POST OPERATIONS ANALYSIS REPORT

November, 2024

CENTRAL COMMAND CENTER, C-ATFM, DELHI

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A. Executive Summary

Average Domestic air traffic has recorded an increase of 16.8% whereas the average international air traffic has increased by 2.8 % in the month of November '24 as compared to October '24.

On average, the Indian Airports in the ATFCM area saw 5237 IFR flights per day in the month of November 2024. The peak days were on 26th & 27th November 2024 (6017 IFR flights). Wednesday's were the busiest days throughout this month with an average of 5510 IFR flights per day.

Total Fifty Eight (58) ATFM measures were applied this month during periods of congestion at Bengaluru, Chennai, Delhi and Mumbai Airport.

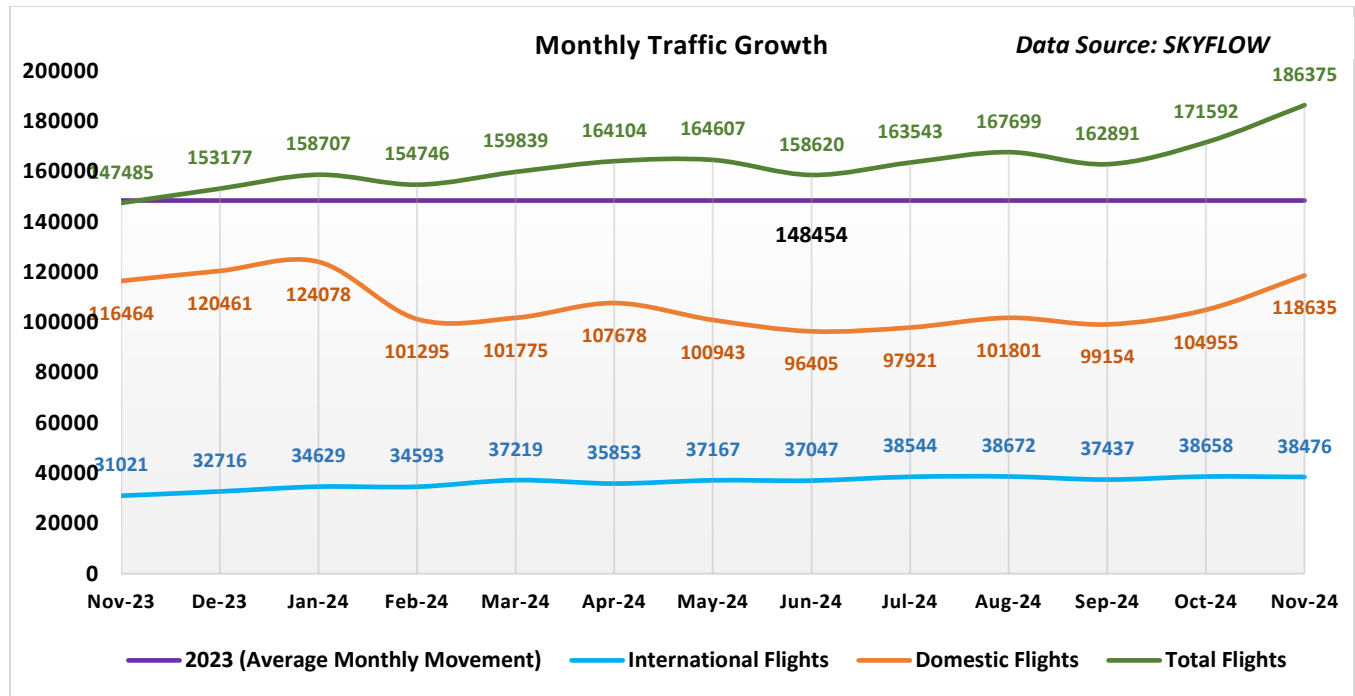**Monthly Traffic Growth**   *Data Source: SKYFLOW*

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 (November'23 to November'24).

B. Traffic Analysis

I.   Air Traffic Movement at Major Airports in India

Average Daily Movements(Oct'24 vs Nov'24)

Source: AOCC, Skyflow & ATC Automation

	Bengaluru	Chennai	Delhi	Hyderabad	Kolkata	Mumbai
	↓1.7%	↑0.5%	↓1.0%	↓1.8%	↓3.3%	↑1.1%
Oct'24	752	429	1357	571	423	949
Nov'24	739	431	1343	561	409	959

Y-axis: Average daily ATMs (0 to 2000)
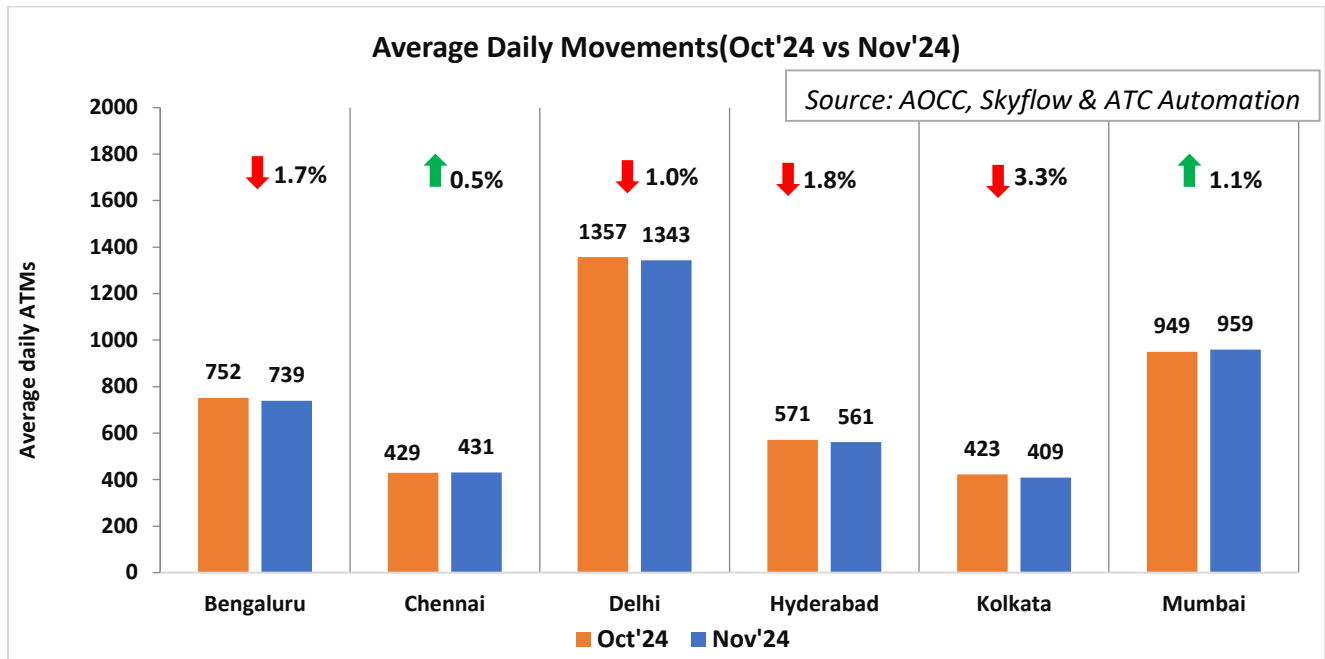
Figure 2: Average Daily Movements (Oct '24 vs Nov '24)

