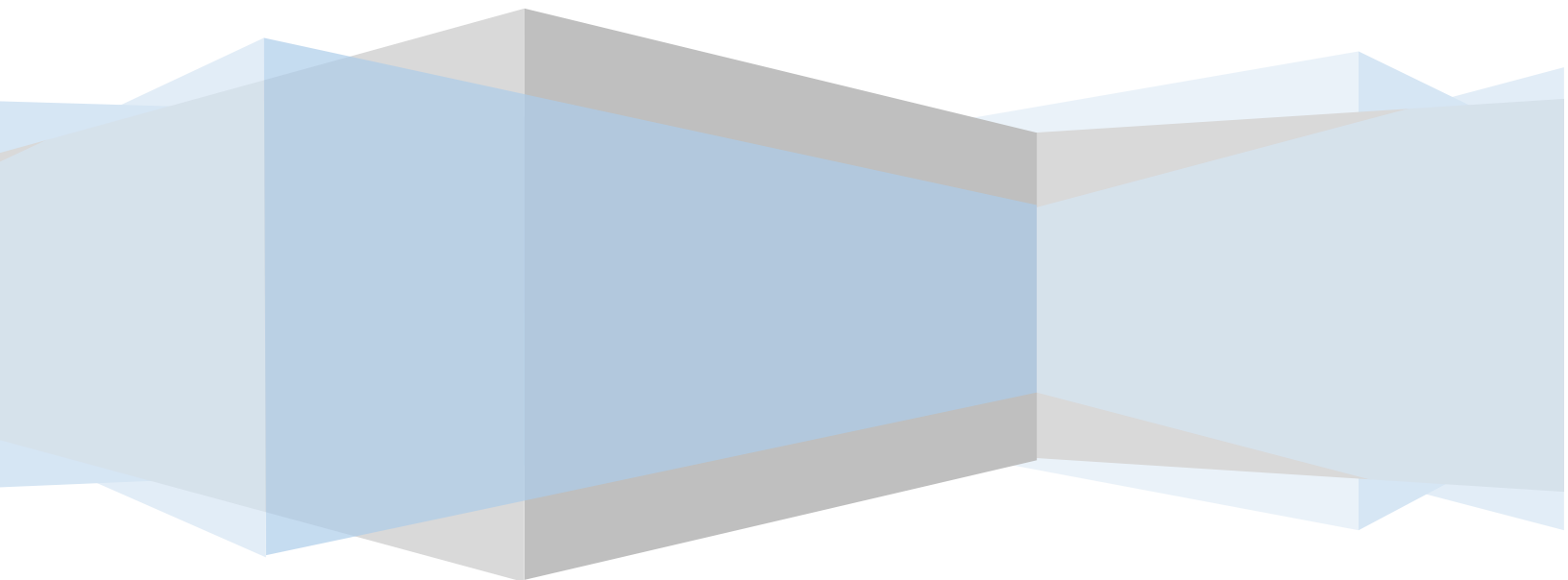


# POST OPERATIONS ANALYSIS REPORT

March, 2024

CENTRAL COMMAND CENTER, C-ATFM, DELHI







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## A. Executive Summary

Average Domestic air traffic has recorded a decrease of 6.01 % whereas the average international air traffic has increased by 0.6 % in the month of March'24 as compared to Feb'24.

On average, the Indian Airports in the ATFCM area saw 4483 IFR flights per day in the month of March 2024. The peak day was on 17<sup>th</sup> March 2024 (4629 IFR flights). Wednesday's were the busiest days throughout this month with an average of 4527 IFR flights per day.

Total Seventy three (73) ATFM measures were applied this month during periods of congestion at Delhi, Chennai, Kolkata and Mumbai Airport.

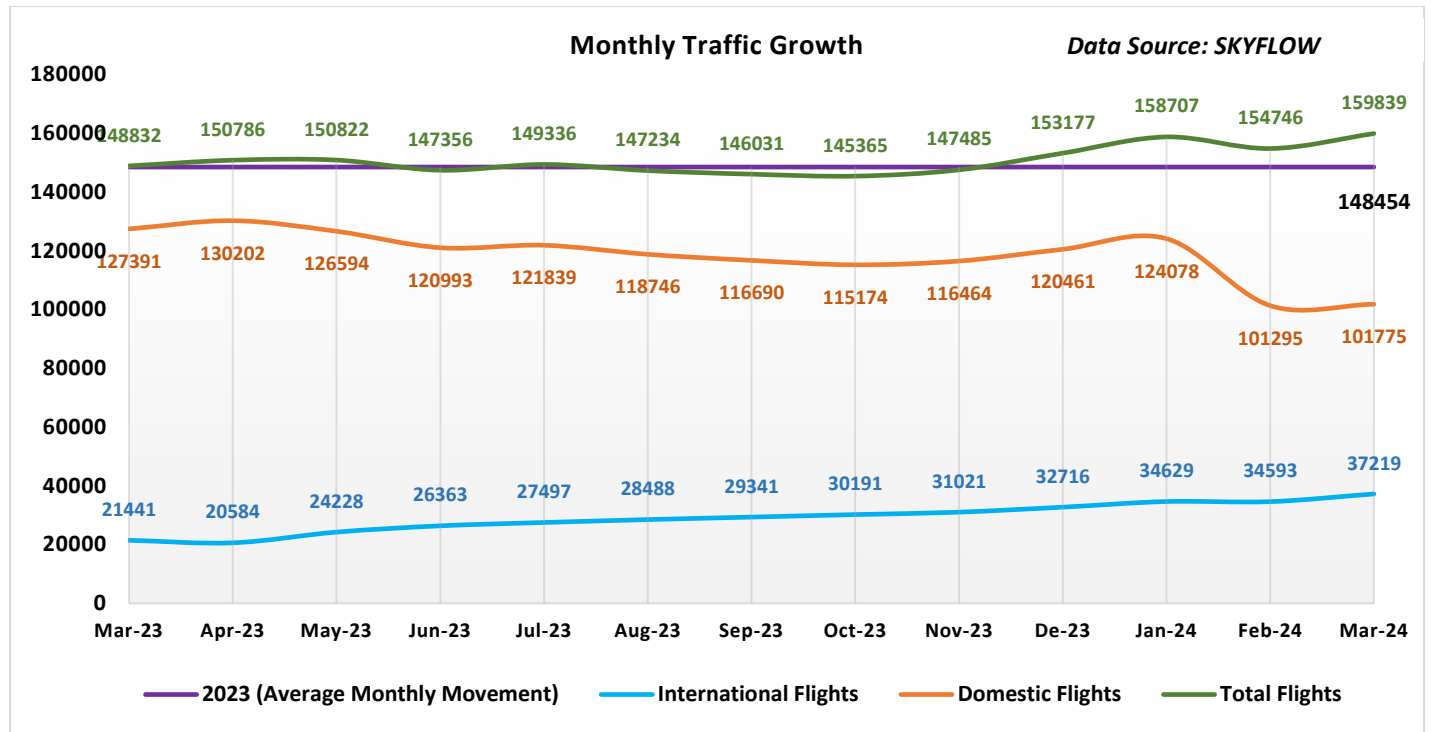


Figure 1: Monthly Traffic Growth

The graph above depicts the Domestic and international Air traffic in Indian ATFCM Area during the last 13 months (March'2023 to March'24).



