POST OPERATIONS ANALYSIS REPORT

November, 2023

CENTRAL COMMAND CENTER, C-ATFM, DELHI

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A. Executive Summary

Average Domestic air traffic has recorded an increase of 4.5% whereas the average international air traffic has increased by 6.2% in the month of Nov'23 as compared to Oct'23.

(Note: The SKYFLOW system did not receive ATS messages from Delhi AMSS intermittently for few days resulting in less data being captured as compared to actual movement.)

On average, the Indian Airports in the ATFCM area saw 4916 IFR flights per day in the month of November'2023. The peak day was on 18th November 2023 (5404 IFR flights). Satudays were the busiest days throughout this month with an average of 5289 IFR flights per day.

Total Twenty Nine (29) ATFM measures were applied this month during periods of congestion at Delhi,Chennai and Mumbai Airport.
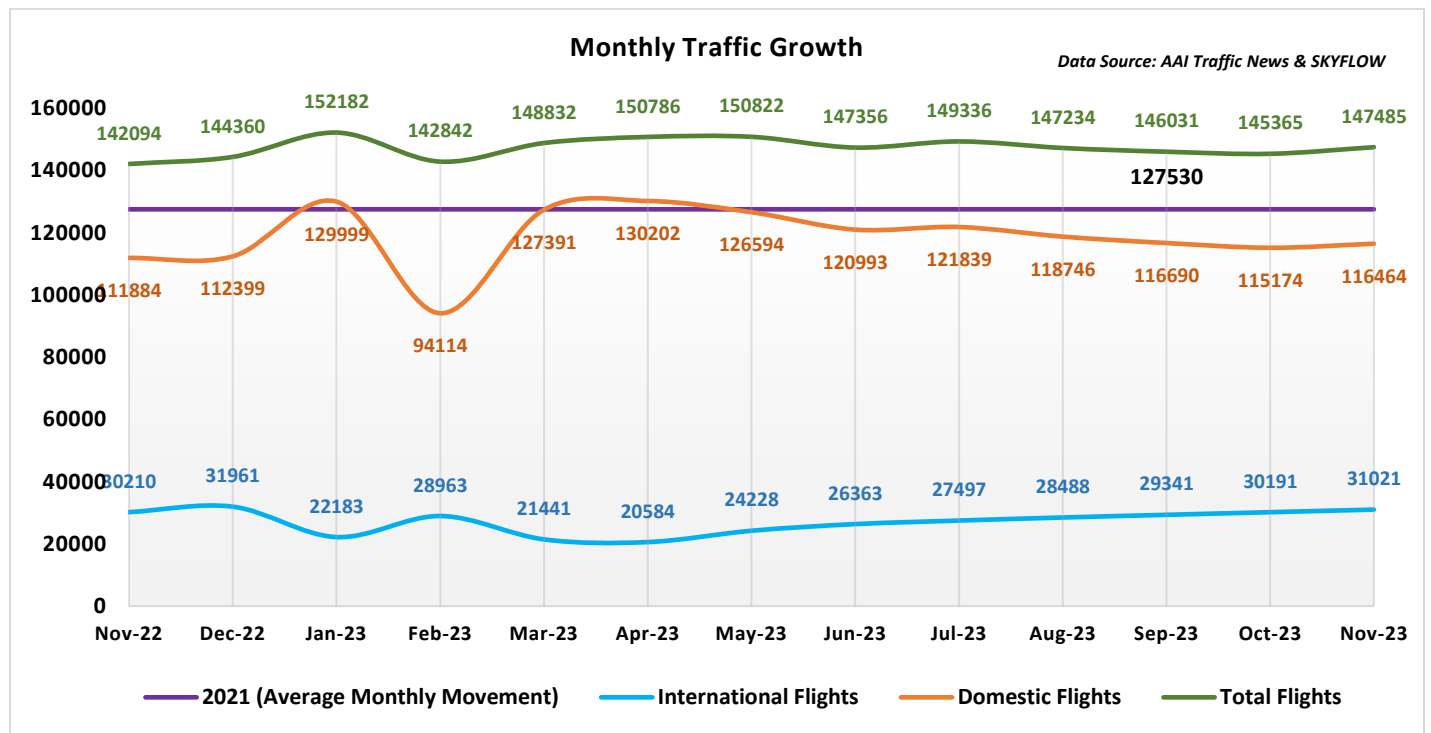
Figure 1: Monthly Traffic Growth

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

B. Traffic Analysis

I. Air Traffic Movement at Major Airports in India
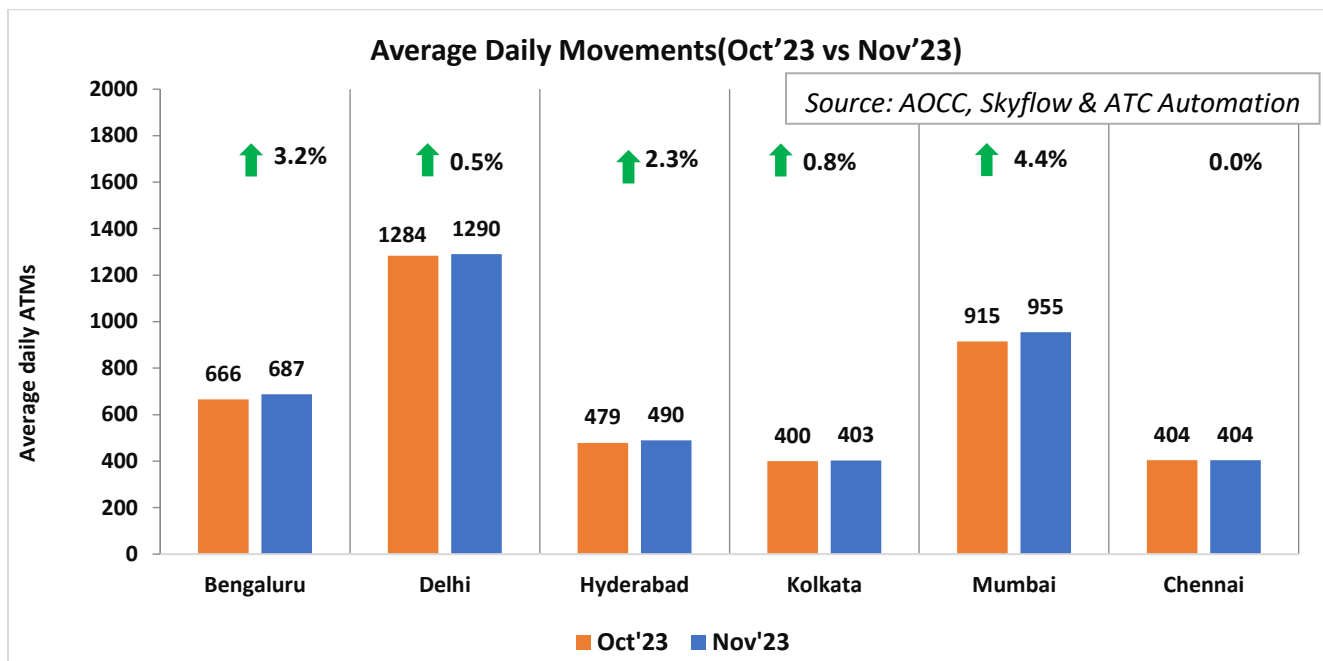
Figure 2: Average Daily Movements (Oct'23 vs Nov '23)

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

Airports\Year	Avg. Daily ATMs (YoY) for six major airports				
	Nov'19	Nov'20	Nov'21	Nov'22	Nov'23
Bengaluru	664	421	540	623	687
Delhi	1402	797	1210	1270	1290
Hyderabad	551	310	388	423	490
Kolkata	504	265	369	394	403
Mumbai	898	469	715	845	955
Chennai	495	243	323	339	404