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

Airports\Year	Avg. Daily ATMs (YoY) for six major airports				
	Nov'20	Nov'21	Nov'22	Nov'23	Nov'24
Bengaluru	421	540	623	687	739
Chennai	243	323	339	404	431
Delhi	797	1210	1270	1290	1343
Hyderabad	310	388	423	490	561
Kolkata	265	369	394	403	409
Mumbai	469	715	845	955	959

Air Traffic Movement for each day in November'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.
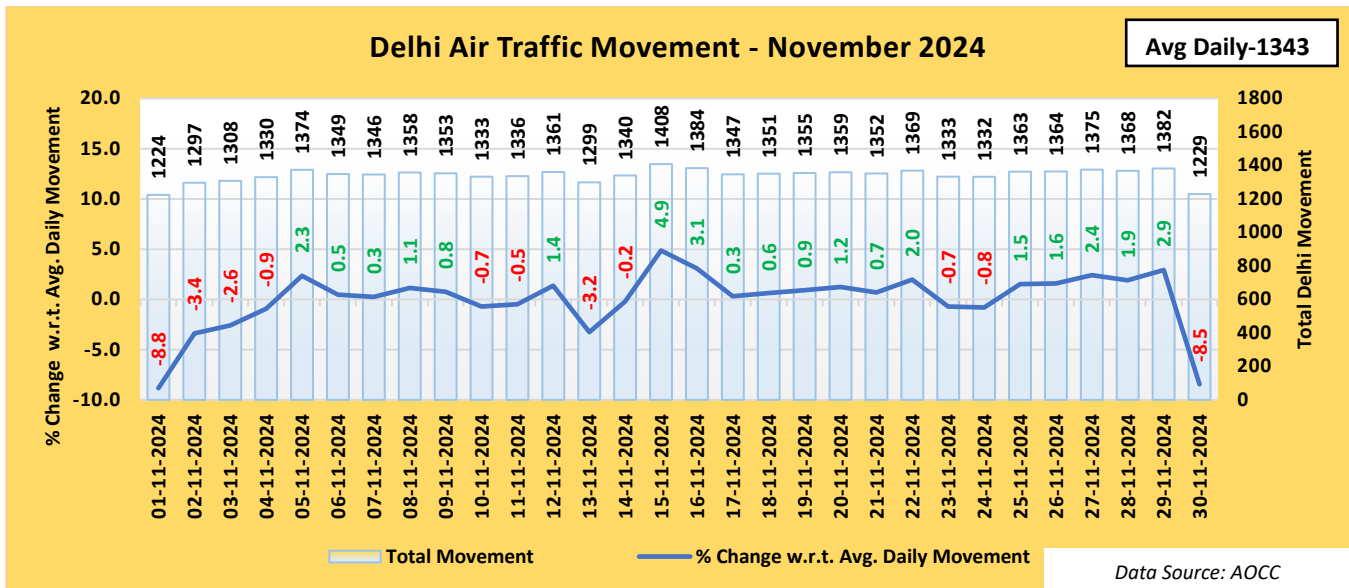
Figure 3: Air Traffic Movement for Delhi –November 2024
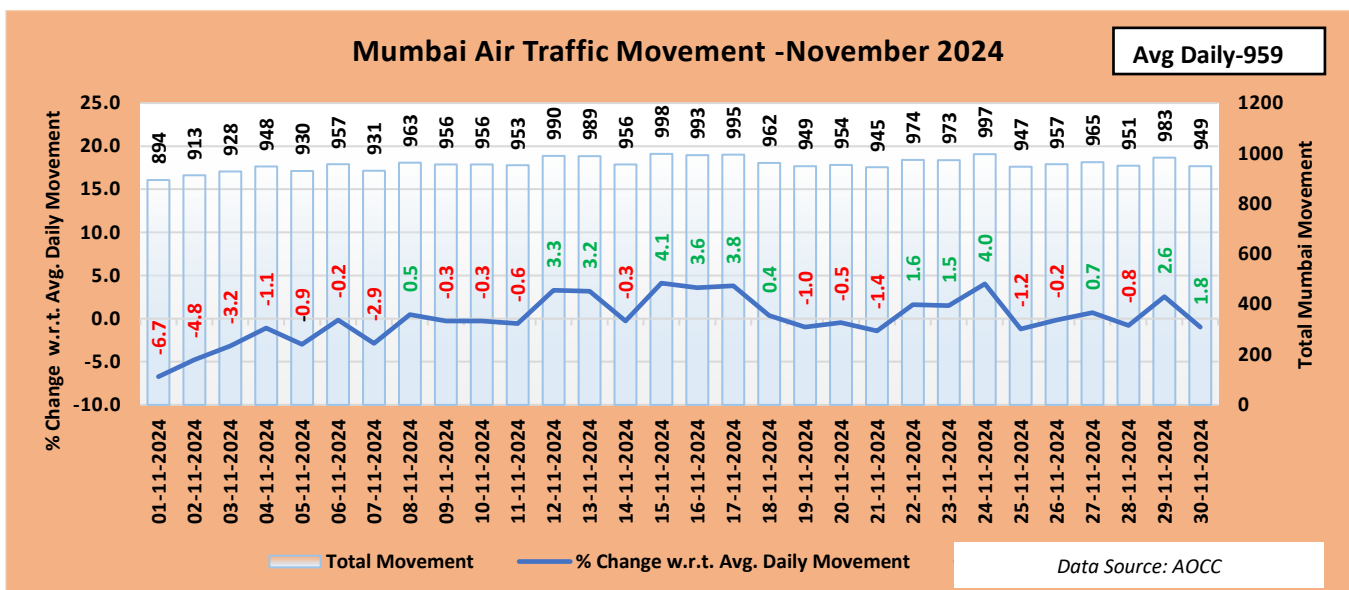
Figure 4: Air Traffic Movement for Mumbai - November 2024
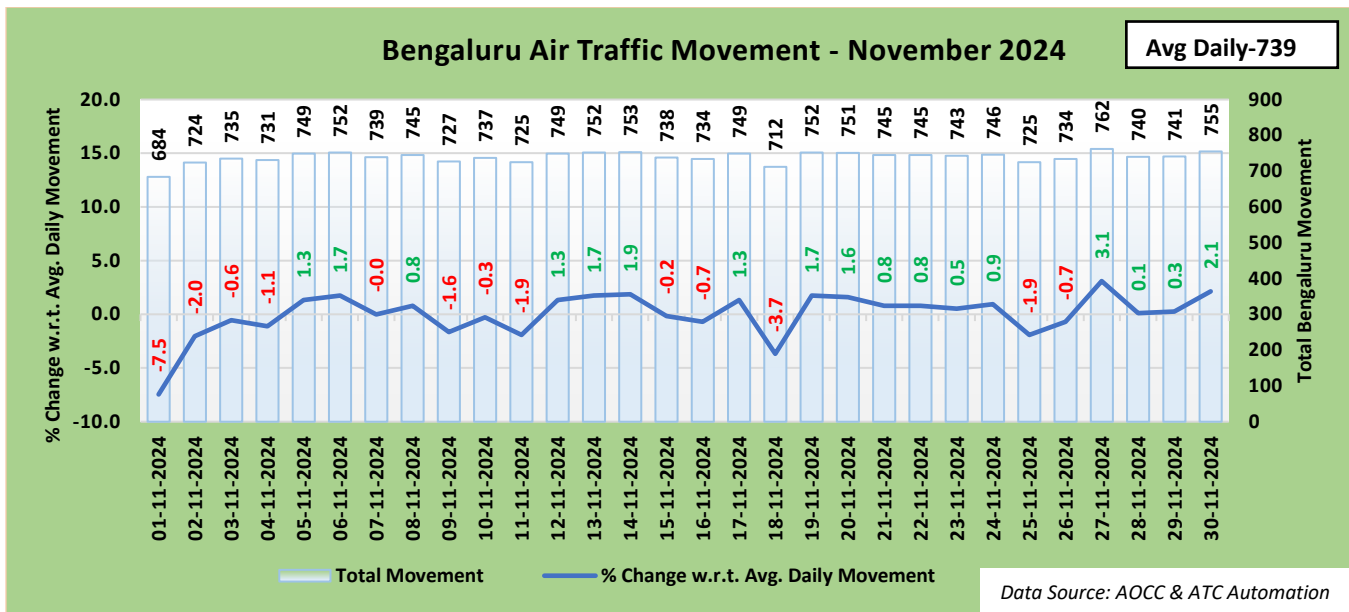
Figure 5: Air Traffic Movement for Bengaluru – November 2024
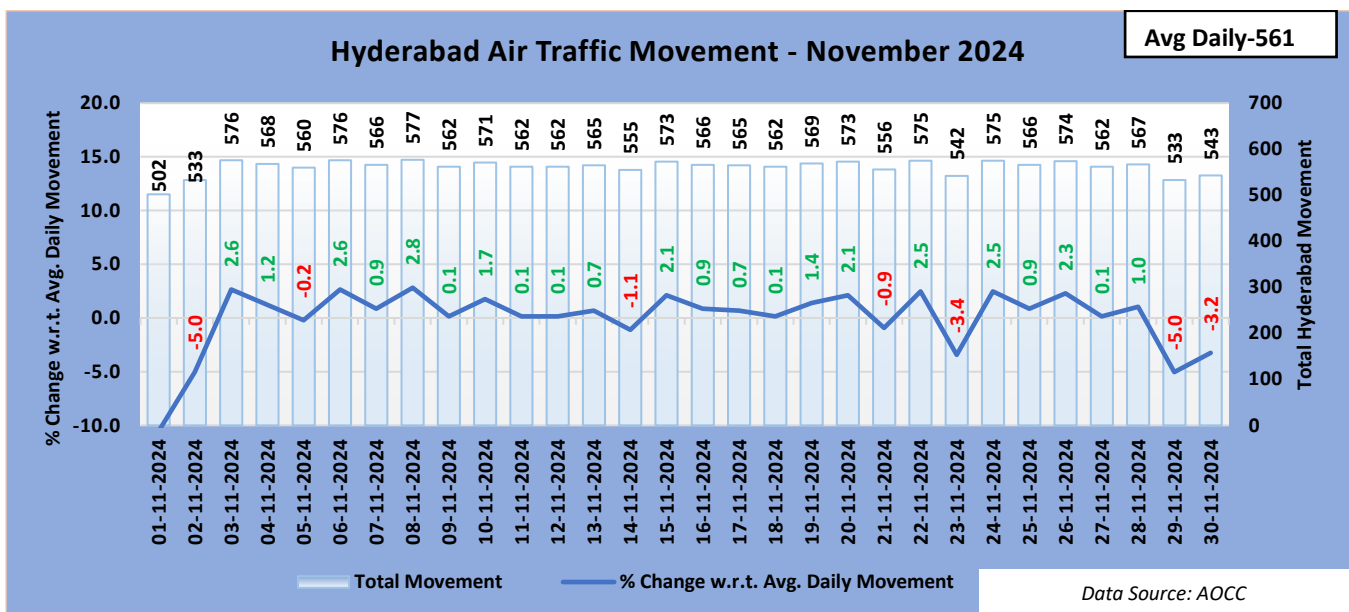
Figure 6: Air Traffic Movement for Hyderabad – November 2024