## B. Traffic Analysis

### I. Air Traffic Movement at Major Airports in India

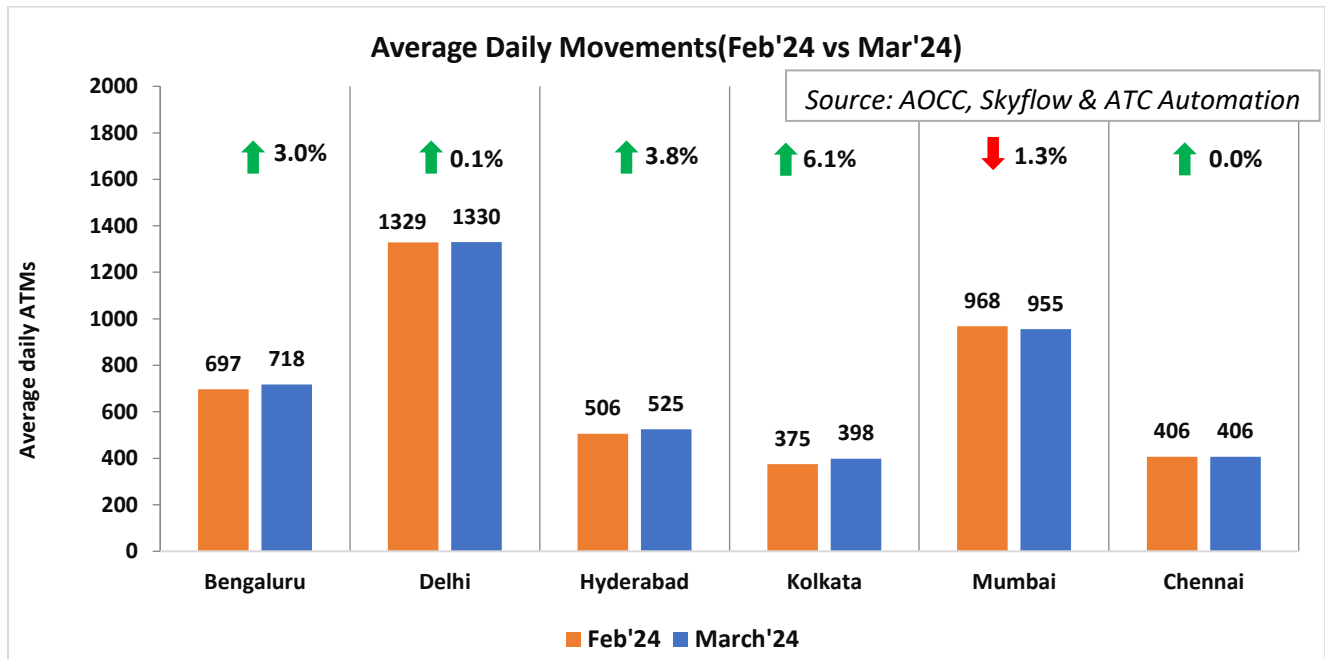


Figure 2: Average Daily Movements ( Feb '24 vs March'24 )

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

Airports\Year	Avg. Daily ATMs (YoY) for six major airports				
	Mar'20	Mar'21	Mar'22	Mar'23	March'24
Bengaluru	463	529	494	713	718
Delhi	912	1185	1025	1285	1330
Hyderabad	366	399	353	490	525
Kolkata	351	357	331	384	398
Mumbai	580	723	577	910	955
Chennai	338	327	311	414	406



Air Traffic Movement for each day in March'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.

