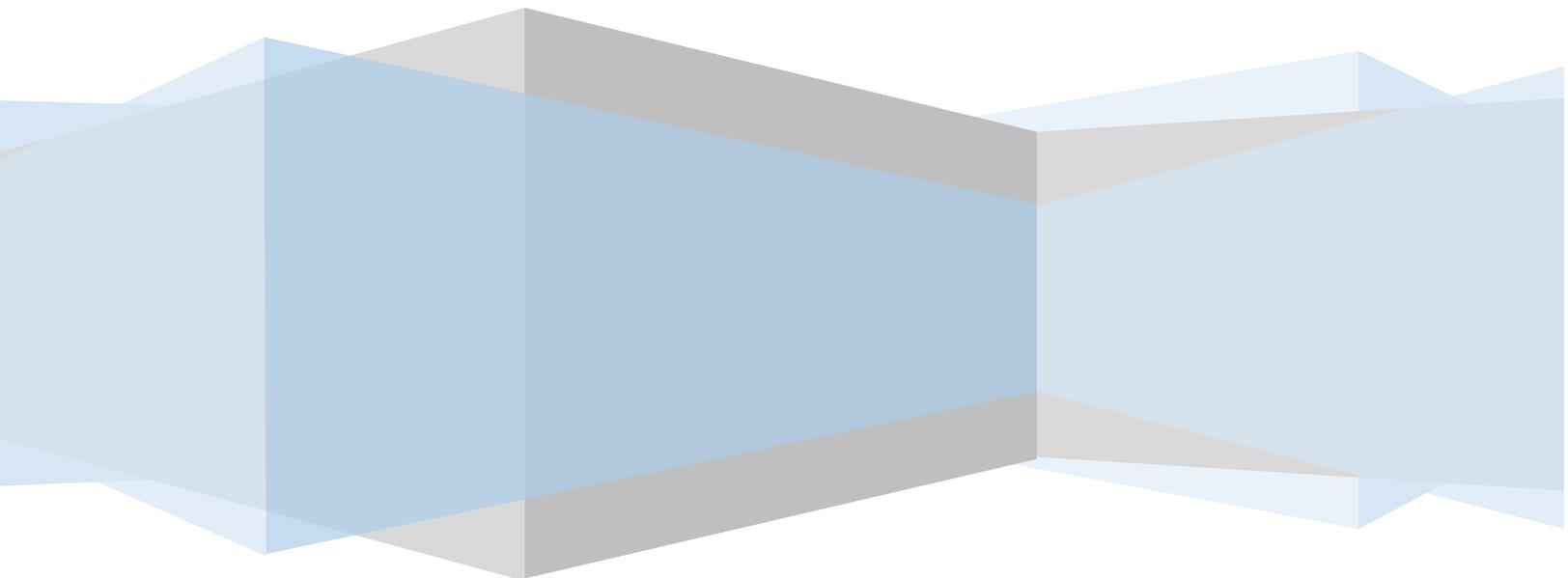


POST OPERATIONS ANALYSIS REPORT

May, 2024

CENTRAL COMMAND CENTER, C-ATFM, DELHI







Contents

A. Executive Summary	4
B. Traffic Analysis	5
I. Air Traffic Movement at Major Airports in India	5
II. Comparison of total ATMs (YoY) and Monthwise	8
III. Flight Operations – Airlinewise	9
C. ATFM Post Operations – CDM Analysis.....	10
I. Introduction	10
II. ATFM Measures Overview.....	11
III. Overall Compliance	12
IV. CTOT Compliance rate – Airportwise	14
V. CTOT Compliance rate – Airlinewise	17
VI. Reason For Non Compliance.....	18
VII. Air Delay during the CDM Scenario period	19
VIII. Tangible Benefits due to ATFM Measures	20
D. Glossary	22
Annexure-A	23



List of Figures

Figure 1: Monthly Traffic Growth.....	4
Figure 2: Average Daily Movements (Apr '24 vs May'24)	5
Figure 3: Air Traffic Movement for Delhi –May 2024.....	6
Figure 4: Air Traffic Movement for Mumbai - May 2024	6
Figure 5: Air Traffic Movement for Bengaluru – May 2024.....	7
Figure 6: Air Traffic Movement for Hyderabad – May 2024	7
Figure 7: Traffic Variation (YoY)	8
Figure 8: Flight Movements –Airlinewise	9
Figure 9: ATFM Measures –May '24.....	10
Figure 10: Affected Flight Statistics –May'24.....	11
Figure 11: Overall Compliance – May '24	12
Figure 12: Compliance(Monthwise)	13
Figure 13: Airline wise Compliance –May'24.....	17
Figure 14: Reason for Non-Compliance as provided by FMPs	18
Figure 15: Air Delay distribution during the CDM period.....	19



A. Executive Summary

Average Domestic air traffic has recorded an decrease of 6.2% whereas the average international air traffic has increased by 0.33 % in the month of May '24 as compared to April '24.

On average, the Indian Airports in the ATFCM area saw 4455 IFR flights per day in the month of May 2024. The peak day was on 03rd May 2024 (4989 IFR flights). Saturday's were the busiest days throughout this month with an average of 4533 IFR flights per day.

Total Forty one (41) ATFM measures were applied this month during periods of congestion at Delhi, Chennai, Bengaluru and Mumbai Airport.