It can be concluded from the above charts that the ATM at Delhi, Mumbai, Bengaluru and Hyderabad exceeds the average daily movement for 19days, 13 days, 18 days and 22 days respectively in the month of November'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 November 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.
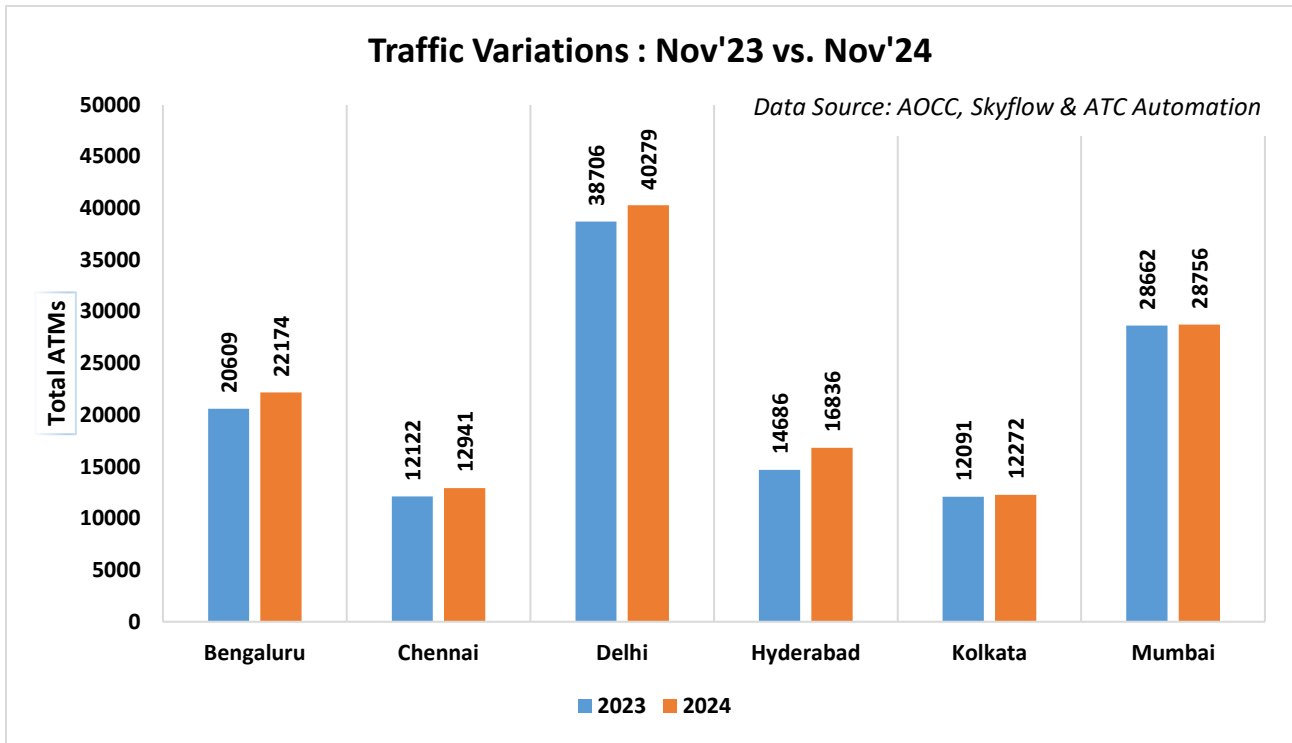
Figure 7: Traffic Variation (YoY)