Air Traffic Movement for each day in Nov'23 is plotted for Delhi, Mumbai, Bengaluru and Hyderabad Airport along with the percentage change w.r.t. Avg. Daily Movements for the same month.
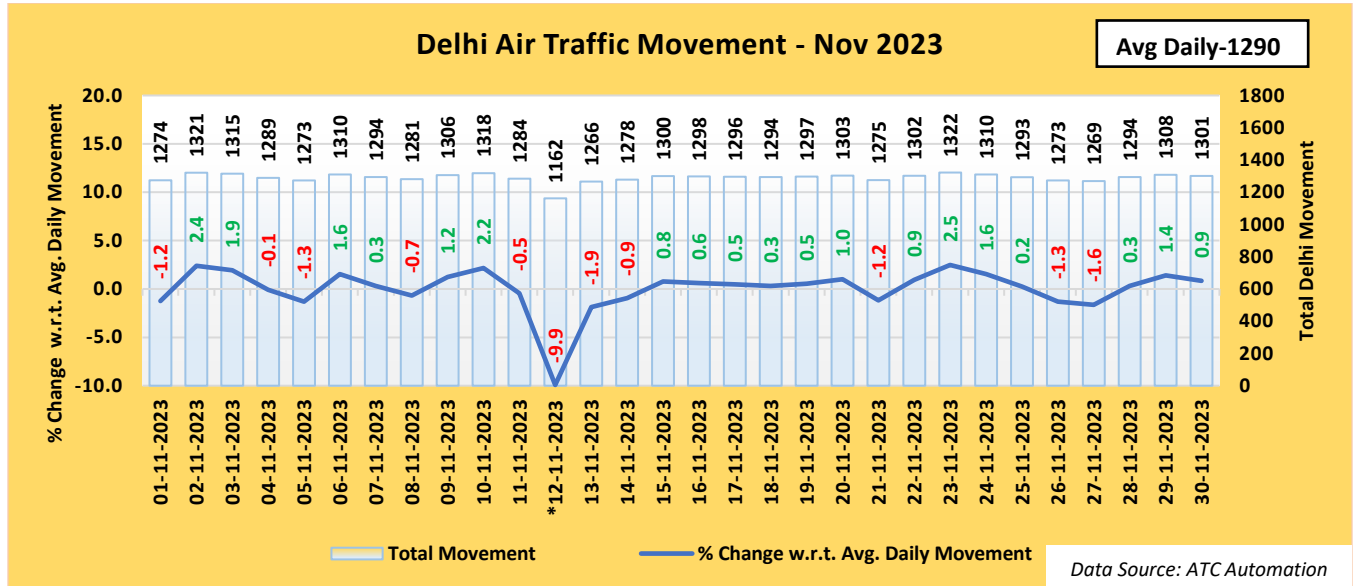
Figure 3: Air Traffic Movement for Delhi –Nov 2023
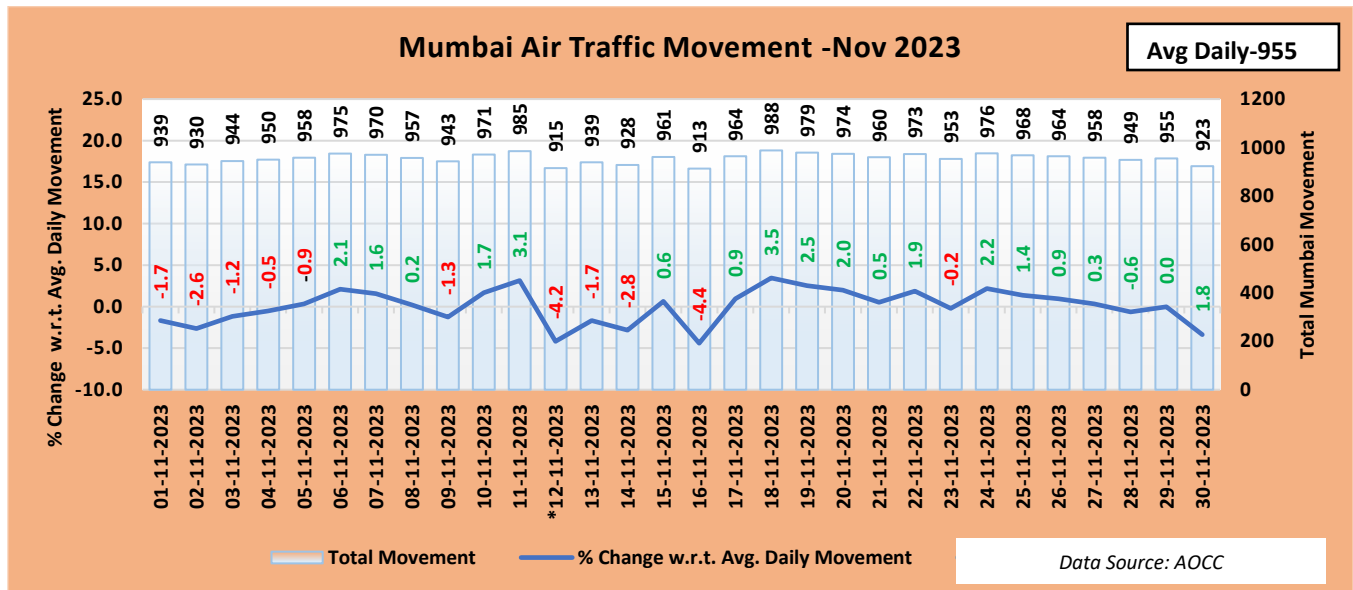
Figure 4: Air Traffic Movement for Mumbai - Nov 2023
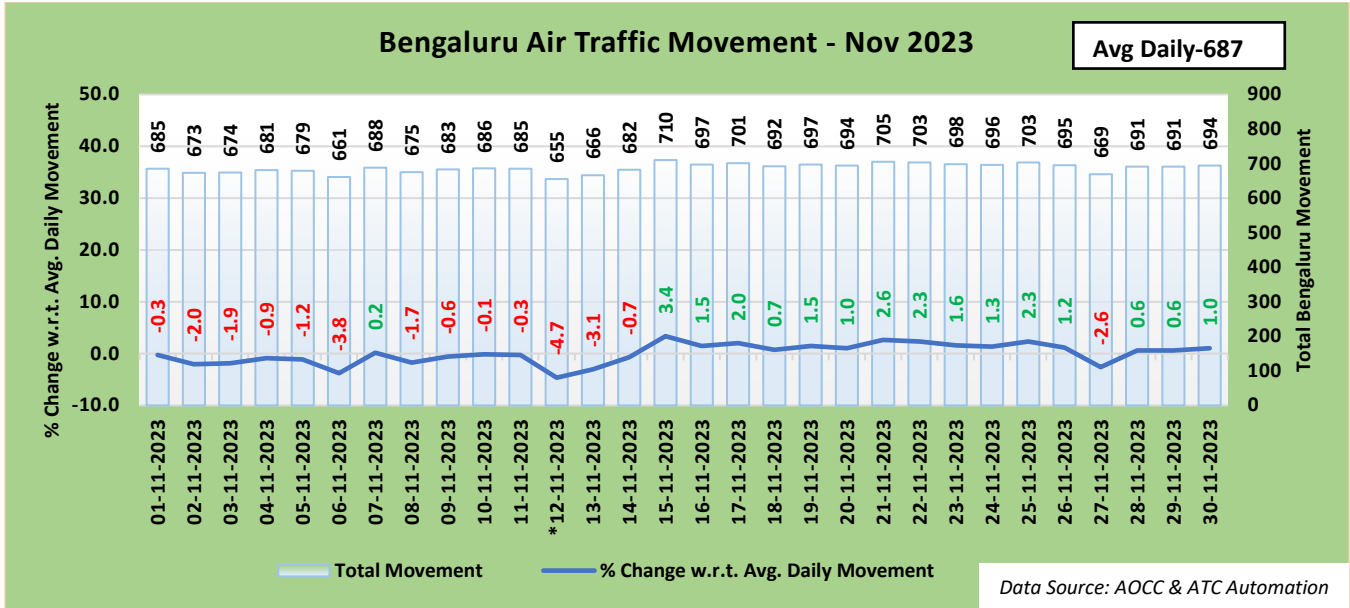
Figure 5: Air Traffic Movement for Bengaluru – Nov 2023
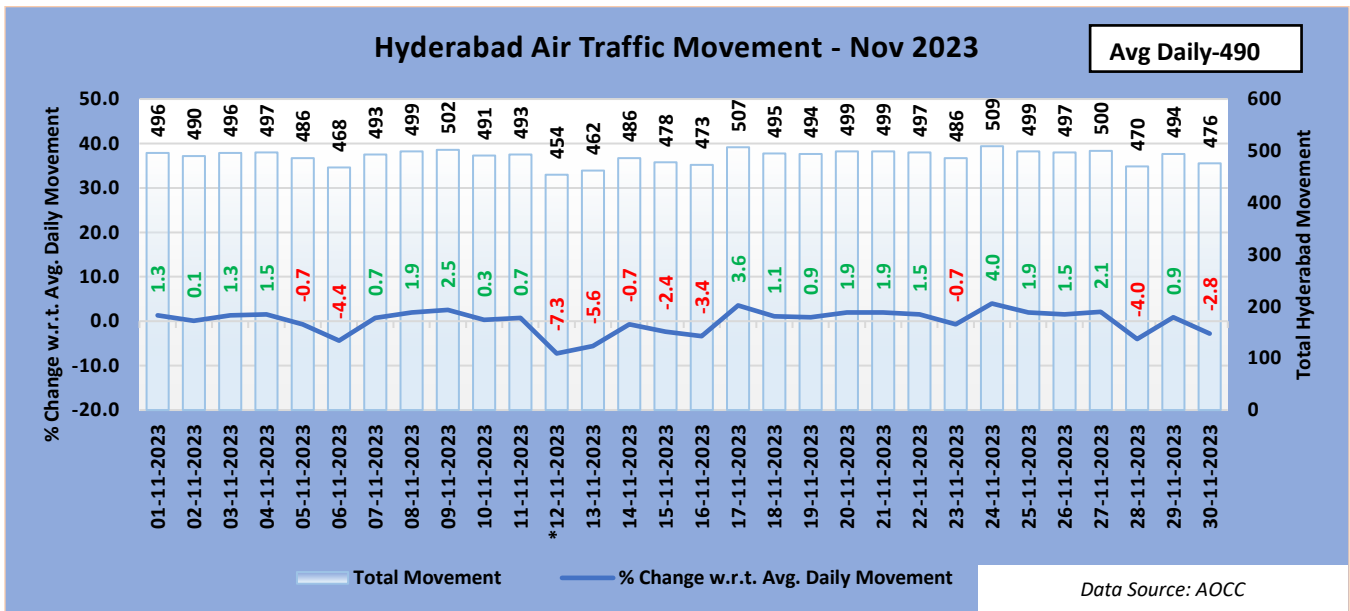
Figure 6: Air Traffic Movement for Hyderabad - Nov 2023