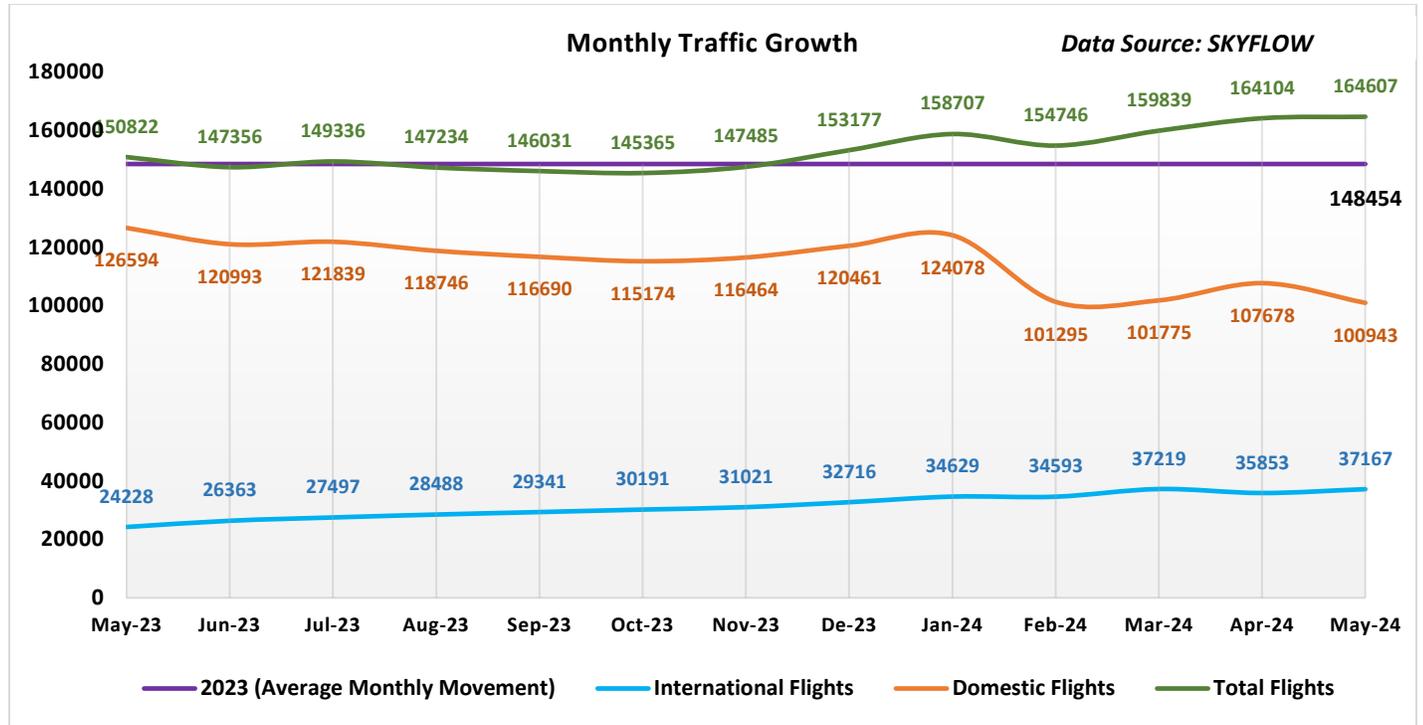


Figure 1: Monthly Traffic Growth

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



B. Traffic Analysis

I. Air Traffic Movement at Major Airports in India

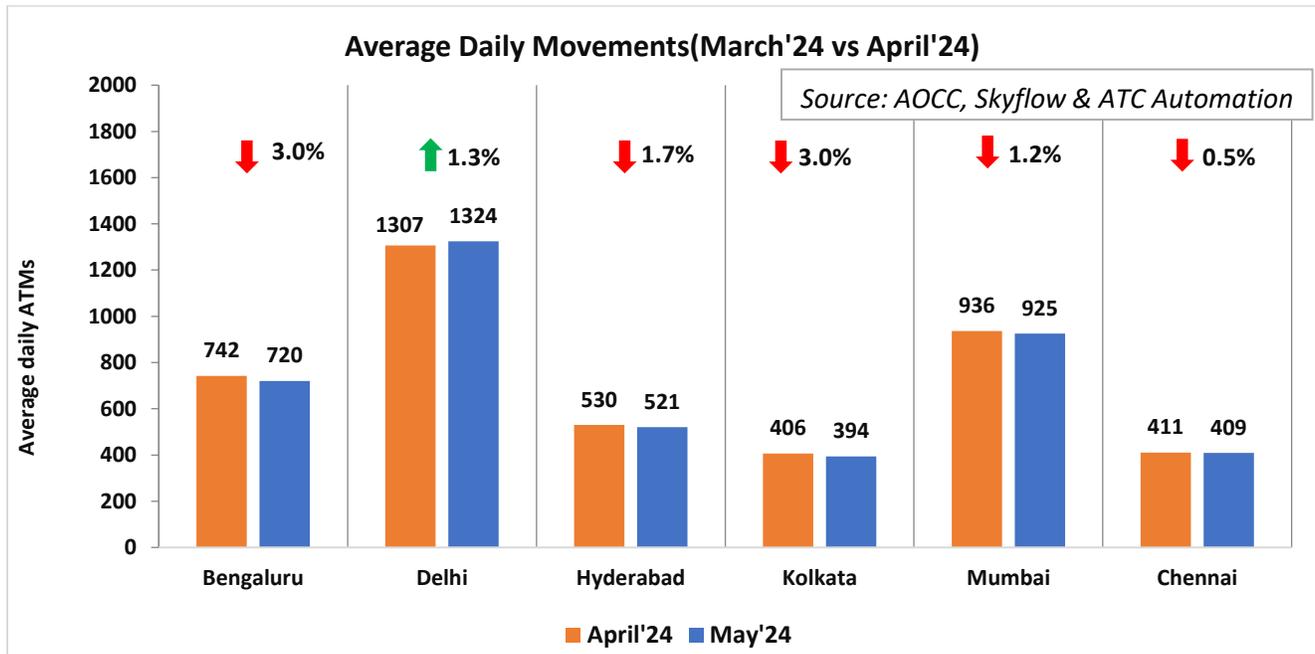


Figure 2: Average Daily Movements (Apr '24 vs May'24)

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

Airports\Year	Avg. Daily ATMs (YoY) for six major airports				
	May'20	May'21	May'22	May'23	May'24
Bengaluru	50	204	583	665	720
Delhi	132	528	1220	1229	1324
Hyderabad	27	157	441	467	521
Kolkata	26	143	390	377	394
Mumbai	60	252	798	871	925
Chennai	37	141	361	403	409



Air Traffic Movement for each day in May'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.