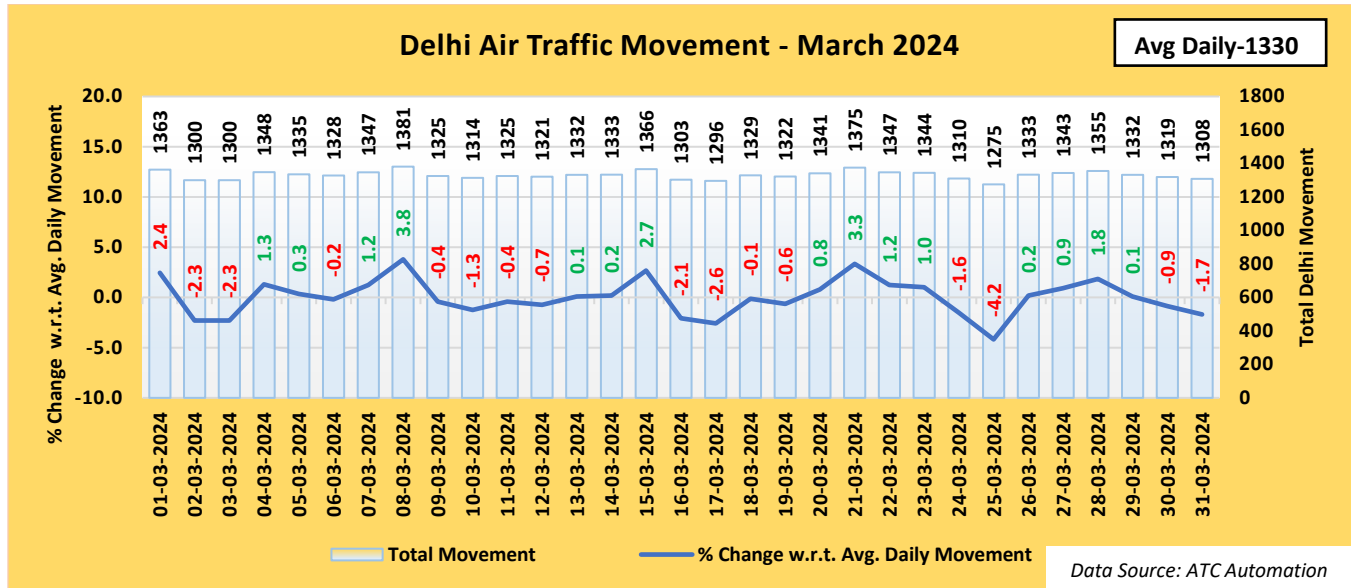


Figure 3: Air Traffic Movement for Delhi –March 2024

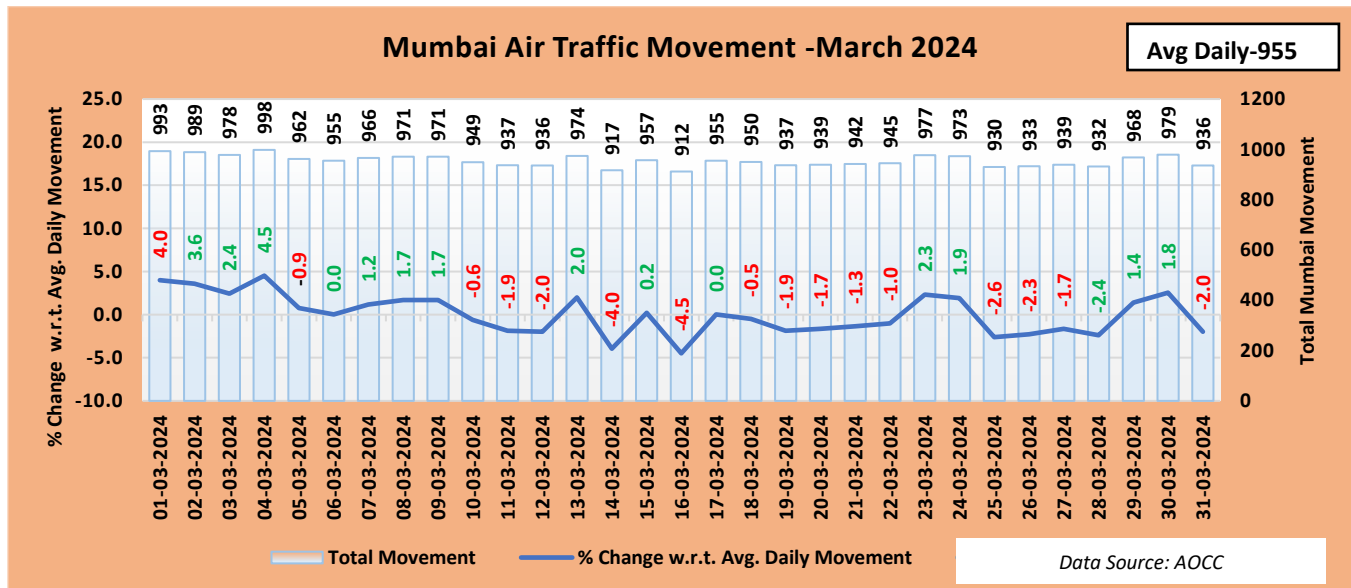


Figure 4: Air Traffic Movement for Mumbai - March 2024

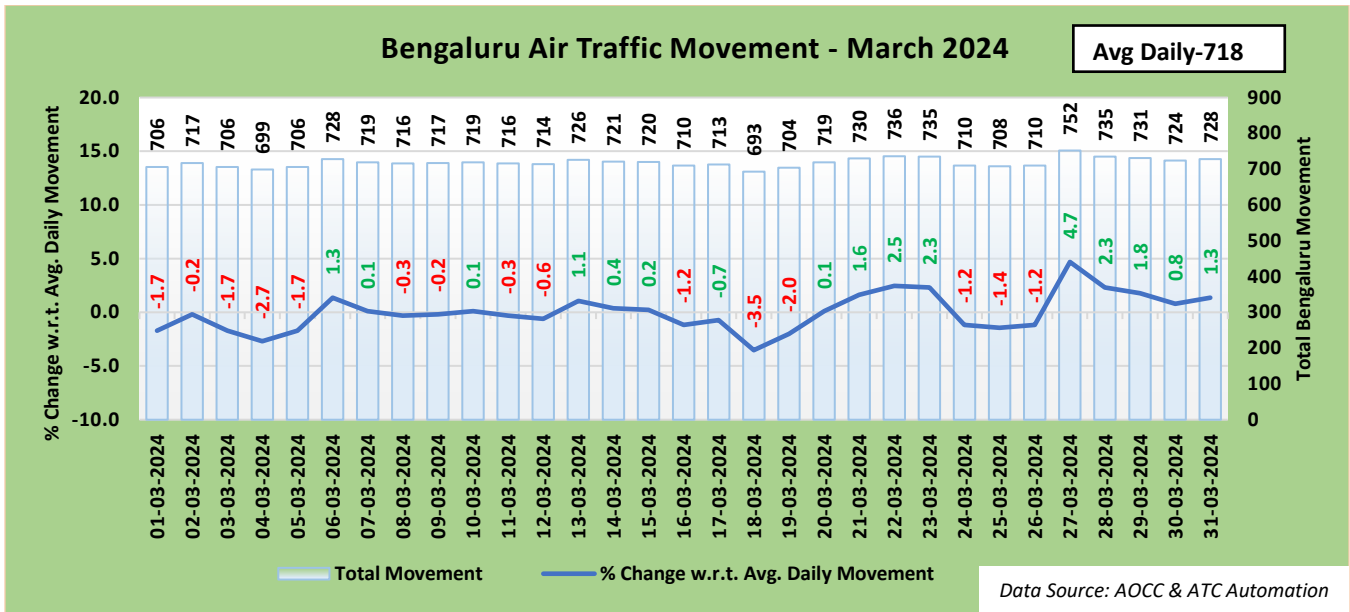


Figure 5: Air Traffic Movement for Bengaluru – March 2024

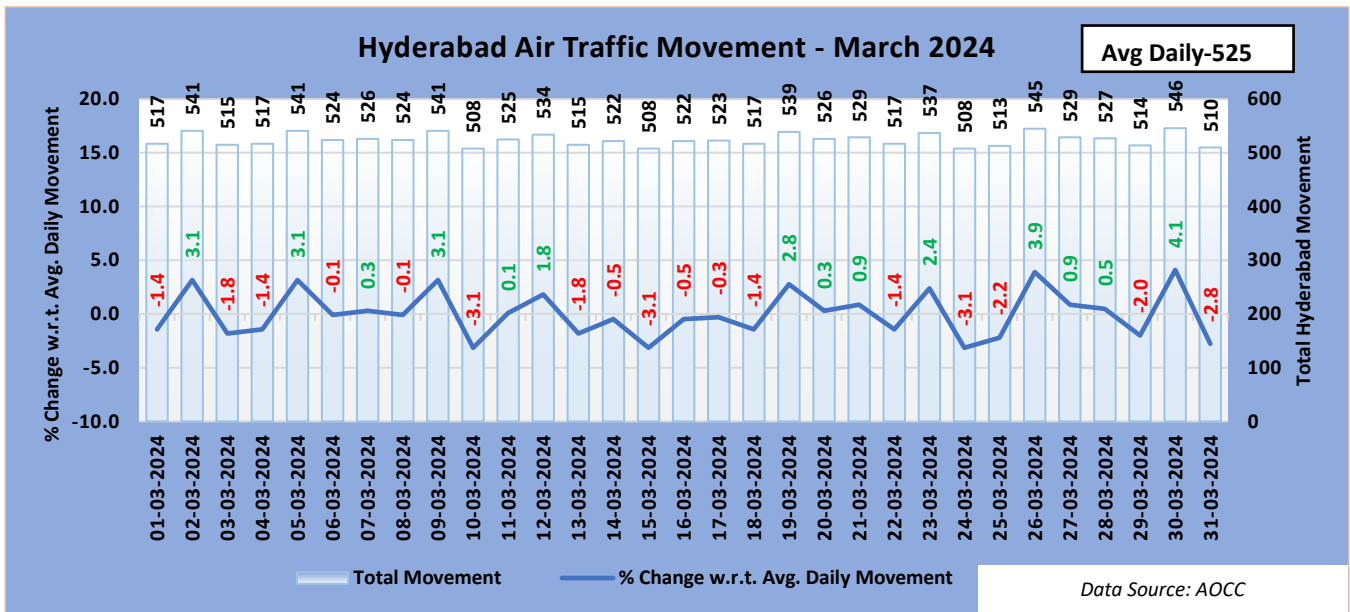


Figure 6: Air Traffic Movement for Hyderabad – March 2024

It can be concluded from the above charts that on 31<sup>st</sup> March 2024 (month end), the ATM at Bengaluru saw an increase of 1.3% whereas the ATM at Delhi, Mumbai and Hyderabad saw a decline of 1.7%, 2.0% and 2.8% respectively in comparison to the average daily movement for March'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 March 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.