*Note: Deepawali festival on 12th Nov '23 resulted in less movements at the Airports.

It can be concluded from the above charts that on 30th Nov 2023(month end), the ATMs at Hyderabad saw a decline of 2.8% whereas ATMs at Delhi, Mumbai and Bengaluru witnessed an increase of 0.9%, 1.8% and 1% respectively in comparison to the average daily movement for Nov'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 November 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.
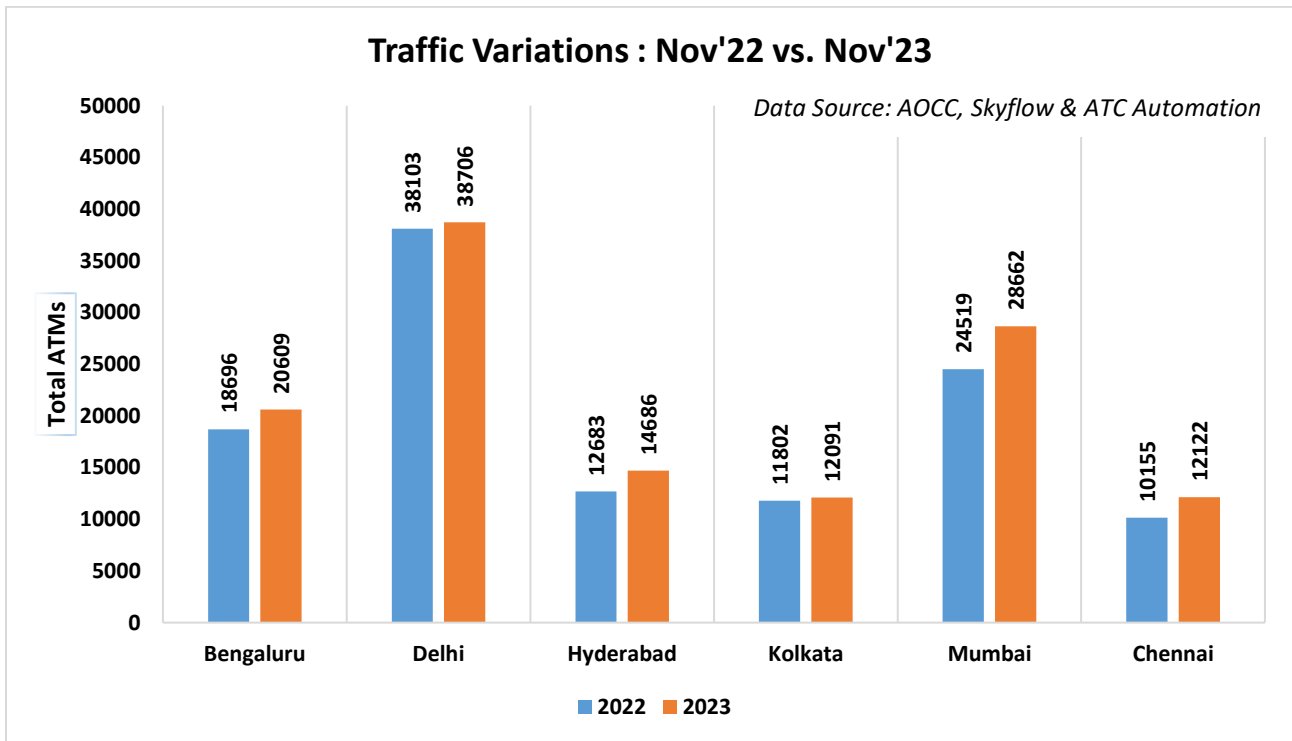
Figure 7: Traffic Variation (YoY)