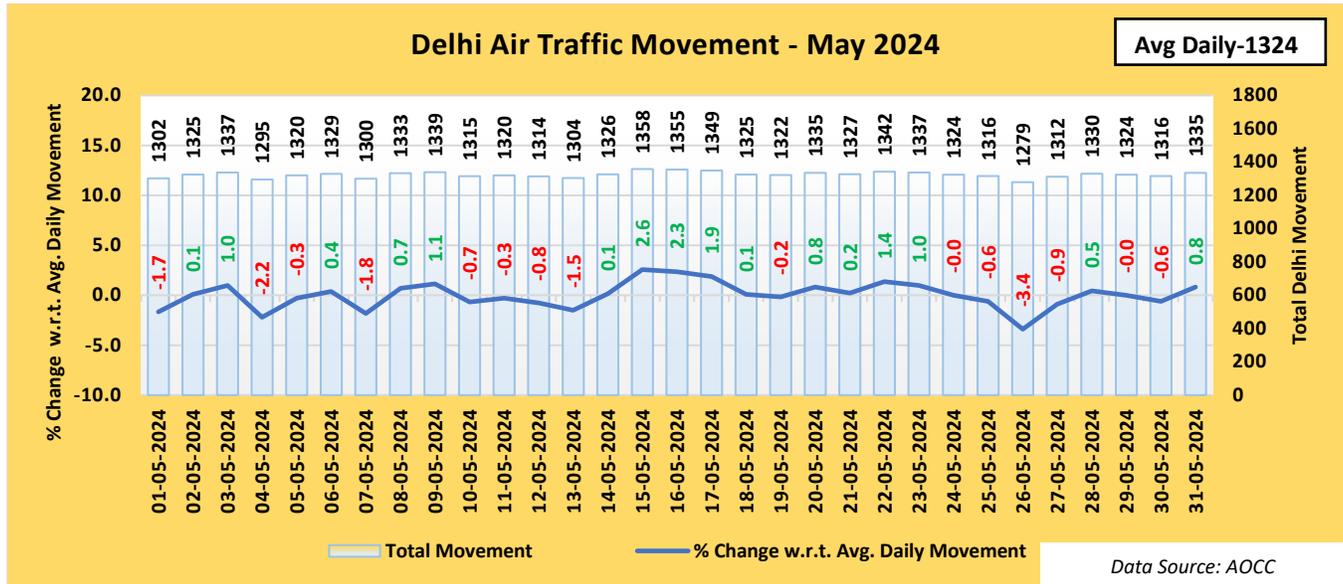


Figure 3: Air Traffic Movement for Delhi –May 2024

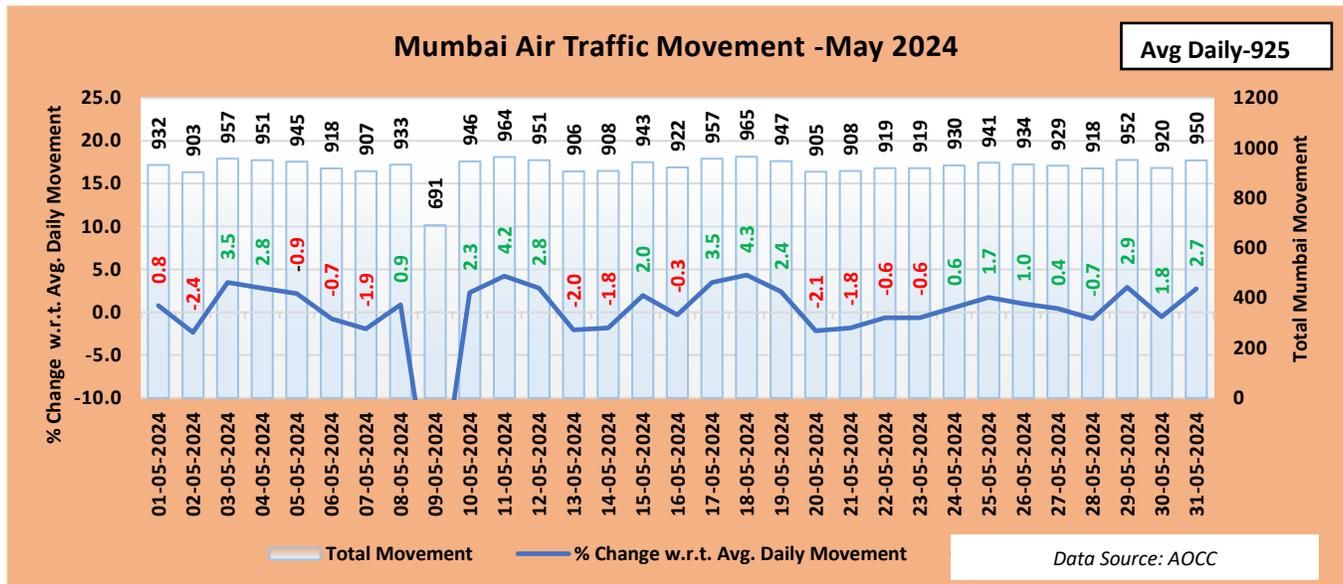


Figure 4: Air Traffic Movement for Mumbai - May 2024

*Low movements were recorded on 09-05-2024 due to Runway Closure for five hours at Mumbai Airport.

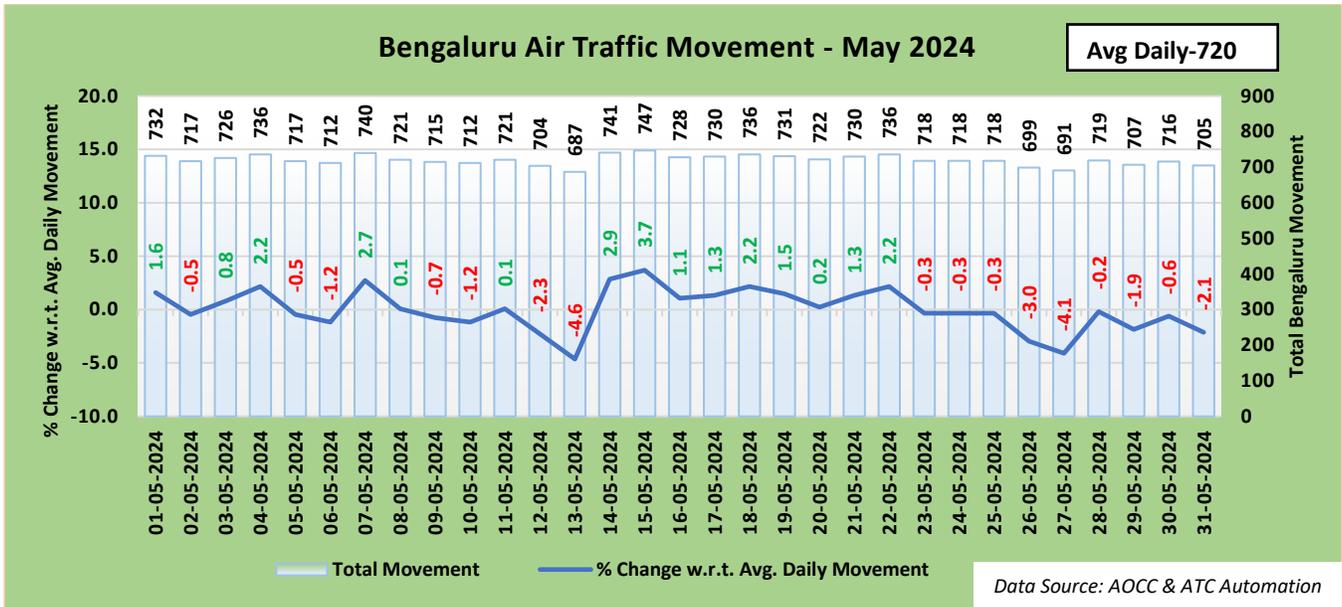


Figure 5: Air Traffic Movement for Bengaluru – May 2024

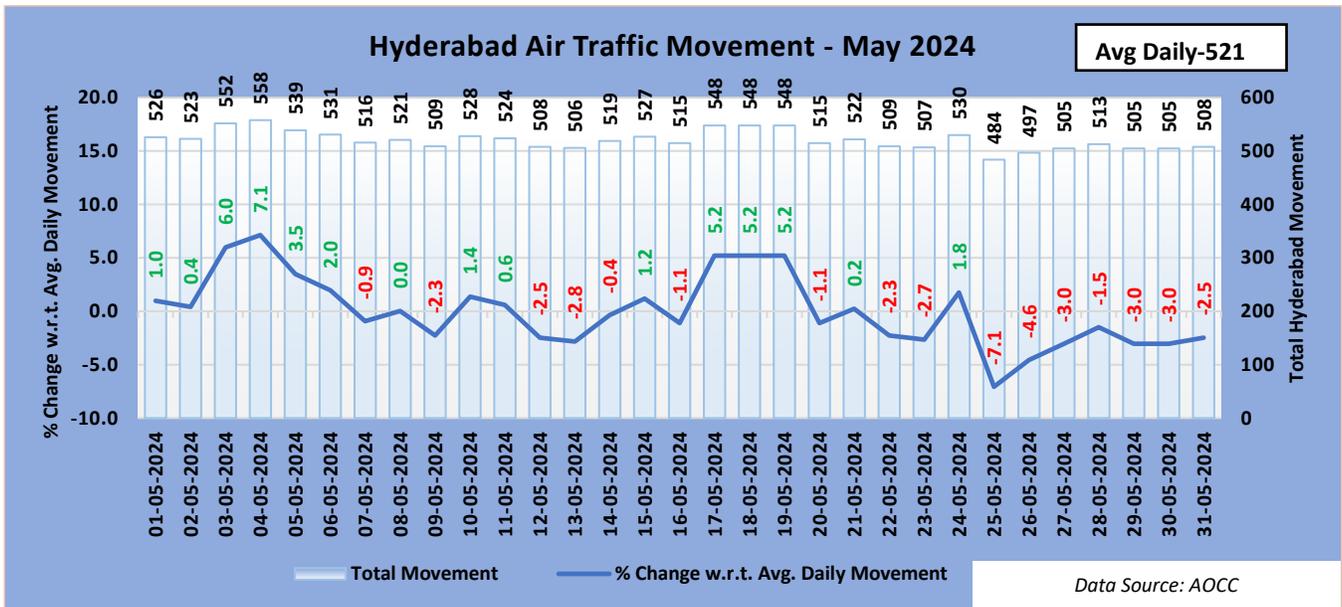


Figure 6: Air Traffic Movement for Hyderabad – May 2024

It can be concluded from the above charts that on 31st May 2024 (month end), the ATM at Delhi and Mumbai saw an increase of 0.8% and 2.7% respectively whereas the ATM at Bengaluru and Hyderabad saw a decline of 2.1% and 2.5% respectively in comparison to the average daily movement for May'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 May 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.