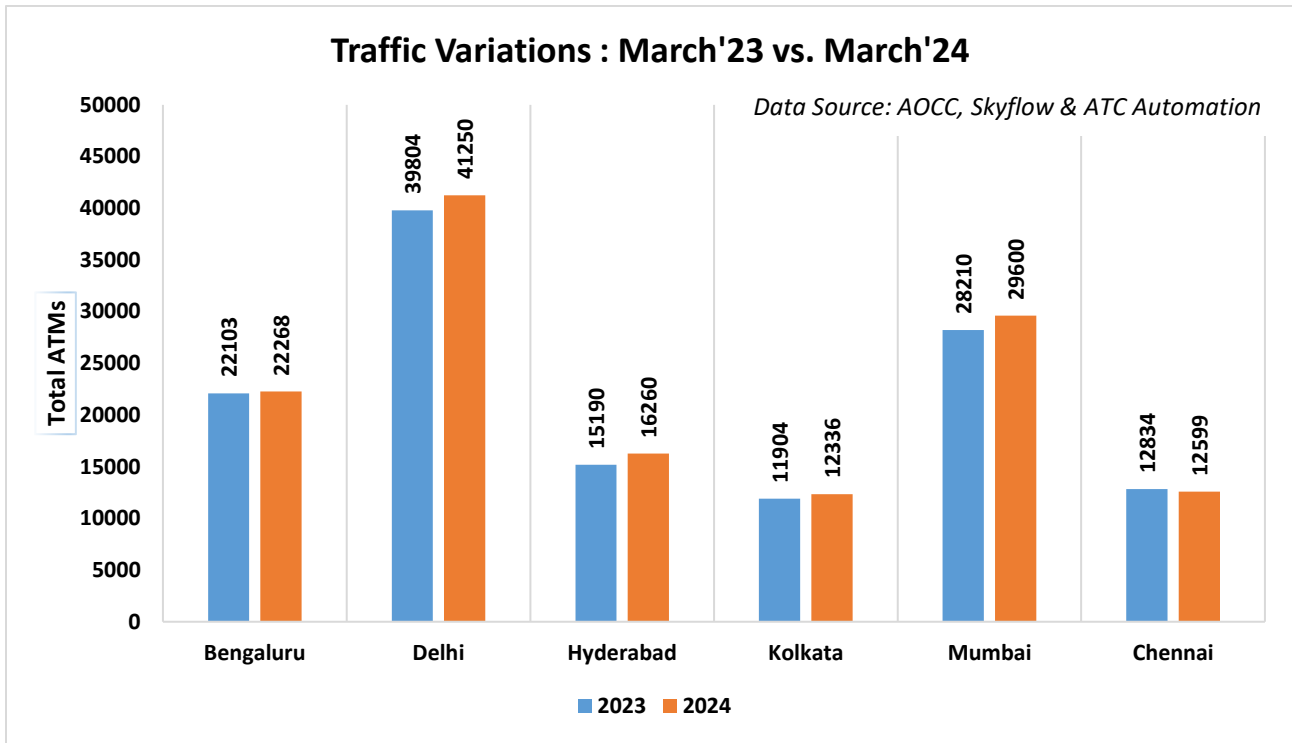


Figure 7: Traffic Variation (YoY)



### III. Flight Operations – Airlinewise

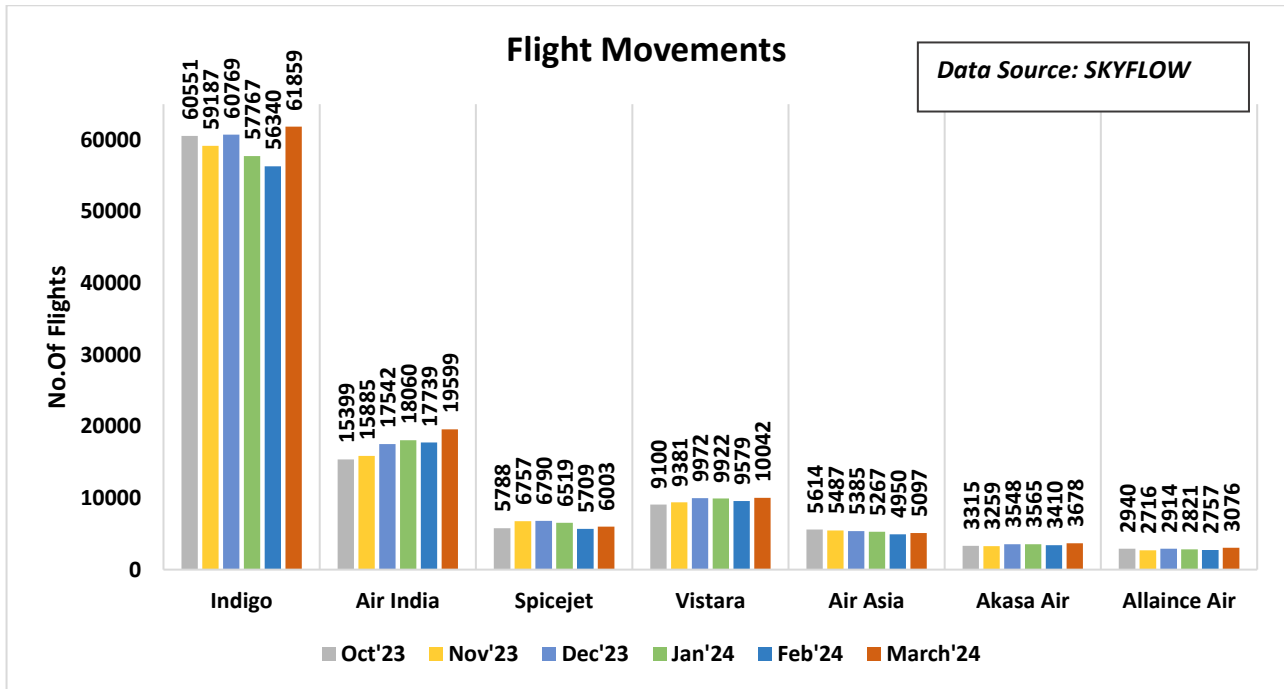


Figure 8: Flight Movements –Airlinewise

#### Inference:

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



## C. ATFM Post Operations – CDM Analysis

### I. Introduction

**Analysis Period** 1<sup>st</sup> – 31<sup>st</sup> March 24

**Back Ground** During the above mentioned period, **Three (03)** ATFM measures were applied for **Delhi Airport**, **Fifty One (51)** ATFM measures were applied for **Mumbai Airport**, **Twelve (12)** ATFM measures were applied for **Kolkata Airport** and **Seven (07)** ATFM measures were applied for **Chennai airport** due to the following reasons as illustrated in the bar chart below:-

