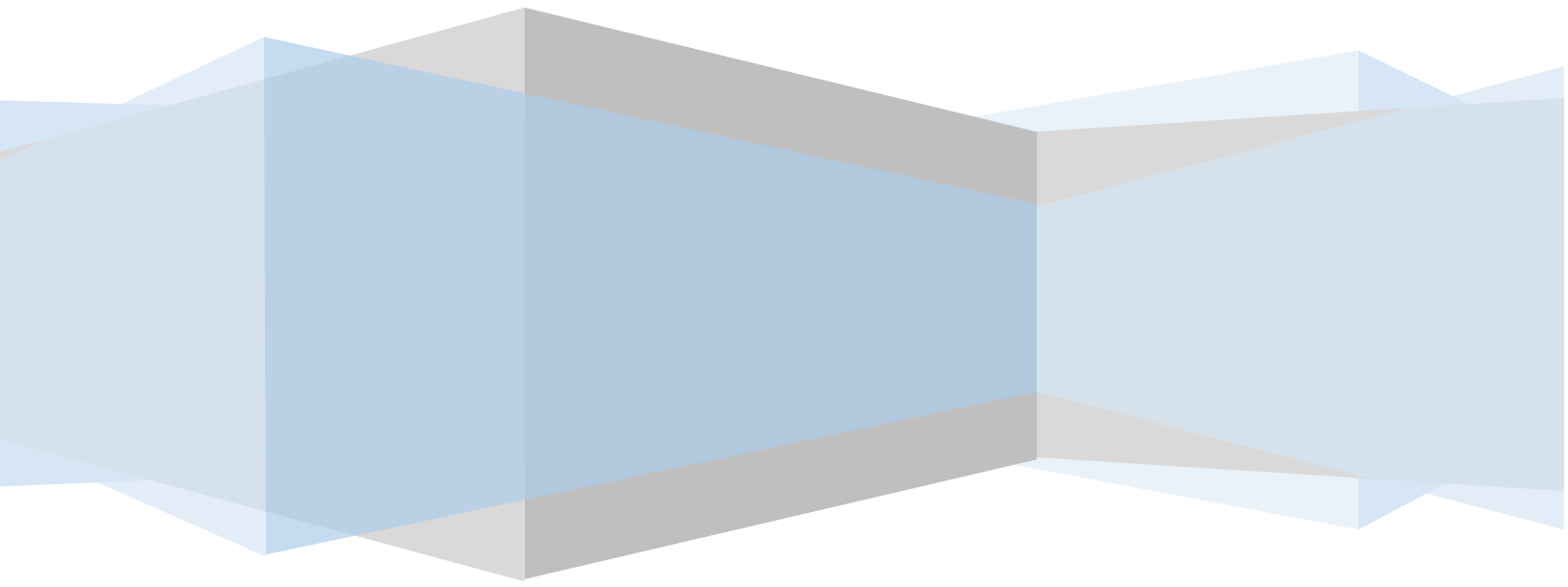
POST OPERATIONS ANALYSIS REPORT

June, 2024

CENTRAL COMMAND CENTER, C-ATFM, DELHI



Contents

List of Figures

A. Executive Summary

Average Domestic air traffic has recorded a decrease of 4.4% whereas the average international air traffic has decreased by 0.32 % in the month of June '24 as compared to May '24.

On average, the Indian Airports in the ATFCM area saw 4448 IFR flights per day in the month of June 2024. The peak day was on 13th June 2024 (4575 IFR flights). Thursday's were the busiest days throughout this month with an average of 4514 IFR flights per day.

Total Forty (40) ATFM measures were applied this month during periods of congestion at Delhi, Chennai, Bengaluru and Mumbai Airport.

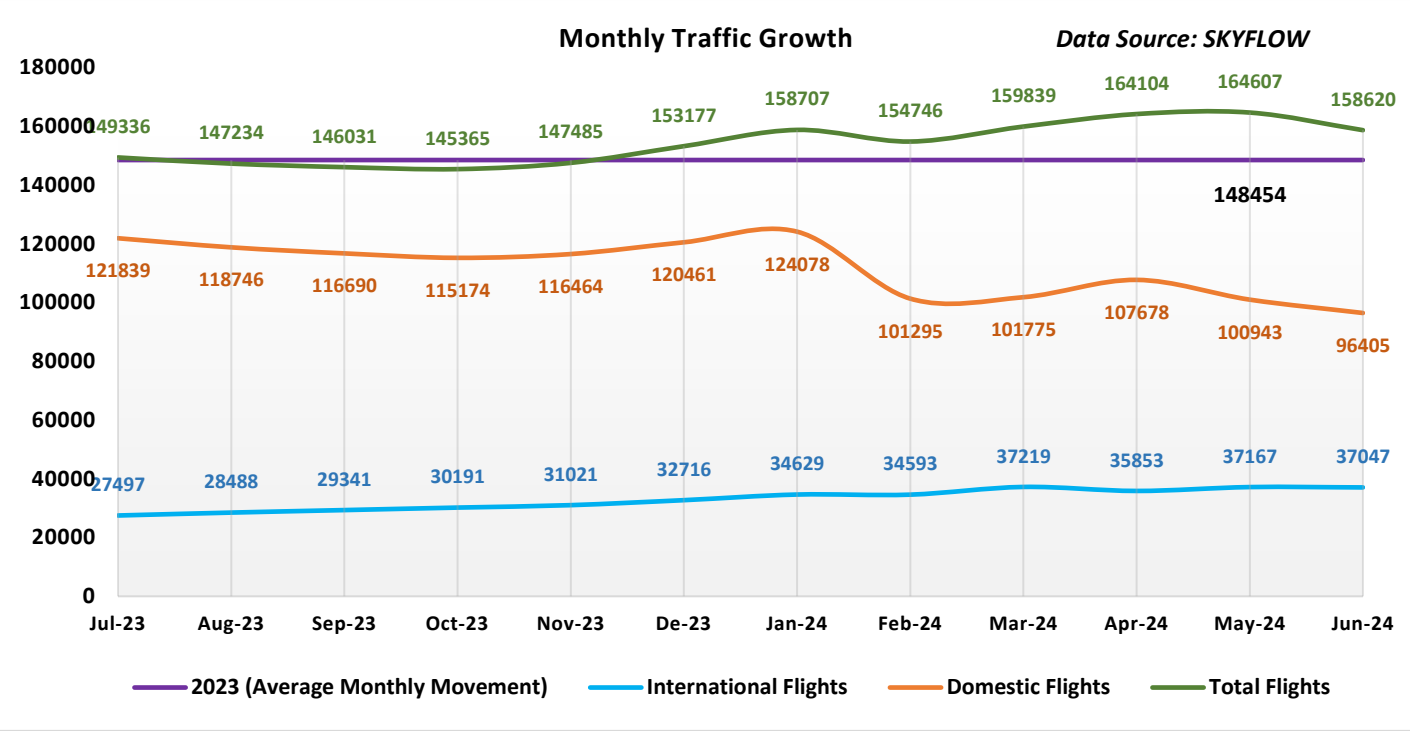


Figure 1: Monthly Traffic Growth

Note: From Feb 24 onwards the total traffic includes those international movements also that have overflown Indian Airspace.

