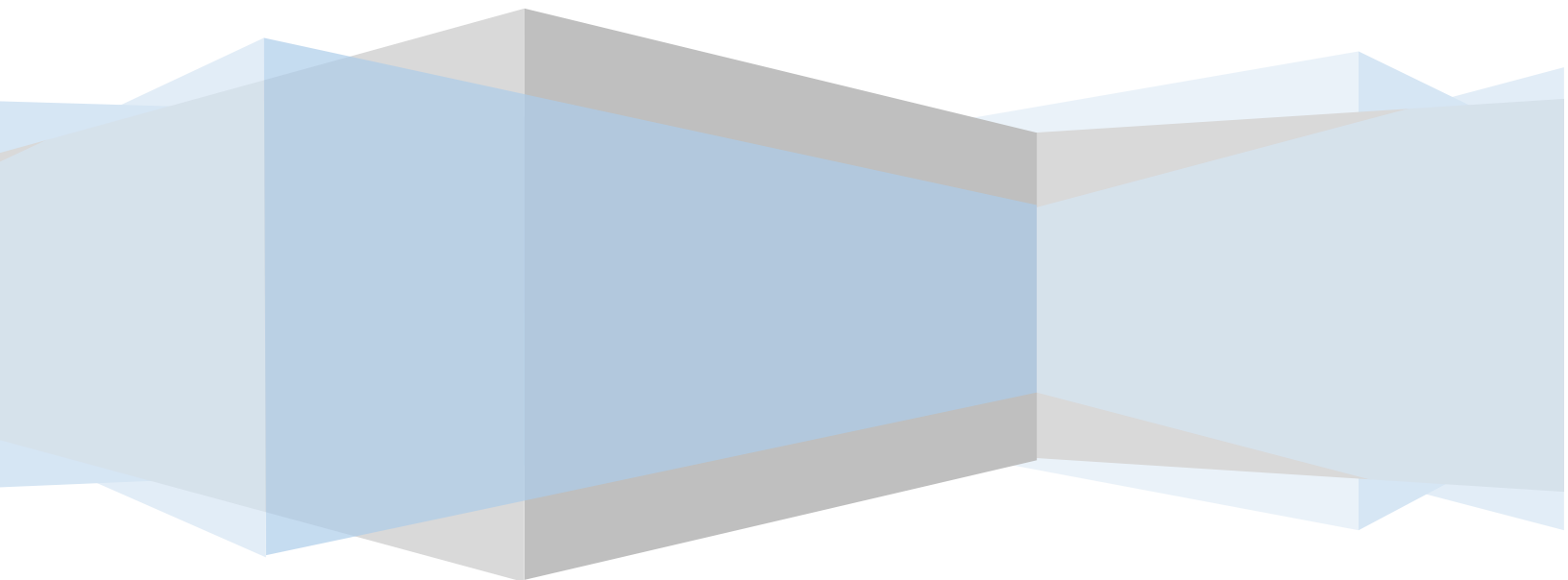


POST OPERATIONS ANALYSIS REPORT

September, 2024

CENTRAL COMMAND CENTER, C-ATFM, DELHI







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A. Executive Summary

Average Domestic air traffic has recorded an increase of 0.65% whereas the average international air traffic has increased by 0.03 % in the month of September '24 as compared to August '24.

On average, the Indian Airports in the ATFCM area saw 4553 IFR flights per day in the month of August 2024. The peak day was on 27th September 2024 (4673 IFR flights). Friday's were the busiest days throughout this month with an average of 4641 IFR flights per day.

Total Fifty Eight (58) ATFM measures were applied this month during periods of congestion at Bengaluru, Chennai, Delhi and Mumbai Airport.

