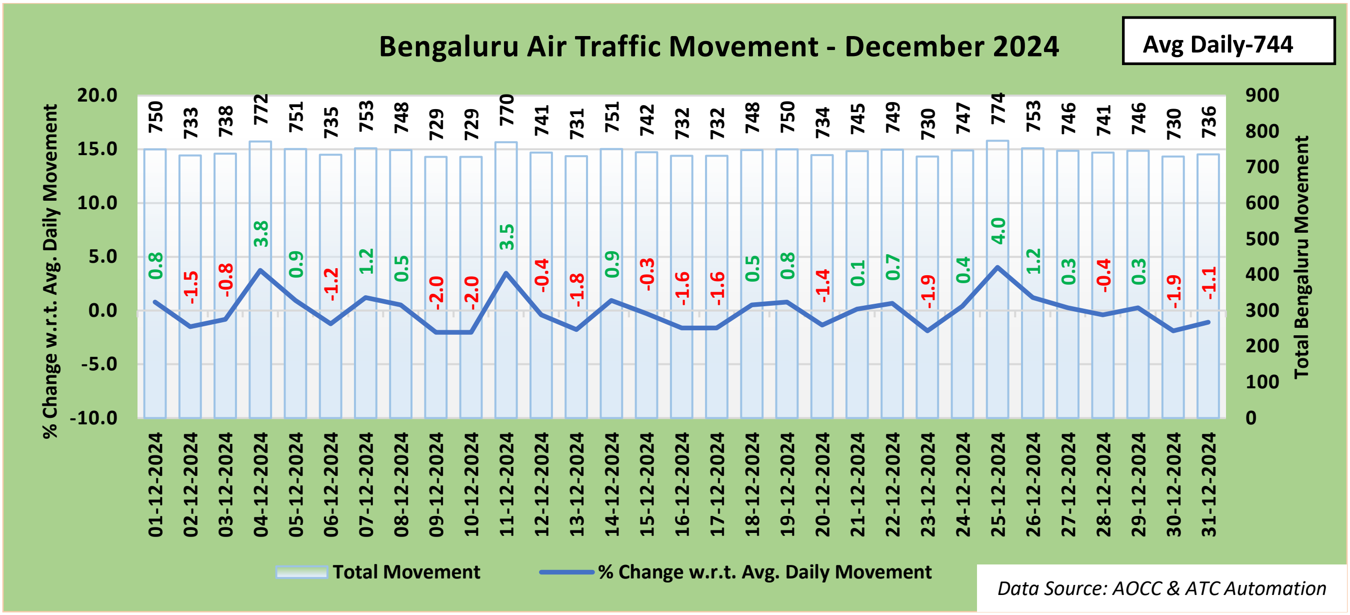
Data Source: AOCC

Figure 3: Air Traffic Movement for Delhi –December 2024



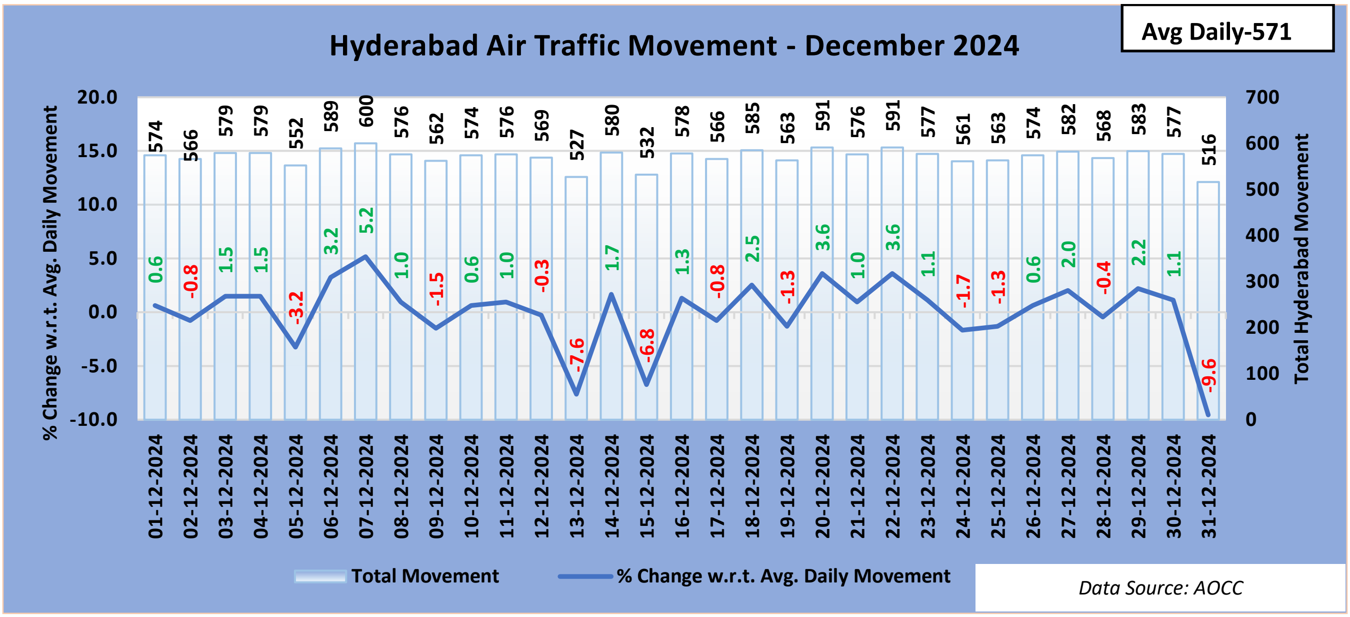
Data Source: AOCC

Figure 4: Air Traffic Movement for Mumbai - December 2024



Data Source: AOCC & ATC Automation

Figure 5: Air Traffic Movement for Bengaluru – December 2024



Data Source: AOCC

Figure 6: Air Traffic Movement for Hyderabad – December 2024

It can be concluded from the above charts that the ATM at Delhi, Mumbai, Bengaluru and Hyderabad exceeds the average daily movement for 17days, 13 days, 16 days and 19 days respectively in the month of December’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 December 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.