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

B. Traffic Analysis

I. Air Traffic Movement at Major Airports in India

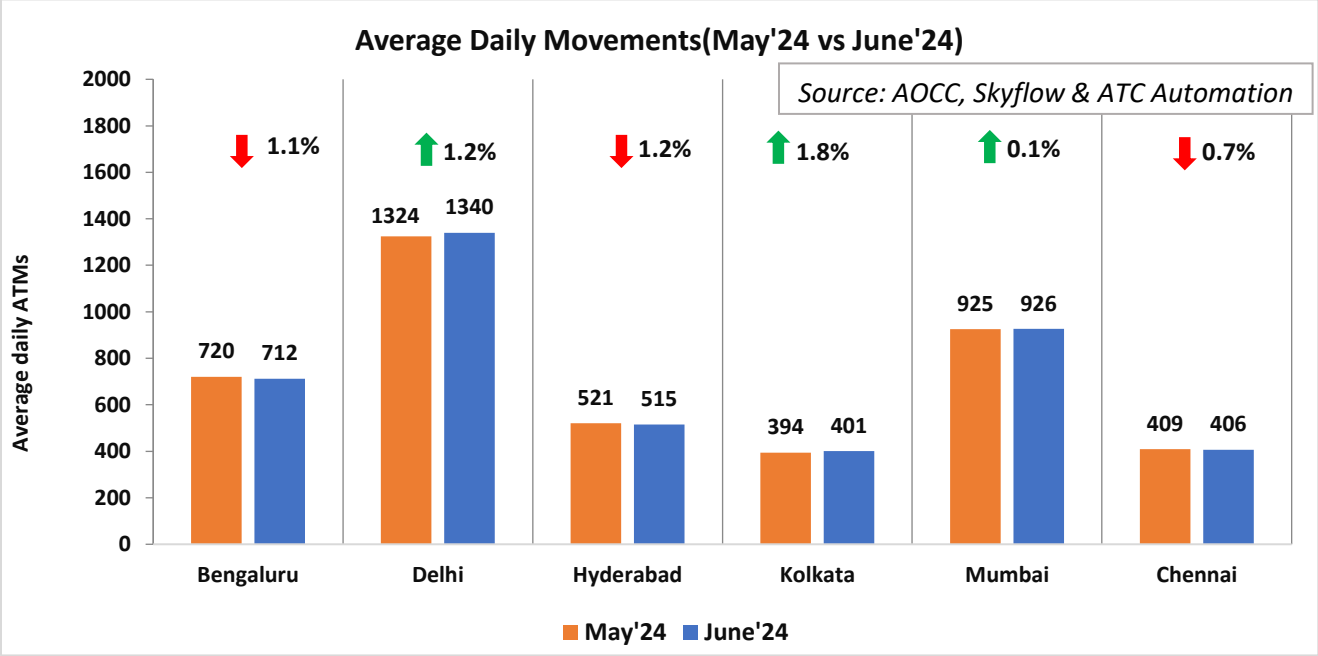


Figure 2: Average Daily Movements (May ’24 vs June ’24)

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

Airports\Year	Avg. Daily ATMs (YoY) for six major airports				
	June’20	June’21	June’22	June’23	June’24
Bengaluru	167	221	571	638	712
Delhi	417	584	1232	1219	1340
Hyderabad	138	176	441	457	515
Kolkata	158	151	390	379	401
Mumbai	146	299	783	872	926
Chennai	93	150	369	394	406

Air Traffic Movement for each day in June'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.