III. Flight Operations – Airlinewise

Flight Movements

Data Source: SKYFLOW

	Indigo	Spicejet	Air India	Go First	Vistara	Air Asia
Jun'23	55850	5168	15071		7831	6154
Jul'23	58291	5206	15618		8319	6146
Aug'23	59355	5144	15530		8983	5963
Sep'23	58262	5260	15154		9110	5571
Oct'23	60551	5788	15399		9100	5614
Nov'23	59187	6757	15885		9381	5487
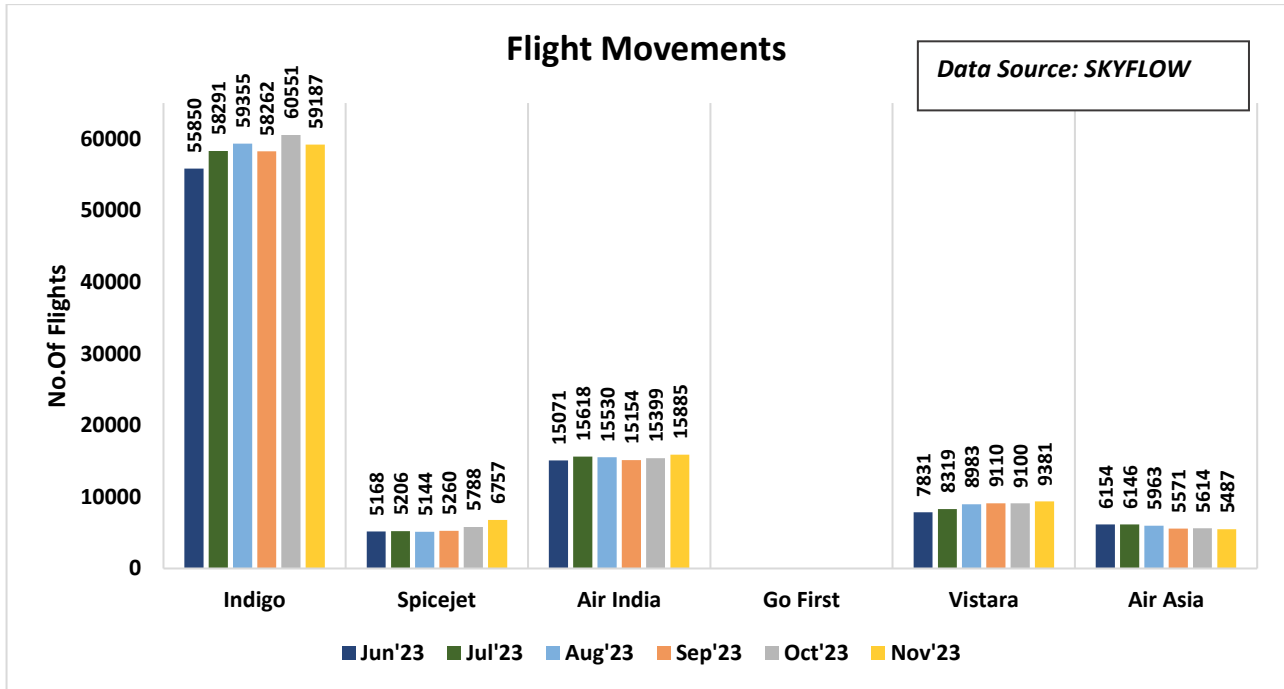
Figure 8: Flight Movements –Airlinewise

Inference:

1. All domestic airlines (Indigo,Spicejet, Air India, Vistara and Air Asia Airlines) have recorded an increase in the monthly average Flight movement in Nov'23 as compared to Oct '23.Go first Airline has stopped operations from 3rd May 2023.

C. ATFM Post Operations – CDM Analysis

I. Introduction

Analysis Period   **1ˢᵗ – 30ᵗʰ November 23**

Back Ground   During the above mentioned period, **Sixteen (16)** ATFM measures were applied **for Delhi Airport, Nine (09)** ATFM measures were applied **for Mumbai Airport and Four (04)** ATFM measures were applied **for Chennai** due to the following reasons as illustrated in the bar chart below:–
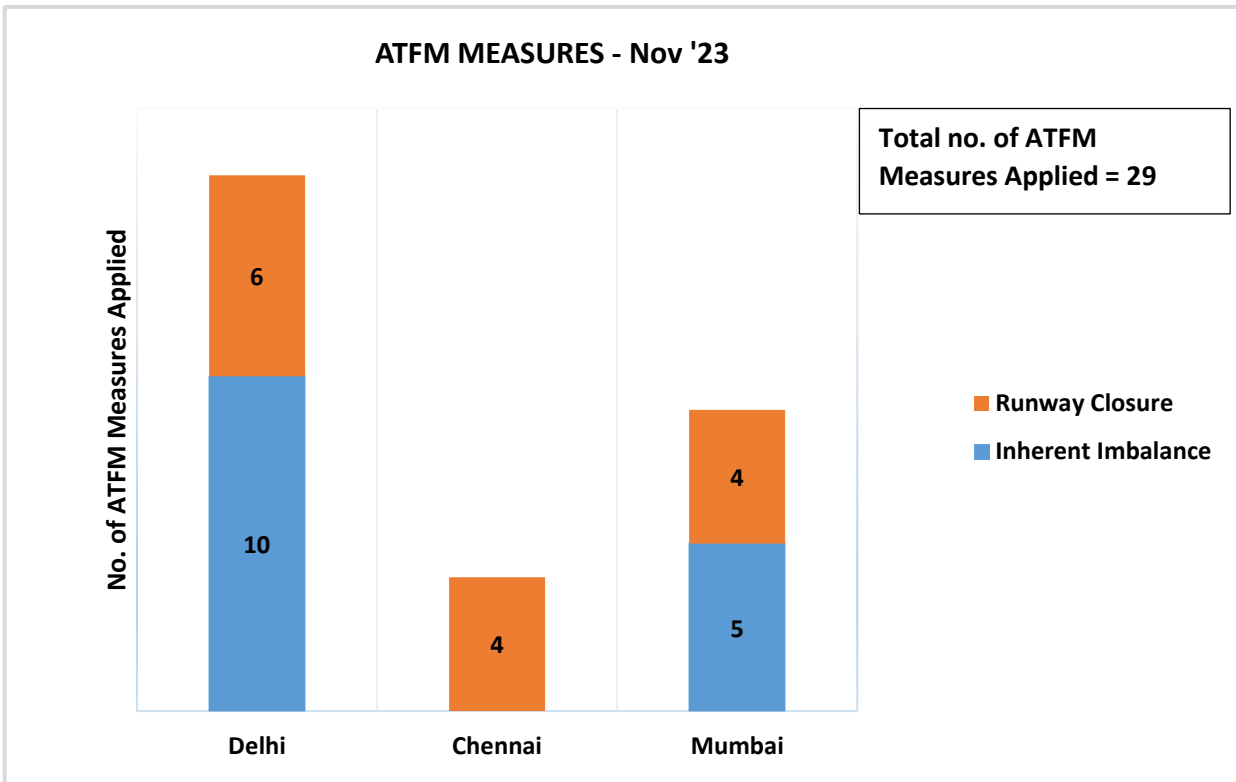
Figure 9: ATFM Measures –Nov '23

II. ATFM Measures Overview

Constrained Airport	Delhi	Mumbai	Chennai
Number of ATFM measures applied	16	9	4
Average ATFM Ground delay(in min) due to measures*	21.4	23.6	22.6
Maximum ATFM Ground delay(in min) due to measures	109	58	38
% Compliance	65.2	76.1	75

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

Total Arrivals	2137
Total International Arrivals(exempted)	429
Total affected flights in scenario (Domestic Arrivals)	1708
Total Domestic Arrivals with zero ATFM delay	146
Total Domestic Arrivals with ATFM delay	1562