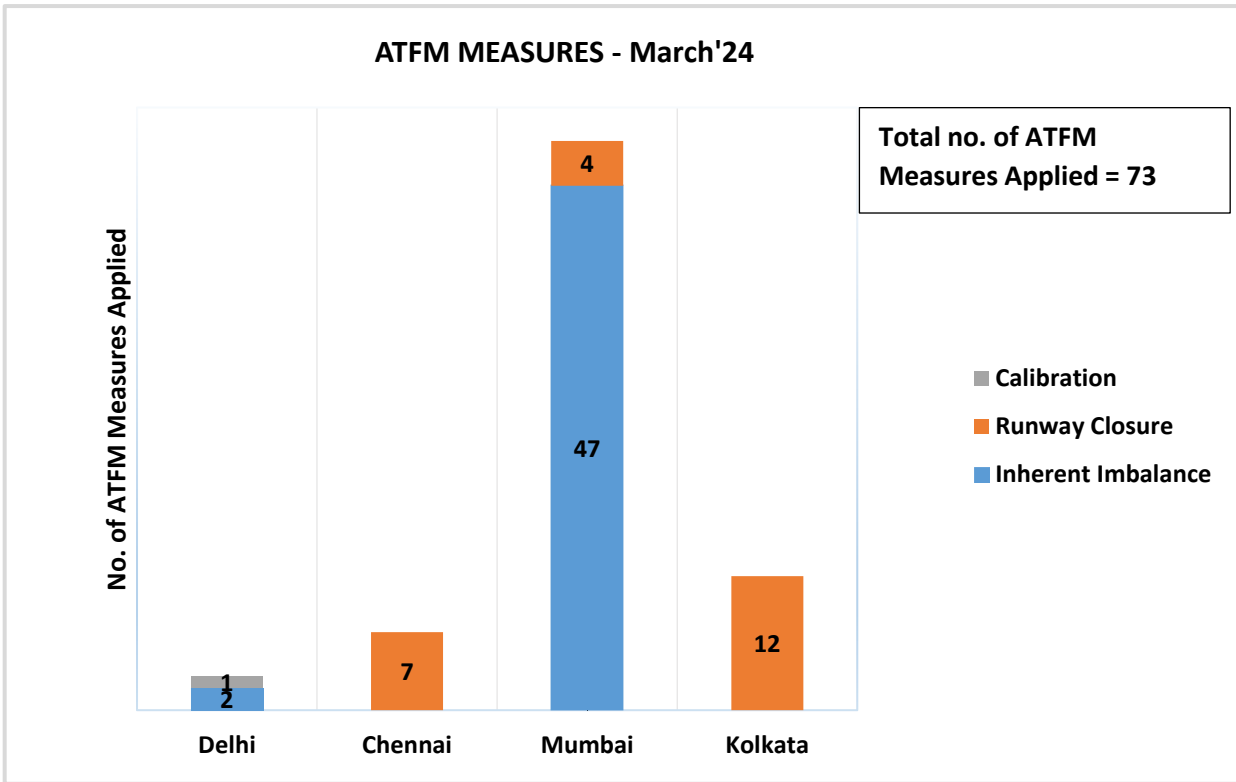


Figure 9: ATFM Measures –March'24



## II. ATFM Measures Overview

Constrained Airport	Delhi	Mumbai	Kolkata	Chennai
Number of ATFM measures applied	3	51	12	7
Average ATFM Ground delay(in min) due to measures*	21.6	31.5	11.1	21.5
Maximum ATFM Ground delay(in min) due to measures	53	105	45	51
% Compliance	69.9	86.0	82.6	74.0

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

Total Arrivals	4538
Total International Arrivals(exempted)	1123
Total affected flights in scenario (Domestic Arrivals)	3415
Total Domestic Arrivals with zero ATFM delay	347
Total Domestic Arrivals with ATFM delay	3068

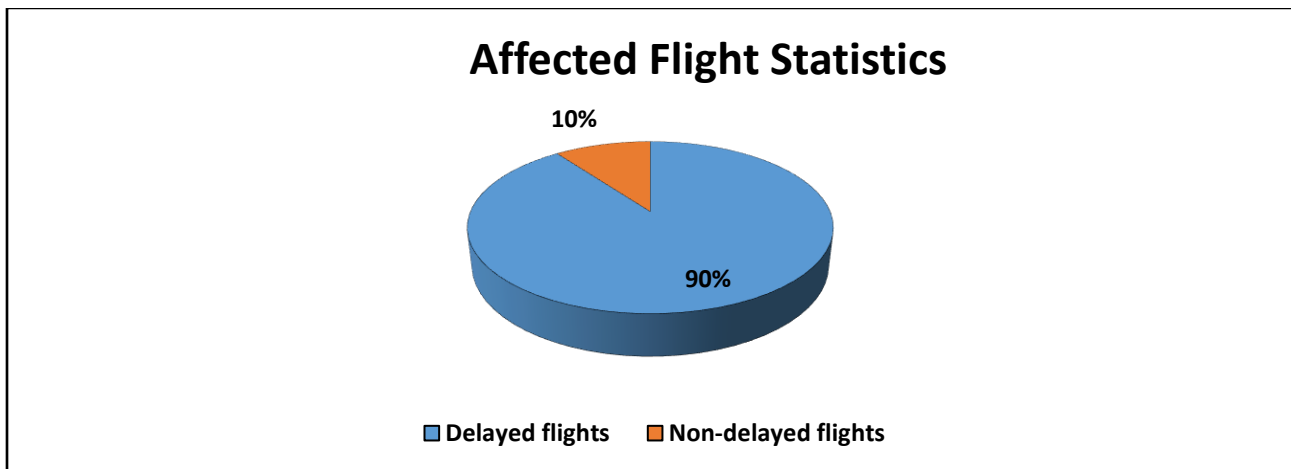


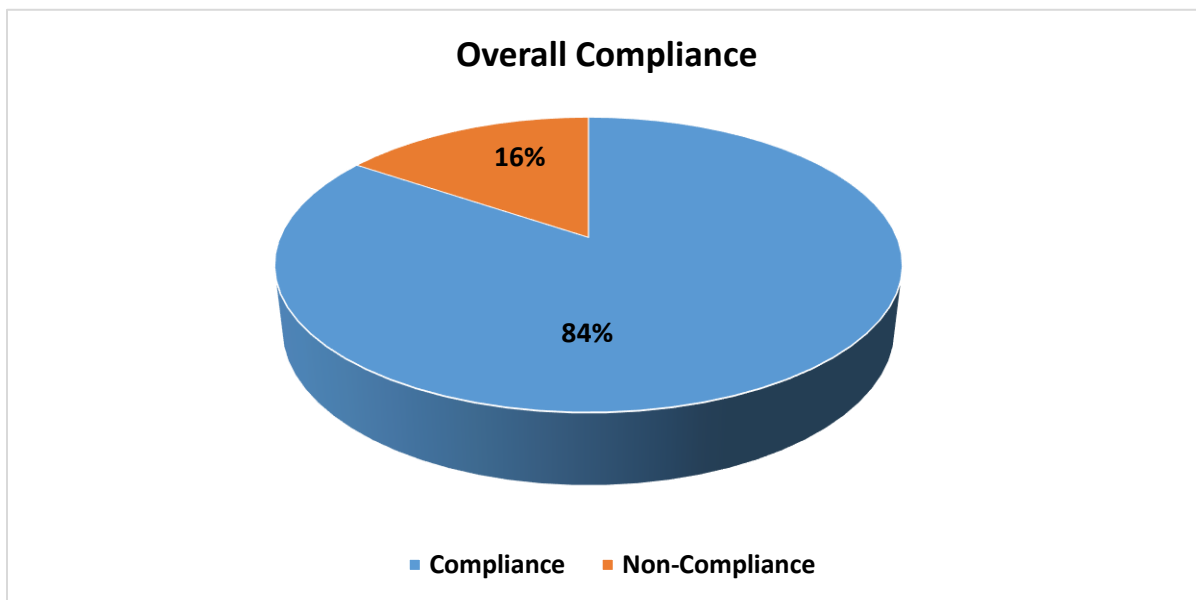
Figure 10: Affected Flight Statistics –March'24



### III. Overall Compliance

<b>Total arrivals</b>	4538
<b>Domestic arrivals</b>	3415
<b>Flights with complete data (ATOT)</b>	3318
<b>Flights with incomplete data</b>	31
<b>Flights Not Operated</b>	66
<b>Compliant*</b>	2802
<b>Non-Compliant</b>	516

\*Total No. of Revised CTOTs issued = 746 (Compliance calculation for flights which were issued revised CTOT is w.r.t. new CTOT issued)