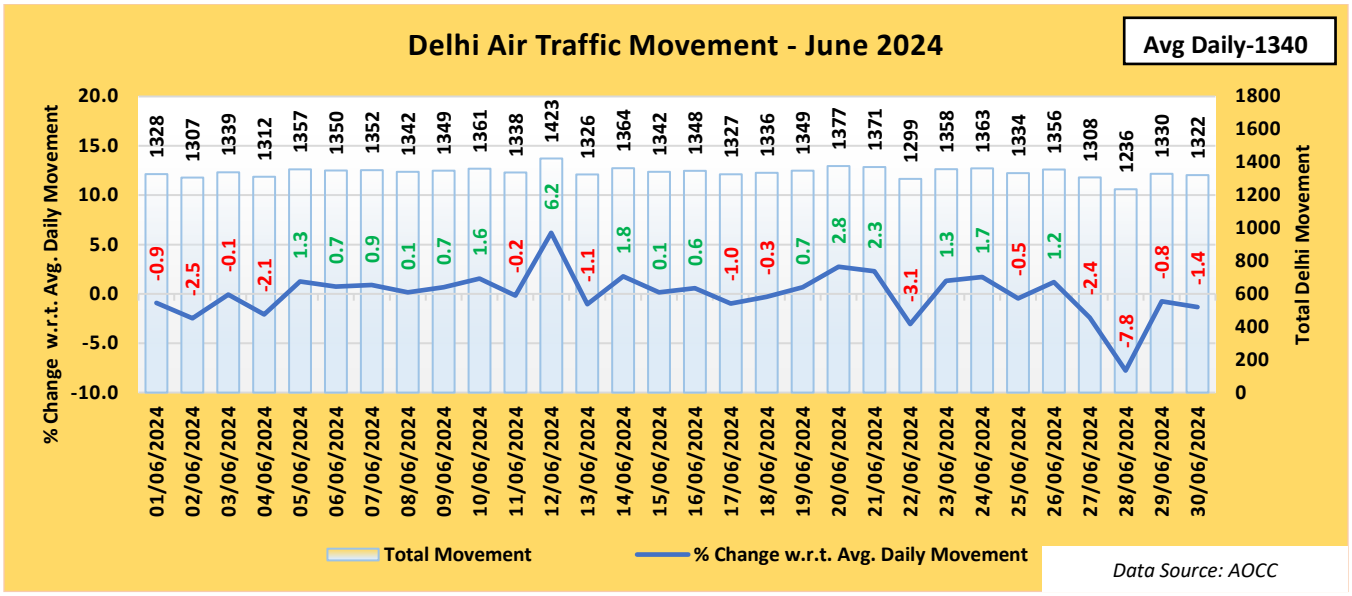


Figure 3: Air Traffic Movement for Delhi –June 2024

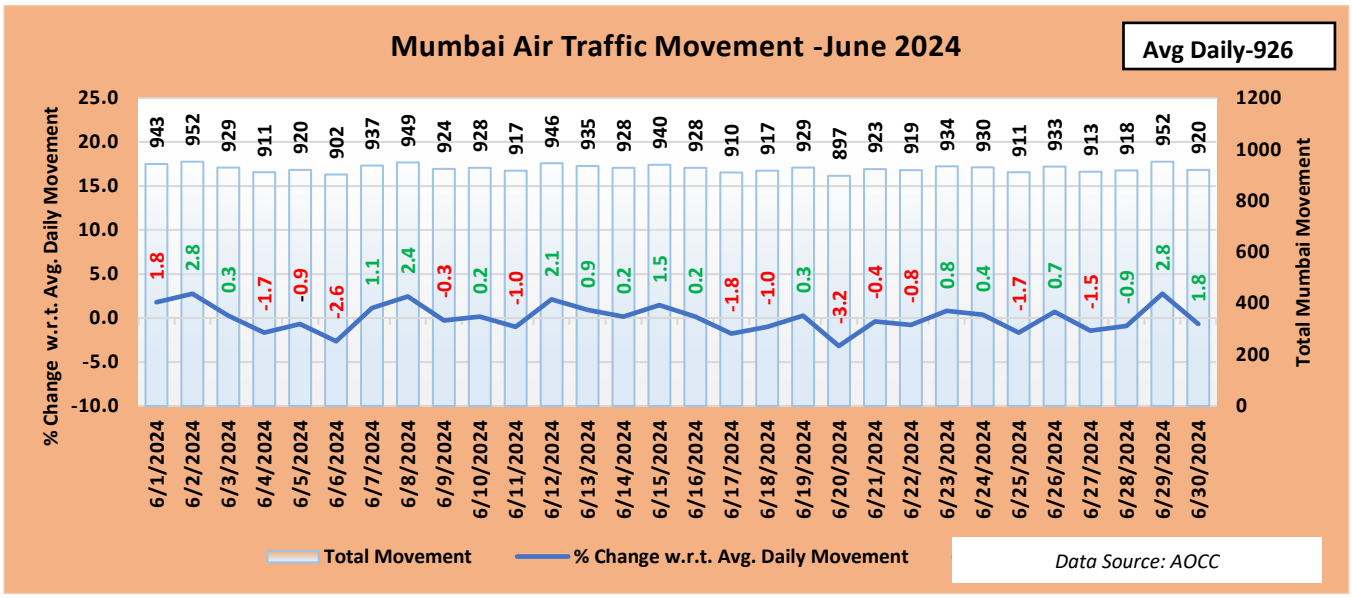


Figure 4: Air Traffic Movement for Mumbai - June 2024

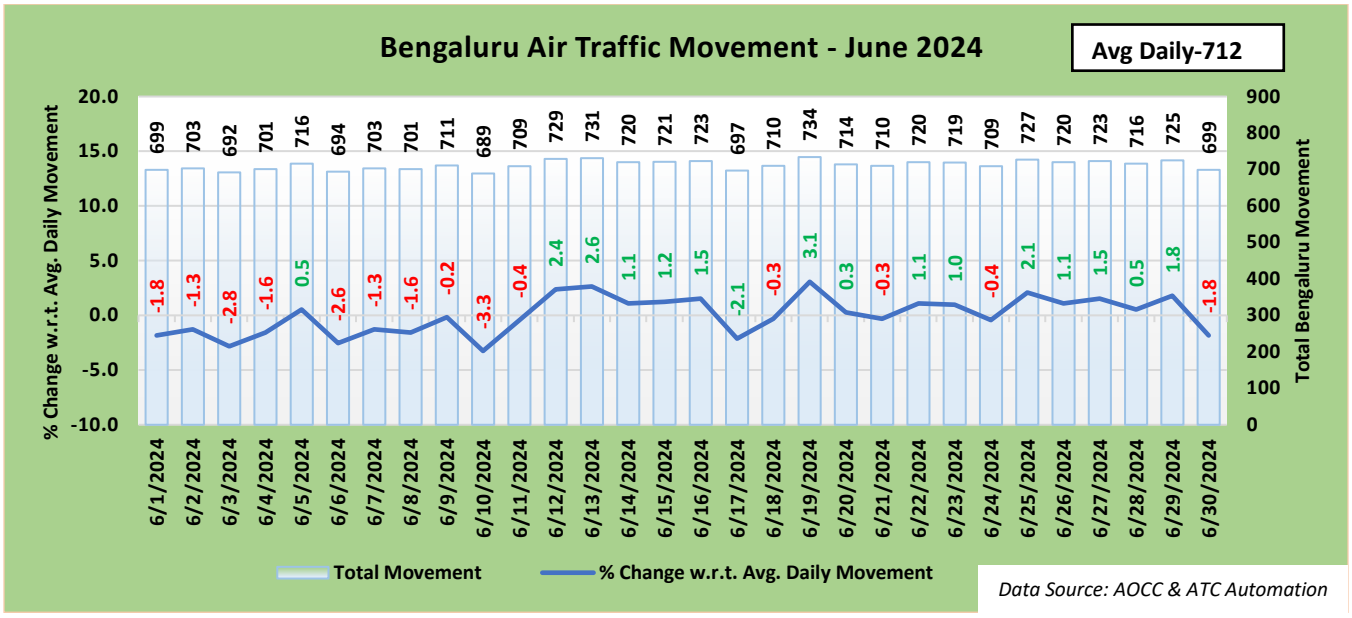


Figure 5: Air Traffic Movement for Bengaluru – June 2024

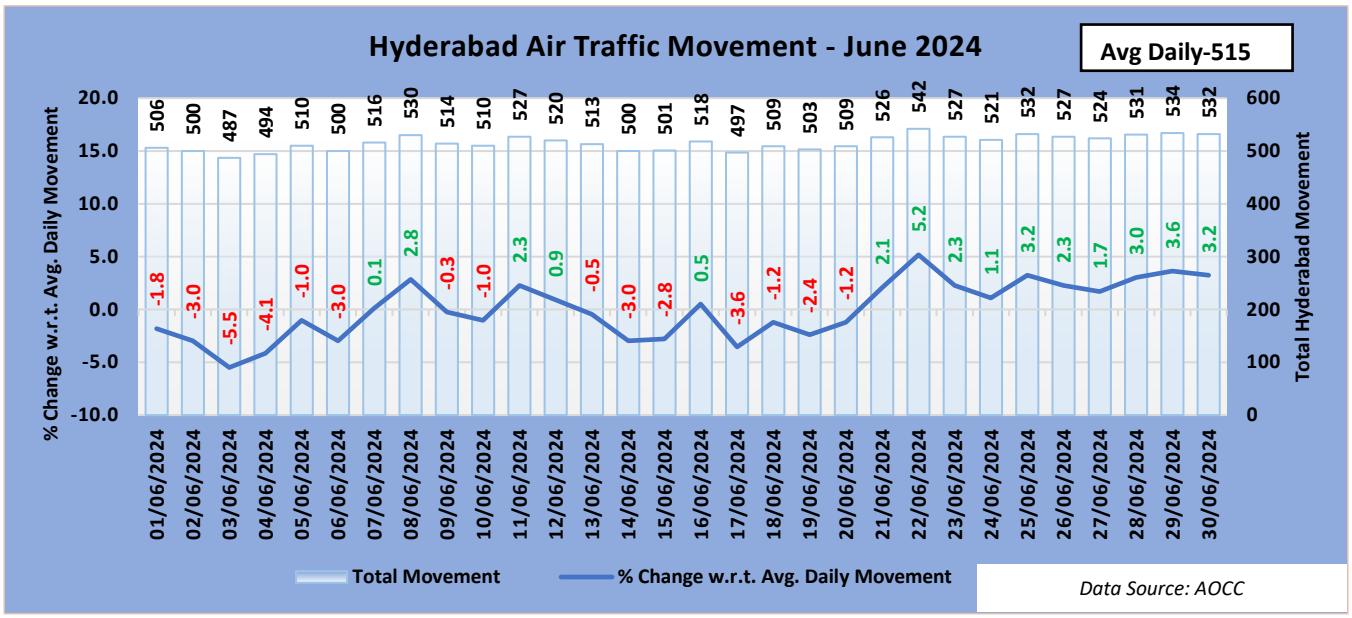


Figure 6: Air Traffic Movement for Hyderabad – June 2024

It can be concluded from the above charts that on 30th June 2024 (month end), the ATM at Mumbai and Hyderabad saw an increase of 1.8% and 3.2% respectively whereas the ATM at Delhi and Bengaluru saw a decline of 1.4% and 1.8% respectively in comparison to the average daily movement for June'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 June 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.

