POST OPERATIONS ANALYSIS REPORT

October, 2023

CENTRAL COMMAND CENTER, C-ATFM, DELHI

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A. Executive Summary

Average Domestic air traffic has recorded a decrease of 1.3% whereas the average international air traffic has increased by 2.9% in the month of Oct'23 as compared to Sep'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 4690 IFR flights per day in the month of October 2023. The peak day was on 27th October 2023 (5208 IFR flights). Thursday's were the busiest days throughout this month with an average of 5002 domestic IFR flights per day.

Total Thirty two (32) ATFM measures were applied this month during periods of congestion at Delhi,Chennai,Pune and Mumbai Airport.
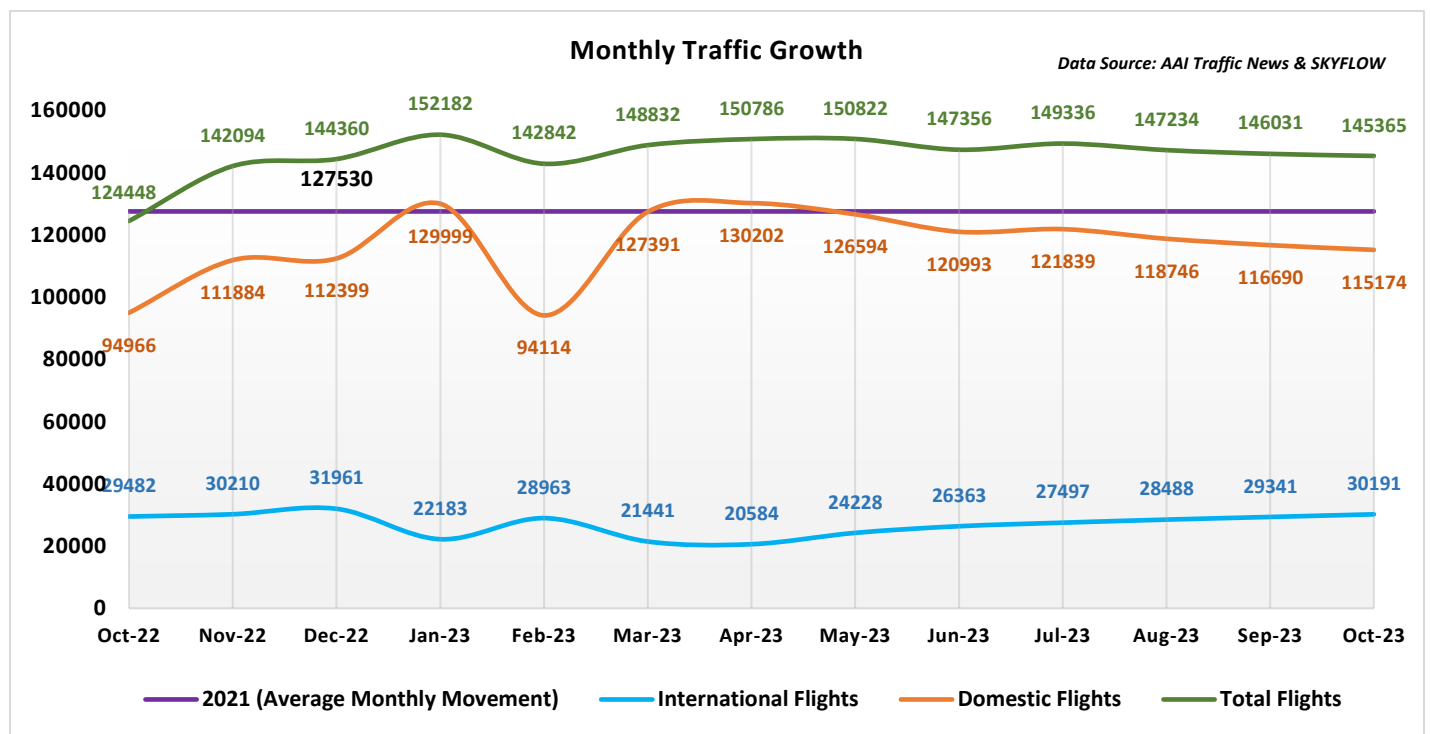
Figure 1: Monthly Traffic Growth

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

B.   Traffic Analysis

I.   Air Traffic Movement at Major Airports in India

Average Daily Movements(Sep'23 vs Oct '23)

Source: AOCC, Skyflow & ATC Automation
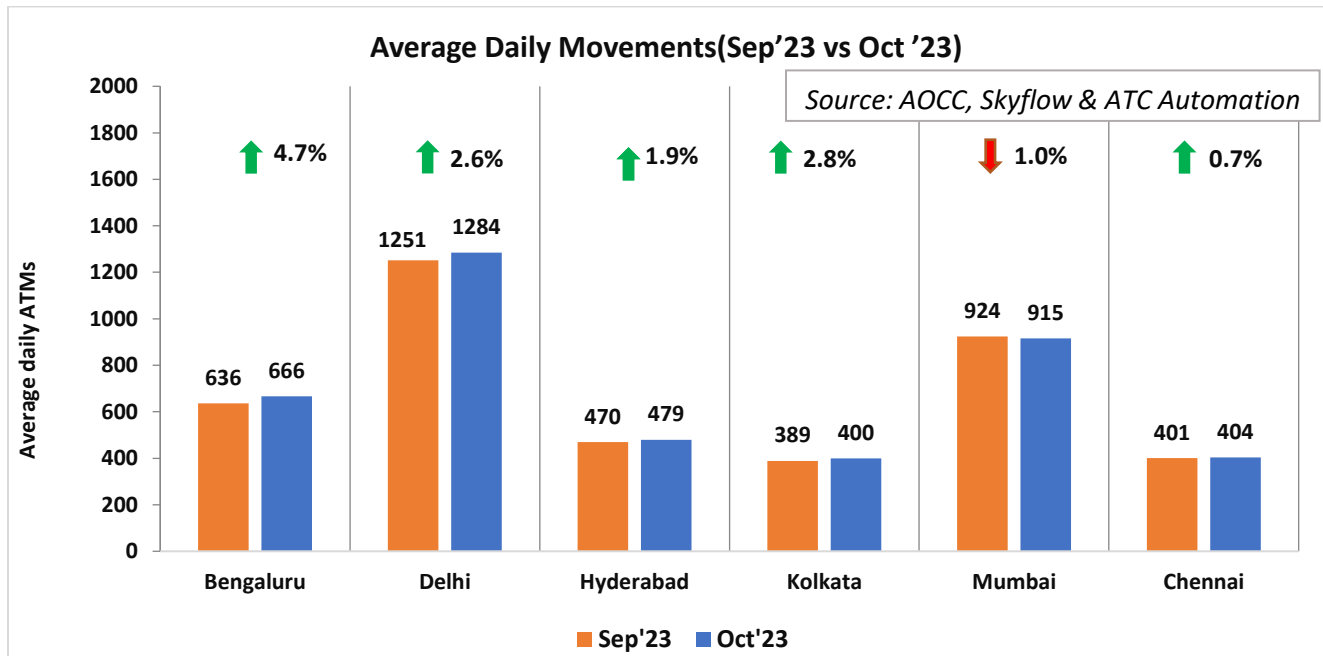
Figure 2: Average Daily Movements (Sep '23 vs Oct '23)

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

Airports\Year	Avg. Daily ATMs (YoY) for six major airports				
	Oct'19	Oct'20	Oct'21	Oct'22	Oct'23
Bengaluru	610	318	486	620	666
Delhi	1302	734	1074	1224	1284
Hyderabad	484	266	372	436	479
Kolkata	450	208	328	392	400
Mumbai	884	301	627	801	915
Chennai	462	205	281	356	404

Air Traffic Movement for each day in Oct'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.