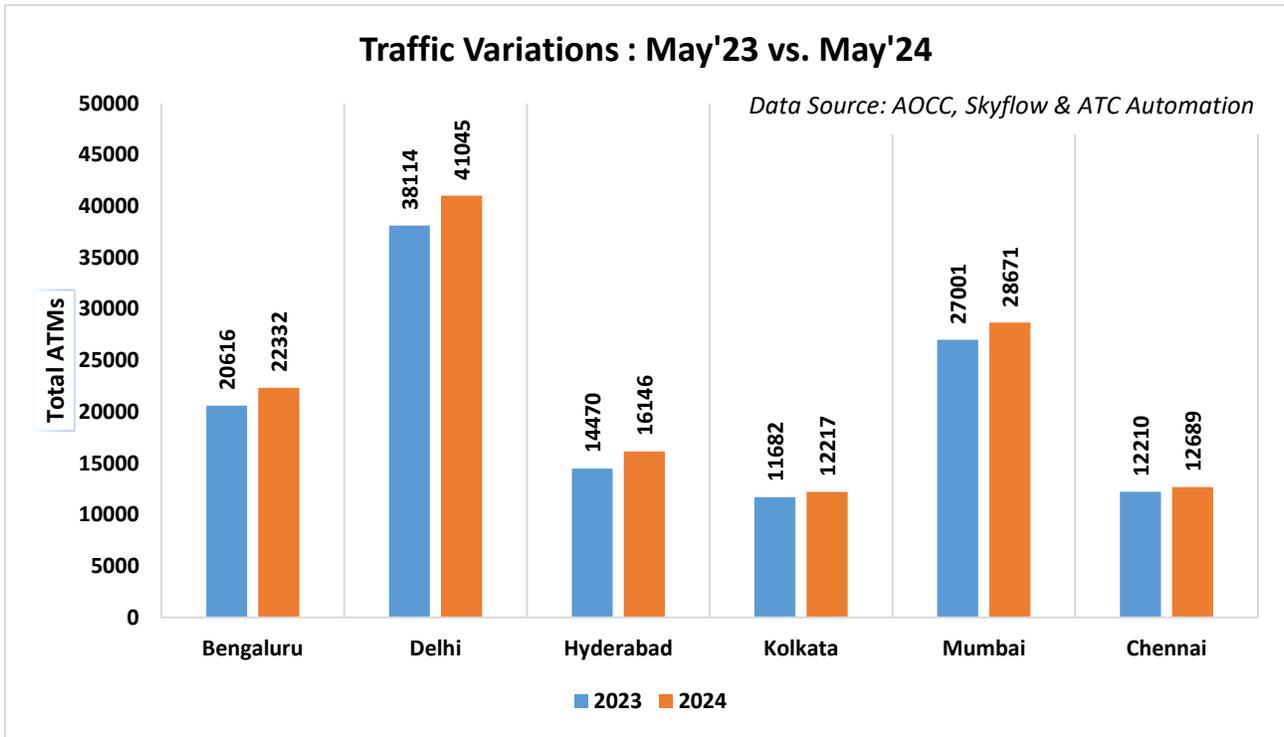


Figure 7: Traffic Variation (YoY)



III. Flight Operations – Airlinewise

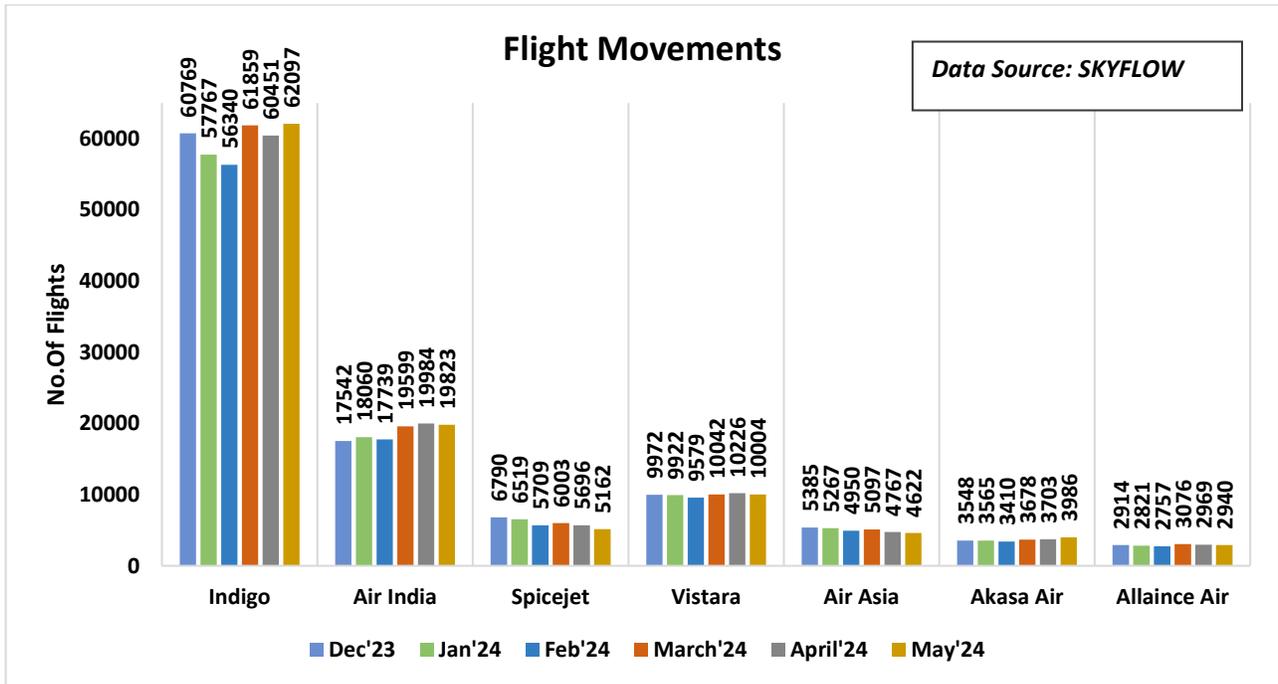


Figure 8: Flight Movements –Airlinewise

Inference:

1. Akasa Air has recorded an increase in the monthly average(31 days) Flight movement in May'24 as compared to April '24 while other Airlines have recorded a decline during the same period.



C. ATFM Post Operations – CDM Analysis

I. Introduction

Analysis Period 1st – 31st May 24

Back Ground During the above mentioned period, **Four (04)** ATFM measures were applied for **Delhi Airport**, **Twenty Five (25)** ATFM measures were applied for **Mumbai Airport**, **Seven (07)** ATFM measure were applied for **Bengaluru Airport** and **Five (05)** ATFM measure were applied for **Chennai Airport** due to the following reasons as illustrated in the bar chart below:-