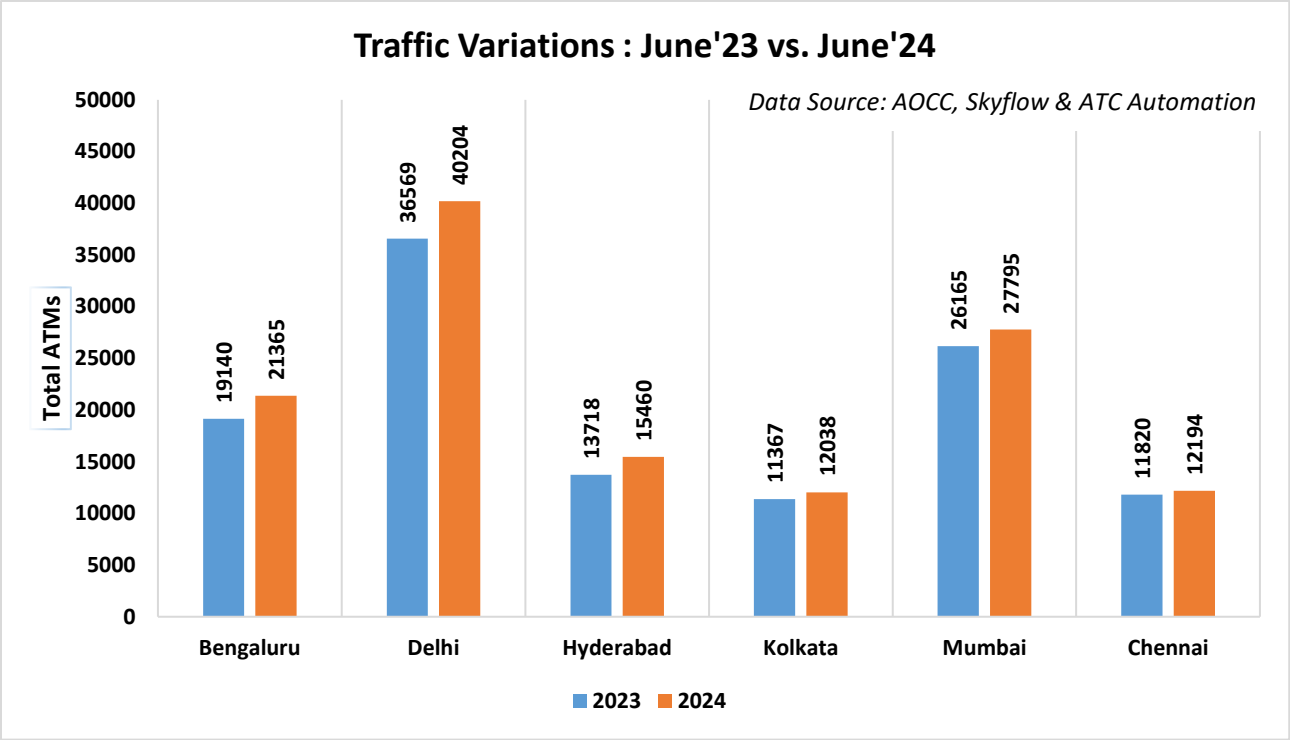


Figure 7: Traffic Variation (YoY)

III. Flight Operations – Airlinewise

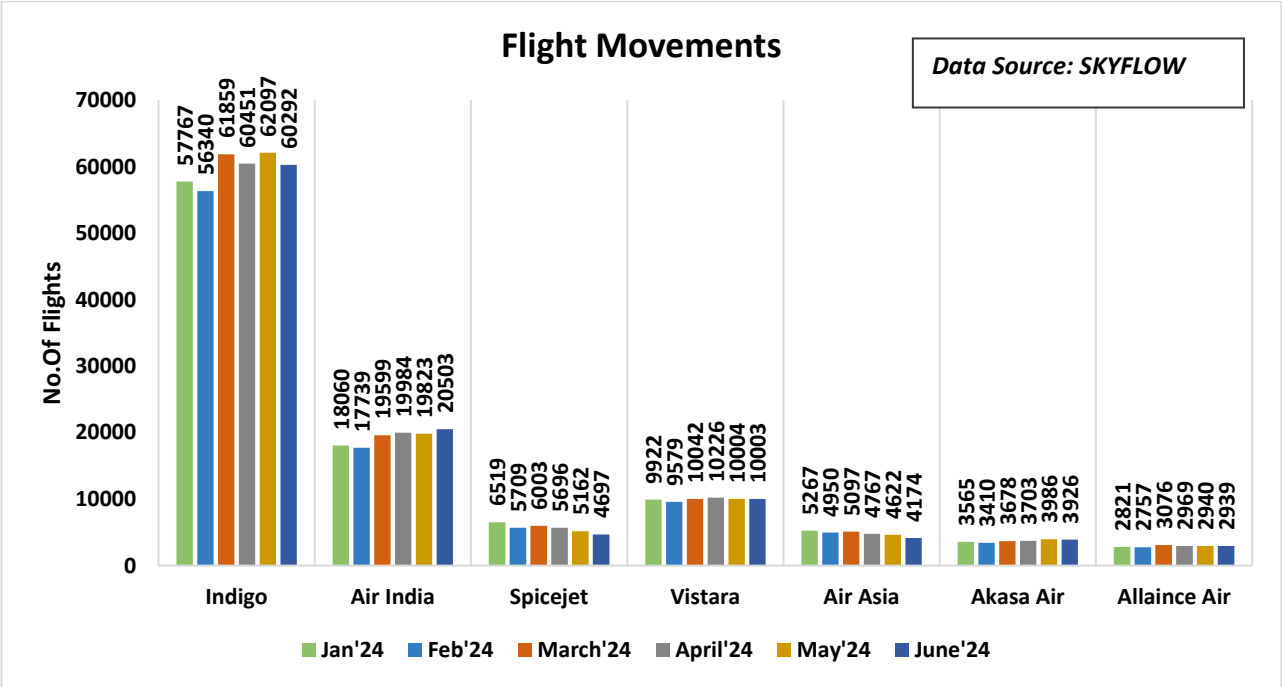


Figure 8: Flight Movements –Airlinewise

Inference:

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

C. ATFM Post Operations – CDM Analysis

I. Introduction

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

Back Ground During the above mentioned period, **Nine (09)** ATFM measures were applied **for Delhi Airport, Twenty Six (26)** ATFM measures were applied **for Mumbai Airport, One (01)** ATFM measure was applied **for Bengaluru Airport and Four (04)** ATFM measure were applied **for Chennai Airport** due to the following reasons as illustrated in the bar chart below:–