Delhi Air Traffic Movement - Oct 2023

Avg Daily-1284

Data Source: ATC Automation
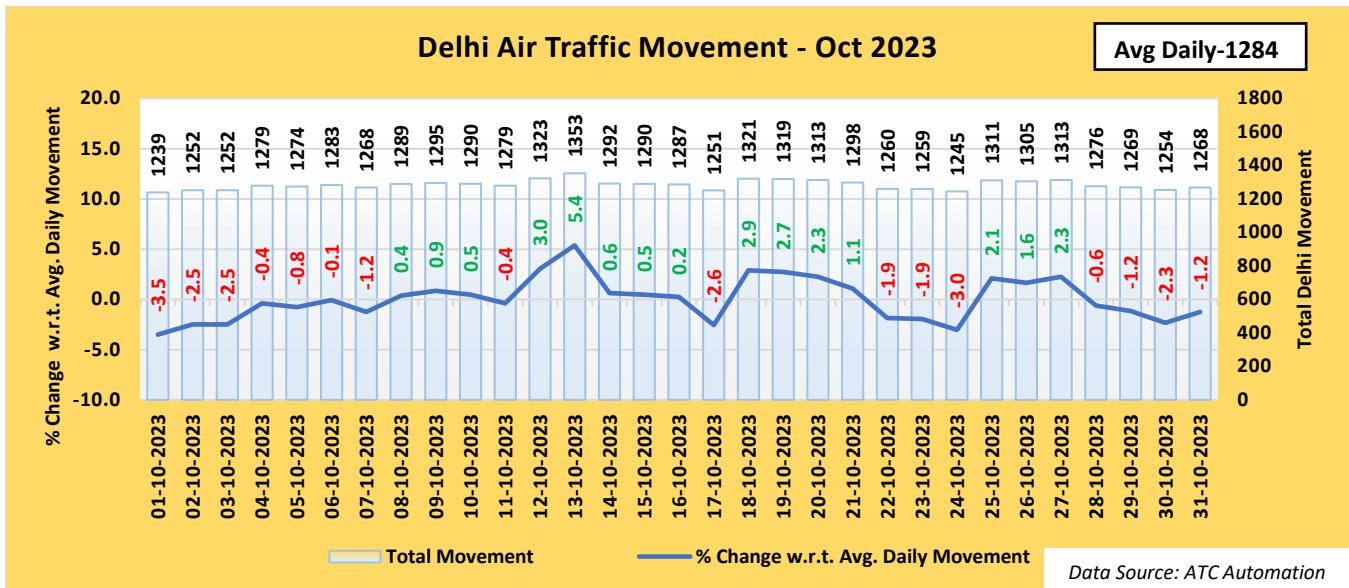
Figure 3: Air Traffic Movement for Delhi –Oct 2023

Mumbai Air Traffic Movement -Oct 2023

Avg Daily-915

Data Source: AOCC
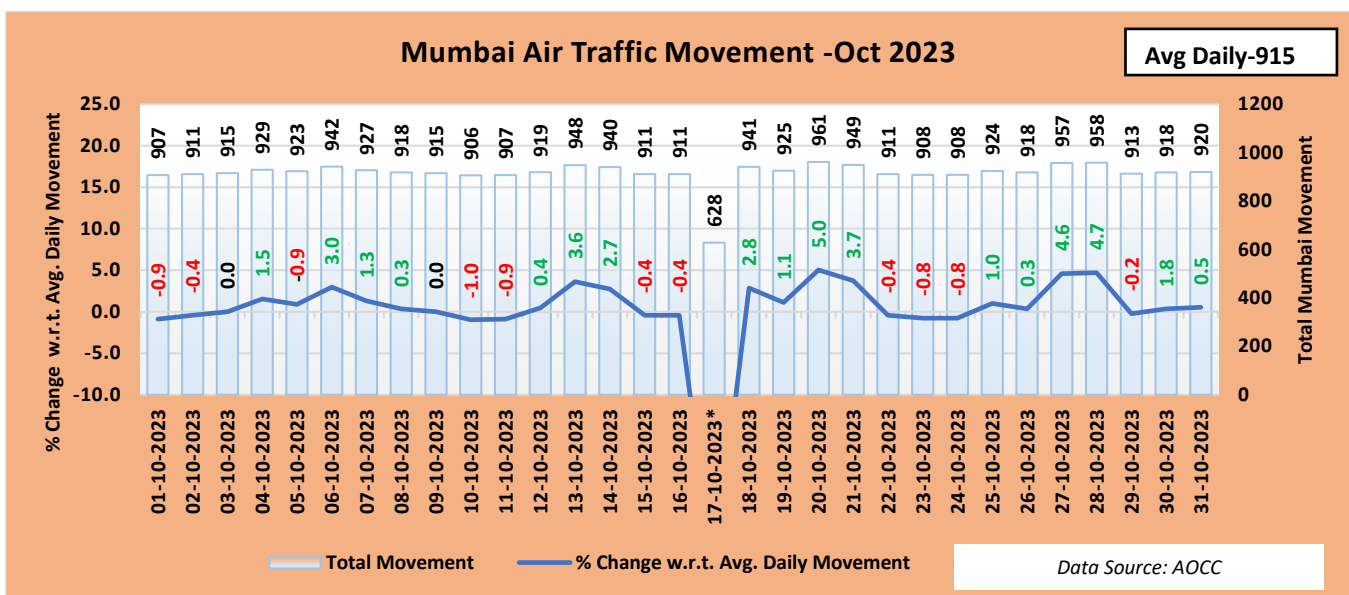
Figure 4: Air Traffic Movement for Mumbai - Oct 2023