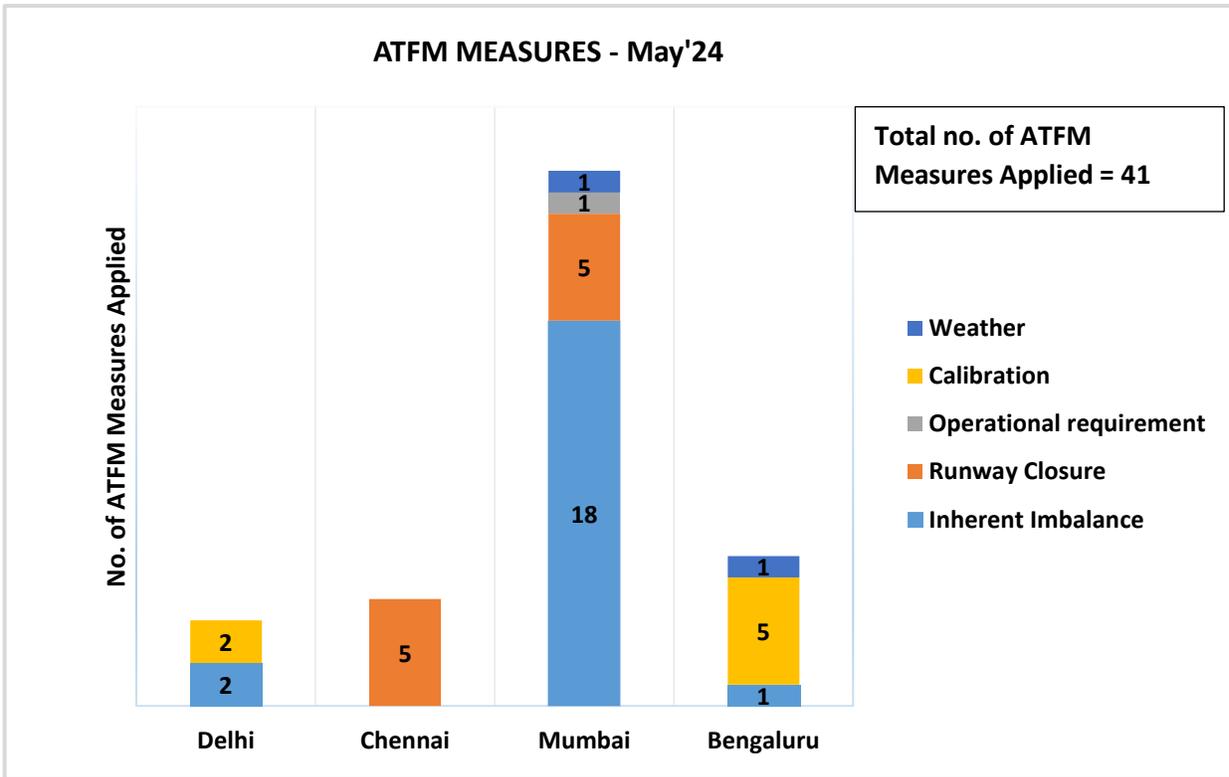


Figure 9: ATFM Measures –May '24



II. ATFM Measures Overview

Constrained Airport	Delhi	Mumbai	Bengaluru	Chennai
Number of ATFM measures applied	4	25	7	5
Average ATFM Ground delay(in min) due to measures*	12.2	31.9	12.2	22.8
Maximum ATFM Ground delay(in min) due to measures	31	108	39	42
% Compliance	78.8	84	77.8	89.3

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

Total Arrivals	2438
Total International Arrivals(exempted)	532
Total affected flights in scenario (Domestic Arrivals)	1906
Total Domestic Arrivals with zero ATFM delay	128
Total Domestic Arrivals with ATFM delay	1778

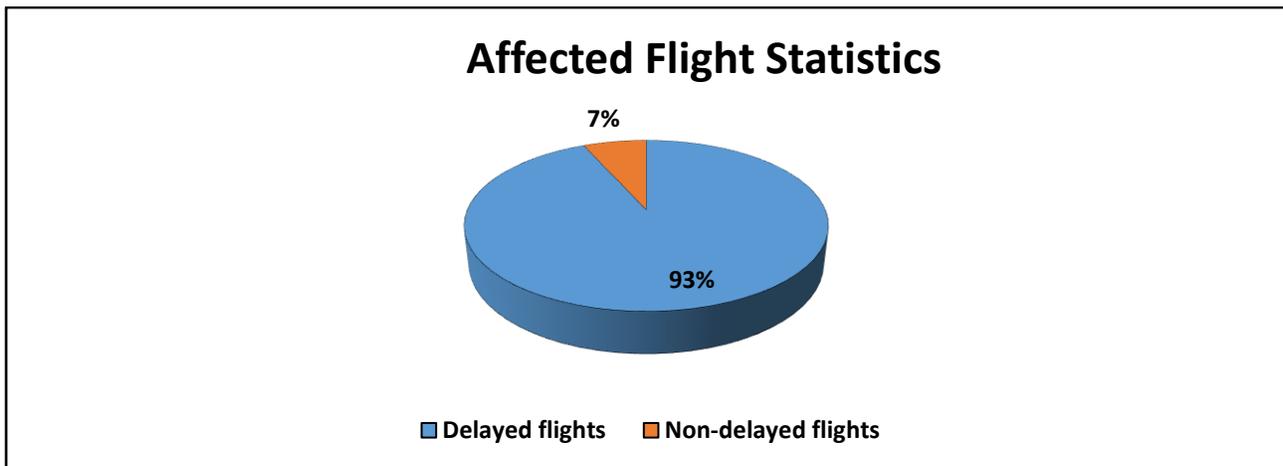


Figure 10: Affected Flight Statistics –May'24



III. Overall Compliance

Total arrivals	2438
Domestic arrivals	1906
Flights with complete data (ATOT)	1833
Flights with incomplete data	16
Flights Not Operated	57
Compliant*	1509
Non-Compliant	324

*Total No. of Revised CTOTs issued = 478 (Compliance calculation for flights which were issued revised CTOT is w.r.t. new CTOT issued)