III. Flight Operations – Airlinewise

Flight Movements

Data Source: SKYFLOW

No.Of Flights

| Indigo | Air India | Spicejet | Vistara | Air Asia | Akasa Air | Allaince Air |

■ June'24   ■ July'24   ■ Aug'24   ■ Sep-24   ■ Oct-24   ■ Nov-24
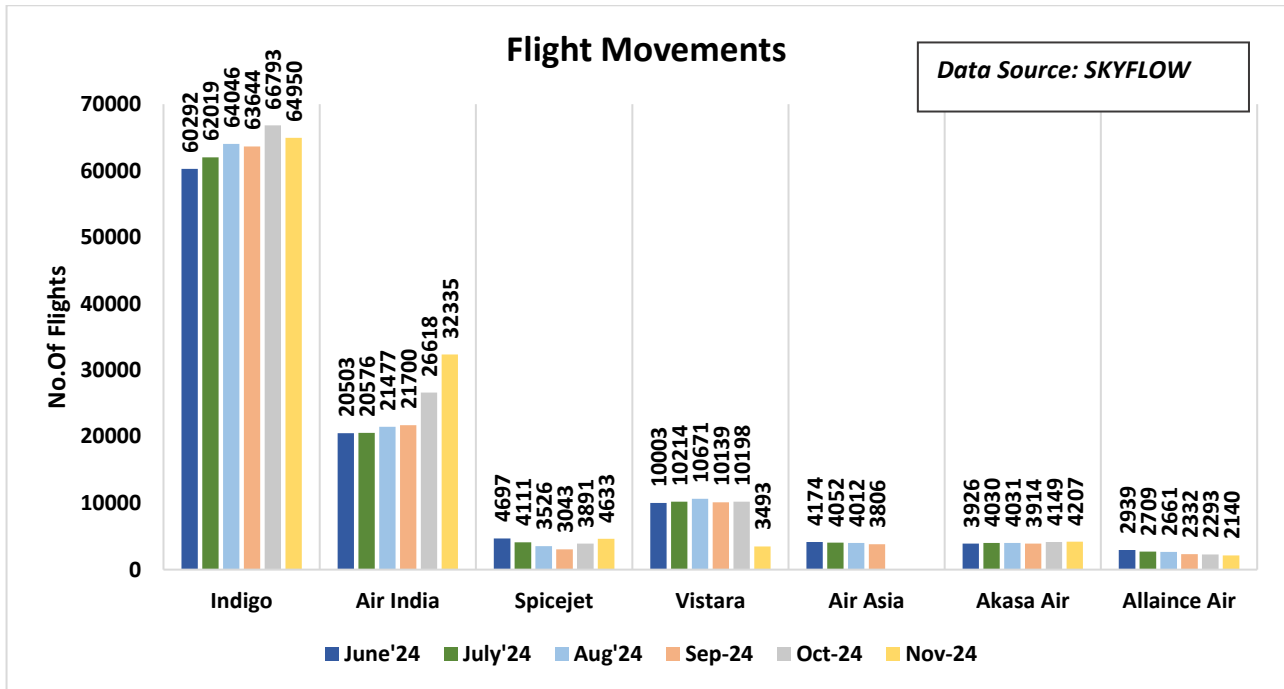
Figure 8: Flight Movements –Airlinewise

Inference:

1. Air India, Spicejet and Akasa airlines have recorded an increase in the monthly average(30 days) Flight movement in November'24 as compared to Oct '24 while Indigo, Alliance air and Vistara airlines have recorded a decline during the same period.

C. ATFM Post Operations – CDM Analysis

I. Introduction

Analysis Period   **1ˢᵗ – 30ᵗʰ November 24**

Back Ground   During the above mentioned period, **Three (03)** ATFM measure was applied **for Bengaluru Airport, Six (06)** ATFM measures were applied **for Chennai Airport, Five (05)** ATFM measures were applied **for Delhi Airport and Forty Four (44)** ATFM measures were applied **for Mumbai Airport** due to the following reasons as illustrated in the bar chart below:–
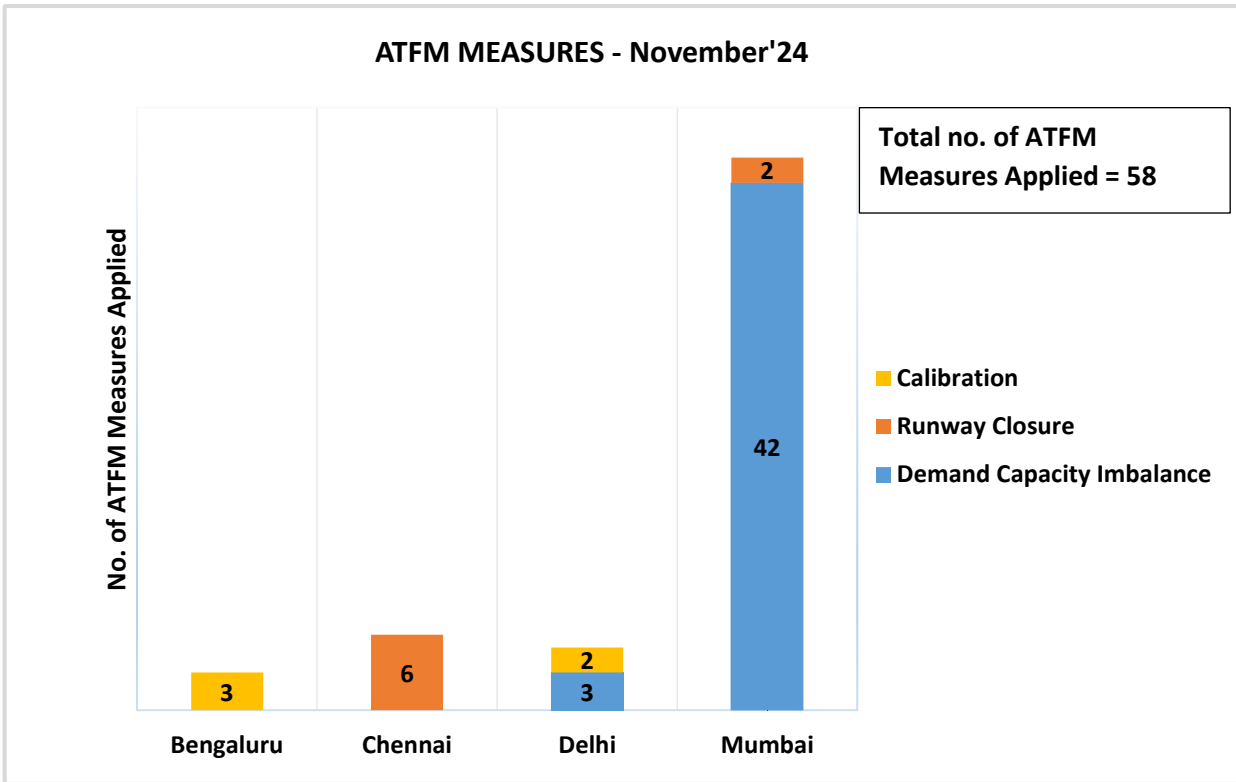
Figure 9: ATFM Measures –Nov'24

II. ATFM Measures Overview

Constrained Airport	Bengaluru	Chennai	Delhi	Mumbai
Number of ATFM measures applied	3	6	5	44
Average ATFM Ground delay(in min) due to measures*	22.3	23.3	12.8	30.1
Maximum ATFM Ground delay(in min) due to measures	47	45	42	95
% Compliance	91.7	88.6	95.6	98.4