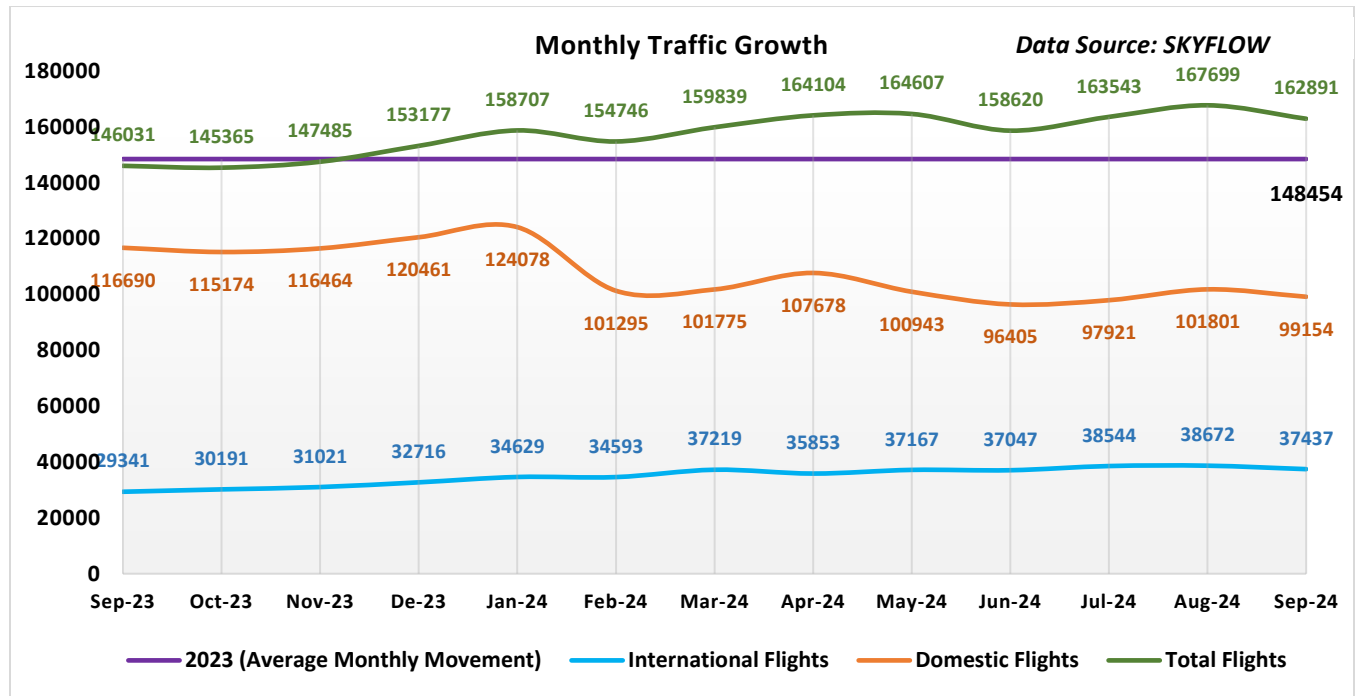


Figure 1: Monthly Traffic Growth

The graph above depicts the Domestic, International and Overflying Air traffic in Indian ATFCM Area during the last 13 months (September'23 to September'24).