*Note: Annual post-monsoon preventive maintenance planned closure(0530 UTC-1130 UTC) of Runways resulted in less movement on 17th Oct'23.
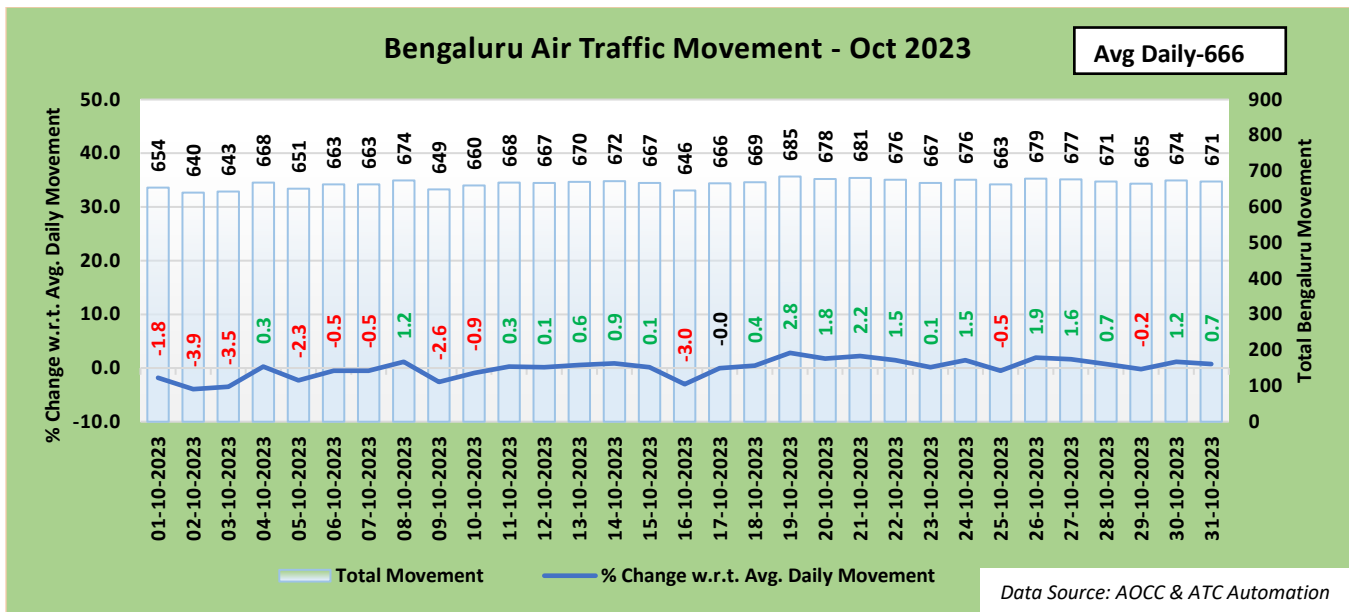
Figure 5: Air Traffic Movement for Bengaluru – Oct 2023
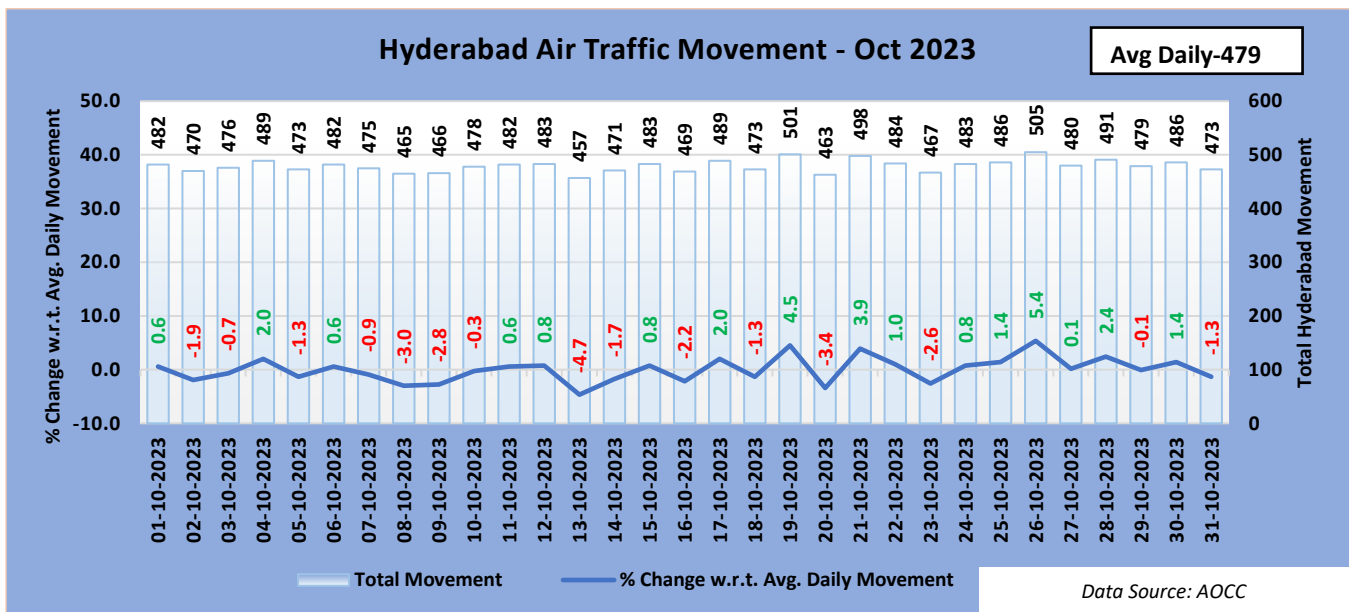
Figure 6: Air Traffic Movement for Hyderabad - Oct 2023

It can be concluded from the above charts that on 31st Oct 2023(month end), the ATMs at Delhi and Hyderabad saw a decline of 1.2% and 1.3% respectively whereas ATMs at Mumbai and Bengaluru witnessed an increase of 0.5% and 0.7% respectively in comparison to the average daily movement for Oct'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 October 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.
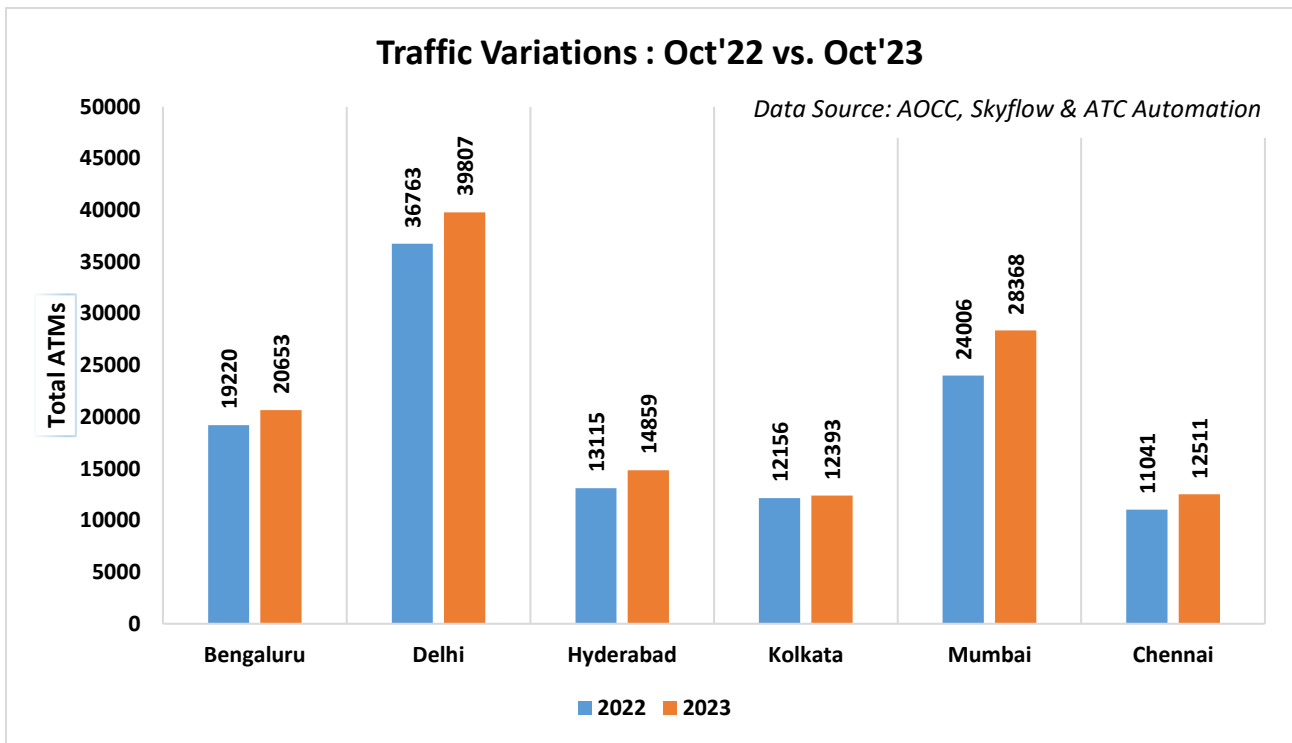
Figure 7: Traffic Variation (YoY)