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

Total Arrivals	4192
Total International Arrivals(exempted)	1007
Total affected flights in scenario (Domestic Arrivals)	3185
Total Domestic Arrivals with zero ATFM delay	240
Total Domestic Arrivals with ATFM delay	2945

Affected Flight Statistics

8%

92%

■ Delayed flights   ■ Non-delayed flights
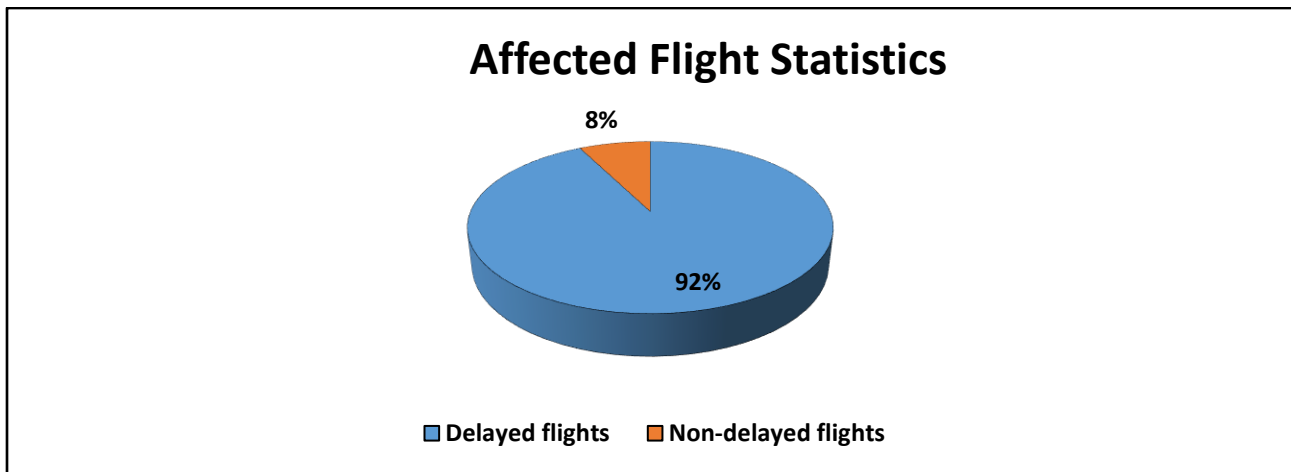
Figure 10: Affected Flight Statistics –Nov'24

III. Overall Compliance

Total arrivals	4192
Domestic arrivals	3185
Flights with complete data (ATOT)	3063
Flights with incomplete data	44
Flights Not Operated	78
Compliant*	2999
Non-Compliant	64

*Total No. of Revised CTOTs issued = 1245 (Compliance calculation for flights which were issued revised CTOT is w.r.t. new CTOT issued)
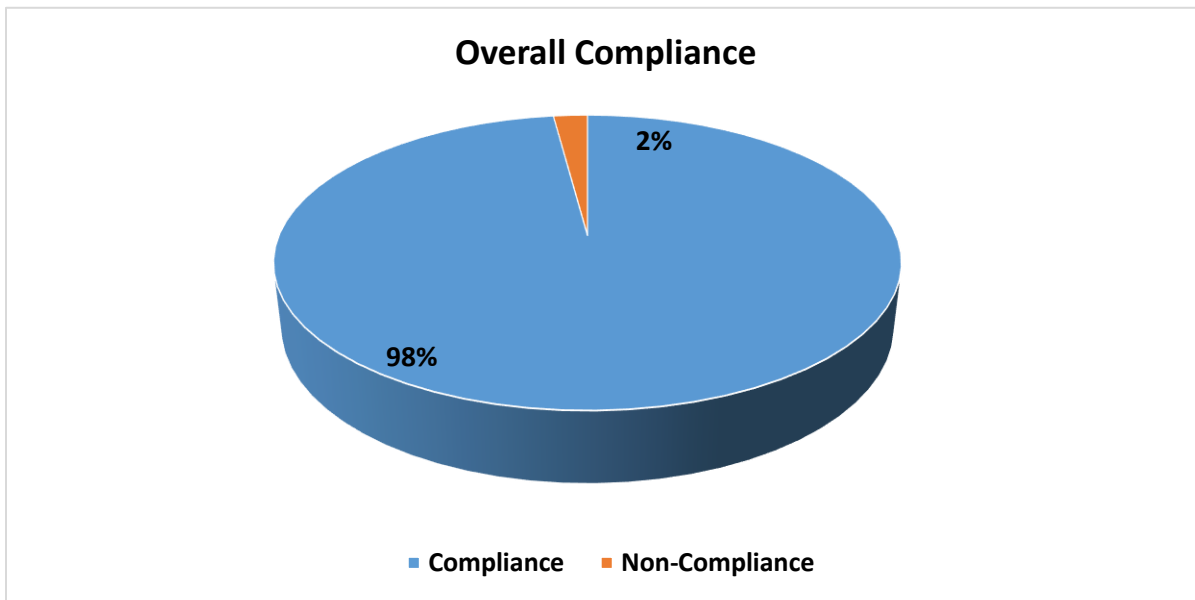
Figure 11: Overall Compliance – Nov'24

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 November 2024 whereas 87% arrivals were compliant for the month of October 2024 and there has been an increase of 11% in compliance in the month of November'24 with respect to October'24.
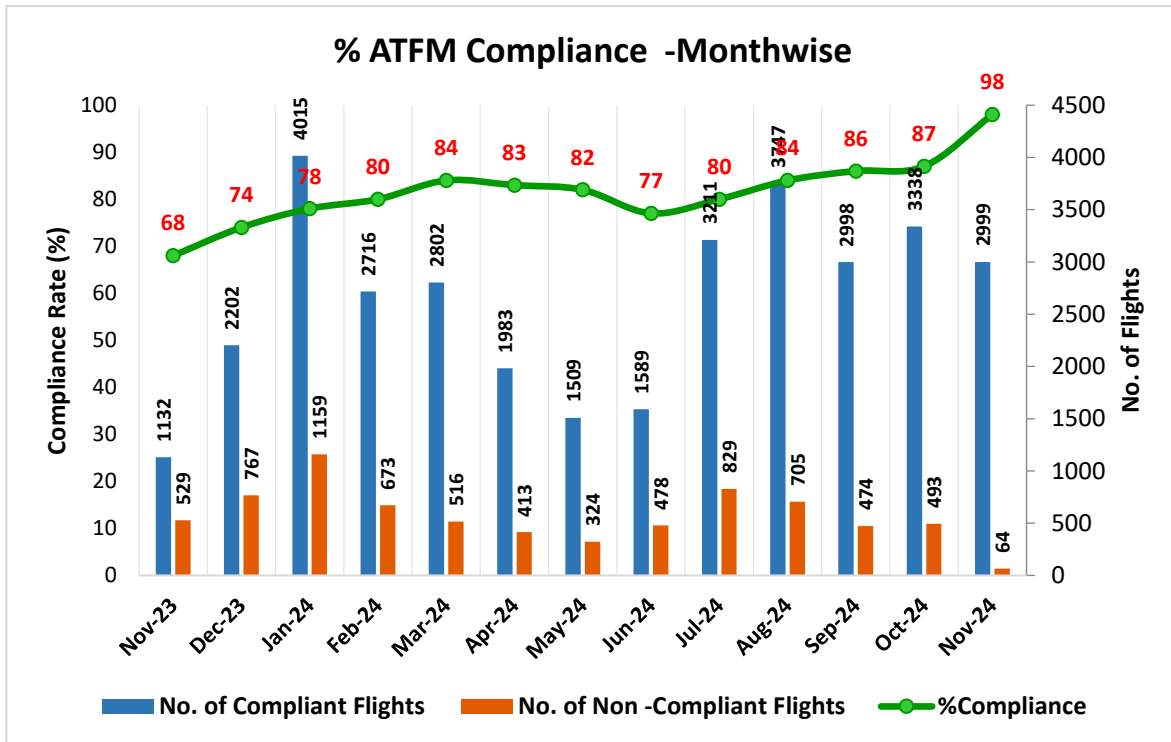
Figure 12: Compliance(Monthwise)