Affected Flight Statistics

9%
91%

■ Delayed flights ■ Non-delayed flights
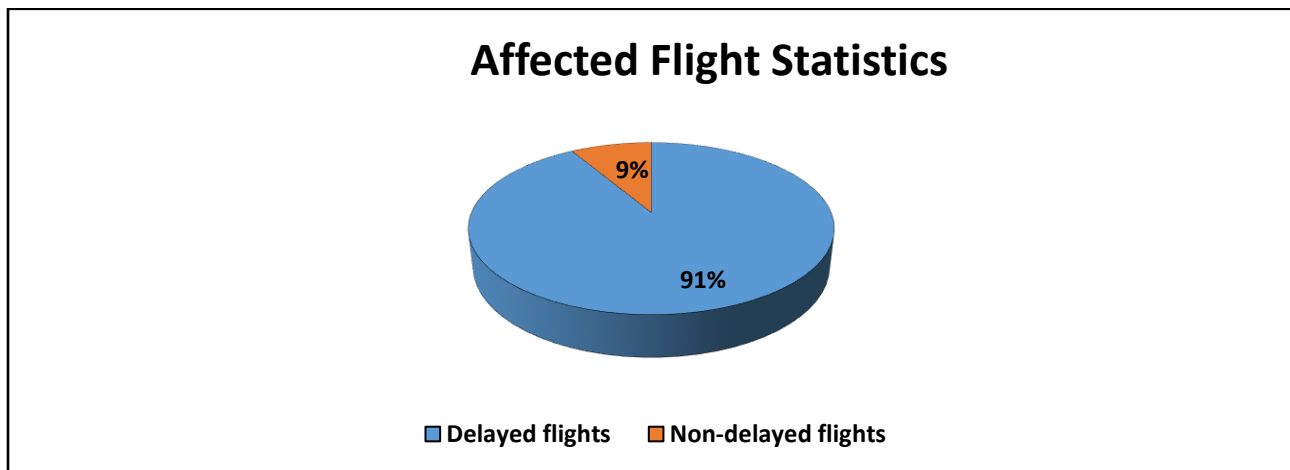
Figure 10: Affected Flight Statistics –Nov'23

III. Overall Compliance

Total arrivals	2137
Domestic arrivals	1708
Flights with complete data (ATOT)	1661
Flights with incomplete data	03
Flights Not Operated	44
Compliant*	1132
Non-Compliant	529

*Total No. of Revised CTOTs issued = 363 (Compliance calculation for flights which were issued revised CTOT is w.r.t. new CTOT issued)

Overall Compliance

68%

32%

■ **Compliance** ■ **Non-Compliance**
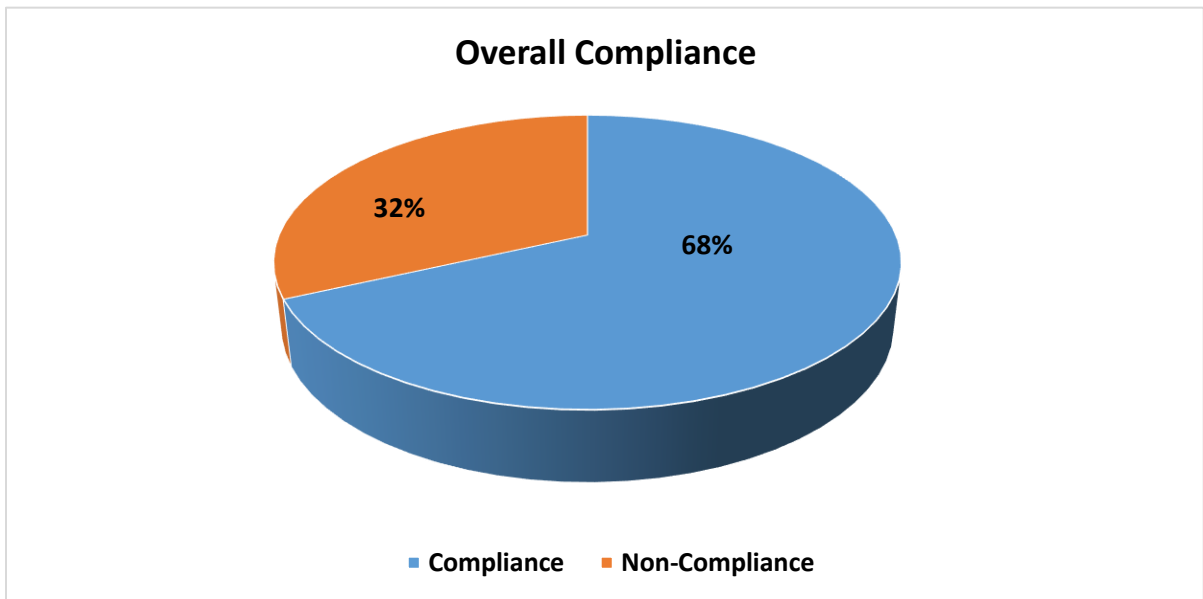
Figure 11: **Overall Compliance – Nov'23**

NOTE: Flights with required data (i.e. ATOT) are only considered for compliance measurement
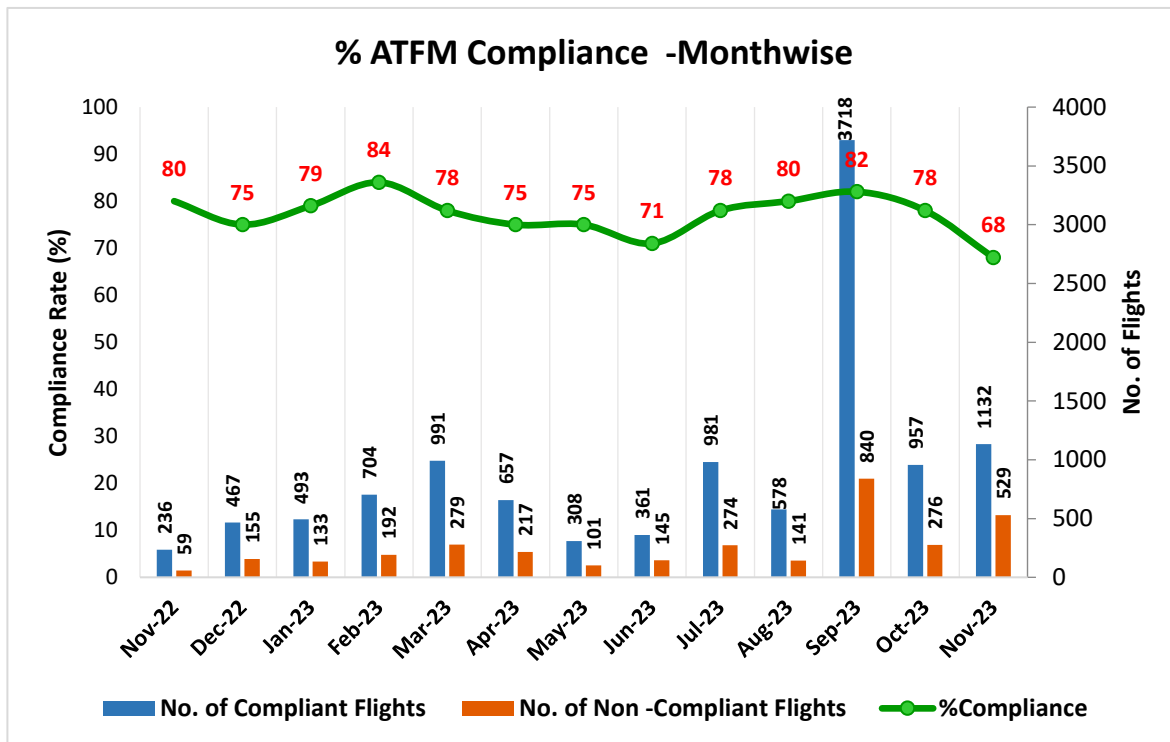
Figure 12: Compliance(Monthwise)

Inference

1. Out of the total arrivals captured(2137 flights) during the CDM scenario for the constrained Airports, 79.9% of flights i.e. domestic arrivals(1708 flights) were candidates for ground delay(participating).
2. Out of these Domestic Arrivals(1708), 91.5% (1562 flights) are assigned ATFM ground delay.
3. Out of the total arrivals captured(2137 flights) to the constrained Airport during the ATFM scenario, only 73.1% of flights(1562 flights) were assigned ATFM Ground Delay.