III. Flight Operations – Airlinewise
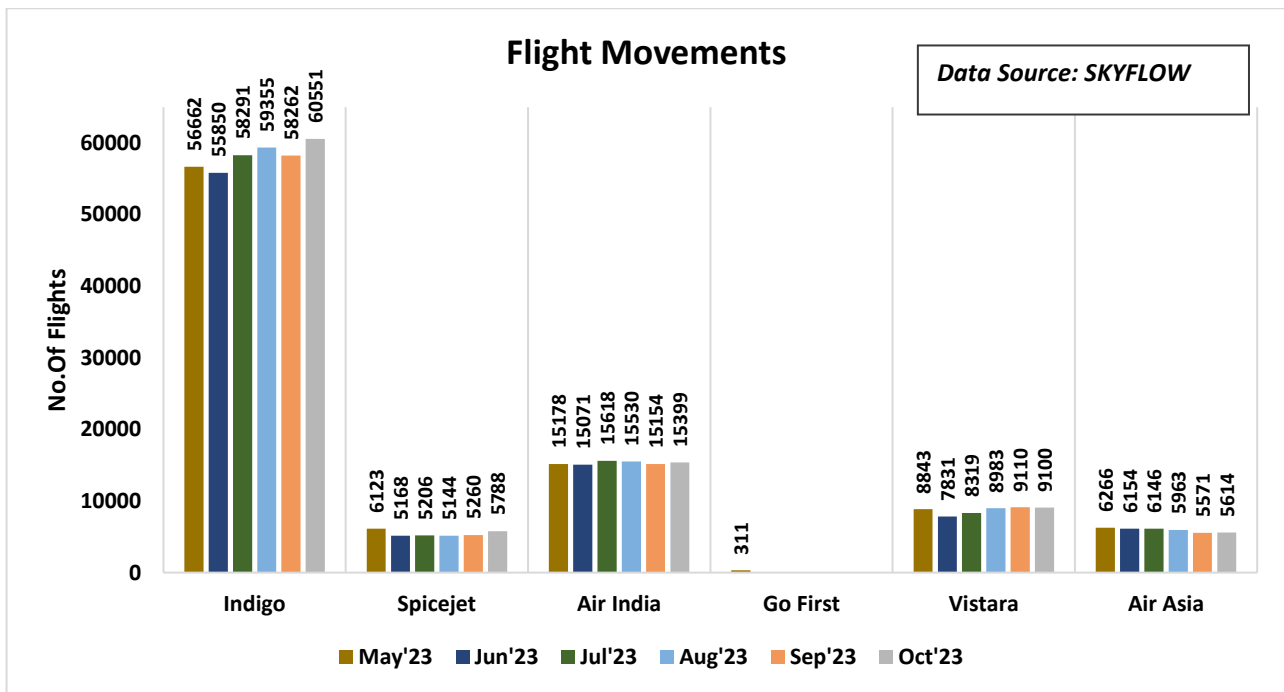
Figure 8: Flight Movements –Airlinewise

Inference:

1. Spicejet and Indigo Airlines have recorded an increase in the monthly average Flight movement in Oct'23 as compared to Sep '23 while Air India, Air Asia and Vistara 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 October 23**

Back Ground   During the above mentioned period, **Ten (10)** ATFM measures were applied **for Delhi Airport, Ten (10)** ATFM measures were applied **for Mumbai Airport , Seven (07)** ATFM measures were applied **for Chennai Airport** and **Five (05)** ATFM measures were applied **for Pune Airport** due to the following reasons as illustrated in the bar chart below:–
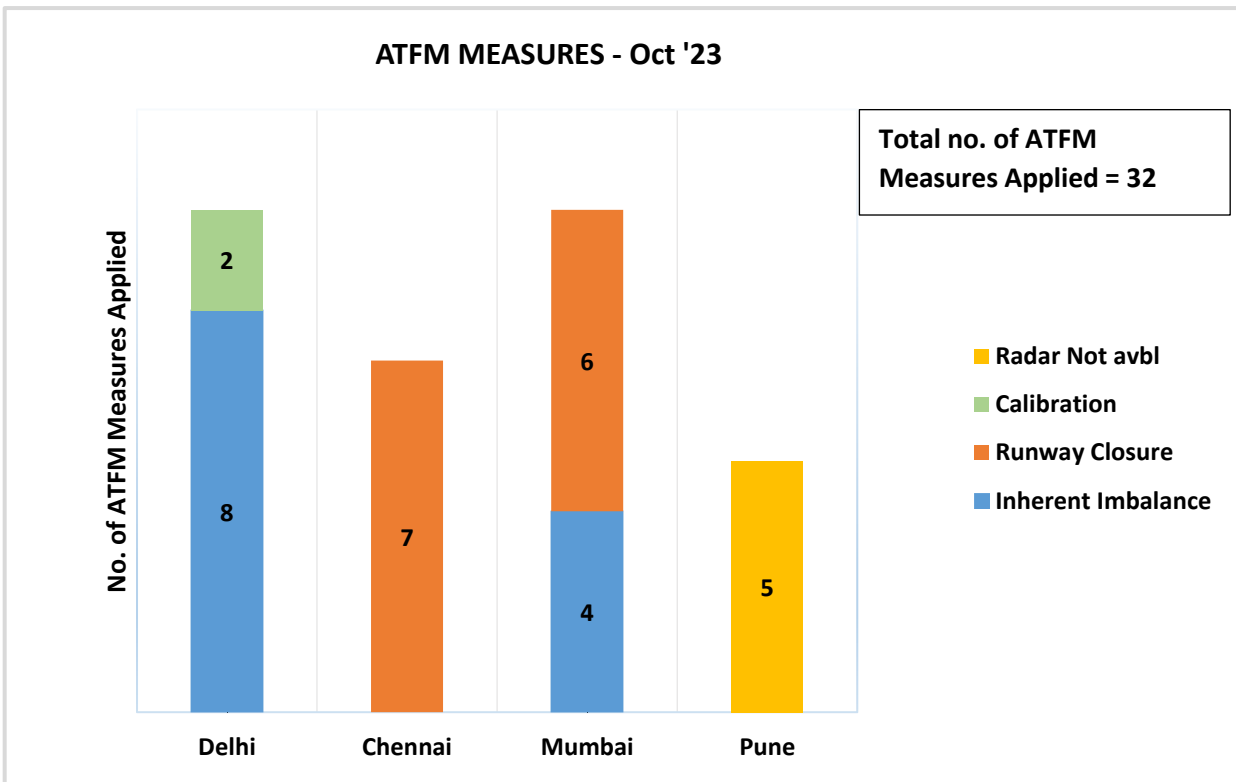
Figure 9: ATFM Measures –Oct '23

II. ATFM Measures Overview

Constrained Airport	Delhi	Mumbai	Pune	Chennai
Number of ATFM measures applied	10	10	5	7
Average ATFM Ground delay(in min) due to measures*	20.1	20.7	11.7	26.6
Maximum ATFM Ground delay(in min) due to measures	77	46	48	47
% Compliance	74.1	79.1	76	90.8