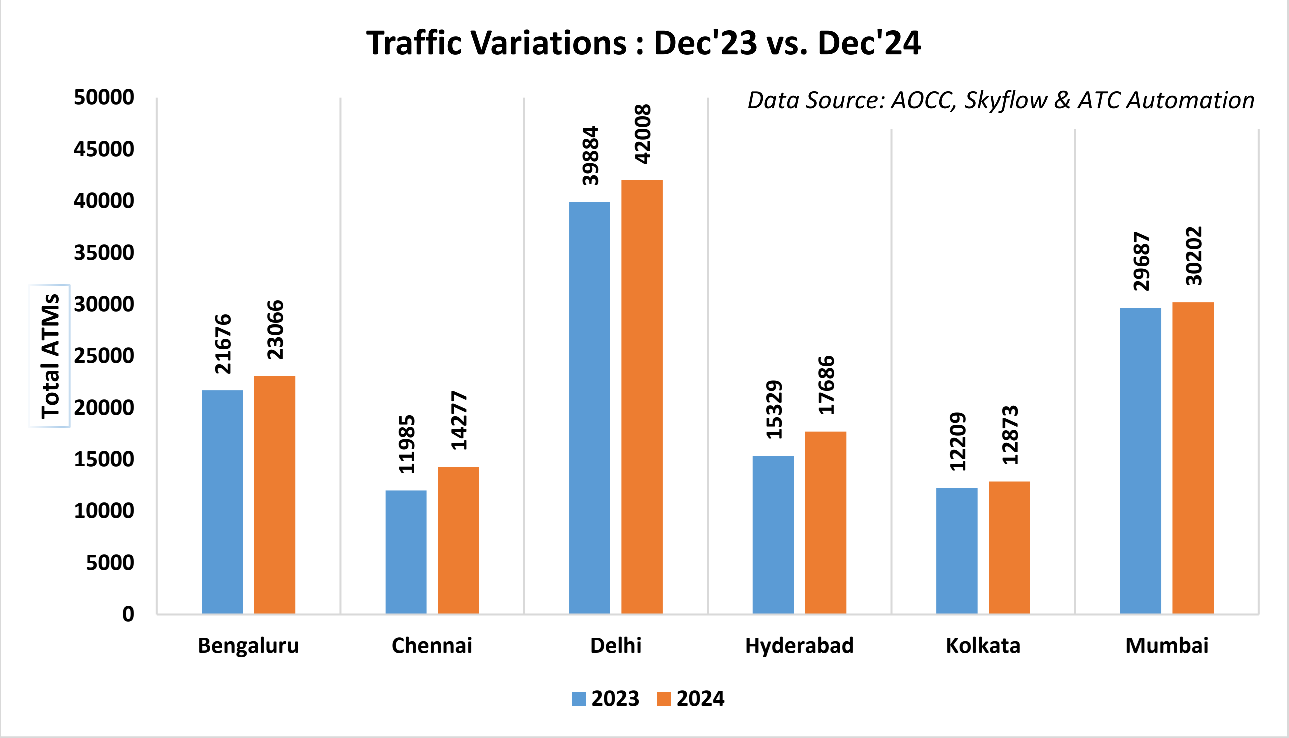


Figure 7: Traffic Variation (YoY)

III. Flight Operations – Airlinewise

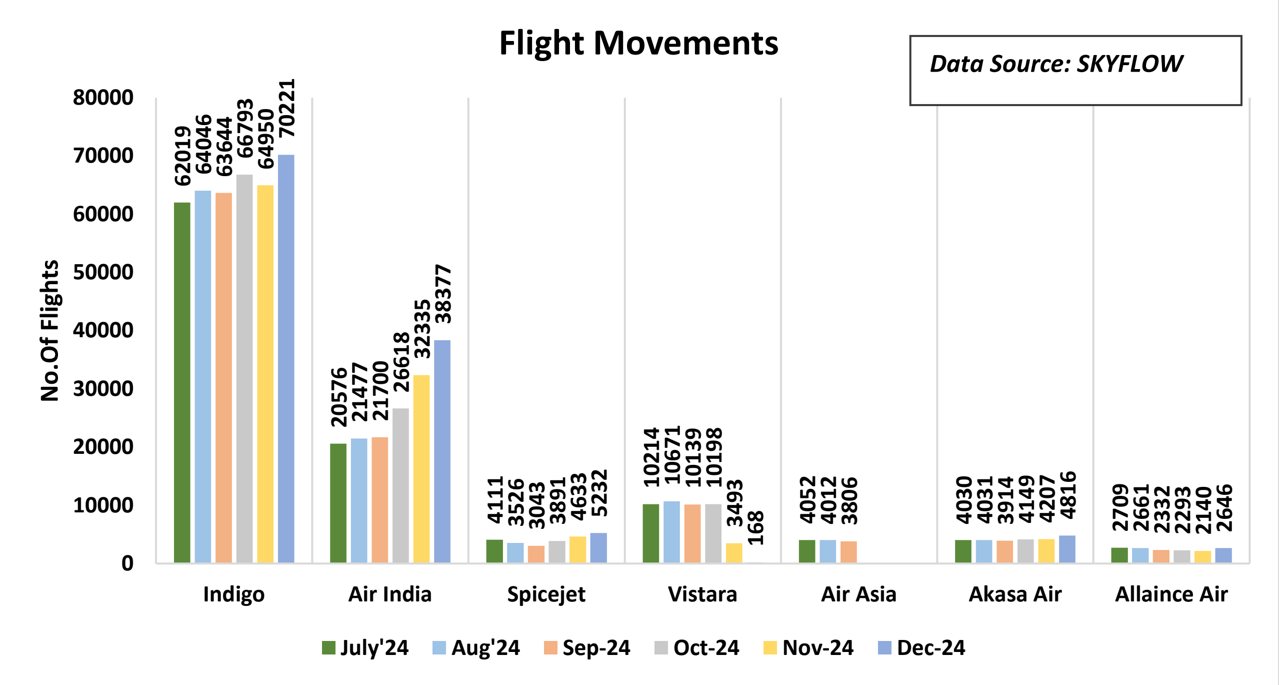


Figure 8: Flight Movements –Airlinewise

Inference:

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

C. ATFM Post Operations – CDM Analysis

I. Introduction

Analysis Period **1st – 31st December 24**

Back Ground During the above mentioned period, **One (01)** ATFM measure was applied **for Bengaluru Airport, Eight (08)** ATFM measures were applied **for Chennai Airport, Two (02)** ATFM measures were applied **for Delhi Airport and Fifty Four (54)** ATFM measures were applied **for Mumbai Airport** due to the following reasons as illustrated in the bar chart below:–

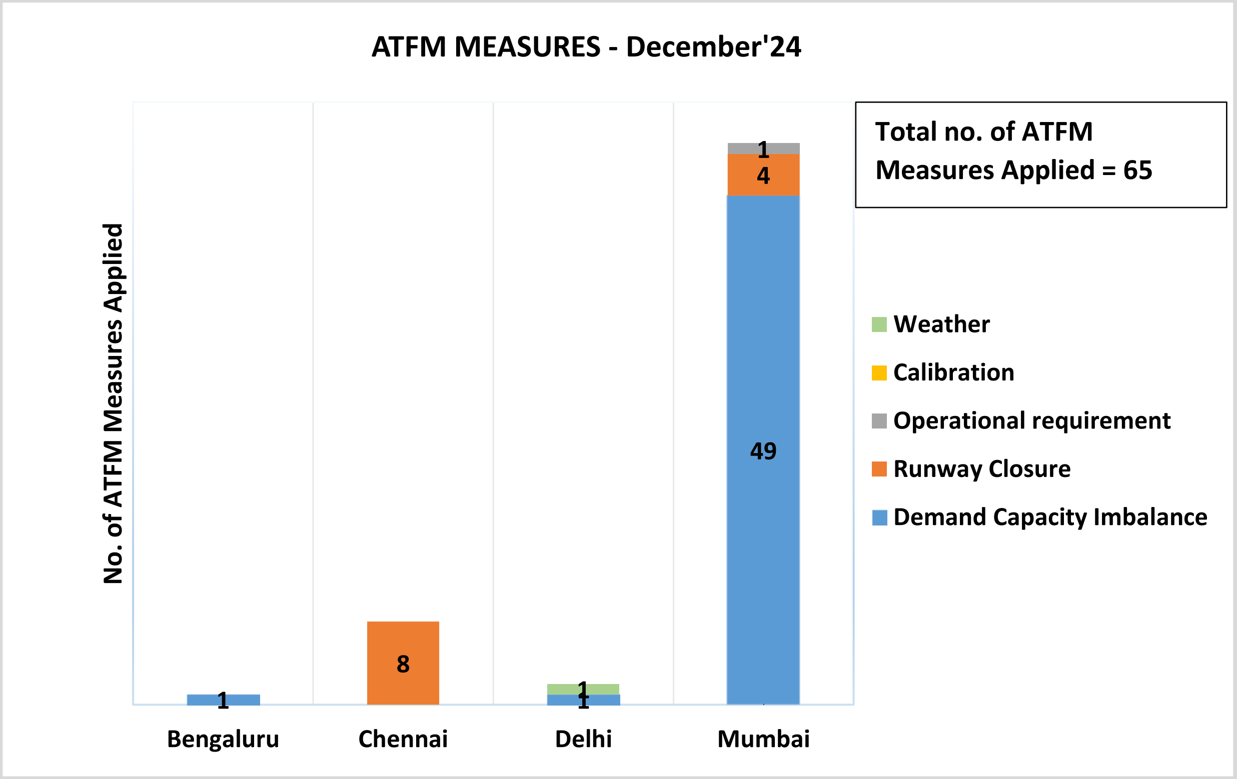


Figure 9: ATFM Measures –Dec'24

II. ATFM Measures Overview

Constrained Airport	**Bengaluru**	**Chennai**	**Delhi**	**Mumbai**
Number of ATFM measures applied	1	8	2	54
Average ATFM Ground delay(in min) due to measures*	22.6	25.4	13.7	26.9
Maximum ATFM Ground delay(in min) due to measures	31	50	40	87
% Compliance	100	97.2	96.8	97.7

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

Total Arrivals	4485
Total International Arrivals(exempted)	1071
Total affected flights in scenario (Domestic Arrivals)	3414
Total Domestic Arrivals with zero ATFM delay	276
Total Domestic Arrivals with ATFM delay	3138