IV. CTOT Compliance rate – Airportwise

MUMBAI FIR (69%)*	Compliant	Non Compliant	% Compliant
Ahmedabad	31	24	56%
Aurangabad	1	2	33%
Mumbai	80	37	68%
Vadodara	5	2	71%
Bhopal	20	4	83%
Bhavnagar	4	0	100%
Diu	2	1	67%
Hirasar	7	4	64%
Indore	14	7	67%
Jabalpur	6	2	75%
Jamnagar	2	3	40%
Kandla	0	2	0%
Nagpur	19	3	86%
Pune	24	18	57%
Porbandar	2	0	100%
Shirdi	10	1	91%
Surat	8	2	80%
Udaipur	19	4	83%
KOLKATA FIR (72%)*	Compliant	Non Compliant	% Compliant
Prayagraj	2	6	25%
Agartala	3	2	60%
Siliguri	36	6	86%
Shillong	1	0	100%
Varanasi	27	10	73%
Bhubaneswar	22	6	79%
Bilaspur	0	1	0%
Kolkata	54	17	76%
Chakeri	2	0	100%
Durgapur	3	3	50%
Darbhanga	2	5	29%
Deoghar	1	0	100%
Gorakhpur	12	9	57%
Guwahati	31	5	86%

Gaya	4	0	100%
Hollongi	2	2	50%
Imphal	4	1	80%
Jharsuguda	2	4	33%
Khajuraho	0	1	0%
Aizawl	3	1	75%
Dibrugarh	9	2	82%
Patna	36	18	67%
Ranchi	17	9	65%
Raipur	13	6	68%
DELHI FIR (59%)*	**Compliant**	**Non Compliant**	**% Compliant**
Agra	1	0	100%
Amritsar	11	9	55%
Adampur	0	1	0%
Bikaner	2	4	33%
Bhuntar	0	2	0%
Bareilly	2	1	67%
Chandigarh	9	19	32%
Dehradun	11	7	61%
Delhi	51	18	74%
Hindon	1	1	50%
Kangra	6	5	55%
Gwalior	4	2	67%
Halwara Air Force Station	0	2	0%
Jodhpur	6	4	60%
Jaipur	27	10	73%
Jaisalmer	3	6	33%
Jammu	13	14	48%
Suratgarh	0	2	0%
Leh	11	2	85%
Lucknow	24	13	65%
Pantnagar	0	3	0%
Shimla	3	1	75%
Srinagar	33	25	57%
Sirsa	0	1	0%
Uttarlai	0	1	0%

CHENNAI FIR (80%)*	Compliant	Non Compliant	% Compliant
Hal Bangalore	2	1	67%
Bangalore	99	25	80%
Belgaum	3	2	60%
Vijayawada	6	1	86%
Coimbatore	22	1	96%
Kochi	32	5	86%
Calicut	1	0	100%
MOPA Goa	12	20	38%
Goa	31	28	53%
Hubli	5	0	100%
Hyderabad	69	20	78%
Begumpet Hyderabad	2	1	67%
Kannur	2	2	50%
Madurai	8	1	89%
Mangalore	6	4	60%
Chennai	54	21	72%
Mysore	0	1	0%
Port Blair	4	4	50%
Salem	0	1	0%
Tiruchirappally	1	2	33%
Thiruvananthapuram	13	1	93%
Visakhapatnam	3	2	60%

*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(68%) for the month are highlighted in red.

V. CTOT Compliance rate – Airlinewise

Overall Compliance Chart of Airline Operators - Nov'23
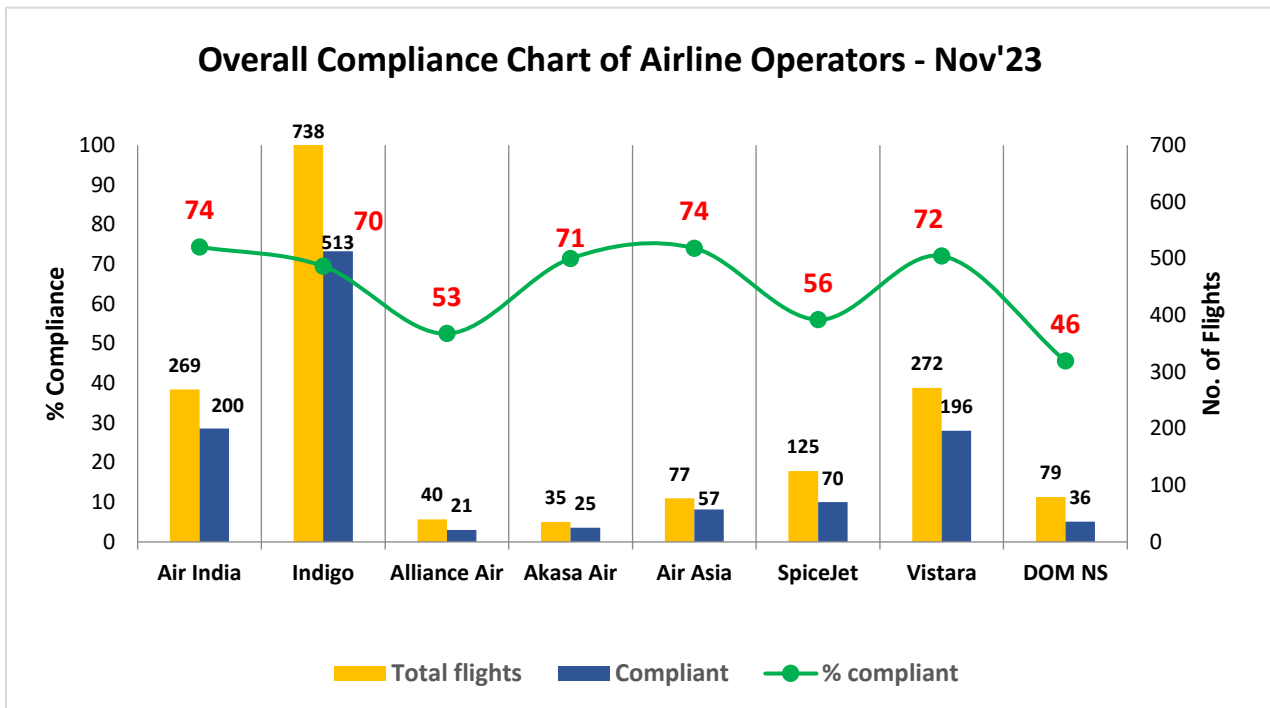
Figure 13: Airline wise Compliance –Nov'23

Inference

1. Out of the total domestic arrivals with complete data in the CDM scenario, 68% arrivals are compliant.
2. Chennai region record the highest compliance of 72% whereas Delhi region has the lowest percentage compliance of 59%.
3. Indigo, Air India, Akasa Air, Air Asia and Vistara Airlines have a CTOT compliance higher than the average recorded compliance for the month of Nov '23.
4. Non- Scheduled movements have been identified as one of the major contributors for Non-Compliance.