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

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

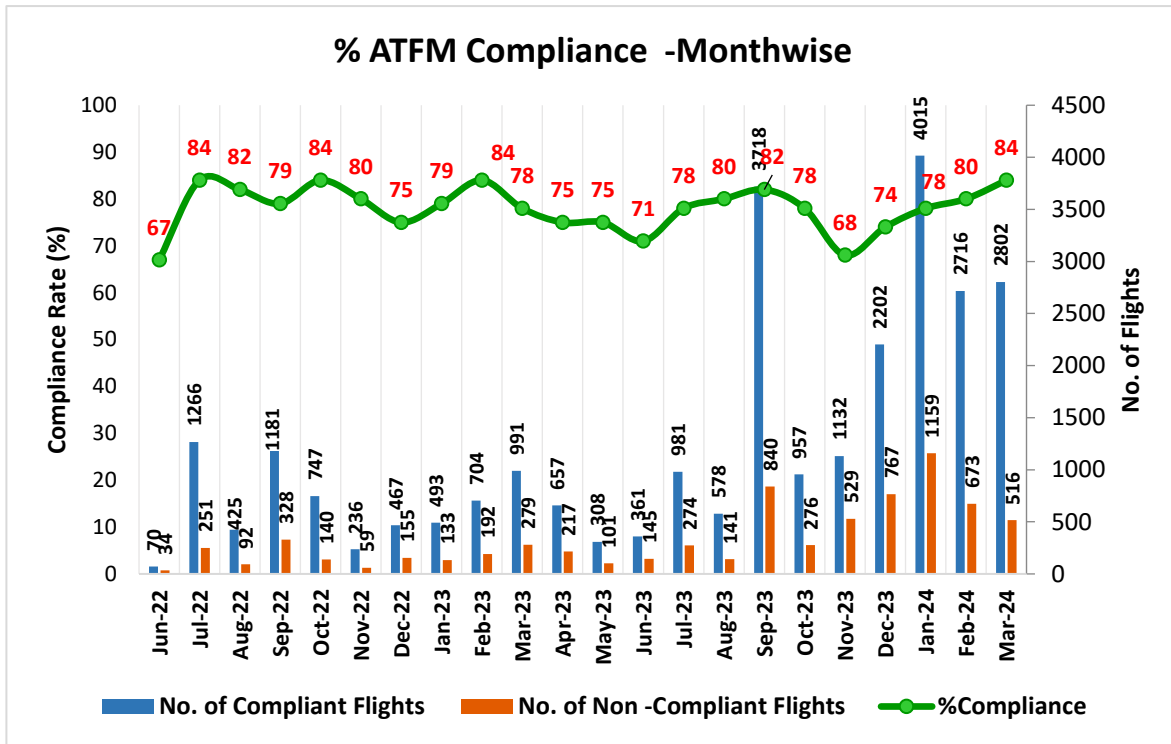


Figure 12: Compliance(Monthwise)

### Inference

1. Out of the total arrivals captured(4538 flights) during the CDM scenario for the constrained Airports, 75.3% of flights i.e. domestic arrivals(3415 flights) were candidates for ground delay(participating).
2. Out of these Domestic Arrivals(3415), 89.8% (3068 flights) are assigned ATFM ground delay.
3. Out of the total arrivals captured(4538 flights) to the constrained Airport during the ATFM scenario, only 67.6% of flights(3068 flights) were assigned ATFM Ground Delay.



## IV. CTOT Compliance rate – Airportwise

<b>MUMBAI FIR (78%)*</b>	<b>Compliant</b>	<b>Non Compliant</b>	<b>% Compliant</b>
Ahmedabad	101	8	93%
Aurangabad	6	2	75%
Mumbai	31	7	82%
Bhuj	0	1	0%
Vadodara	23	10	70%
Bhopal	31	6	84%
Bhavnagar	2	2	50%
Diu	2	3	40%
Hirasar	16	2	89%
Indore	47	16	75%
Jabalpur	0	4	0%
Jamnagar	15	22	41%
Kandla	2	0	100%
Mundra	2	0	100%
Nagpur	59	12	83%
Pune	1	2	33%
Surat	1	2	33%
Udaipur	25	4	86%
<b>KOLKATA FIR (83%)*</b>	<b>Compliant</b>	<b>Non Compliant</b>	<b>% Compliant</b>
Prayagraj	2	1	67%
Angul	0	1	0%
Agartala	15	5	75%
Ayodhya	8	3	73%
Bagdogra	26	3	90%
Shillong	1	1	50%
Varanasi	50	14	78%
Bhubaneswar	54	9	86%
Kolkata	146	26	85%
Cooch Behar	9	2	82%
Chakeri	2	3	40%
Durgapur	1	0	100%
Darbhanga	13	3	81%



Deoghar	7	0	100%
Gorakhpur	12	4	75%
Guwahati	57	13	81%
Imphal	3	1	75%
Silchar	7	0	100%
Dibrugarh	11	1	92%
Dimapur	10	2	83%
Uttar Satali	30	8	79%
Ranchi	8	1	89%
Raipur	34	3	92%
<b>DELHI FIR (83%)*</b>	<b>Compliant</b>	<b>Non Compliant</b>	<b>% Compliant</b>
Agra	0	1	0%
Amritsar	26	4	87%
Bhuntar	0	1	0%
Bhatinda	1	0	100%
Bareilly	0	1	0%
Chandigarh	31	18	63%
New Delhi	2	0	100%
Dehradun	14	6	70%
Delhi	453	67	87%
Kangra	1	0	100%
Gwalior	0	1	0%
Jodhpur	3	0	100%
Jaipur	83	13	86%
Jaisalmer	1	0	100%
Jammu	18	5	78%
Ajmer	0	1	0%
Leh	3	0	100%
Lucknow	72	9	89%
Srinagar	15	16	48%
Thoise	0	1	0%
<b>CHENNAI FIR (86%)*</b>	<b>Compliant</b>	<b>Non Compliant</b>	<b>% Compliant</b>
Hal Bangalore	3	4	43%
Bangalore	292	41	88%
Belgaum	3	0	100%





Vijayawada	7	1	88%
Coimbatore	70	3	96%
Kochi	97	7	93%
Baldota koppal	14	1	93%
MOPA Goa	64	9	88%
Dambolim Goa	126	21	86%
Hubli	0	2	0%
Hyderabad	193	25	89%
Begumpet Hyderabad	5	2	71%
Kannur	2	2	50%
Madurai	22	3	88%
Mangalore	36	6	86%
Chennai	170	36	83%
Port Blair	35	12	74%
Salem	0	1	0%
Sindhudurg	0	2	0%
Tuticorin	0	1	0%
Tirupati	3	1	75%
Tiruchirappally	2	4	33%
Manglore	39	1	98%
Visakhapatnam	1	4	20%