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

Total Arrivals	1524
Total International Arrivals(exempted)	263
Total affected flights in scenario (Domestic Arrivals)	1261
Total Domestic Arrivals with zero ATFM delay	127
Total Domestic Arrivals with ATFM delay	1134
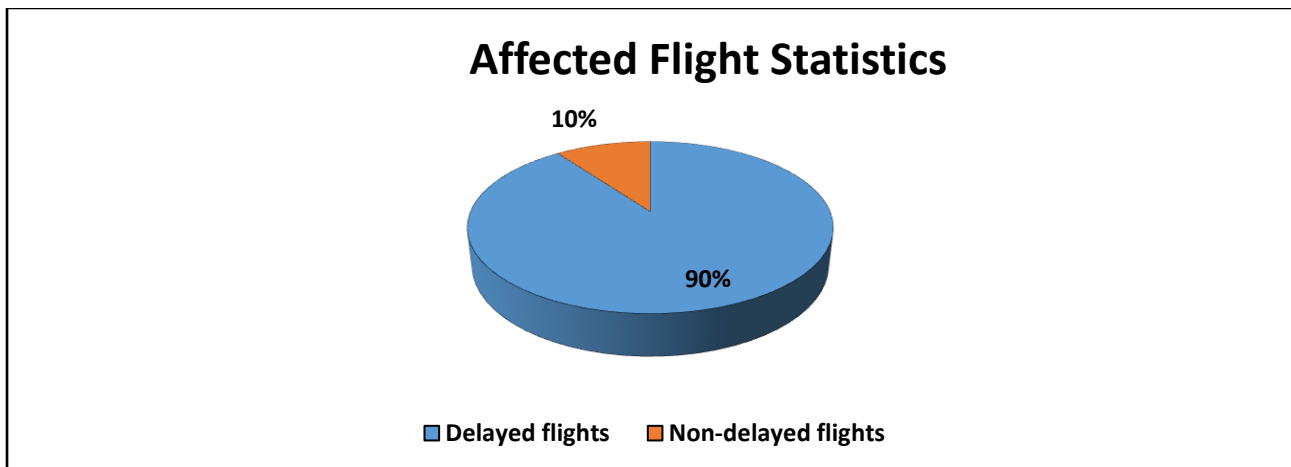
Figure 10: Affected Flight Statistics –Oct'23

III. Overall Compliance

Total arrivals	1524
Domestic arrivals	1261
Flights with complete data (ATOT)	1233
Flights with incomplete data	10
Flights Not Operated	18
Compliant*	957
Non-Compliant	276

*Total No. of Revised CTOTs issued = 229 (Compliance calculation for flights which were issued revised CTOT is w.r.t. new CTOT issued)
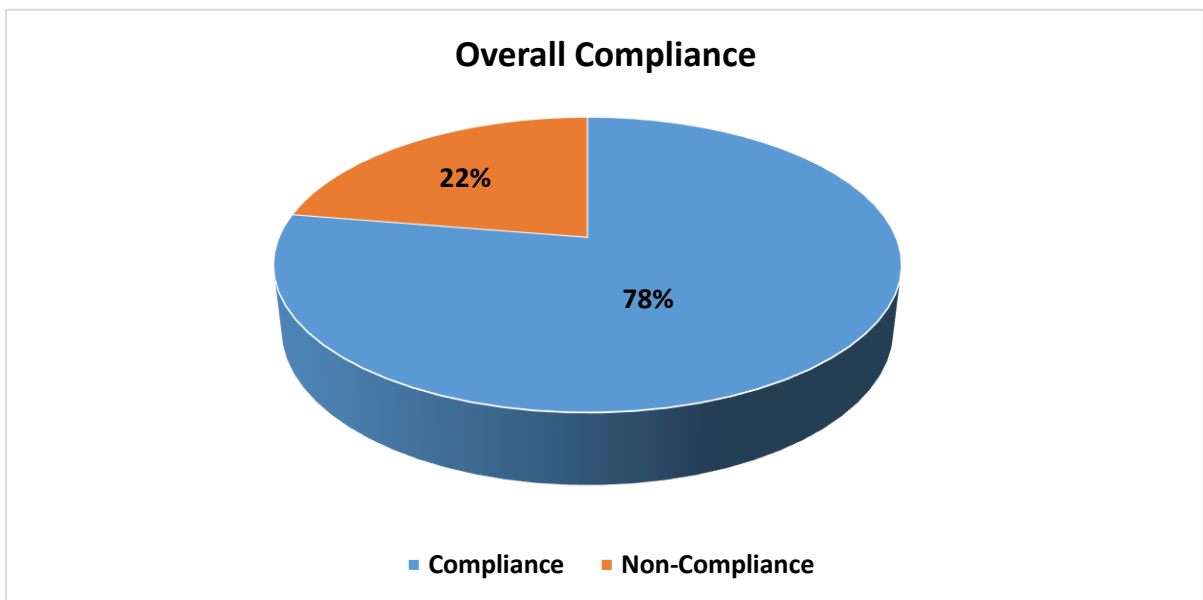
Figure 11: **Overall Compliance – Oct'23**

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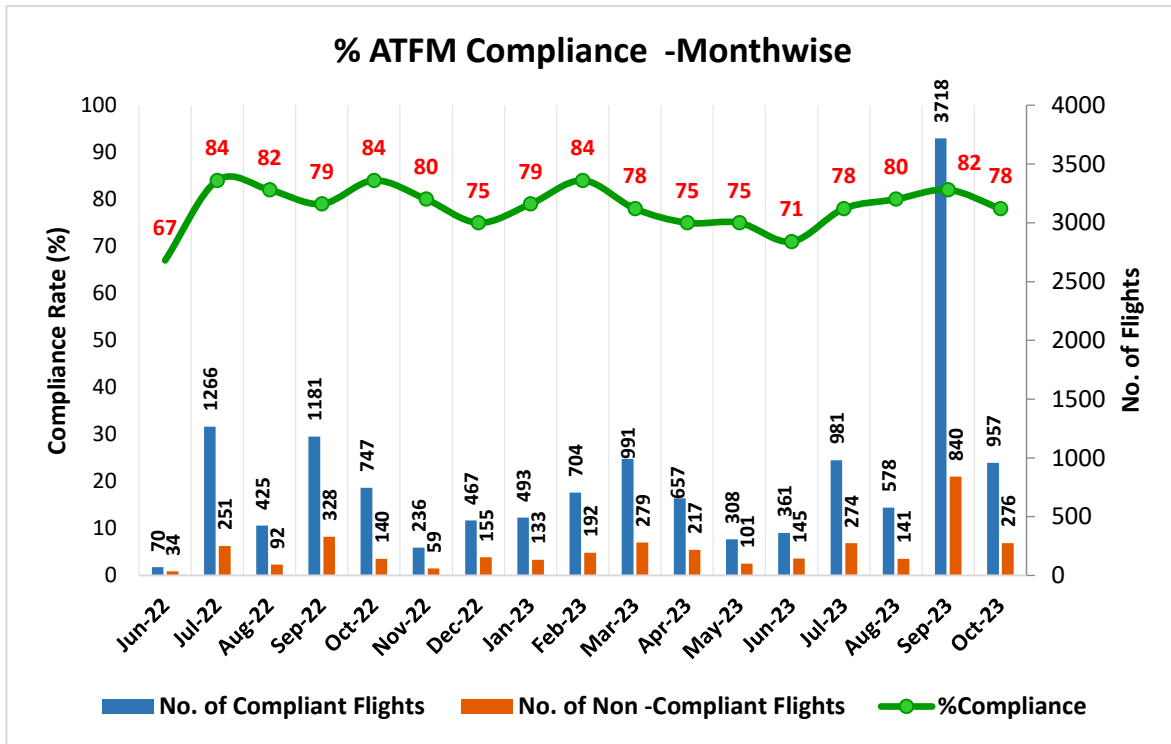
Figure 12: Compliance(Monthwise)

Inference

1. Out of the total arrivals captured(1524 flights) during the CDM scenario for the constrained Airports, 82.7% of flights i.e. domestic arrivals(1261 flights) were candidates for ground delay(participating).
2. Out of these Domestic Arrivals(1261), 89.9% (1134 flights) are assigned ATFM ground delay.
3. Out of the total arrivals captured(1524 flights) to the constrained Airport during the ATFM scenario, only 74.4% of flights(1134 flights) were assigned ATFM Ground Delay.