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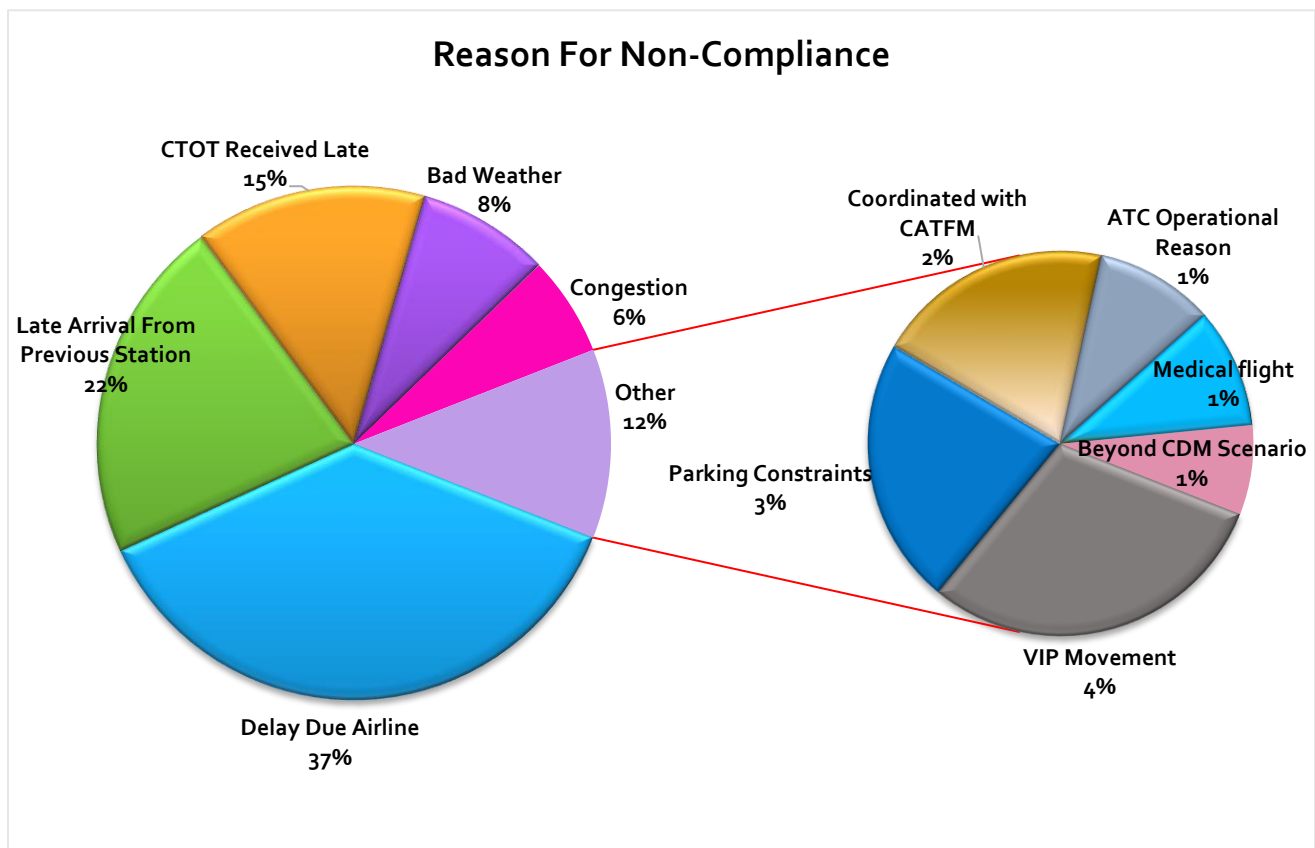
Figure 14: Reason for Non-Compliance as provided by FMPs

Inference:

1. 37 % of CTOT Non- Compliance was reported by concerned FMPs to be due to delay by Airlines.
2. 22 % of the CTOT Non- compliance was reported to be due to late arrival from previous station. Updated EOBTs of such flights was not available to ATFM unit leading to wastage of unused slots.
3. 15 % 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. 8 % of CTOT Non- Compliance was reported by concerned FMPs to be due to bad weather.

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 12.4, 14.0 and 9.6 minutes respectively.

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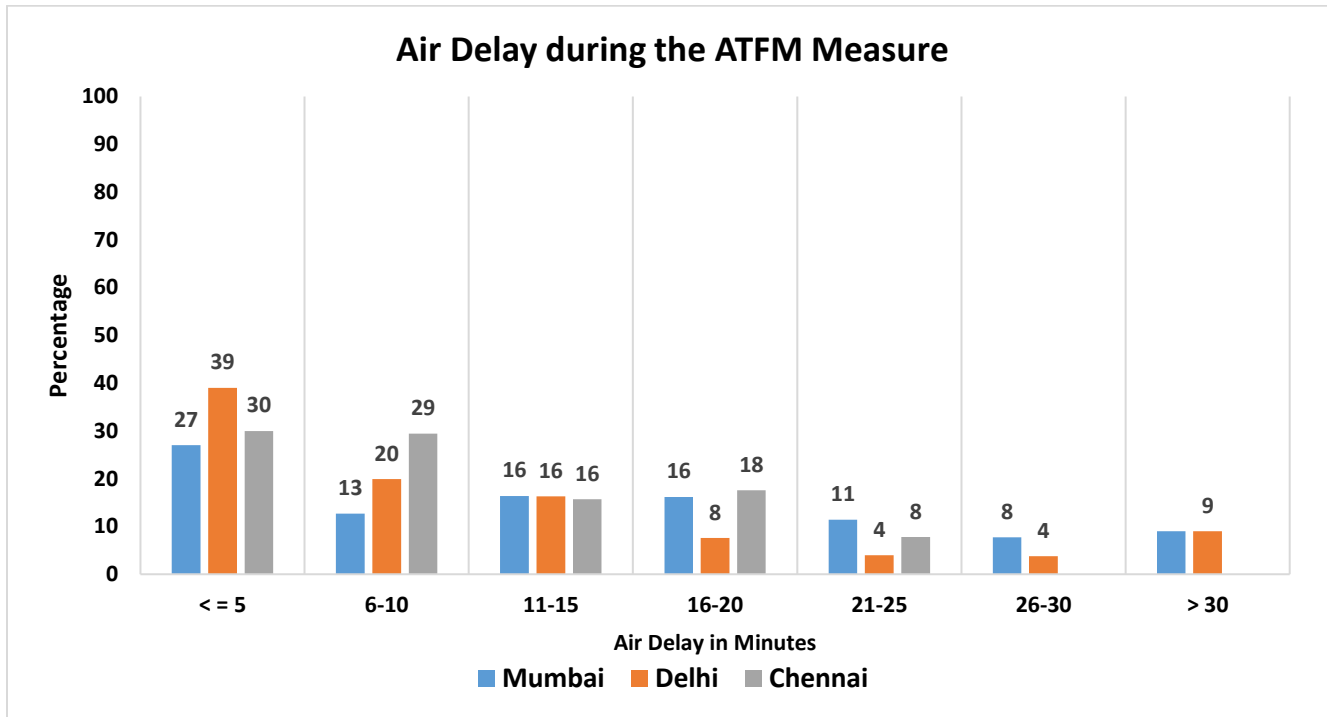
Figure 15: Air Delay distribution during the CDM period

Inference

1. 40% of domestic arriving flights to Mumbai had an Air delay of equal to or less than 10 minutes during the CDM period.
2. 59% of domestic arriving flights to Delhi had an Air delay of equal to or less than 10 minutes during the CDM period.
3. 59% of domestic arriving flights to Chennai 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)= 23666 mins