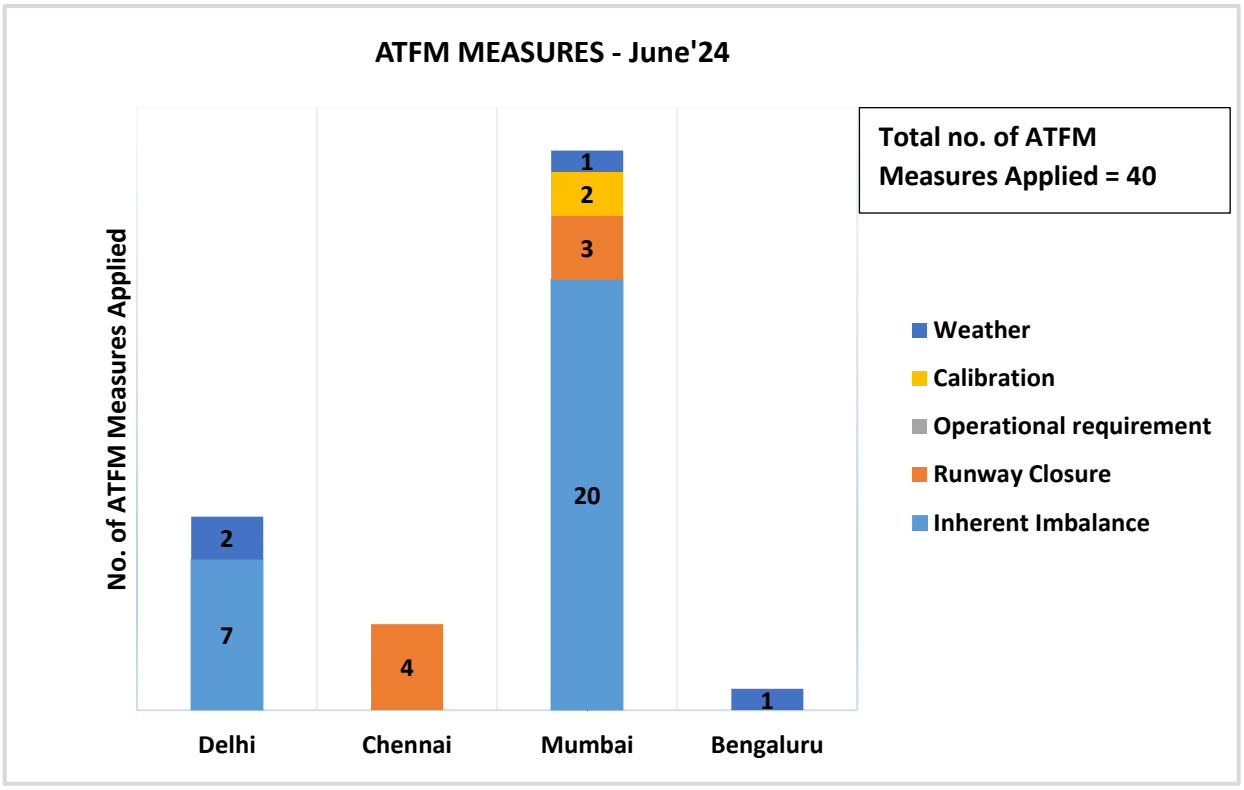


Figure 9: ATFM Measures –June '24

II. ATFM Measures Overview

Constrained Airport	Delhi	Mumbai	Bengaluru	Chennai
Number of ATFM measures applied	9	26	1	4
Average ATFM Ground delay(in min) due to measures*	30.2	27.6	39	21
Maximum ATFM Ground delay(in min) due to measures	62	83	65	47
% Compliance	66.5	82.6	97	79.5

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

Total Arrivals	2783
Total International Arrivals(exempted)	642
Total affected flights in scenario (Domestic Arrivals)	2141
Total Domestic Arrivals with zero ATFM delay	119
Total Domestic Arrivals with ATFM delay	2022

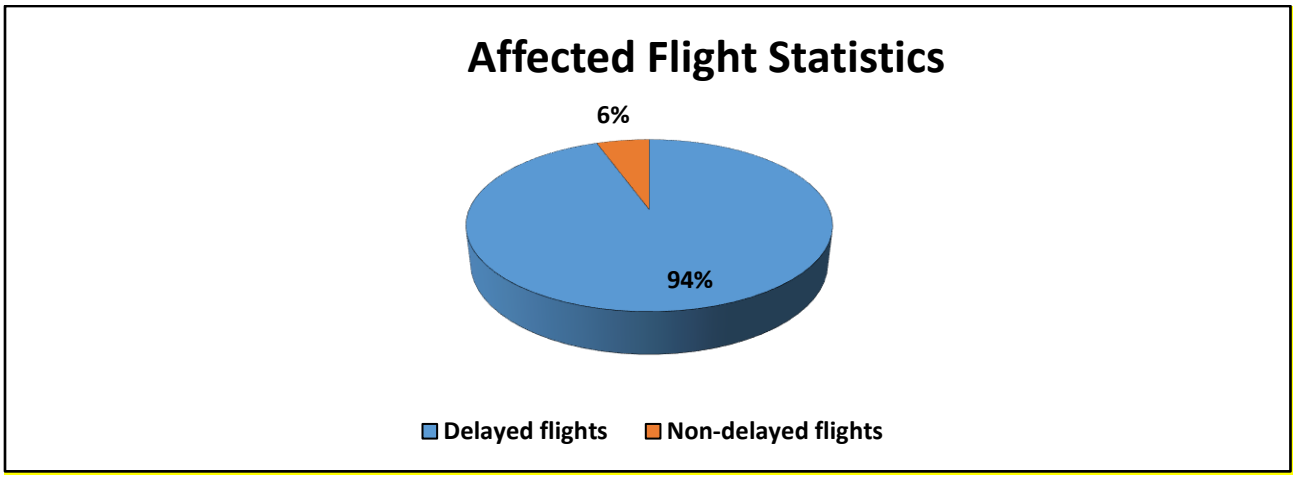


Figure 10: Affected Flight Statistics –June'24

III. Overall Compliance

Total arrivals	2783
Domestic arrivals	2141
Flights with complete data (ATOT)	2067
Flights with incomplete data	10
Flights Not Operated	64
Compliant*	1589
Non-Compliant	478

*Total No. of Revised CTOTs issued = 537 (Compliance calculation for flights which were issued revised CTOT is w.r.t. new CTOT issued)