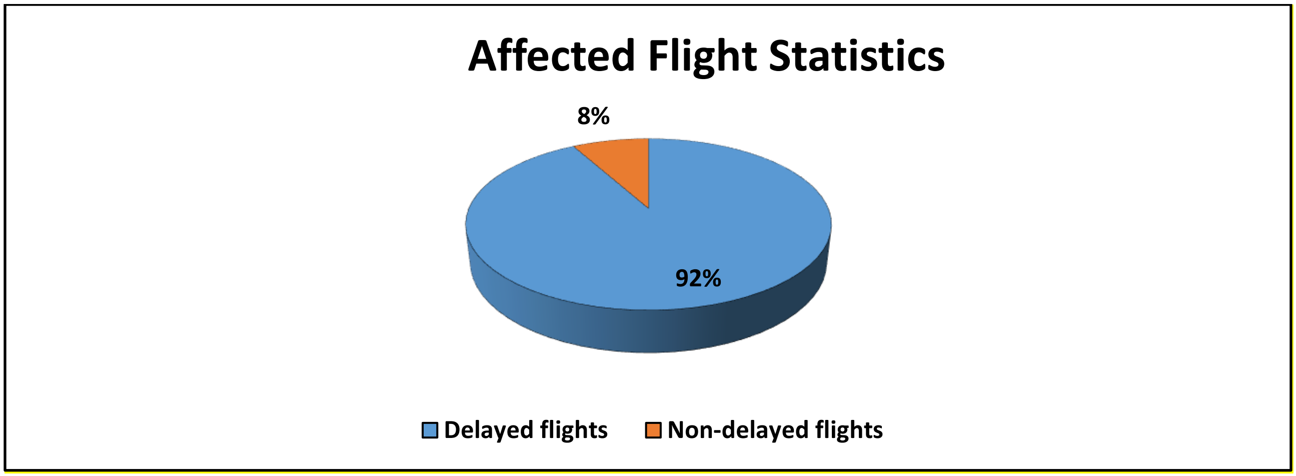


Figure 10: Affected Flight Statistics –Dec’24

III. Overall Compliance

Total arrivals	4485
Domestic arrivals	3414
Flights with complete data (ATOT)	3367
Flights with incomplete data	6
Flights Not Operated	41
Compliant*	3289
Non-Compliant	78

*Total No. of Revised CTOTs issued = 1229 (Compliance calculation for flights which were issued revised CTOT is w.r.t. new CTOT issued)

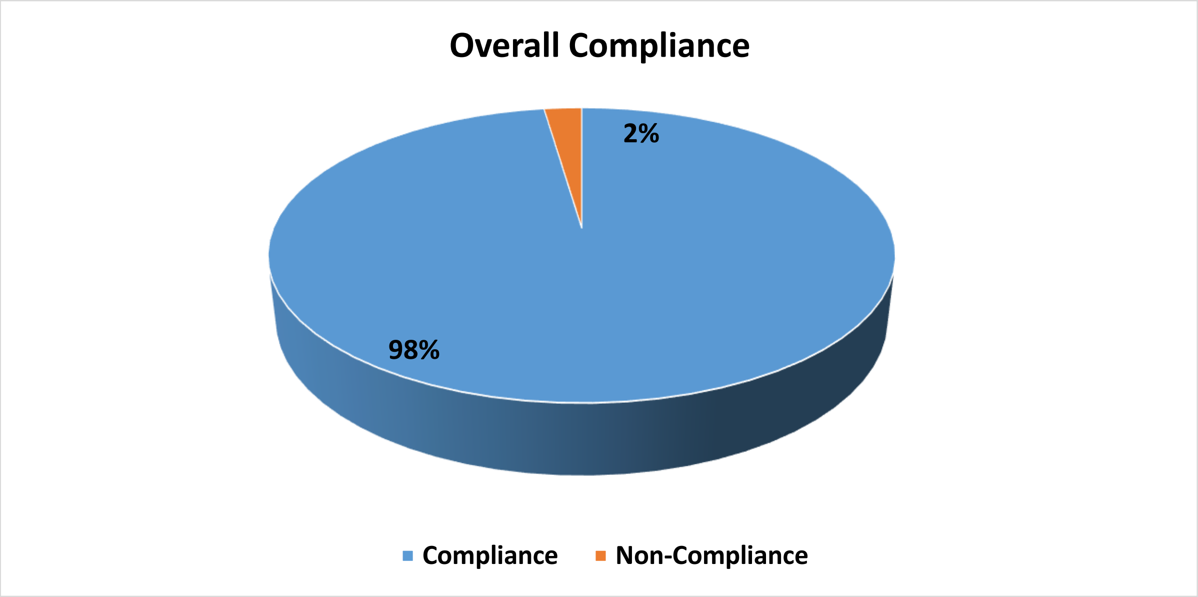


***Figure 11*: Overall Compliance – Dec'24**

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, 98% arrivals are compliant for the month of December 2024.