IV. CTOT Compliance rate – Airportwise

MUMBAI FIR (80%)*	Compliant	Non Compliant	% Compliant
Ahmedabad	32	3	91%
Aurangabad	2	2	50%
Mumbai	57	11	84%
Bhuj	2	0	100%
Vadodara	7	4	64%
Bhopal	15	5	75%
Diu	0	1	0%
Hirasar	5	2	71%
Indore	18	4	82%
Jabalpur	2	1	67%
Jamnagar	4	1	80%
Kandla	2	2	50%
Kolhapur	1	1	50%
Nagpur	11	3	79%
Pune	23	6	79%
Shirdi	11	1	92%
Surat	5	3	63%
Udaipur	5	2	71%
KOLKATA FIR (80%)*	Compliant	Non Compliant	% Compliant
Prayagraj	2	0	100%
Agartala	2	0	100%
Siliguri	16	6	73%
Shillong	1	0	100%
Varanasi	15	2	88%
Bhubaneswar	16	4	80%
Bilaspur	1	0	100%
Kolkata	48	9	84%
Chakeri	0	1	0%
Durgapur	3	0	100%
Darbhanga	1	1	50%
Deoghar	1	0	100%
Gorakhpur	4	2	67%
Guwahati	14	8	64%

KOLKATA FIR (80%)*	Compliant	Non Compliant	% Compliant
Hollongi	0	1	0%
Imphal	2	0	100%
Jharsuguda	2	0	100%
Kushinagar	1	0	100%
Khajuraho	2	0	100%
Aizawl	0	1	0%
Dibrugarh	3	1	75%
Patna	19	5	79%
Ranchi	20	3	87%
Rourkela	1	0	100%
Raipur	11	2	85%
DELHI FIR (70%)*	Compliant	Non Compliant	% Compliant
Amritsar	9	6	60%
Bikaner	1	0	100%
Bareilly	0	1	0%
Chandigarh	19	5	79%
Dehradun	10	1	91%
Delhi	83	26	76%
Kangra	7	3	70%
Gwalior	1	0	100%
Jodhpur	6	4	60%
Jaipur	23	7	77%
Jaisalmer	0	1	0%
Jammu	7	4	64%
Leh	7	9	44%
Lucknow	27	6	82%
Pantnagar	2	1	67%
Suratgarh	0	1	0%
			100%
Shimla	1	0	
Srinagar	24	21	53%

CHENNAI FIR (80%)*	Compliant	Non Compliant	% Compliant
Hal Bangalore	0	1	0%
Bangalore	70	25	74%
Belgaum	0	1	0%
Vijayawada	2	1	67%
Coimbatore	21	1	95%
Kochi	29	3	91%
Calicut	2	0	100%
MOPA	16	12	57%
Goa	28	14	67%
Hubli	4	1	80%
Hyderabad	55	9	86%
Begumpet Hyderabad	1	0	100%
Kurnool	4	1	80%
Madurai	8	2	80%
Mangalore	3	3	50%
Chennai	52	5	91%
Port Blair	10	2	83%
Sindhudurg	2	1	67%
Tuticorin	11	0	100%
Tirupati	1	0	100%
Tiruchirappally	1	0	100%
Thiruvananthapuram	23	2	92%
Visakhapatnam	4	3	57%

*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(78%) for the month are highlighted in red.

V. CTOT Compliance rate – Airlinewise

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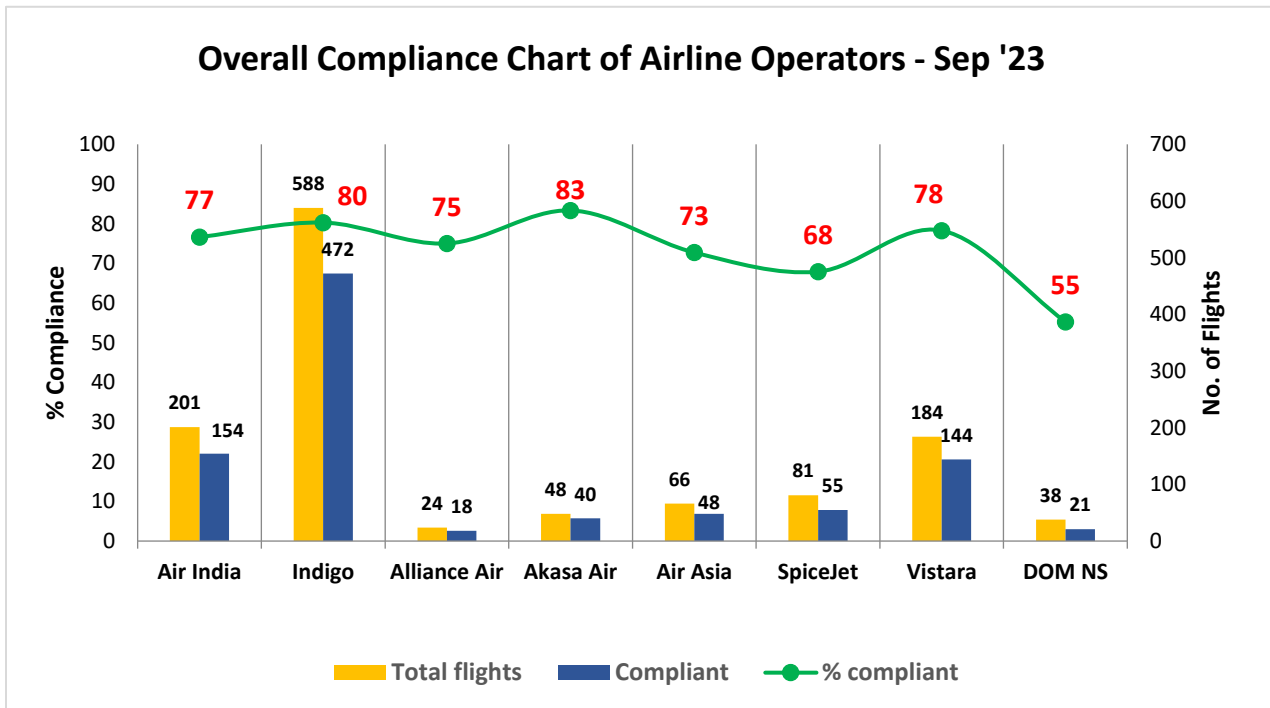
Figure 13: Airline wise Compliance –Oct'23

Inference

1. Out of the total domestic arrivals with complete data in the CDM scenario, 78% arrivals are compliant.
2. Chennai, Mumbai and Kolkata region record the highest compliance of 80% whereas Delhi region has the lowest percentage compliance of 70%.
3. Indigo, Akasa Air and Vistara Airlines have a CTOT compliance higher than the average recorded compliance for the month of Oct '23.