B. Traffic Analysis

I. Air Traffic Movement at Major Airports in India

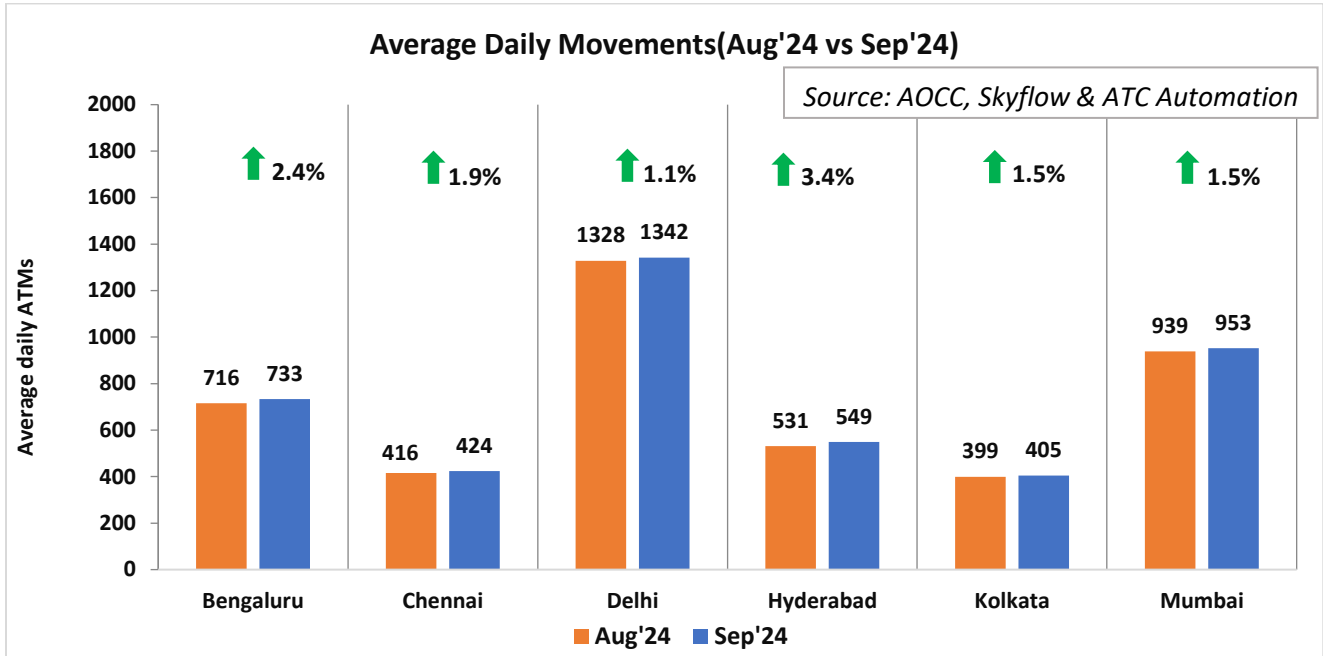


Figure 2: Average Daily Movements (Aug '24 vs Sep '24)

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

Airports\Year	Avg. Daily ATMs (YoY) for six major airports				
	Sep'20	Sep'21	Sep'22	Sep'23	Sep'24
Bengaluru	321	412	570	636	733
Chennai	168	260	362	401	424
Delhi	647	951	1198	1251	1342
Hyderabad	268	328	427	470	549
Kolkata	202	281	359	389	405
Mumbai	301	526	805	924	953



Air Traffic Movement for each day in September'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.