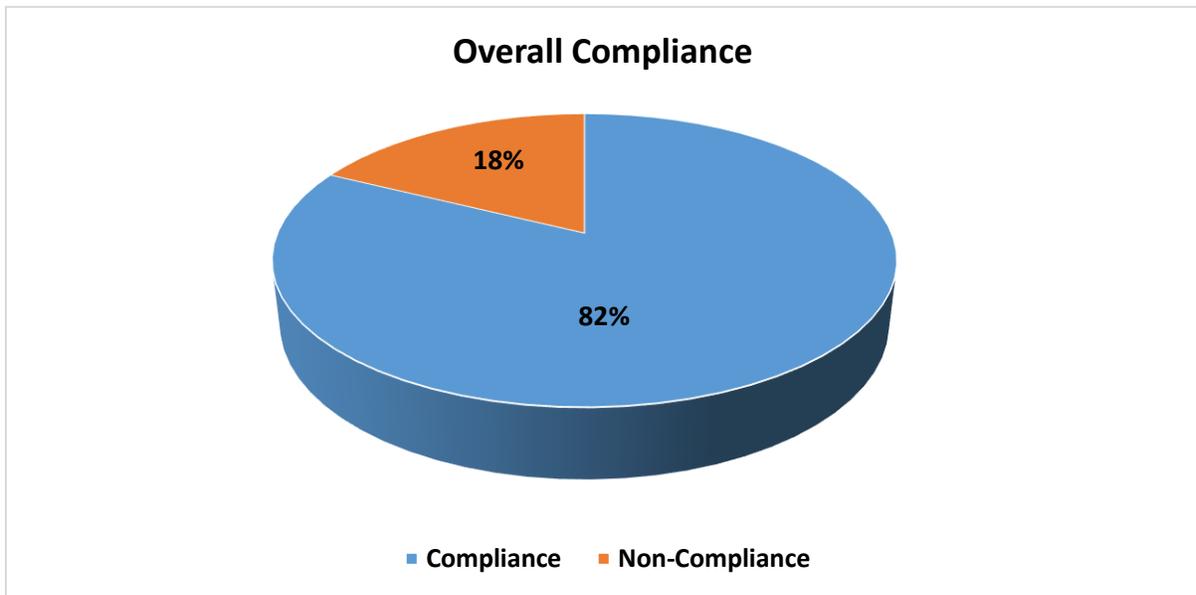


Figure 11: Overall Compliance – May '24

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

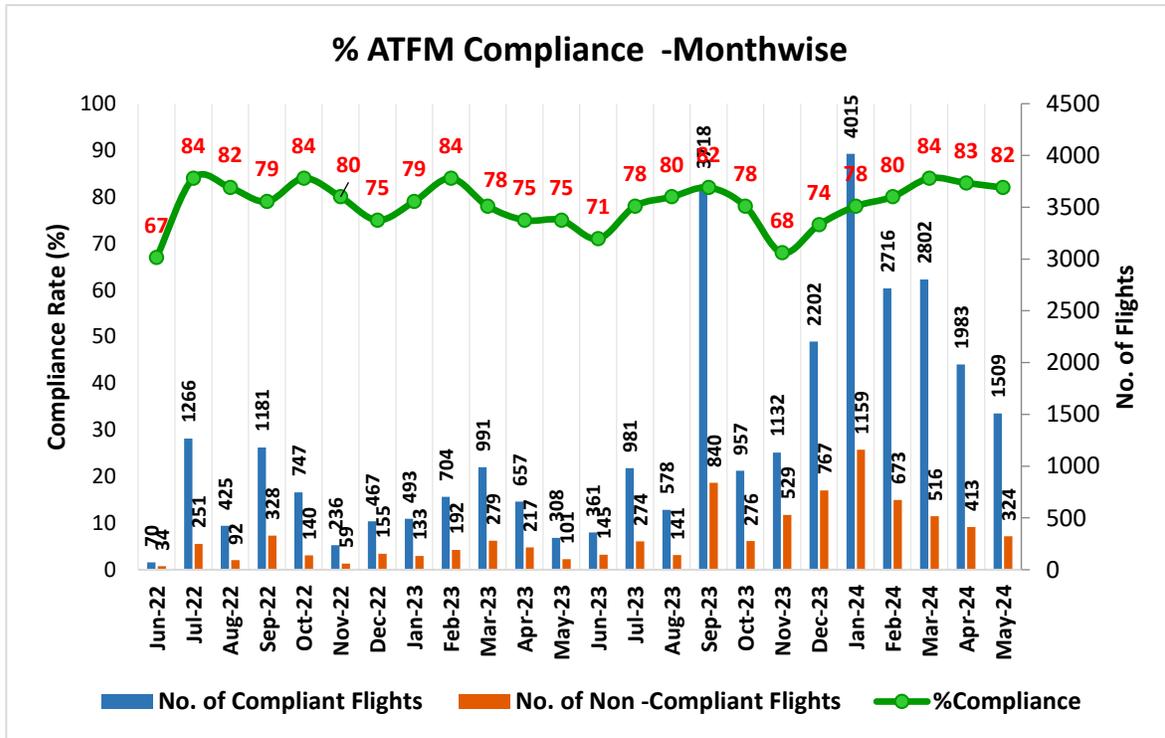


Figure 12: Compliance(Monthwise)

Inference

1. Out of the total arrivals captured(2438 flights) during the CDM scenario for the constrained Airports, 78.2% of flights i.e. domestic arrivals(1906 flights) were candidates for ground delay(participating).
2. Out of these Domestic Arrivals(1906), 93.3% (1778 flights) are assigned ATFM ground delay.
3. Out of the total arrivals captured(2438 flights) to the constrained Airport during the ATFM scenario, only 72.9% of flights(1778 flights) were assigned ATFM Ground Delay.



IV. CTOT Compliance rate – Airportwise

MUMBAI FIR (81%)*	Compliant	Non Compliant	% Compliant
Ahmedabad	52	18	74%
Aurangabad	8	2	80%
Mumbai	51	12	81%
Vadodara	1	5	17%
Bhopal	20	1	95%
Diu	0	1	0%
Hirasar, rajkot	6	1	86%
Indore	31	4	89%
Jabalpur	3	0	100%
Jamnagar	4	3	57%
Kolhapur	3	1	75%
Nagpur	34	3	92%
Pune	15	3	83%
Shirdi	4	0	100%
Surat	7	2	78%
Udaipur	11	1	92%
KOLKATA FIR (86%)*	Compliant	Non Compliant	% Compliant
Prayagraj	1	2	33%
Angul	0	1	0%
Agartala	1	1	50%
Ayodhya	10	1	91%
Siliguri	23	4	85%
Varanasi	33	6	85%
Bhubneshwar	34	5	87%
Shillong	1	0	100%
Kolkatta	102	16	86%
Chakeri	2	0	100%
Durgapur	3	0	100%
Darbhanga	1	0	100%
Gorakhpur	4	0	100%
Guwahati	14	7	67%
Gaya	2	0	100%



Jharsuguda	1	0	100%
Jagdalpur	1	0	100%
Dibrugarh	4	0	100%
Dimapur	0	1	0%
Patna	29	1	97%
Ranchi	10	3	77%
Raipur	19	1	95%
DELHI FIR (76%)*	Compliant	Non Compliant	% Compliant
Agra	3	2	60%
Bhuntar	1	2	33%
Bareilly	0	1	0%
Chandigarh	16	9	64%
Dehradun	9	2	82%
Delhi	201	41	83%
Gaggal	1	3	25%
Gwalior	2	3	40%
Jodhpur	3	2	60%
Jaipur	33	6	85%
Jaisalmer	1	0	100%
Jammu	4	3	57%
Kishangarh	0	1	0%
Leh	7	8	47%
Lucknow	36	3	92%
Pantnagar	0	2	0%
Shimla	1	1	50%
Srinagar	22	16	58%
CHENNAI FIR (85%)*	Compliant	Non Compliant	% Compliant
Agatti	0	1	0%
Hal Bangalore	0	4	0%
Bangalore	139	24	85%
Belgaum	1	3	25%
Vijaywada	6	2	75%
Coimbatore	37	1	97%
Kochi	36	9	80%
Calicut	6	1	86%



Kadapa	1	0	100%
MOPA Goa	36	8	82%
Gulbarga	1	2	33%
Dabolim,Goa	66	15	81%
Hubli	2	0	100%
Shashabad Hyderabad	114	17	87%
Begumpet Hyderabad	1	0	100%
Vijaynagar	1	1	50%
Kannur	6	0	100%
Madurai	13	1	93%
Mangaluru	12	2	86%
Chennai	81	14	85%
Nanded	1	0	100%
Port Blair	6	2	75%
Rajahmundry	3	0	100%
Shivmogga	1	0	100%
Salem	2	1	67%
Sindhudurg	4	1	80%
Sulur	1	0	100%
Tuticorin	3	0	100%
Tiruchirappally	5	0	100%
Thiruvananthapuram	33	3	92%
Visakhapatnam	4	1	80%