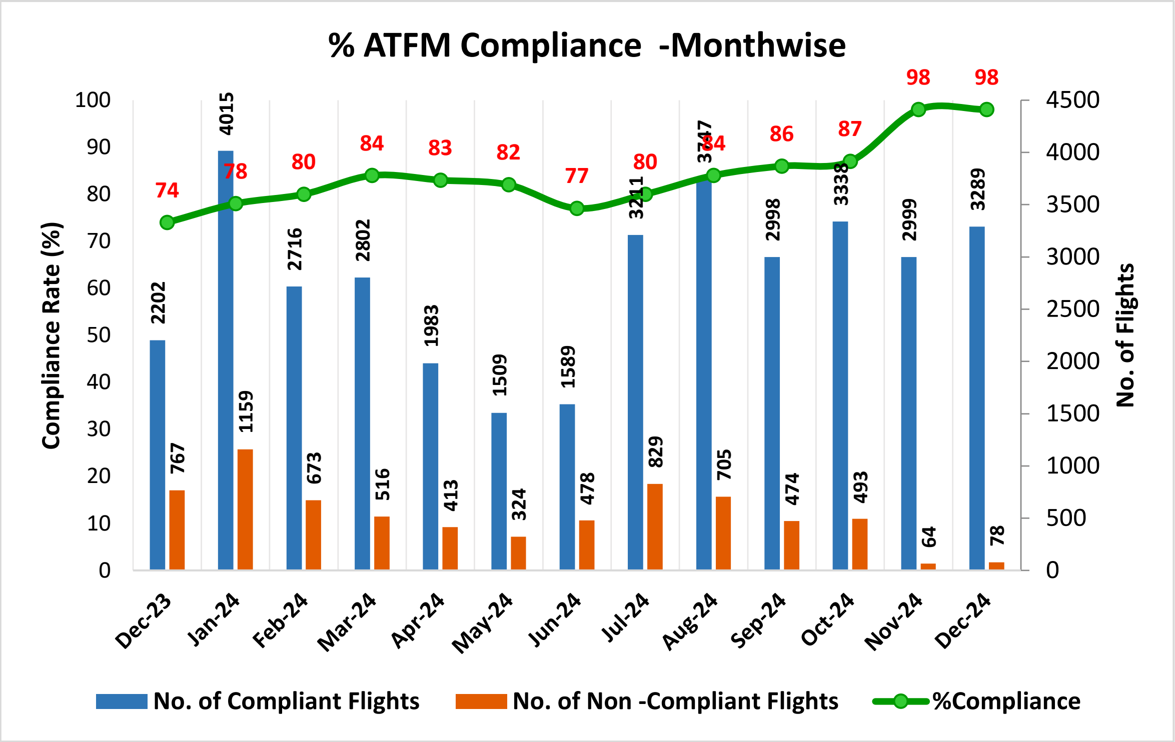


Figure 12: Compliance(Monthwise)

Inference

1. Out of the total arrivals captured(4485 flights) during the CDM scenario for the constrained Airports, 76% of flights i.e. domestic arrivals(3414 flights) were candidates for ground delay(participating).
2. Out of these Domestic Arrivals(3414), 91.9% (3138 flights) are assigned ATFM ground delay.
3. Out of the total arrivals captured(4485 flights) to the constrained Airport during the ATFM scenario, 70% of flights(3138 flights) were assigned ATFM Ground Delay.

IV. CTOT Compliance rate – Airportwise

MUMBAI FIR (98%)*	**Compliant**	**Non Compliant**	**% Compliant**
Ahmedabad	151	3	98%
Aurangabad	23	1	96%
Mumbai	24	0	100%
Vadodara	22	0	100%
Bhopal	34	0	100%
Bhavnagar	1	0	100%
Diu	4	0	100%
Hirasar, rajkot	25	0	100%
Indore	61	2	97%
Jabalpur	6	0	100%
Jalgaon	11	0	100%
Jamnagar	21	4	84%
Kandla	5	1	83%
Kolhapur	8	0	100%
Keshod	2	0	100%
Nagpur	74	0	100%
Nasik	2	0	100%
Pune	18	0	100%
Shirdi	2	0	100%
Surat	2	0	100%
Udaipur	33	0	100%

KOLKATA FIR (97%)*	**Compliant**	**Non Compliant**	**% Compliant**
Prayagraj	12	0	100%
Agartala	1	0	100%
Ayodhya	27	0	100%
Siliguri	23	1	96%
Varanasi	78	0	100%
Bhubaneswar	48	0	100%
Bilaspur	0	1	0%
Kolkata	196	6	97%
Chakeri	6	0	100%
Durgapur	11	0	100%

Darbhanga	13	2	87%
Deoghar	1	0	100%
Gorakhpur	27	3	90%
Guwahati	40	3	93%
Jharsuguda	4	0	100%
Jorhat	1	0	100%
Khajuraho	1	1	50%
Aizawl	2	0	100%
Dibrugarh	1	0	100%
Patna	39	1	98%
Ranchi	12	0	100%
Raipur	39	0	100%
DELHI FIR **(97%)***	**Compliant**	**Non Compliant**	**% Compliant**
Agra	1	0	100%
Amritsar	22	1	96%
Bareilly	4	1	80%
Chandigarh	55	2	96%
Dehradun	30	0	100%
Delhi	531	21	96%
Gwalior	8	0	100%
Jodhpur	8	0	100%
Jaipur	95	3	97%
Jaisalmer	1	0	100%
Jammu	17	1	94%
Kishangarh	1	0	100%
Lucknow	76	1	99%
Srinagar	11	1	92%
CHENNAI FIR (99%)*	Compliant	Non Compliant	% Compliant
Hal Bangalore	6	0	100%
Bangalore	303	6	98%
Belgaum	4	0	100%
Vijayawada	38	0	100%
Coimbatore	88	0	100%
Kochi	104	2	98%
Calicut	5	1	83%
MOPA Goa	79	3	96%

Goa	152	2	99%
Hubli	2	0	100%
Shamsabad, Hyderabad	186	0	100%
Begumpet Hyderabad	5	0	100%
Kannur	6	0	100%
Madurai	22	0	100%
Mangalore	35	1	97%
Chennai	182	1	99%
Port Blair	12	1	92%
Rajahmundry	22	0	100%
Tuticorin	7	0	100%
Tiruchirappally	8	1	89%
Thiruvananthapuram	35	0	100%
Visakhapatnam	15	0	100%