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



### V. CTOT Compliance rate – Airlinewise

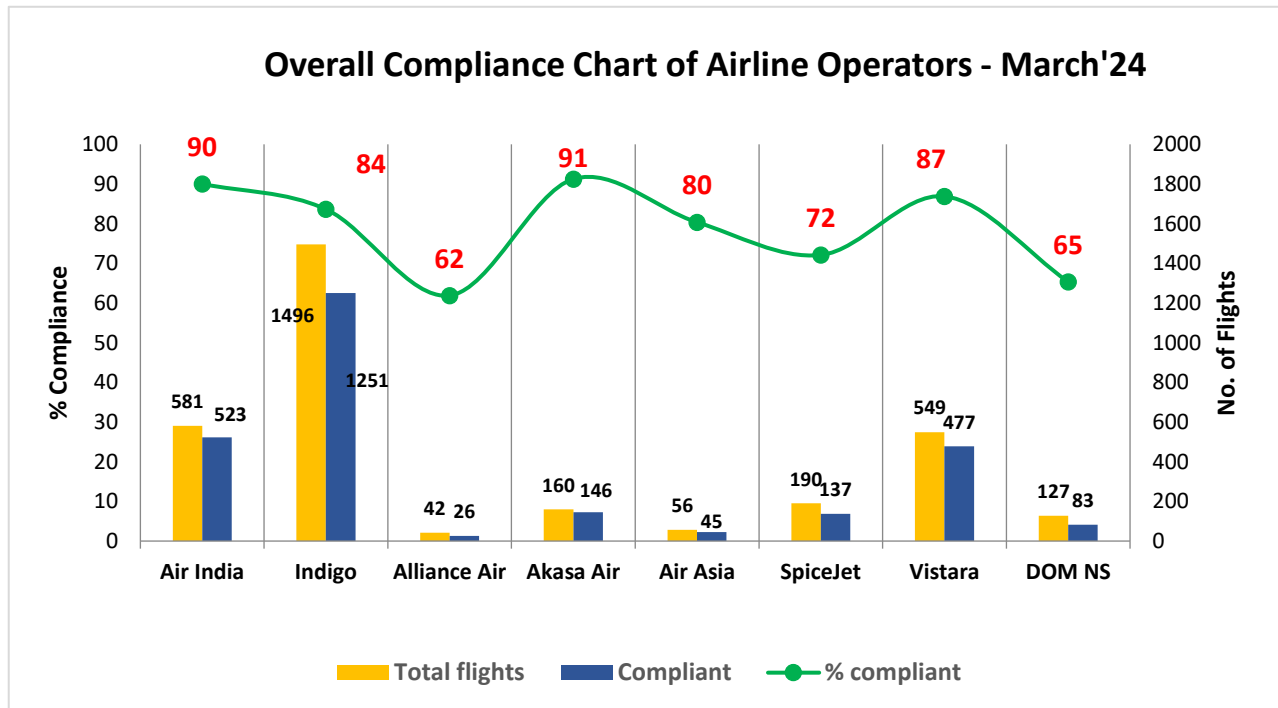


Figure 13: Airline wise Compliance –March'24

#### Inference

1. Out of the total domestic arrivals with complete data in the CDM scenario, 84% arrivals are compliant.
2. Chennai region record the highest compliance of 86% whereas Mumbai region has the lowest percentage compliance of 78%.
3. Indigo,Air India, Akasa Air and Vistara Airlines have a CTOT compliance higher than the average recorded compliance for the month of March'24.

## VI. Reason For Non Compliance

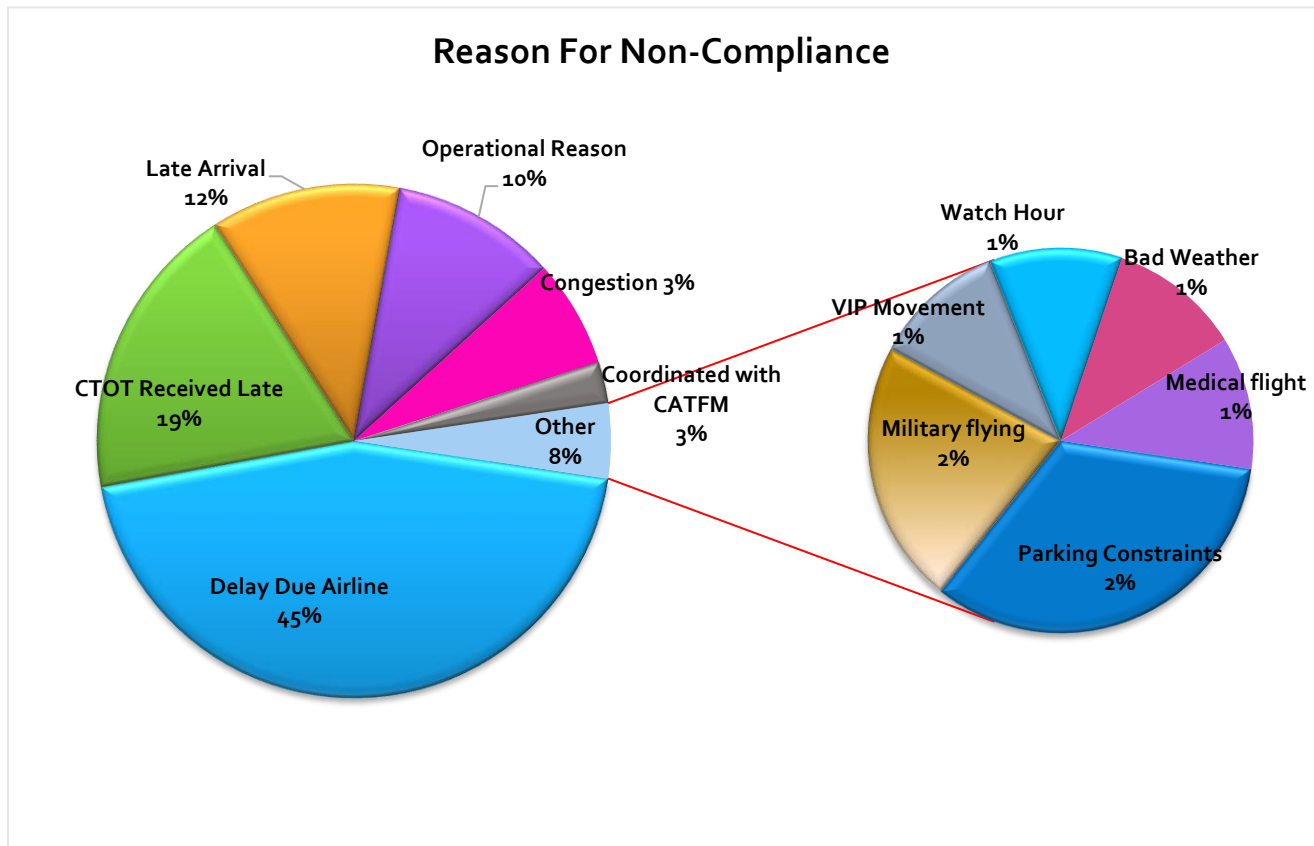


Figure 14: Reason for Non-Compliance as provided by FMPs

### Inference:

1. 45 % of CTOT Non- Compliance was reported by concerned FMPs to be due to delay by Airlines.
2. 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.
3. 12 % 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.
4. 10 % of CTOT Non- Compliance was reported by concerned FMPs to be due to operational reasons.



## VII. Air Delay during the CDM Scenario period

Average Air Delay to domestic arrivals\* within the CDM Scenario period for Delhi, Mumbai, Kolkata and Chennai was 5.5, 8.7, 5.5 and 7.9 minutes respectively.