**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(82%) for the month are highlighted in red.



V. CTOT Compliance rate – Airlinewise

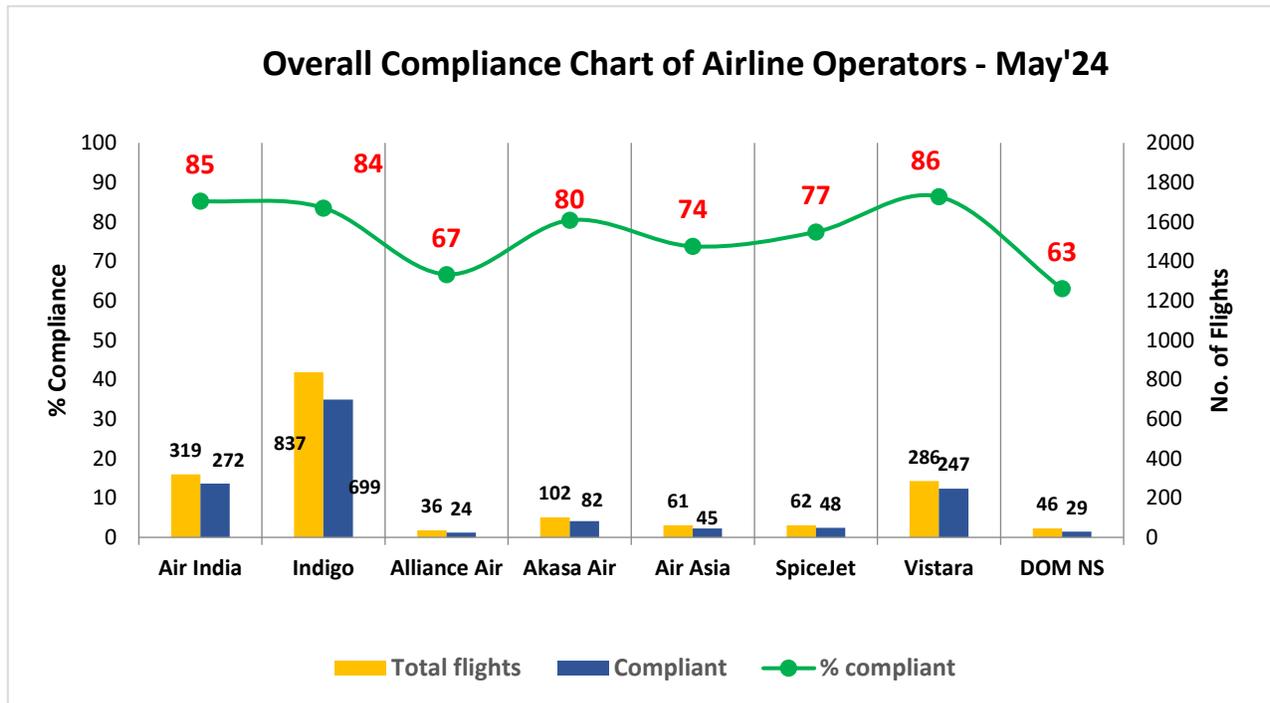


Figure 13: Airline wise Compliance –May’24

Inference

1. Out of the total domestic arrivals with complete data in the CDM scenario, 82% arrivals are compliant.
2. Kolkata region record the highest compliance of 86% whereas Delhi region has the lowest percentage compliance of 76%.
3. Indigo,Air India and Vistara Airlines have a CTOT compliance higher than the average recorded compliance for the month of May’24.

VI. Reason For Non Compliance

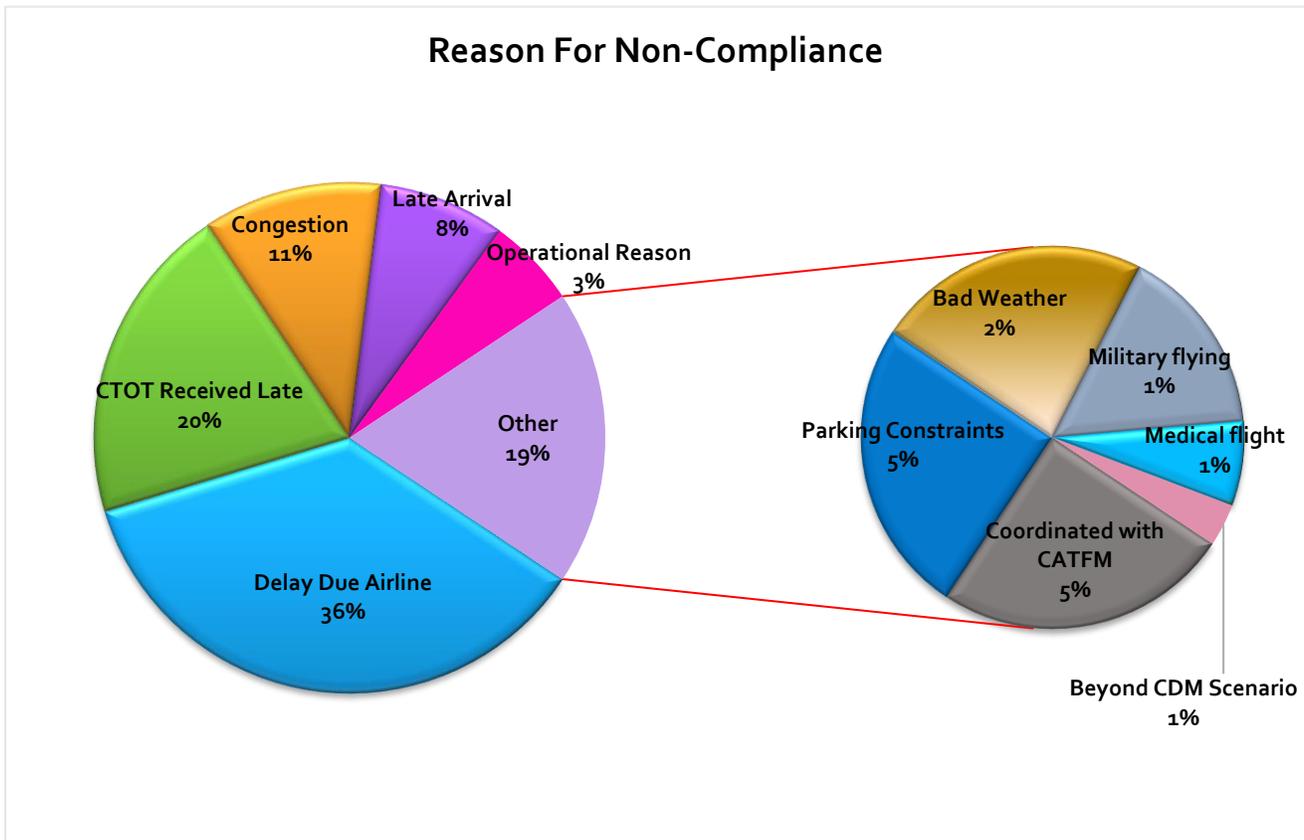


Figure 14: Reason for Non-Compliance as provided by FMPs

Inference:

1. 36 % of CTOT Non- Compliance was reported by concerned FMPs to be due to delay by Airlines.
2. 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.
3. 11 % of CTOT Non- Compliance was reported by concerned FMPs to be due to traffic congestion at airports.
4. 8 % 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, Bengaluru and Chennai was 6.9,9.0, 7.2 and 5.0 minutes respectively.