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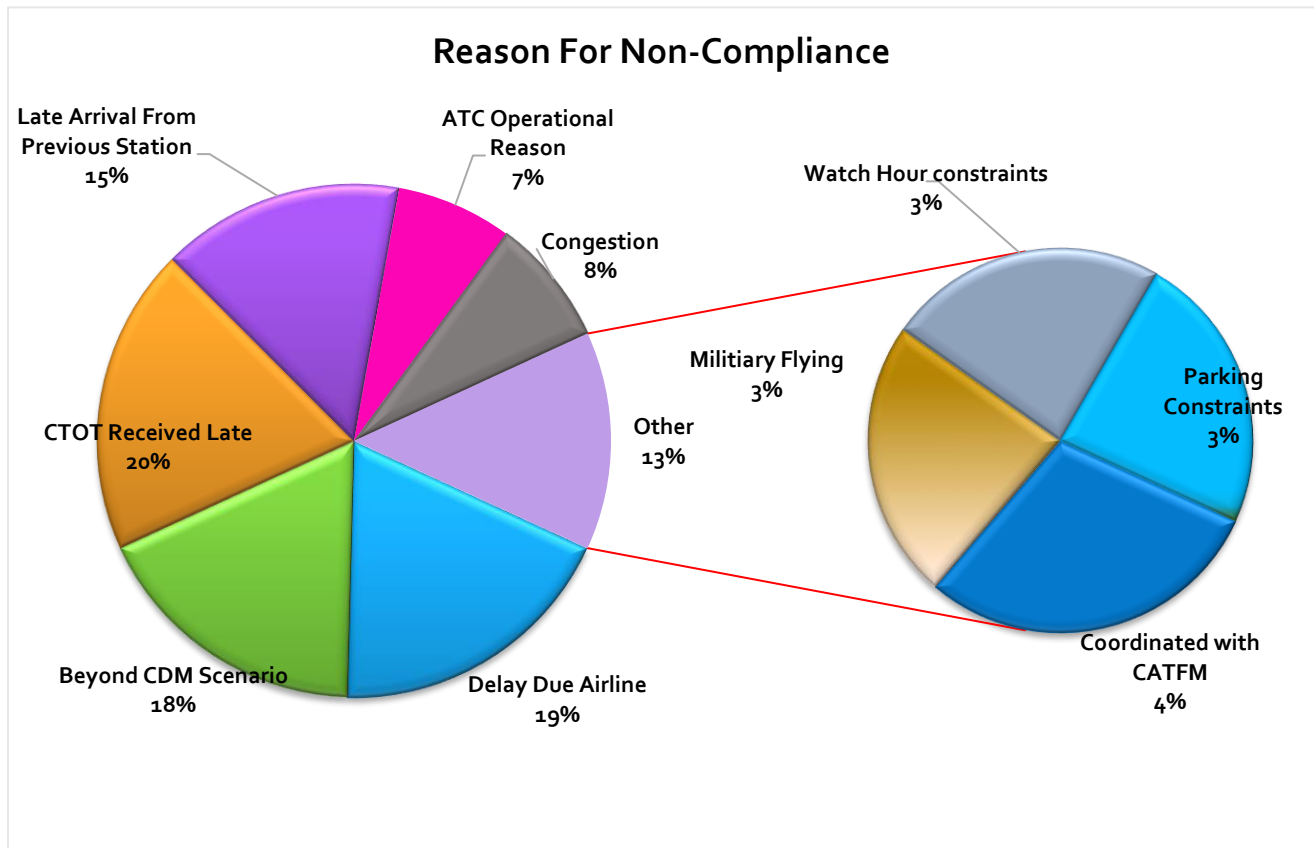
Figure 14: Reason for Non-Compliance as provided by FMPs

Inference:

1. 20 % 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. 19 % of CTOT Non- Compliance was reported by concerned FMPs to be due to delay by Airlines.
3. 18 % of flights captured during the ATFM measures did not operate during the scheduled flight plan timings resulting in under utilization of the constrained Airport.
4. 15 % 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.

VII. Air Delay during the CDM Scenario period

Average Air Delay to domestic arrivals* within the CDM Scenario period for Delhi, Mumbai, Chennai and Pune was 20.1, 20.7, 26.6 and 11.7 minutes respectively.

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

Air Delay during the ATFM Measure
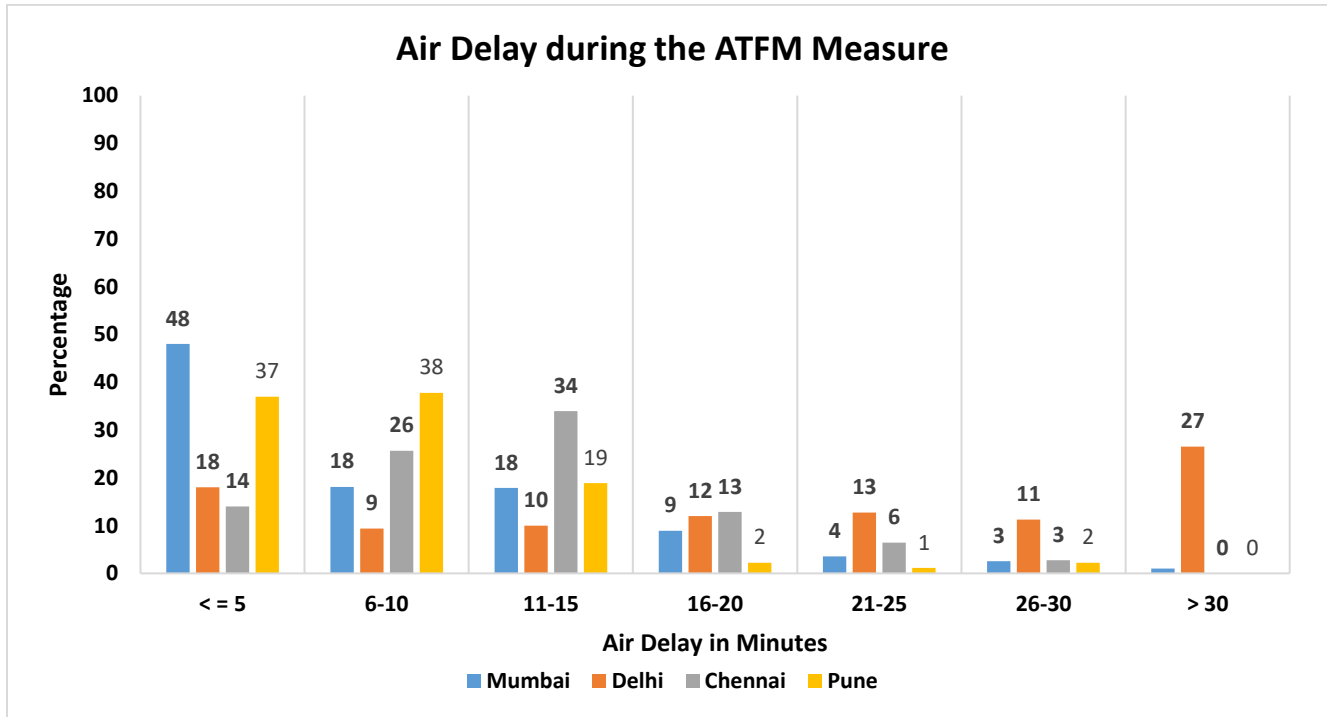
Figure 15: Air Delay distribution during the CDM period

Inference

1. 66% of domestic arriving flights to Mumbai had an Air delay of equal to or less than 10 minutes during the CDM period.
2. 27% of domestic arriving flights to Delhi had an Air delay of equal to or less than 10 minutes during the CDM period.
3. 40% of domestic arriving flights to Chennai had an Air delay of equal to or less than 10 minutes during the CDM period.
4. 75% of domestic arriving flights to Pune 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)= 22447 mins