Inference

1. Out of the total arrivals captured(4192 flights) during the CDM scenario for the constrained Airports, 76% of flights i.e. domestic arrivals(3185 flights) were candidates for ground delay(participating).
2. Out of these Domestic Arrivals(3185), 92.5% (2945 flights) are assigned ATFM ground delay.
3. Out of the total arrivals captured(4192 flights) to the constrained Airport during the ATFM scenario, 70.3% of flights(2945 flights) were assigned ATFM Ground Delay.

IV. CTOT Compliance rate – Airportwise

MUMBAI FIR (98%)*	Compliant	Non Compliant	% Compliant
Ahmedabad	139	1	99%
Aurangabad	24	0	100%
Mumbai	50	5	91%
Vadodara	22	1	96%
Bhopal	28	0	100%
Diu	1	1	50%
Hirasar, rajkot	26	0	100%
Indore	58	0	100%
Jabalpur	8	0	100%
Jalgaon	11	0	100%
Jamnagar	11	1	92%
Kandla	5	0	100%
Kolhapur	8	0	100%
Keshod	4	0	100%
Mundra	2	0	100%
Nagpur	65	0	100%
Nasik	1	1	50%
Pune	13	1	93%
Shirdi	4	0	100%
Surat	6	0	100%
Udaipur	33	0	100%
KOLKATA FIR (98%)*	**Compliant**	**Non Compliant**	**% Compliant**
Prayagraj	9	1	90%
Agartala	1	0	100%
Ayodhya	25	0	100%
Siliguri	27	2	93%
Varanasi	60	1	98%
Bhubaneswar	39	1	98%
Bihta, Patna	1	0	100%
Kolkata	175	2	99%
Chakeri	5	0	100%
Durgapur	8	0	100%

	Compliant	Non Compliant	% Compliant
Darbhanga	5	0	100%
Deoghar	1	0	100%
Gorakhpur	21	1	95%
Guwahati	48	0	100%
Gaya	2	0	100%
Jharsuguda	3	0	100%
Khajuraho	1	0	100%
Aizawl	1	0	100%
Dibrugarh	3	1	75%
Patna	49	1	98%
Ranchi	19	1	95%
Raipur	35	0	100%
DELHI FIR (97%)*	**Compliant**	**Non Compliant**	**% Compliant**
Agra	1	0	100%
Amritsar	21	0	100%
Bathinda	1	0	100%
Bareilly	3	1	75%
Chandigarh	59	1	98%
Dehradun	22	0	100%
Delhi	417	15	97%
Kangra	4	1	80%
Gwalior	5	3	63%
Jodhpur	7	1	88%
Jaipur	78	0	100%
Jammu	20	0	100%
Leh	13	0	100%
Lucknow	63	0	100%
Pantnagar	2	2	50%
Shimla	2	1	67%
Sarsawa Air Force Station	0	1	0%
Srinagar	21	0	100%
Uttarlai	1	0	100%
CHENNAI FIR (99%)*	Compliant	Non Compliant	% Compliant
Hal Bangalore	4	0	100%
Baldota Koppal, karnataka	1	0	100%
Bangalore	276	4	99%

Belgaum	1	1	50%
Vijayawada	40	0	100%
Coimbatore	69	0	100%
Kochi	93	0	100%
Calicut	6	0	100%
MOPA Goa	80	0	100%
Gulbarga	1	0	100%
Goa	131	1	99%
Shamsabad, Hyderabad	175	2	99%
Begumpet Hyderabad	6	0	100%
Vijaynagar	2	1	67%
Kannur	5	0	100%
Kurnool	1	0	100%
Madurai	21	0	100%
Mangalore	30	0	100%
Chennai	179	1	99%
Mysore	1	0	100%
Nanded	0	1	0%
Port Blair	16	1	94%
Rajahmundry	1	0	100%
Shivamogga	1	1	50%
Salem	1	1	50%
Tuticorin	7	0	100%
Tirupati	1	0	100%
Tiruchirappally	9	1	90%
Thiruvananthapuram	35	0	100%
Visakhapatnam	9	1	90%

*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

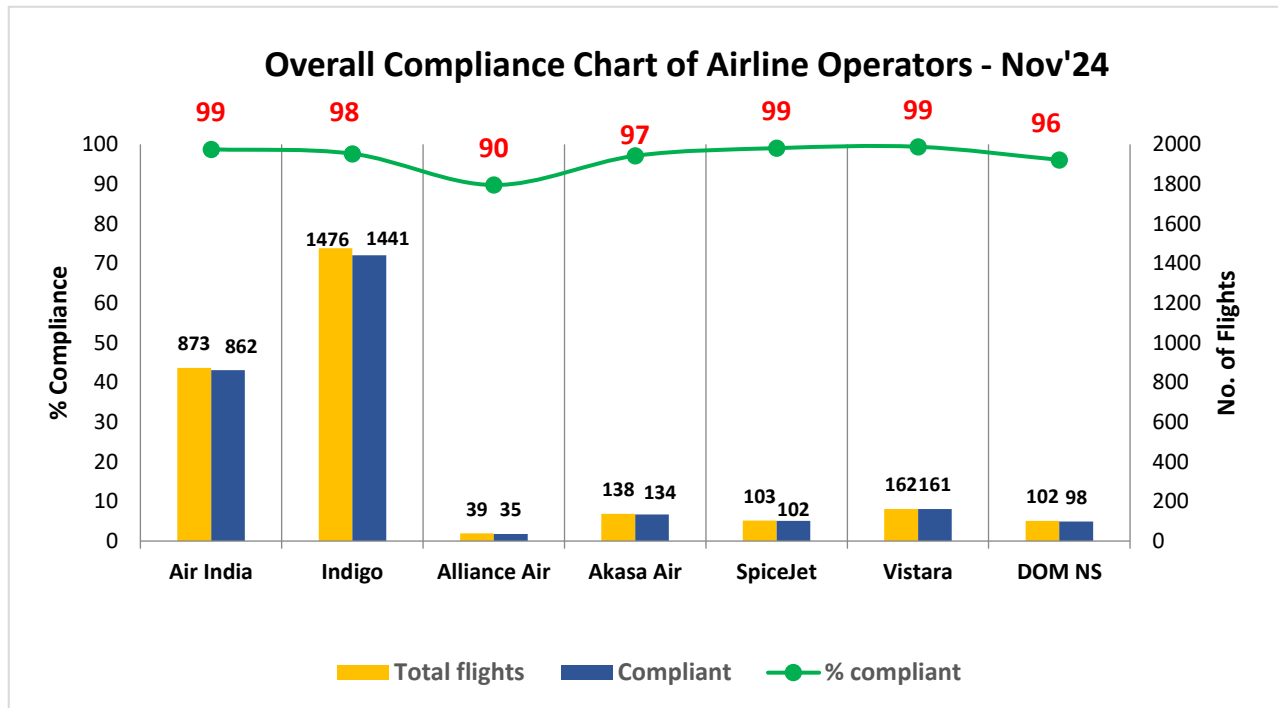**Overall Compliance Chart of Airline Operators - Nov'24**

Figure 13: Airline wise Compliance –Nov'24

Inference

1. Chennai region record the highest compliance of 99% whereas Delhi region has the lowest percentage compliance of 97%.

2. Air India, Indigo, Spicejet and Vistara Airlines have a CTOT compliance higher than the average recorded compliance for the month of November'24.