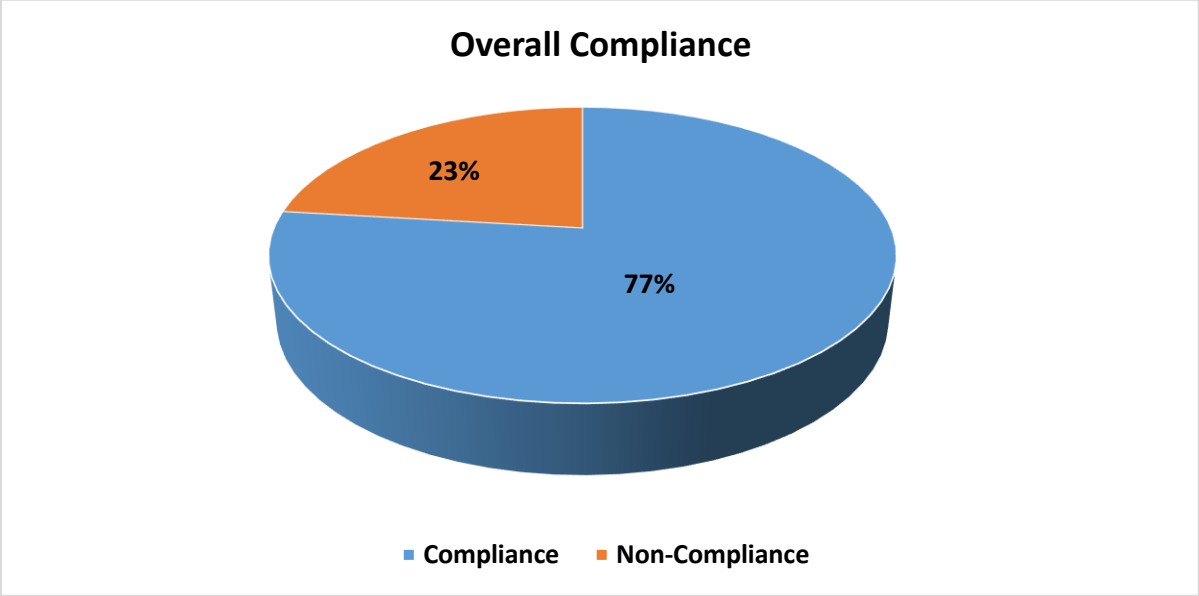


***Figure 11*: Overall Compliance – June'24**

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

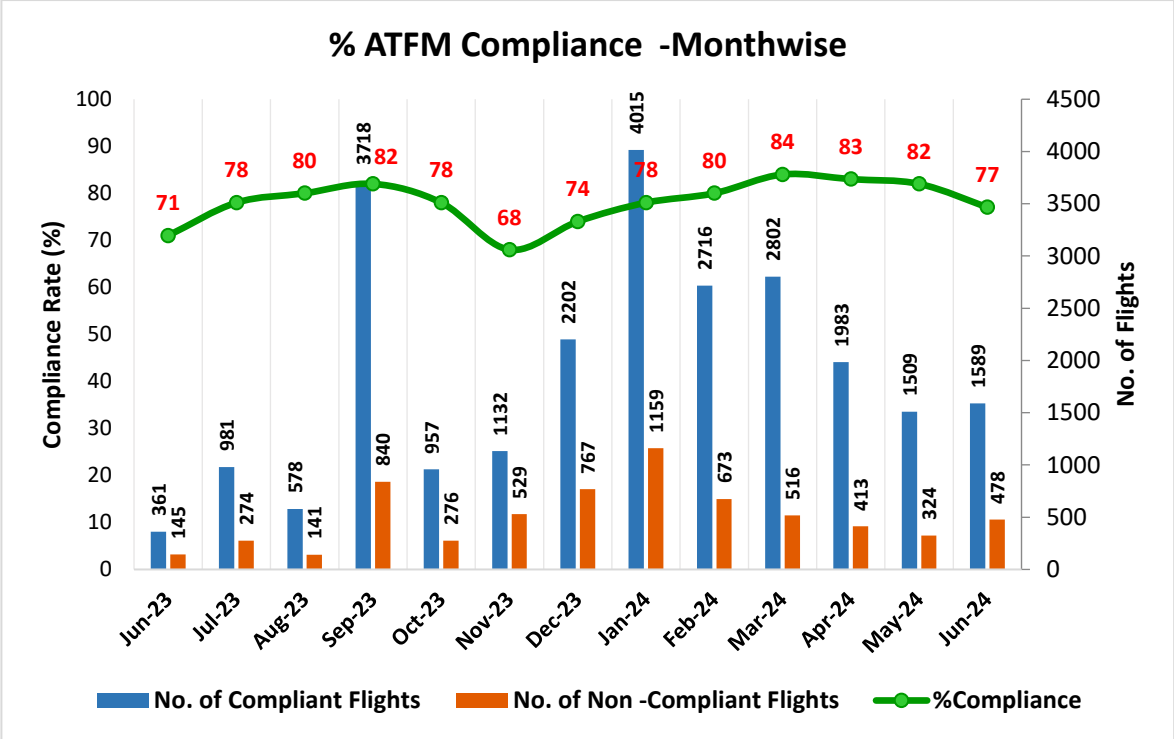


Figure 12: Compliance(Monthwise)

Inference

1. Out of the total arrivals captured(2783 flights) during the CDM scenario for the constrained Airports, 76.9% of flights i.e. domestic arrivals(2141 flights) were candidates for ground delay(participating).
2. Out of these Domestic Arrivals(2141), 94.4% (2022 flights) are assigned ATFM ground delay.
3. Out of the total arrivals captured(2783 flights) to the constrained Airport during the ATFM scenario, only 72.6% of flights(2022 flights) were assigned ATFM Ground Delay.

IV. CTOT Compliance rate – Airportwise

MUMBAI FIR (75%)*	Compliant	Non Compliant	% Compliant
Ahmedabad	54	12	82%
Aurangabad	7	4	64%
Mumbai	72	18	80%
Vadodara	15	4	79%
Bhopal	25	7	78%
Diu	1	1	50%
Hirasar, rajkot	8	3	73%
Indore	34	11	76%
Jabalpur	0	1	0%
Jamnagar	4	4	50%
Kandla	0	5	0%
Kolhapur	1	1	50%
Nagpur	39	10	80%
Ozar	1	2	33%
Pune	21	11	66%
Shirdi	1	1	50%
Surat	4	3	57%
Udaipur	10	3	77%
KOLKATA FIR (75%)*	**Compliant**	**Non Compliant**	**% Compliant**
Prayagraj	6	4	60%
Ayodhya	5	7	42%
Siliguri	16	8	67%
Varanasi	27	12	69%
Bhubneshwar	36	14	72%
Shillong	88	17	84%
Kolkatta	1	0	100%
Durgapur	1	0	100%
Darbhanga	2	0	100%
Gorakhpur	2	2	50%
Guwahati	25	4	86%
Gaya	1	1	50%
Jharsuguda	1	0	100%

Khajuraho	0	1	0%
Jagdalpur	2	1	67%
Patna	38	14	73%
Dimapur	14	5	74%
Raipur	27	5	84%
DELHI FIR (73%)*	**Compliant**	**Non Compliant**	**% Compliant**
Agra	0	2	0%
Amritsar	10	5	67%
Bhuntar	0	1	0%
Bareilly	1	0	100%
Chandigarh	14	6	70%
Dehradun	13	2	87%
Delhi	196	40	83%
Hindon	0	2	0%
Gaggal	0	3	0%
Gwalior	2	2	50%
Jodhpur	2	5	29%
Jaipur	37	9	80%
Jammu	4	2	67%
Leh	2	13	13%
Kishangarh	41	12	77%
Pantnagar	0	2	0%
Lucknow	1	0	100%
Srinagar	28	26	52%
CHENNAI FIR (81%)*	Compliant	Non Compliant	% Compliant
Hal Bangalore	0	2	0%
Baldota Koppal	0	1	0%
Bangalore	157	29	84%
Belgaum	5	1	83%
Vijayawada	8	3	73%
Coimbatore	43	2	96%
Vijaywada	49	9	84%
Calicut	3	1	75%
MOPA Goa	37	15	71%
Goa	71	15	83%

Shamsabad, Hyderabad	128	25	84%
Begumpet, Hyderabad	2	1	67%
Kannur	3	1	75%
Madurai	8	2	80%
Mangalore	13	0	100%
Shashabad Hyderabad	73	24	75%
Port Blair	1	3	25%
Sindhudurg	2	1	67%
Tirupati	0	1	0%
Tiruchirappally	3	2	60%
Mangaluru	31	7	82%
Visakhapatnam	11	4	73%

**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(77%) for the month are highlighted in red.

V. CTOT Compliance rate – Airlinewise

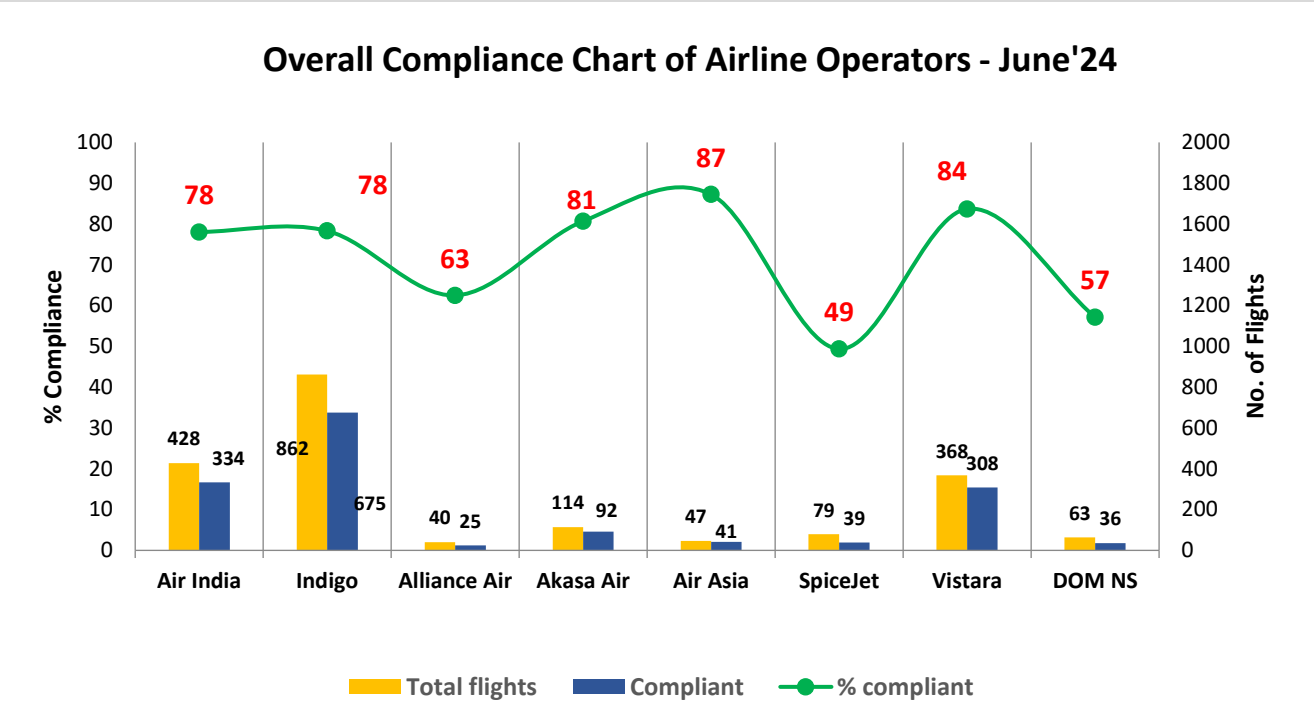


Figure 13: Airline wise Compliance –June'24

Inference

1. Out of the total domestic arrivals with complete data in the CDM scenario, 77% arrivals are compliant.
2. Chennai region record the highest compliance of 81% whereas Delhi region has the lowest percentage compliance of 73%.
3. Indigo,Air India, Akasa, Air Asia and Vistara Airlines have a CTOT compliance higher than the average recorded compliance for the month of June'24.