Total Air Delay (with no ATFM measures) = 37093 mins

Reduction in Air delay due to ATFM measures= (37093-23666) = **13427 mins**

Fuel Saving Calculation:

Total Fuel saved during the ATFM Measure: ***8,60,259.5 Kg***

Total reduction in CO$_2$ emission : 3.16(KgCO$_2$/kg fuel)* 8,60,259.5 Kg = 27,18,420.02 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	$$\frac{\textit{Total monthly ATFM delay } (\textbf{in minutes})}{\textbf{Total Domestic Arrivals}}$$
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: $$\textit{Average Air Delay}$$ $$=\frac{\textit{Total Air Delay to domestic arrivals } (\textbf{with values greater than zero})}{\textbf{Total Domestic Arrivals}}$$ *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)- November'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 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);
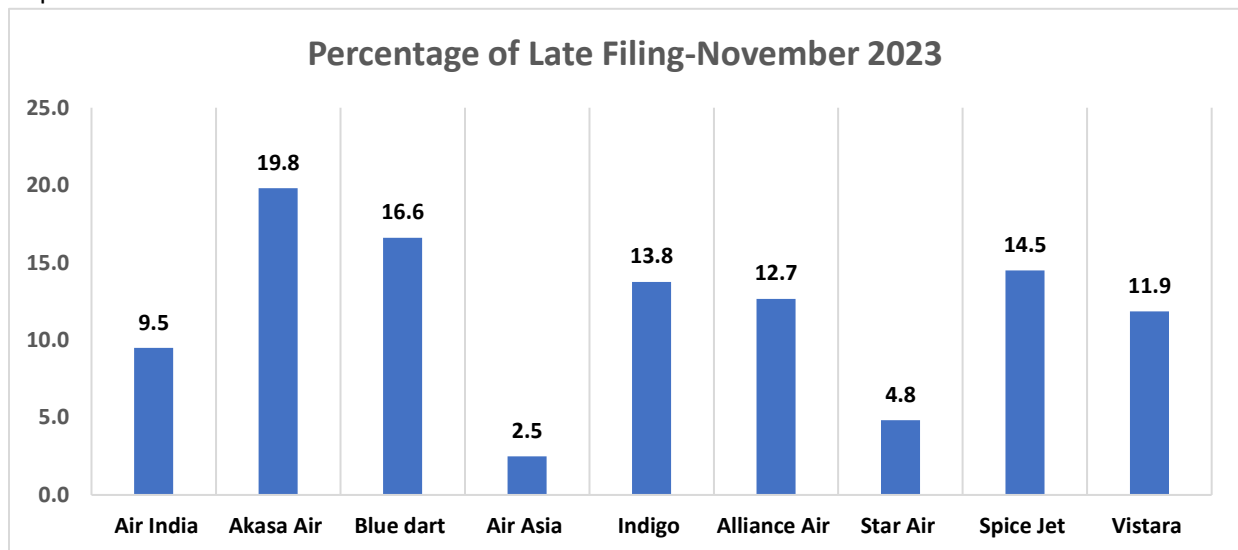 b) The window for filing FPL is between 3 Hours and 120 Hours (Five days) before the EOBT. Earlier filing of FPL will give a realistic demand data to the CCC and hence the requirement of ATFM measures can be identified early for better planning. Late filing of a flight plan will lead to inaccuracies 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 2023 to 30th November 2023.
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 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.

Percentage of Late Filing-November 2023

Airline	Percentage
Air India	9.5
Akasa Air	19.8
Blue dart	16.6
Air Asia	2.5
Indigo	13.8
Alliance Air	12.7
Star Air	4.8
Spice Jet	14.5
Vistara	11.9

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

Name of Airline	Total No. of FPLs	No. of late filed FPLs	% of FPLs filed late
Air India	12555	1192	9.5
Akasa Air	3191	632	19.8
Blue dart	602	100	16.6
Air Asia	5411	135	2.5
Indigo	58182	8005	13.8
Alliance Air	2630	333	12.7
Star Air	932	45	4.8
Spice Jet	6646	964	14.5
Vistara	9121	1081	11.9
Total no. of FPLs for Scheduled Airlines	**99270**	**12487**	**12.6**

B. For the analysis of non-receipt of DLA (Delay) messages for flight plans filed, the EOBT of FPLs 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 were received.

The Table below lists number of flights for which no DLA message was received in November'2023.

{(EOBT of original FPL)- (ATOT received)} > 30 minutes)

Name of Airline	Total No. of flights considered for analysis	DLA Message not received	% of flights for which no DLA message was received
Air India	9731	2962	30.4
Akasa Air	2600	522	20.1
Blue dart	508	116	22.8
Air Asia	4453	588	13.2
Indigo	45286	9454	20.9
Alliance Air	1740	293	16.8
Star Air	411	88	21.4
Spice Jet	4876	1270	26.1
Vistara	7949	2398	30.2

Percentage of DLA Msg not received -November 2023

Airline	Value
Air India	30.4
Akasa Air	20.1
Blue dart	22.8
Air Asia	13.2
Indigo	20.9
Alliance Air	16.8
Star Air	21.4
Spice Jet	26.1
Vistara	30.2
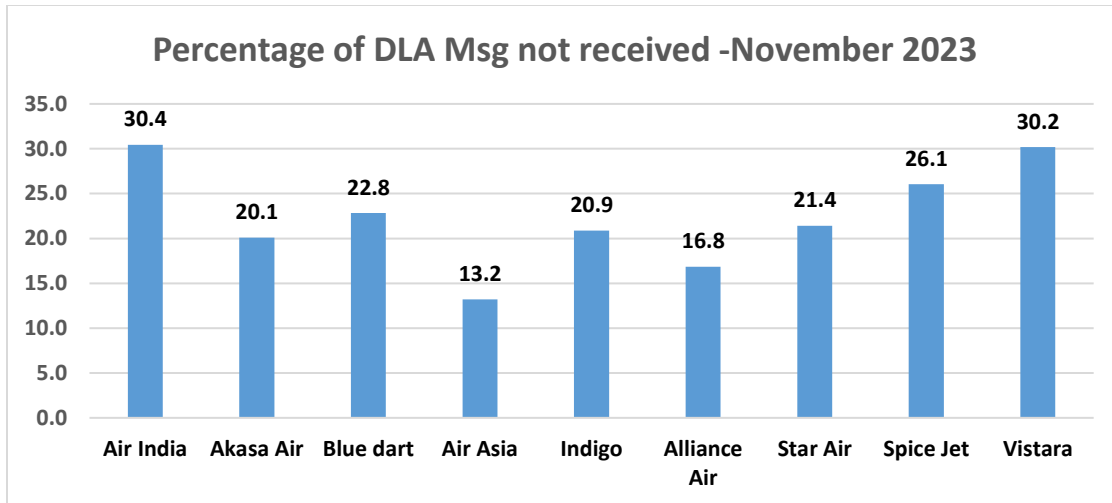
C. For analysis of non-receipt of CNL (cancel) messages for November 2023, annulled FPLs were considered for which no CNL/DEP/DLA messages were received. A FPL gets annulled in SKYFLOW system, if it doesn't get activated through Dep message /surveillance data/ manual activation by FMP within a defined system parameter.

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

Name of Airline	No. of flights annulled	CNL message not received
Air India	15	13
Akasa Air	5	5
Blue dart	3	2
Air Asia	21	20
Indigo	277	269
Alliance Air	121	119
Star Air	24	21
Spice Jet	140	135
Vistara	10	10

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