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

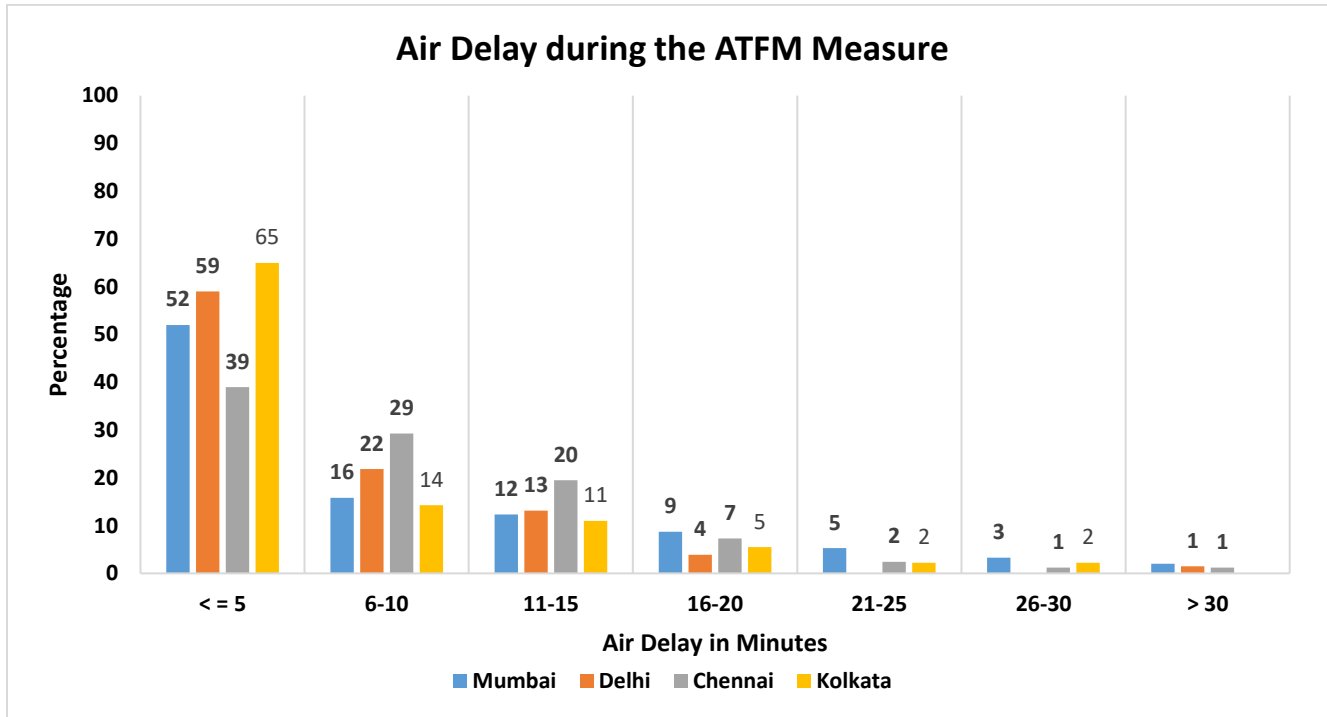


Figure 15: Air Delay distribution during the CDM period

### Inference

1. 68% of domestic arriving flights to Mumbai had an Air delay of equal to or less than 10 minutes during the CDM period.
2. 81% of domestic arriving flights to Delhi had an Air delay of equal to or less than 10 minutes during the CDM period.
3. 68% of domestic arriving flights to Chennai had an Air delay of equal to or less than 10 minutes during the CDM period.
4. 79% of domestic arriving flights to Kolkata 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)= 26464 mins

Total Air Delay (with no ATFM measures) = 93055 mins

Reduction in Air delay due to ATFM measures= (93055-26464) = **66591 mins**

#### **Fuel Saving Calculation:**

Total Fuel saved during the ATFM Measure: **36,88,361.13 Kg**

**Total reduction in CO<sub>2</sub> emission : 3.16(KgCO<sub>2</sub>/kg fuel)\* 36,88,361.13 Kg = 1,16,55,221.17Kg**

*\*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 CO<sub>2</sub> produced by burning a tonne of aviation fuel.*



## D. Glossary

<b>ATFM Parameters</b>	<b>Definition</b>
<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 &amp; 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). <b>Therefore, Air delay = AET-EET</b></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>



## E. Annexure-A

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

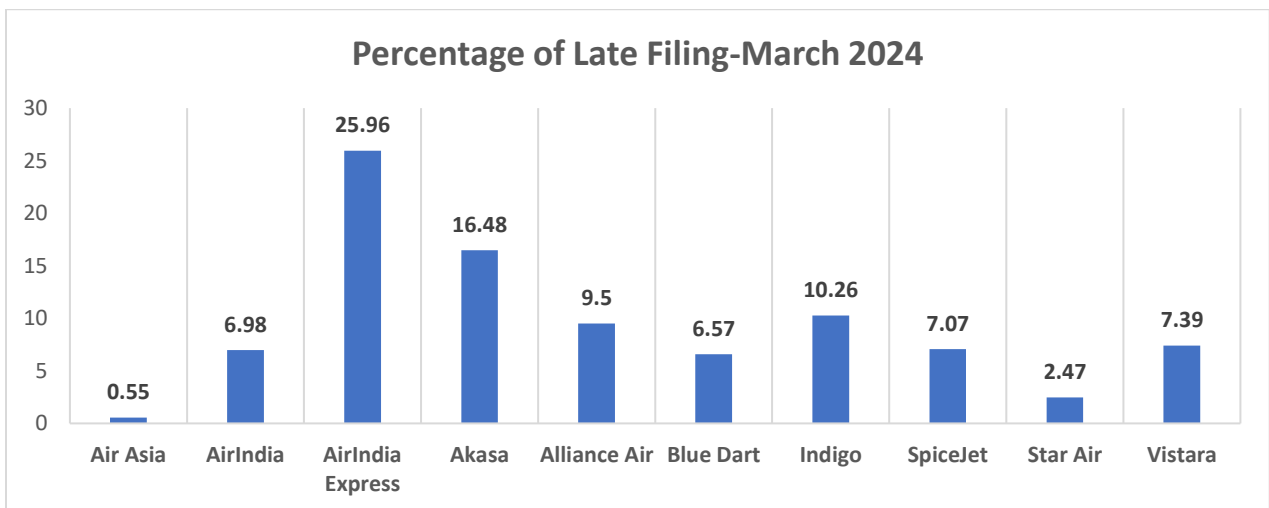
AIP India, ENR 1.9 section 4 on Flight Planning in the context of ATFM recommends Flight Planning requirements for all Airline Operators –

- “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 1<sup>st</sup> March 2024 to 31<sup>st</sup> March 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 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.





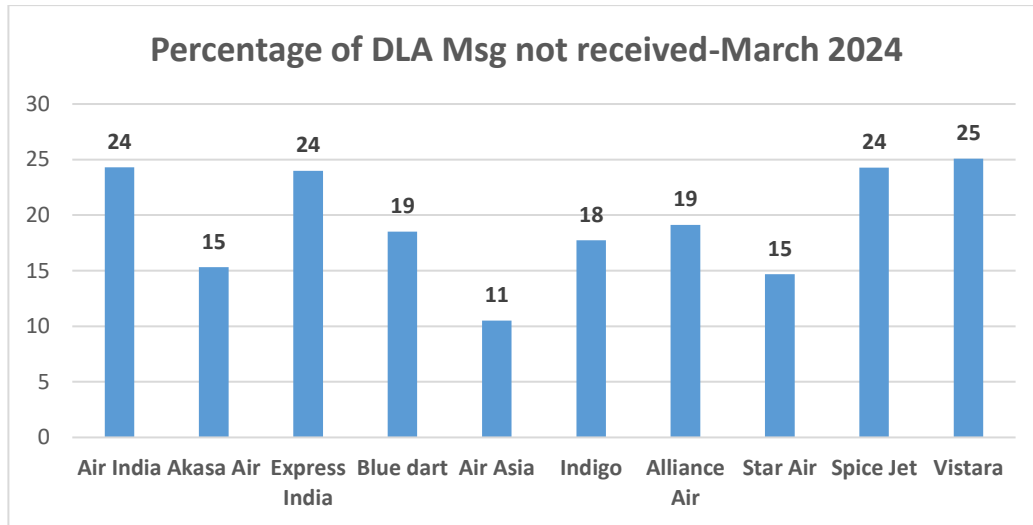
The table below lists number of filed flight plans (FPLs) with less than 3 Hours prior to EOBT:

Name of Airline	Late Filed FPL	Total No. Of FPL	% Delayed Filing
Air Asia	29	5305	0.55
AirIndia	1006	14410	6.98
AirIndia Express	1619	6236	25.96
Akasa	603	3660	16.48
Alliance Air	302	3180	9.50
Blue Dart	41	624	6.57
Indigo	6367	62079	10.26
SpiceJet	437	6185	7.07
Star Air	27	1095	2.47
Vistara	753	10183	7.39
<b>Total no. of FPLs for Scheduled Airlines</b>	11184	112957	9.90

- 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 were received.

The Table below lists number of flights for which no DLA message was received in March 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	2617	10769	24.30
Akasa Air	422	2755	15.32
Express India	969	4038	24.00
Blue dart	97	524	18.51
Air Asia	409	3886	10.52
Indigo	8567	48307	17.73
Alliance Air	349	1825	19.12
Star Air	67	456	14.69
Spice Jet	929	3827	24.27
Vistara	1998	7971	25.07



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

Name of Airline	CNL message not received	No. of flights annulled
Air India	4	34
Akasa Air	0	1
Express India	4	20
Blue dart	1	2
Air Asia	0	26
Indigo	11	129
Alliance Air	1	176
Star Air	0	15
Spice Jet	3	114
Vistara	0	11

-X-