Airline wise compliance

Air India 78% **Indigo Airlines 78%**

Air Asia 87% **Vistara 84%**

Akasa Air 81% **Alliance Ai**

VI. Reason For Non Compliance

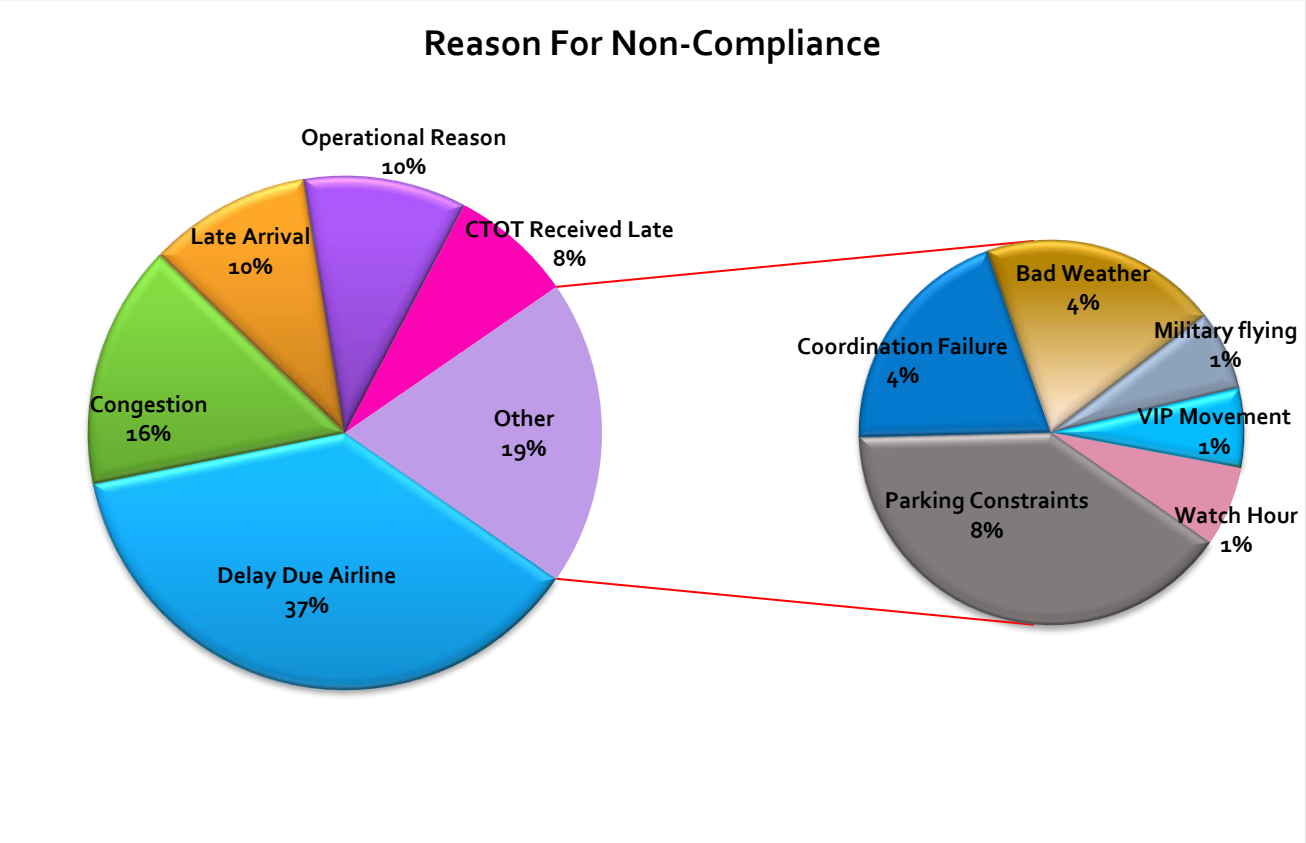


Figure 14: Reason for Non-Compliance as provided by FMPs

Inference:

1. 37 % of CTOT Non- Compliance was reported by concerned FMPs to be due to delay by Airlines.
2. 16 % of CTOT Non- Compliance was reported by concerned FMPs to be due to traffic congestion at airports.
3. 10 % 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. 8 % 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.
5. **37 +10 = 47% non compliance is reported by Airlines. In such cases Airlines are bound to take revised CTOT. ATC station should not release aircraft without revised CTOT.**

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 6.7,10.8, 16.2 and 6.7 minutes respectively.