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

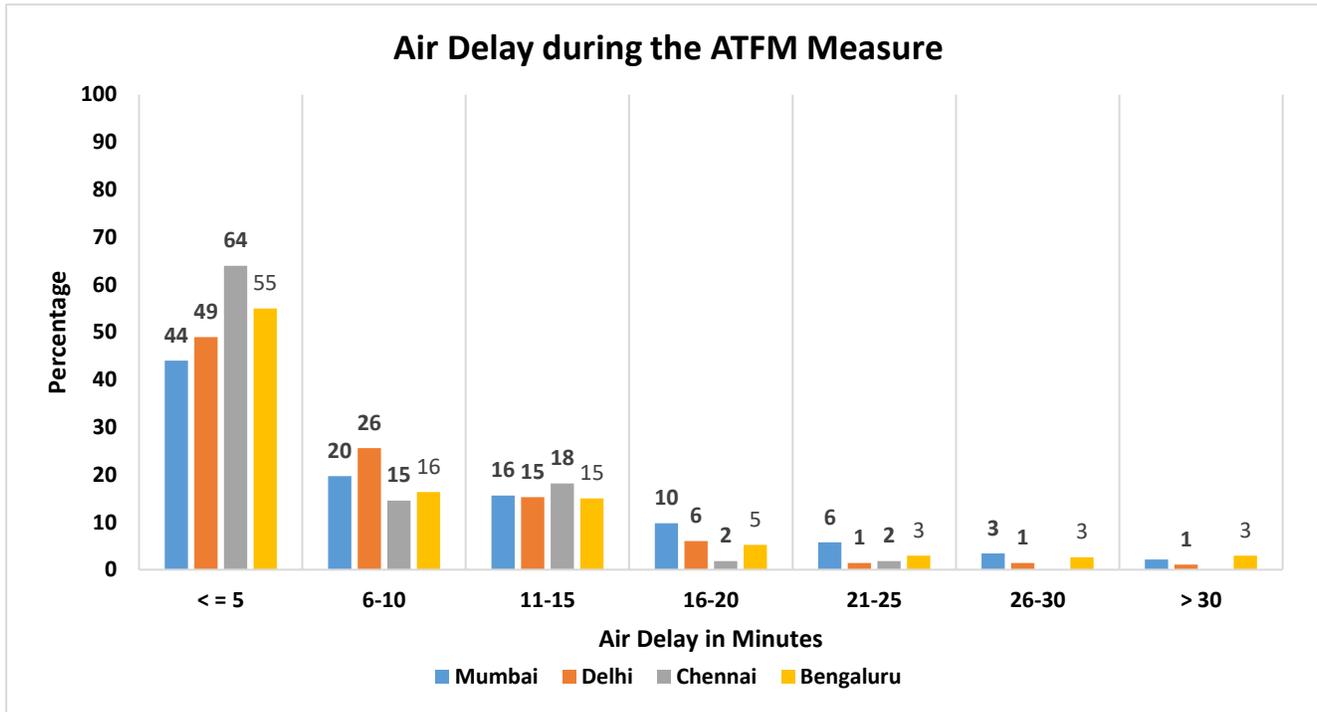


Figure 15: Air Delay distribution during the CDM period

Inference

- 64% of domestic arriving flights to Mumbai had an Air delay of equal to or less than 10 minutes during the CDM period.
- 75% of domestic arriving flights to Delhi had an Air delay of equal to or less than 10 minutes during the CDM period.
- 79% of domestic arriving flights to Chennai had an Air delay of equal to or less than 10 minutes during the CDM period.
- 71% of domestic arriving flights to Bengaluru 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)= 14575 mins

Total Air Delay (with no ATFM measures) = 39986 mins

Reduction in Air delay due to ATFM measures= (39986-14575) = **25411 mins**

Fuel Saving Calculation:

Total Fuel saved during the ATFM Measure: **14,69,099.234 Kg**

Total reduction in CO₂ emission : 3.16(KgCO₂/kg fuel)* 14,69,099.234 Kg = 46,42,353.58Kg

**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
<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
<i>Air delay statistics</i>	<p>Air delay defined as difference between AET & 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). Therefore, Air delay = AET-EET</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>



Annexure-A

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

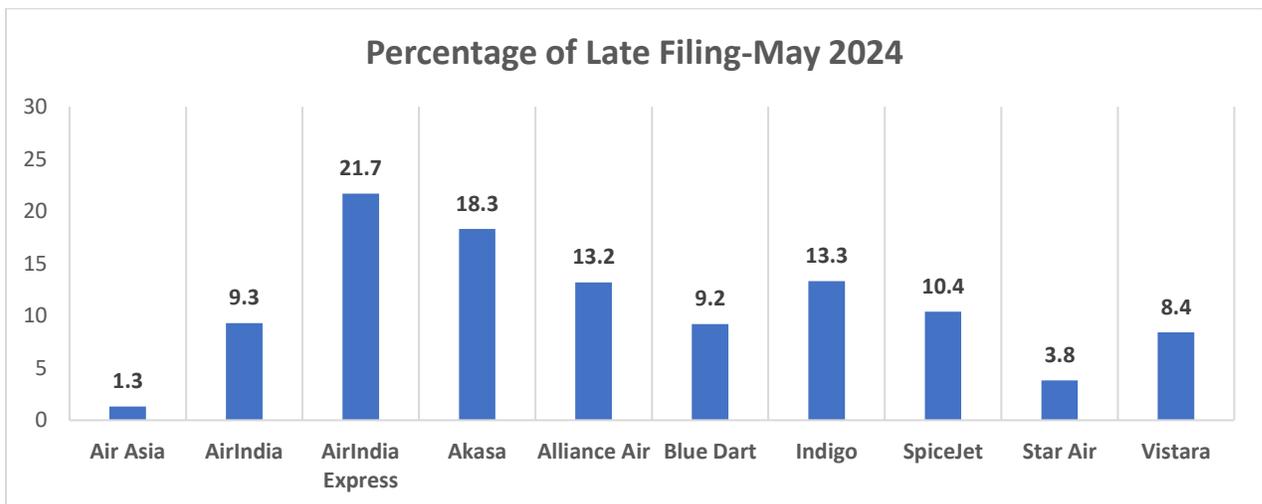
AIP India, ENR 1.9 section 4 on Flight Planning in the context of ATFM recommends Flight Planning requirements for all Airline Operators –

- 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 May 2024 to 31st May 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.





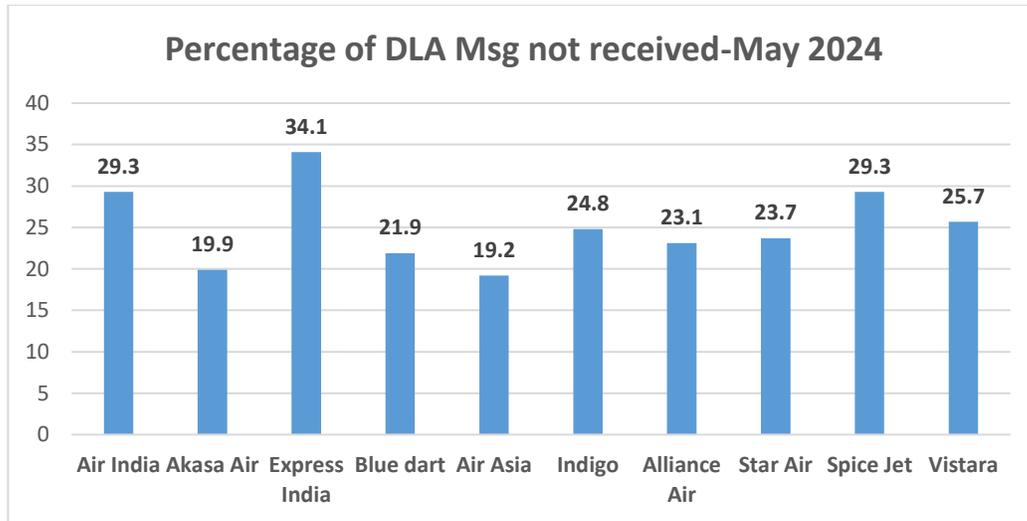
The table below lists number of filed flight plans (FPLs) with less than 3 Hours prior to EOBT:

Name of Airline	Late Filed FPL	Total No. Of FPL	% Delayed Filing
Air Asia	62	4864	1.3
AirIndia	1384	14962	9.3
AirIndia Express	1354	6239	21.7
Akasa	742	4055	18.3
Alliance Air	427	3233	13.2
Blue Dart	64	695	9.2
Indigo	8455	63380	13.3
SpiceJet	555	5324	10.4
Star Air	53	1395	3.8
Vistara	829	9925	8.4
Total no. of FPLs for Scheduled Airlines	13925	114072	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 May 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	3343	11421	29.3
Akasa Air	635	3188	19.9
Express India	1364	3996	34.1
Blue dart	125	572	21.9
Air Asia	729	3796	19.2
Indigo	12082	48779	24.8
Alliance Air	465	2017	23.1
Star Air	112	472	23.7
Spice Jet	1163	3968	29.3
Vistara	2178	8465	25.7



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

Name of Airline	CNL message not received	No. of flights annulled
Air India	105	106
Akasa Air	12	12
Express India	125	148
Blue dart	10	10
Air Asia	41	44
Indigo	415	438
Alliance Air	185	186
Star Air	50	54
Spice Jet	187	191
Vistara	217	262

-X-