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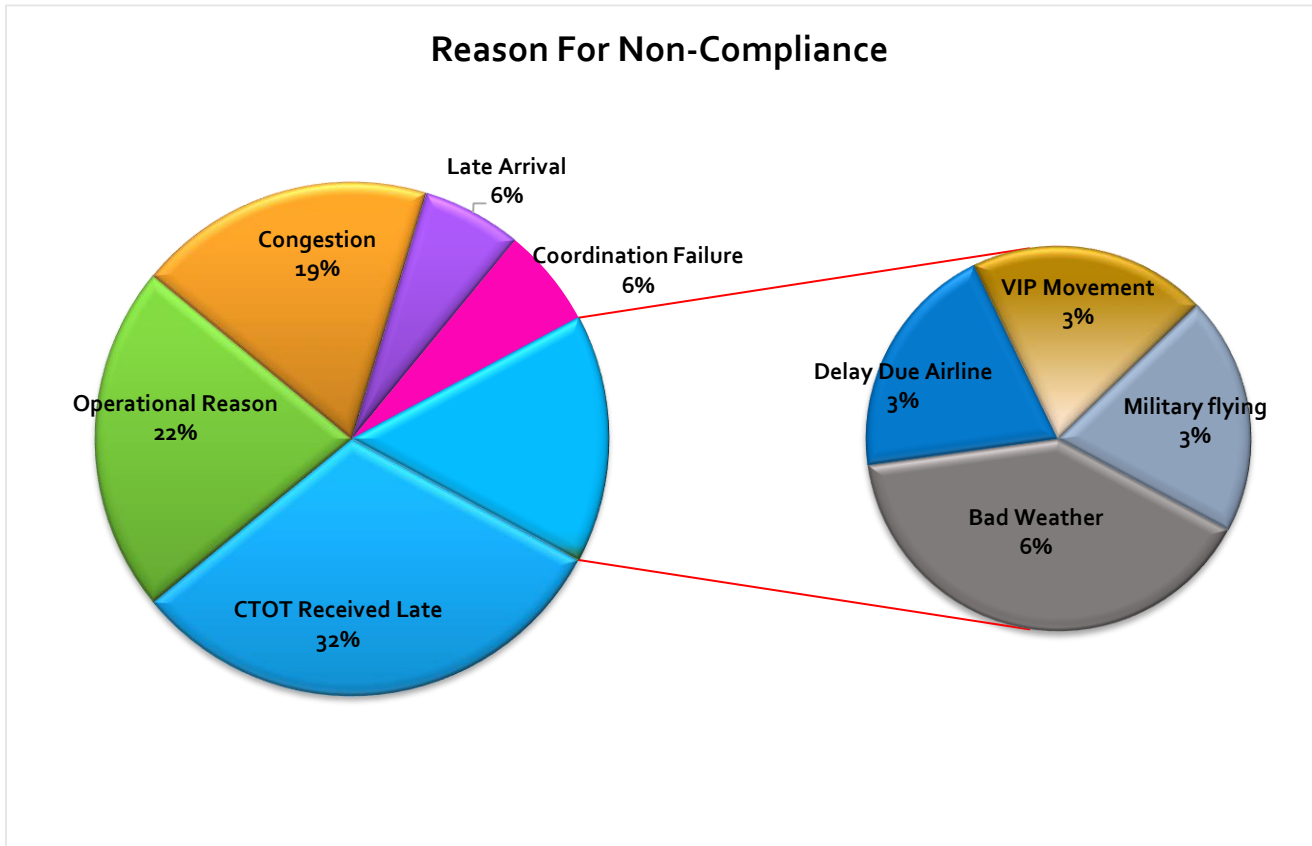
Figure 14: Reason for Non-Compliance as provided by FMPs

Inference:

1. 32 % 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.
2. 22 % of CTOT Non- Compliance was reported by concerned FMPs to be due to operational reasons at various airports.
3. 19 % of the CTOT Non- compliance was reported to congestion at airports while 6% 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 8.3,8.8,8.5 and 11.8 minutes respectively.

*Note: Only calculated for domestic arrivals with both ATOT and ALDT information
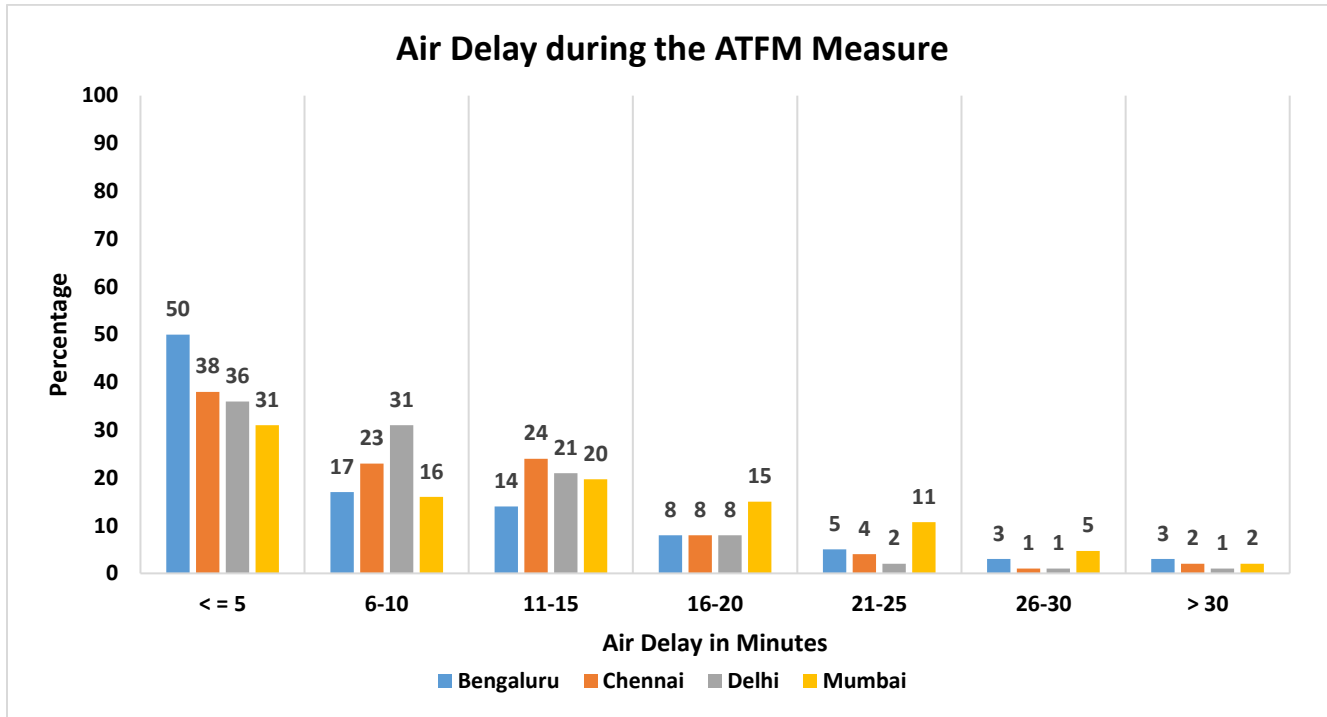
Figure 15: Air Delay distribution during the CDM period