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

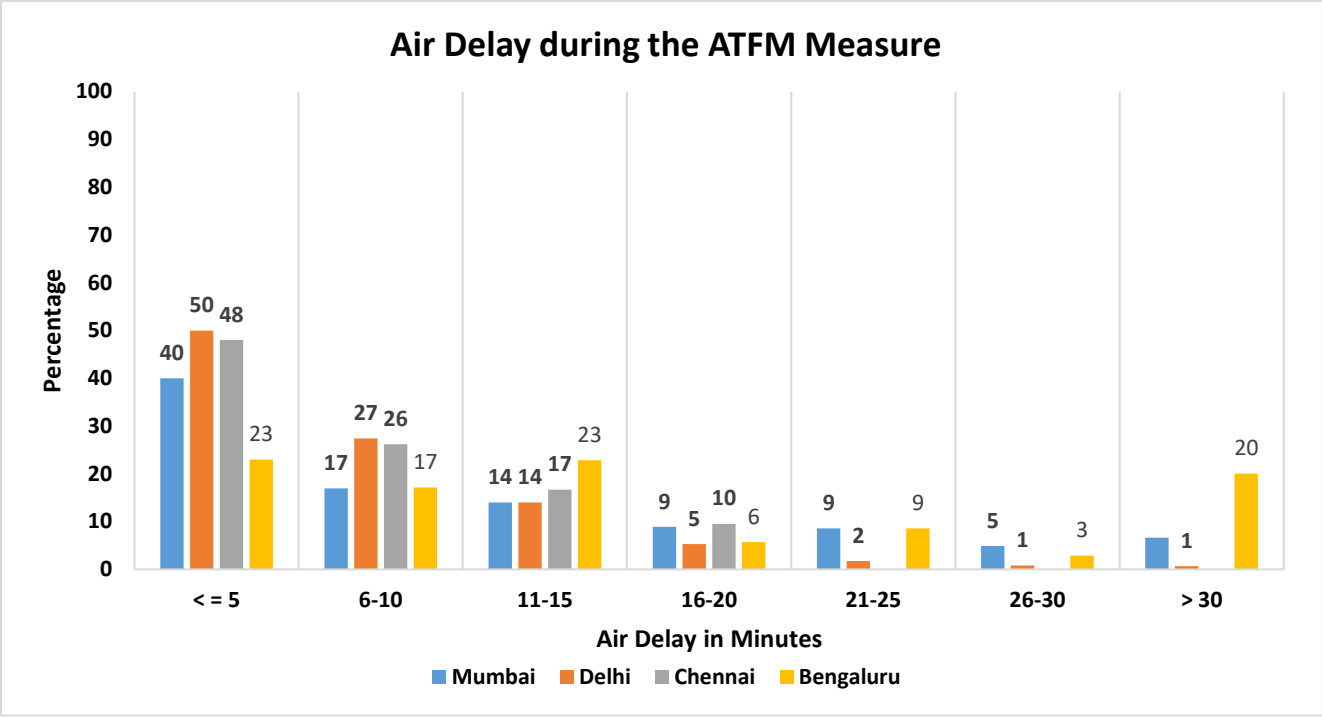


Figure 15: Air Delay distribution during the CDM period

Inference

1. 57% of domestic arriving flights to Mumbai had an Air delay of equal to or less than 10 minutes during the CDM period.
2. 77% of domestic arriving flights to Delhi had an Air delay of equal to or less than 10 minutes during the CDM period.
3. 74% of domestic arriving flights to Chennai had an Air delay of equal to or less than 10 minutes during the CDM period.
4. 40% 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 = ∑ (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)= 21188 mins

Total Air Delay (with no ATFM measures) = 55123 mins

Reduction in Air delay due to ATFM measures= (55123-21188) = **33935 mins**

Fuel Saving Calculation:

Total Fuel saved during the ATFM Measure: ***19,65,160.03 Kg***

Total reduction in CO_2 emission : 3.16(KgCO_2/kg fuel)* 19,65,160.03 **Kg** ***= 62,09,905.69Kg***

**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	$\frac{\boldsymbol{Total\ monthly\ ATFM\ delay\ (in\ minutes)}}{\boldsymbol{Total\ Domestic\ Arrivals}}$
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: $\boldsymbol{Average\ Air\ Delay} = \frac{\boldsymbol{Total\ Air\ Delay\ to\ domestic\ arrivals\ (with\ values\ greater\ than\ zero)}}{\boldsymbol{Total\ Domestic\ Arrivals}}$ *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)- June 2024**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.

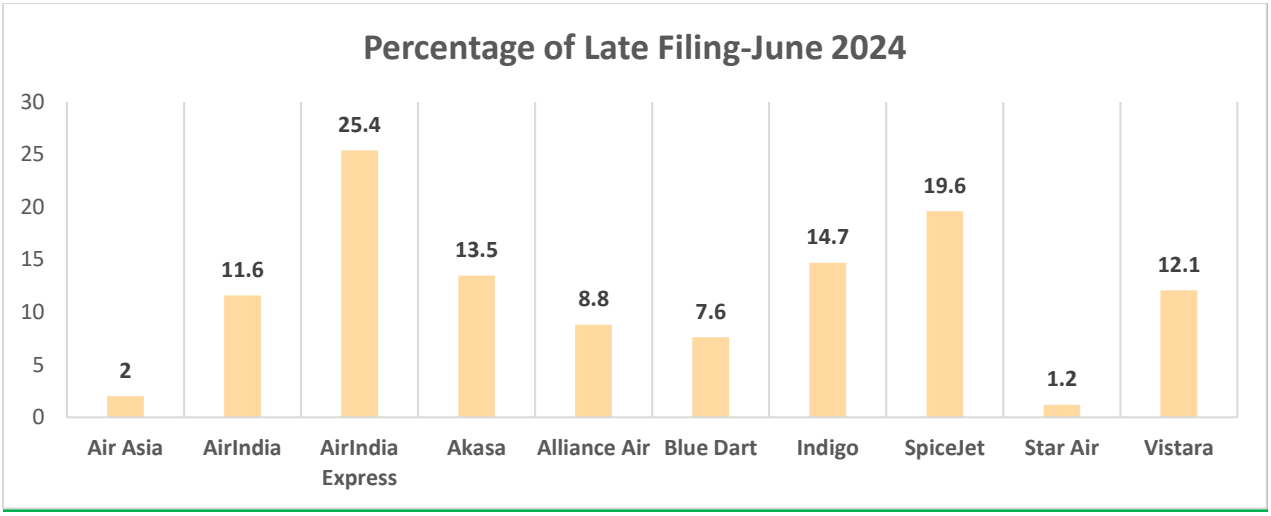
AIP India, ENR 1.9 section 4 on Flight Planning in the context of ATFM recommends Flight Planning requirements for all Airline Operators –

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;"
airlines are required to submit Delay message, Change message, cancellation message etc in time to further refine the demand projection.

I. 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 June 2024 to 30th June 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.



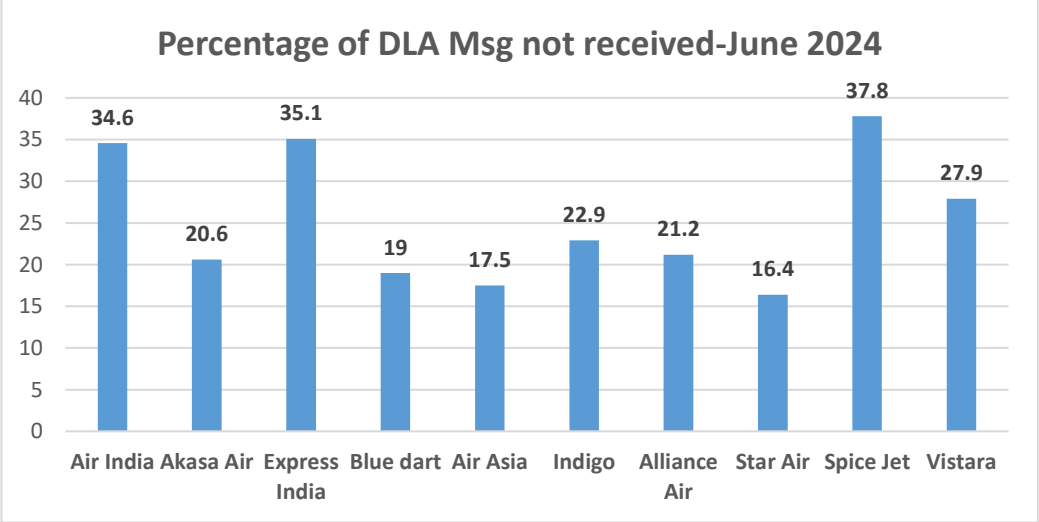
The table below lists number of filed flight plans (FPLs) with less than 3 Hours prior to EOBT:

Name of Airline	Late Filed FPL	Total No. Of FPL	% Delayed Filing
Air Asia	87	4166	2
AirIndia	1680	14365	11.6
AirIndia Express	1799	7071	25.4
Akasa	527	3887	13.5
Alliance Air	273	3077	8.8
Blue Dart	49	639	7.6
Indigo	8916	60609	14.7
SpiceJet	956	4858	19.6
Star Air	16	1333	1.2
Vistara	1215	10008	12.1
Total no. of FPLs for Scheduled Airlines	**15518**	**110013**	**14.1**

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 June 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	3970	11465	34.6
Akasa Air	670	3238	20.6
Express India	1676	4773	35.1
Blue dart	102	535	19
Air Asia	576	3290	17.5
Indigo	10729	46701	22.9
Alliance Air	390	1839	21.2
Star Air	84	510	16.4
Spice Jet	1360	3590	37.8
Vistara	2324	8329	27.9



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

Name of Airline	CNL message not received	No. of flights annulled
Air India	74	86
Akasa Air	11	12
Express India	155	182
Blue dart	2	2
Air Asia	10	10
Indigo	323	332
Alliance Air	255	255
Star Air	14	15
Spice Jet	160	161
Vistara	22	22

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