**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(98%) for the month are highlighted in red.

V. CTOT Compliance rate – Airlinewise

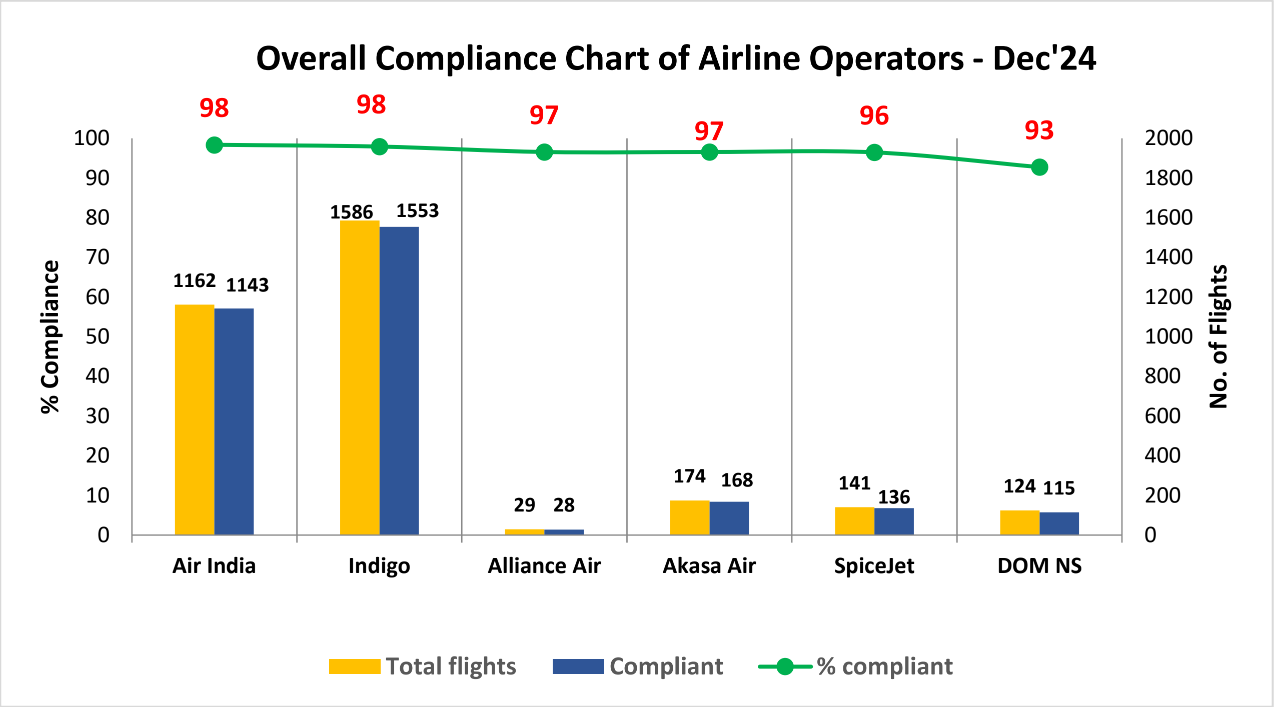


Figure 13: Airline wise Compliance –Dec'24

Inference

1. Chennai region record the highest compliance of 99% whereas Delhi region has the lowest percentage compliance of 97%.
2. Air India and Indigo Airlines have a CTOT compliance higher than the average recorded compliance for the month of December'24.

VI. Reason For Non Compliance

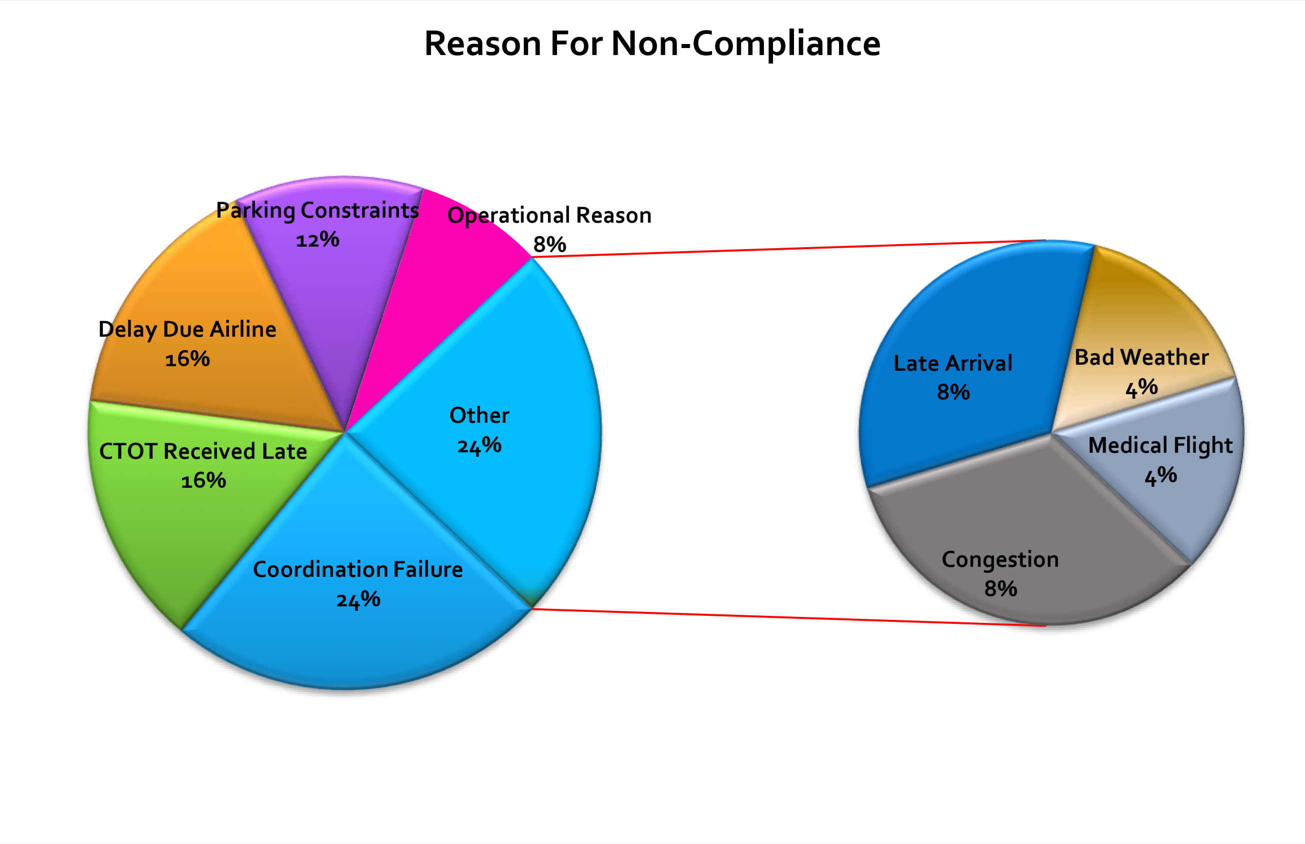


Figure 14: Reason for Non-Compliance as provided by FMPs

Inference:

1. 24 % of CTOT Non- Compliance was reported by concerned FMPs to be due to coordination failure at various airports.
2. 16 % 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.
3. 16 % of the CTOT Non- compliance was due to airline delay. 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 3.8,9.6,19.3 and 10.3 minutes respectively.