Total Air Delay (with no ATFM measures) = 38177 mins

Reduction in Air delay due to ATFM measures= (38177-22447) = **15730 mins**

Fuel Saving Calculation:

Total Fuel saved during the ATFM Measure: ***10,04,788.52 Kg***

Total reduction in CO_2 emission : 3.16(KgCO_2/kg fuel)* 10,04,788.52 Kg = 31,75,131.72 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	$$\frac{\textit{Total monthly ATFM delay }(\textit{in minutes})}{\textit{Total Domestic Arrivals}}$$
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: $$\textit{Average Air Delay}$$ $$= \frac{\textit{Total Air Delay to domestic arrivals }(\textit{with values greater than zero})}{\textit{Total Domestic Arrivals}}$$ *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)- October 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.
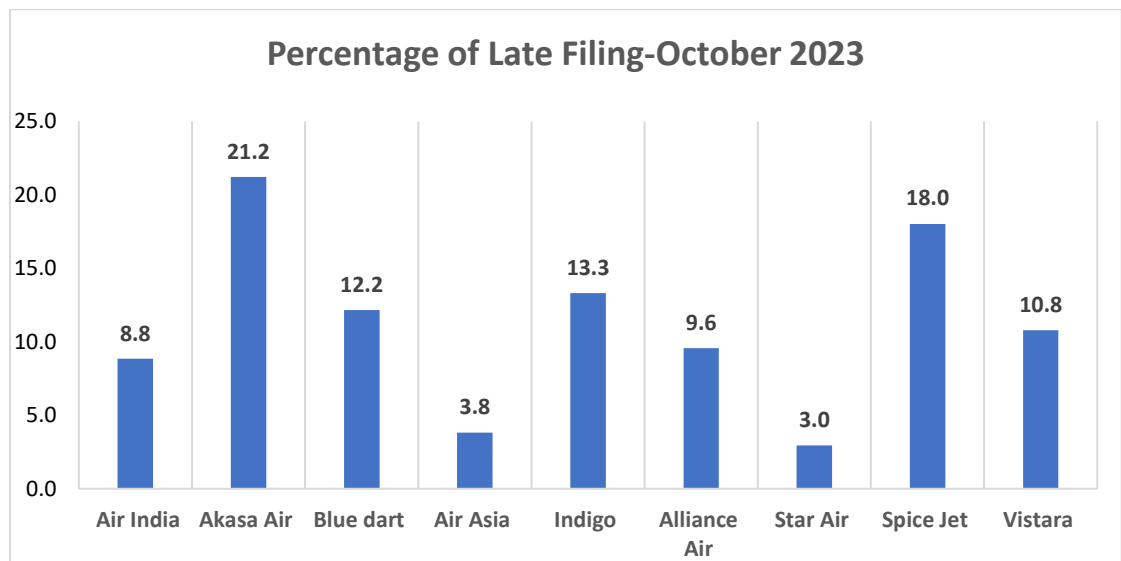
AIP India, ENR 1.9 section 4 on Flight Planning in the context of ATFM recommends Flight Planning requirements for all Airline Operators –

"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 October 2023 to 31st October 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-October 2023

Airline	Percentage
Air India	8.8
Akasa Air	21.2
Blue dart	12.2
Air Asia	3.8
Indigo	13.3
Alliance Air	9.6
Star Air	3.0
Spice Jet	18.0
Vistara	10.8

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 India	1064	12035	8.8
Akasa Air	629	2964	21.2
Blue dart	63	518	12.2
Air Asia	202	5261	3.8
Indigo	7244	54351	13.3
Alliance Air	248	2593	9.6
Star Air	22	745	23.0
Spice Jet	1014	5666	18.0
Vistara	937	8689	10.8
Total no. of FPLs for Scheduled Airlines	**11423**	**92822**	**12.3**

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 October 2023.

{(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	1731	8165	21.2
Akasa Air	358	2202	16.3
Blue dart	42	394	10.7
Air Asia	349	3666	9.5
Indigo	5358	40474	13.2
Alliance Air	250	1589	15.7
Star Air	47	307	15.3
Spice Jet	840	3223	26.1
Vistara	1568	6650	23.6

Percentage of DLA Msg not received -October 2023

Airline	Percentage
Air India	21.2
Akasa Air	16.3
Blue dart	10.7
Air Asia	9.5
Indigo	13.2
Alliance Air	15.7
Star Air	15.3
Spice Jet	26.1
Vistara	23.6
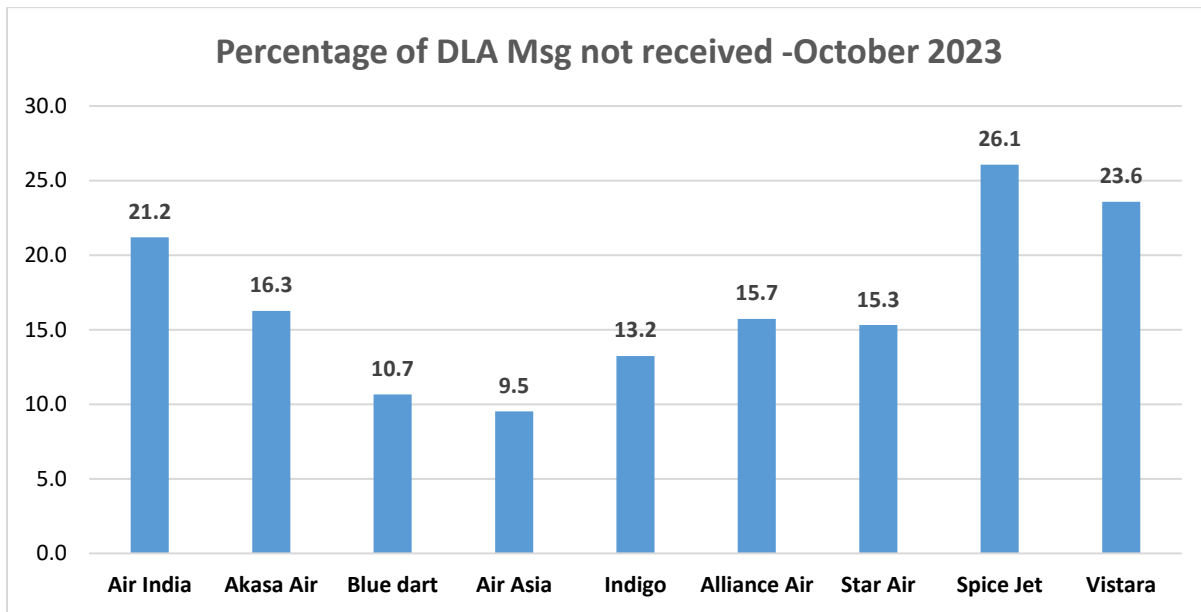
C. For analysis of non-receipt of CNL (cancel) messages for October 2023, annulled FPLs were considered for which no CNL/DEP/DLA messages were received. A FPL gets annulled in SKYFLOW system, if it doesn't get activated through Dep message /surveillance data/ manual activation by FMP within a defined system parameter.

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

Name of Airline	CNL message not received	No. of flights annulled
Air India	26	65
Akasa Air	2	11
Blue dart	0	3
Air Asia	3	12
Indigo	112	242
Alliance Air	81	133
Star Air	3	7
Spice Jet	121	162
Vistara	8	26

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