Inference

1. 67% of domestic arriving flights to Bengaluru had an Air delay of equal to or less than 10 minutes during the CDM period.
2. 61% of domestic arriving flights to Chennai had an Air delay of equal to or less than 10 minutes during the CDM period.
3. 67% of domestic arriving flights to Delhi had an Air delay of equal to or less than 10 minutes during the CDM period.
4. 47% 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)= 40135 mins

Total Air Delay (with no ATFM measures) = 100283 mins

Reduction in Air delay due to ATFM measures= (100283-40135) = **60148 mins**

Fuel Saving Calculation:

Total Fuel saved during the ATFM Measure: ***32,63,067.72 Kg***

Total reduction in CO$_2$ emission : 3.16(KgCO$_2$/kg fuel)* 32,63,067.72 Kg = 103,11,293.98 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	$$\frac{\textit{Total monthly ATFM delay (in minutes)}}{\textit{Total Domestic Arrivals}}$$
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: $$\textit{Average Air Delay} = \frac{\textit{Total Air Delay to domestic arrivals (with values greater than zero)}}{\textit{Total Domestic Arrivals}}$$ *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)- November 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.
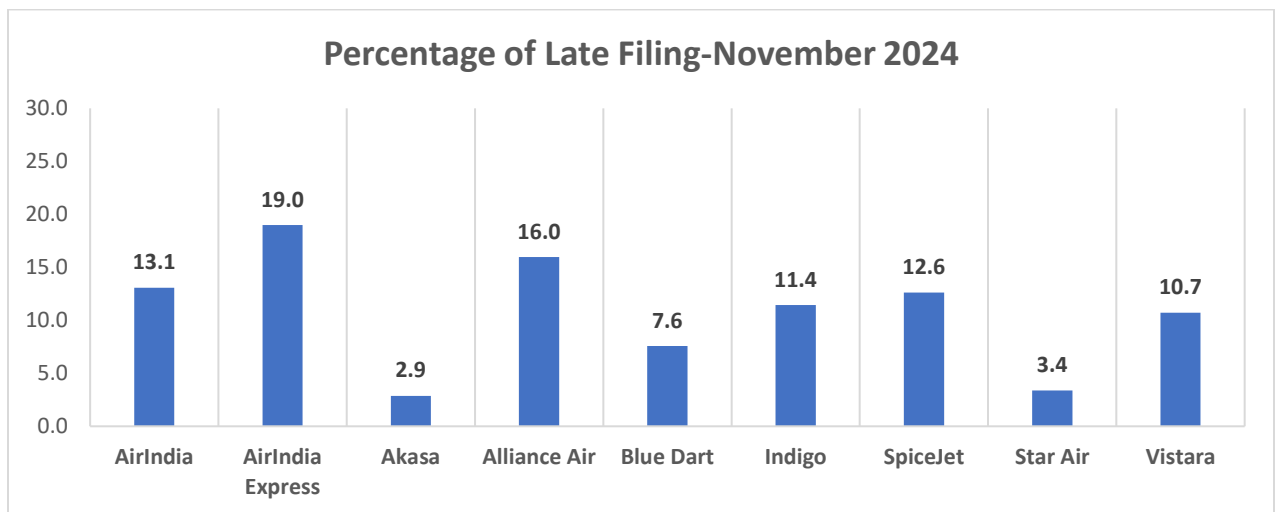
AIP India, ENR 1.9 section 4 on Flight Planning in the context of ATFM recommends Flight Planning requirements for all Airline Operators –

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 November 2024 to 30th November 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.

Percentage of Late Filing-November 2024

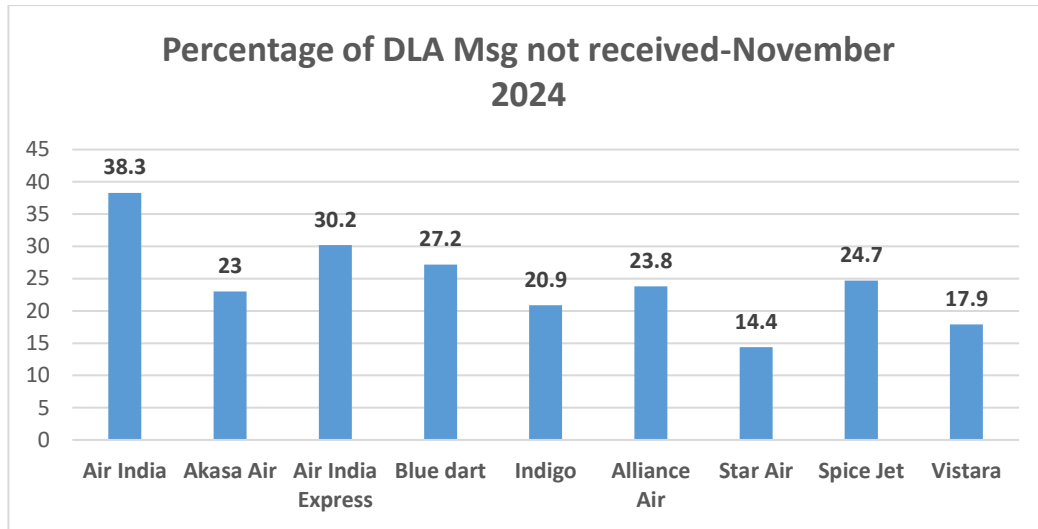| Airline	Percentage
AirIndia	13.1
AirIndia Express	19.0
Akasa	2.9
Alliance Air	16.0
Blue Dart	7.6
Indigo	11.4
SpiceJet	12.6
Star Air	3.4
Vistara	10.7

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	2551	19526	13
AirIndia Express	2207	11621	19
Akasa	115	3999	2.9
Alliance Air	297	1859	16
Blue Dart	49	648	7.6
Indigo	7070	61833	11.4
SpiceJet	551	4366	12.6
Star Air	39	1150	3.4
Vistara	353	3294	10.7
Total no. of FPLs for Scheduled Airlines	**13232**	**108296**	**12.2**

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 November 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	4963	12974	38.3
Akasa Air	505	2195	23
Air India Express	1838	6082	30.2
Blue dart	111	408	27.2
Indigo	8104	38744	20.9
Alliance Air	174	731	23.8
Star Air	48	334	14.4
Spice Jet	547	2215	24.7
Vistara	219	1224	17.9

Percentage of DLA Msg not received-November 2024

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

Name of Airline	CNL message not received	No. of flights annulled
Air India	41	78
Akasa Air	13	21
Air India Express	22	56
Blue dart	4	4
Indigo	117	229
Alliance Air	59	60
Star Air	11	18
Spice Jet	15	34
Vistara	40	62

-End of Report-