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

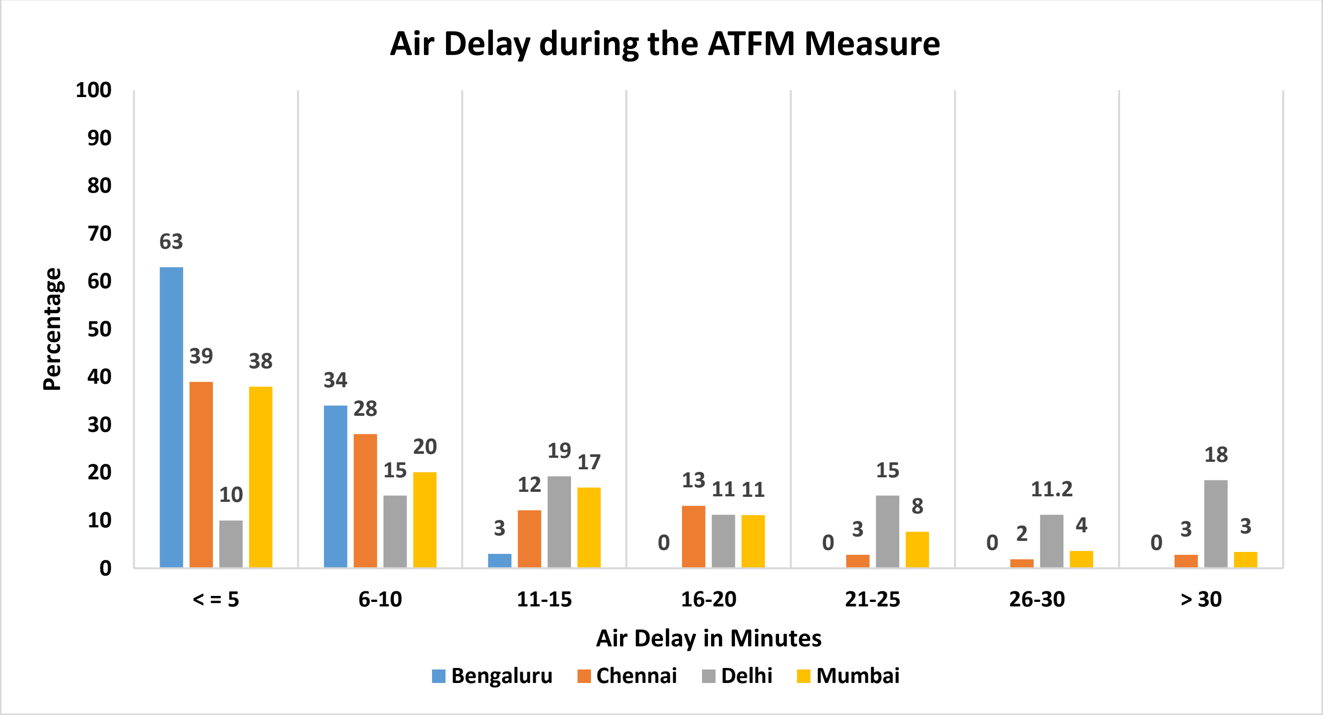


Figure 15: Air Delay distribution during the CDM period

Inference

1. 97% of domestic arriving flights to Bengaluru had an Air delay of equal to or less than 10 minutes during the CDM period.
2. 67% of domestic arriving flights to Chennai had an Air delay of equal to or less than 10 minutes during the CDM period.
3. 25% of domestic arriving flights to Delhi had an Air delay of equal to or less than 10 minutes during the CDM period.
4. 58% 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 = ∑ (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) = **∑ (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)= 40594 mins

Total Air Delay (with no ATFM measures) = 76307 mins

Reduction in Air delay due to ATFM measures= (76307-40594) = **35713 mins**

Fuel Saving Calculation:

Total Fuel saved during the ATFM Measure: ***21,41,370.62 Kg***

Total reduction in CO_2 emission : 3.16($KgCO_2$/kg fuel)* 21,41,370.62 **Kg** ***= 67,66,731.17 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**
Affected Flight statistics	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)
Average ATFM delay	$\frac{\textbf{Total monthly ATFM delay (in minutes)}}{\textbf{Total Domestic Arrivals}}$
Maximum ATFM delay	Maximum ATFM delay (in minutes) assigned in the month
Overall compliance rate	Defined as monthly ATFM departure slot adherence rate of regulated flights. Flights having ATOT within theATFM Slot Tolerance Window (STW) of minus 5 to plus 10 minutes of CTOTs, are considered as compliant flights
CTOT Compliance rate of Airline operators	An overview of CTOT compliance rate of various Airline operators
CTOT Compliance rate of Airports within different Regions	An overview of CTOT compliance rate of Airports within 4 FIRs
Air delay statistics	Air delay defined as difference between AET & EET, whereAET(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** Average Air Delay is calculated as: $\textbf{Average Air Delay} = \frac{\textbf{Total Air Delay to domestic arrivals (with values greater than zero)}}{\textbf{Total Domestic Arrivals}}$ *CLDT: Calculated Landing Time* *CTOT: Calculated Take off Time* *ALDT: Actual Landing Time* *ATOT: Actual Take off Time*

Annexure-A

Compliance by Airlines with Flight Planning Requirements of Common Business rules(CBR)- December 2024.

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 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.

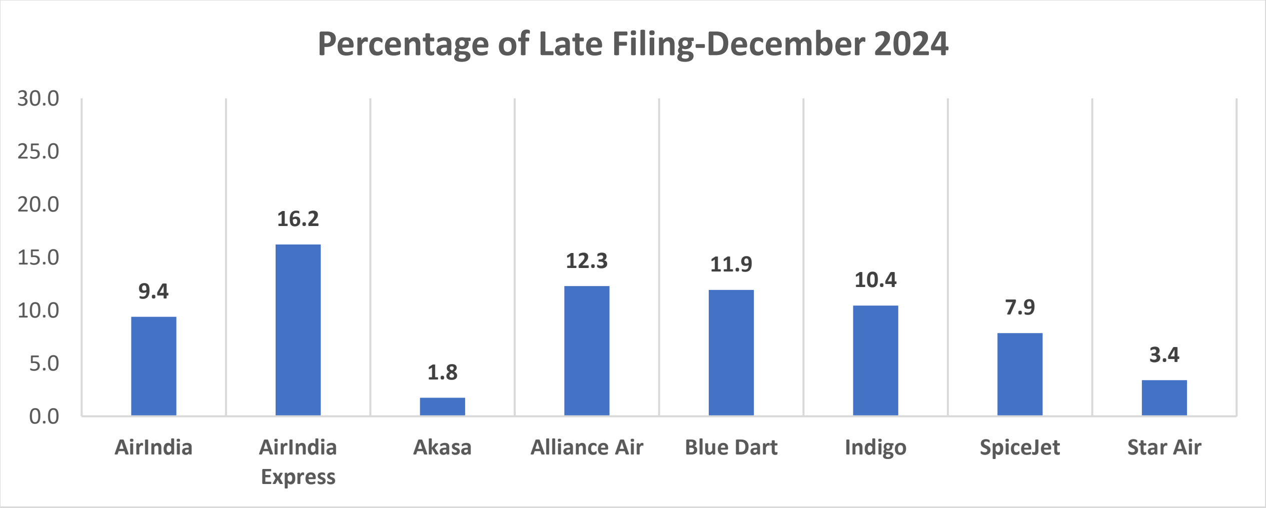
AIP India, ENR 1.9 section 4 on Flight Planning in the context of ATFM recommends Flight Planning requirements for all Airline Operators –

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;”

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 December 2024 to 31st December 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.



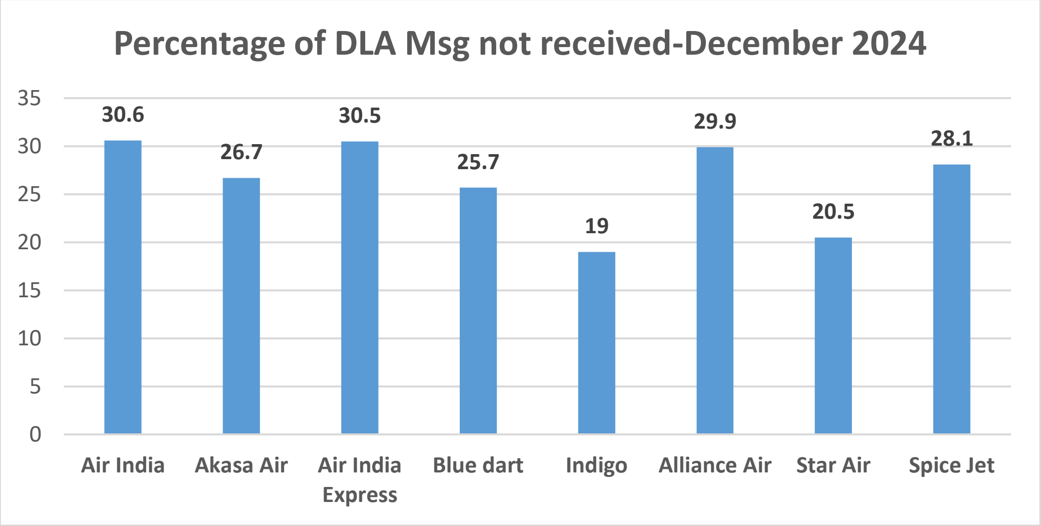
The table below lists number of filed flight plans (FPLs) with less than 3 Hours prior to EOBT:

Name of Airline	**Late Filed FPL**	**Total No. Of FPL**	**% Delayed Filing**
AirIndia	2225	23730	9.4
AirIndia Express	2170	13390	16.2
Akasa	74	4239	1.8
Alliance Air	224	1824	12.3
Blue Dart	83	696	11.9
Indigo	7067	67667	10.4
SpiceJet	373	4746	7.9
Star Air	40	1174	3.4
Total no. of FPLs for Scheduled Airlines	**12256**	**117466**	**10.4**

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 December 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	6033	19691	30.6
Akasa Air	927	3470	26.7
Air India Express	2963	9703	30.5
Blue dart	153	596	25.7
Indigo	9925	52015	19
Alliance Air	292	975	29.9
Star Air	92	447	20.5
Spice Jet	1003	3566	28.1



C. For analysis of non-receipt of CNL (cancel) messages for December 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 December 2024:

Name of Airline	**CNL message not received**	**No. of flights annulled**
Air India	134	137
Akasa Air	36	40
Air India Express	159	170
Blue dart	15	15
Indigo	289	300
Alliance Air	187	188
Star Air	39	39
Spice Jet	73	74

-End of Report-