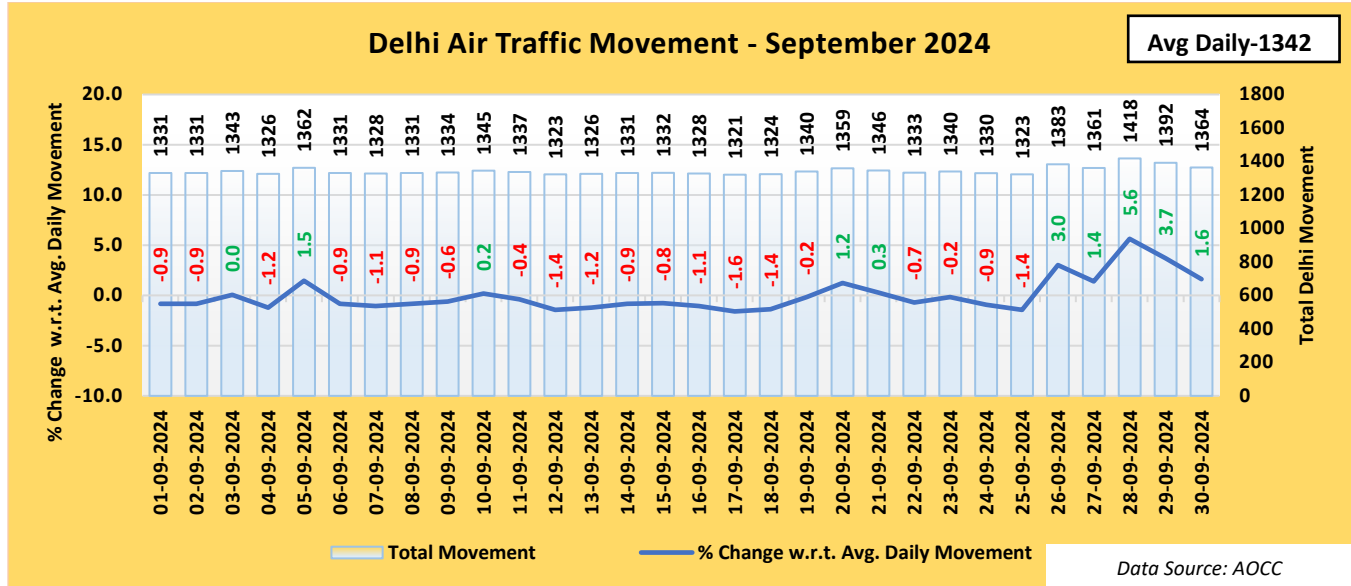


Figure 3: Air Traffic Movement for Delhi –September 2024

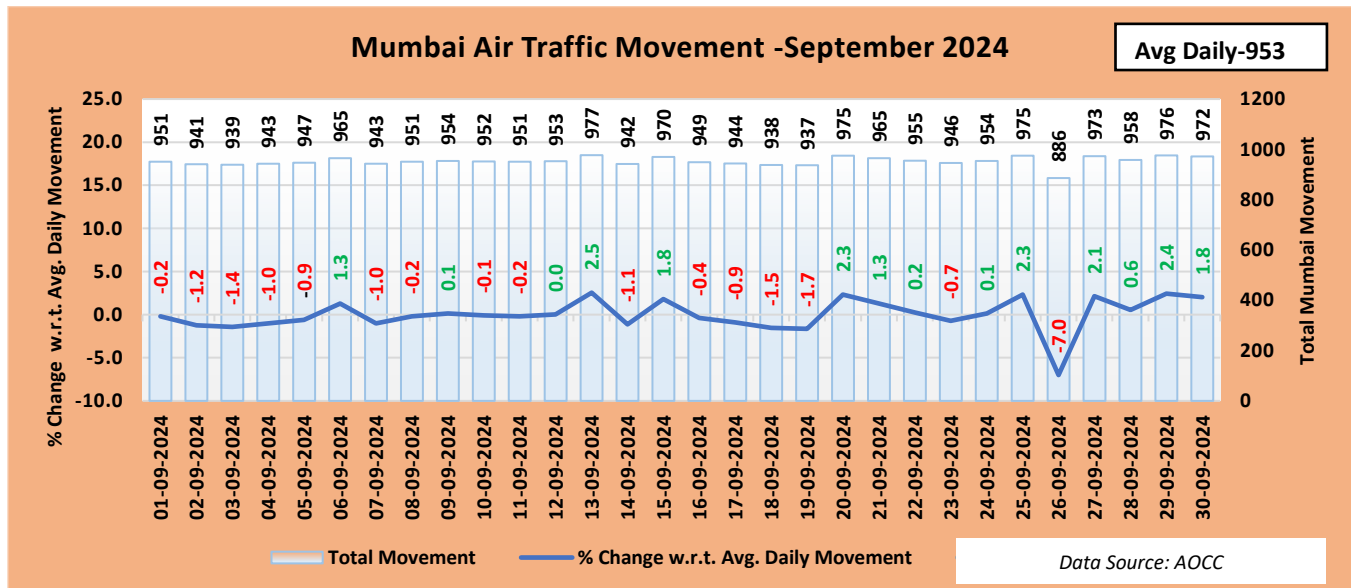


Figure 4: Air Traffic Movement for Mumbai - September 2024

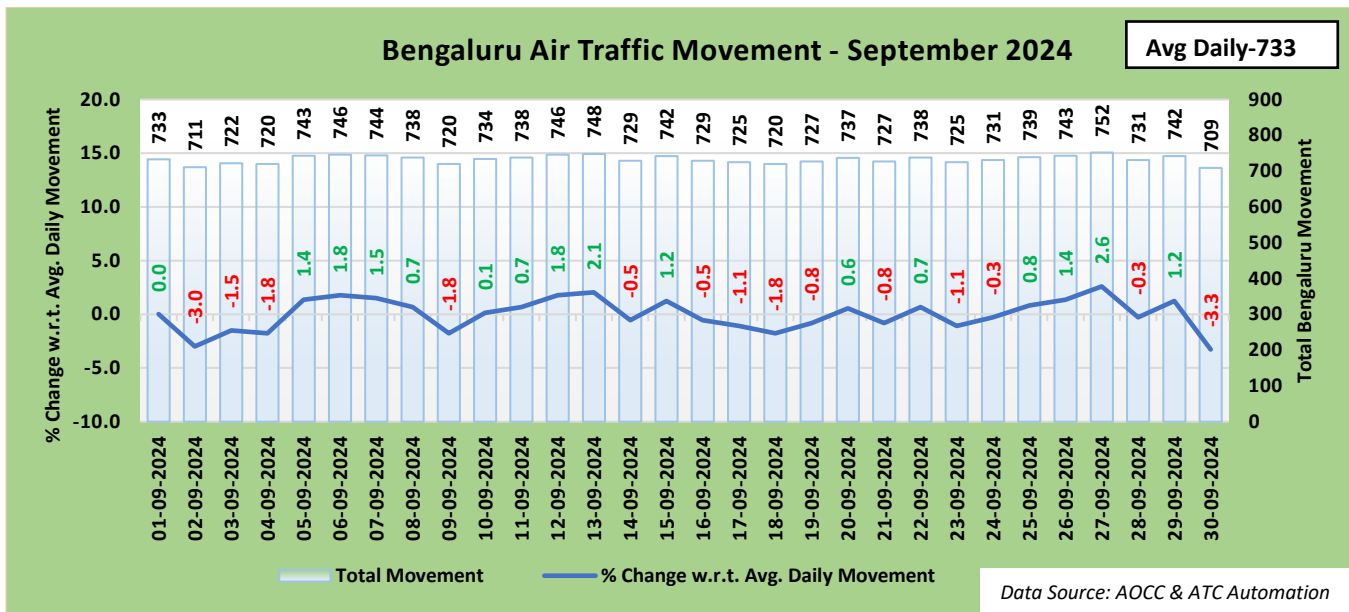


Figure 5: Air Traffic Movement for Bengaluru – September 2024

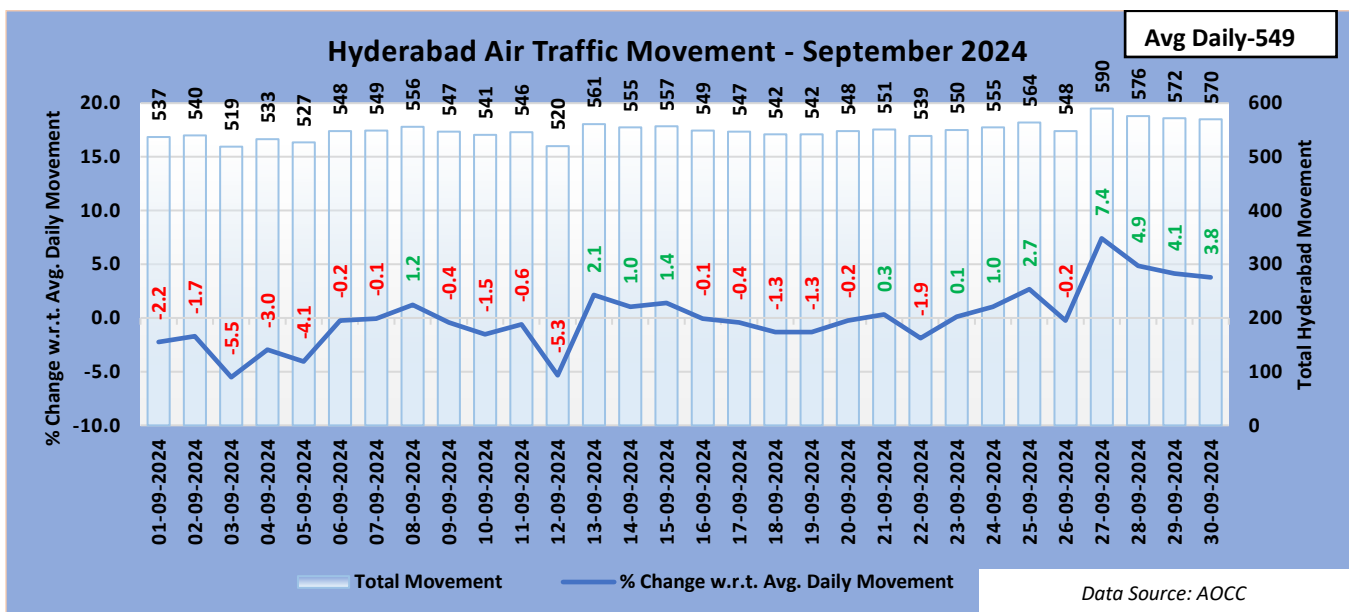


Figure 6: Air Traffic Movement for Hyderabad – September 2024

It can be concluded from the above charts that the ATM at Delhi, Mumbai, Bengaluru and Hyderabad exceeds the average daily movement for 09days, 13 days, 15 days and 12 days respectively in the month of September'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 September 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.

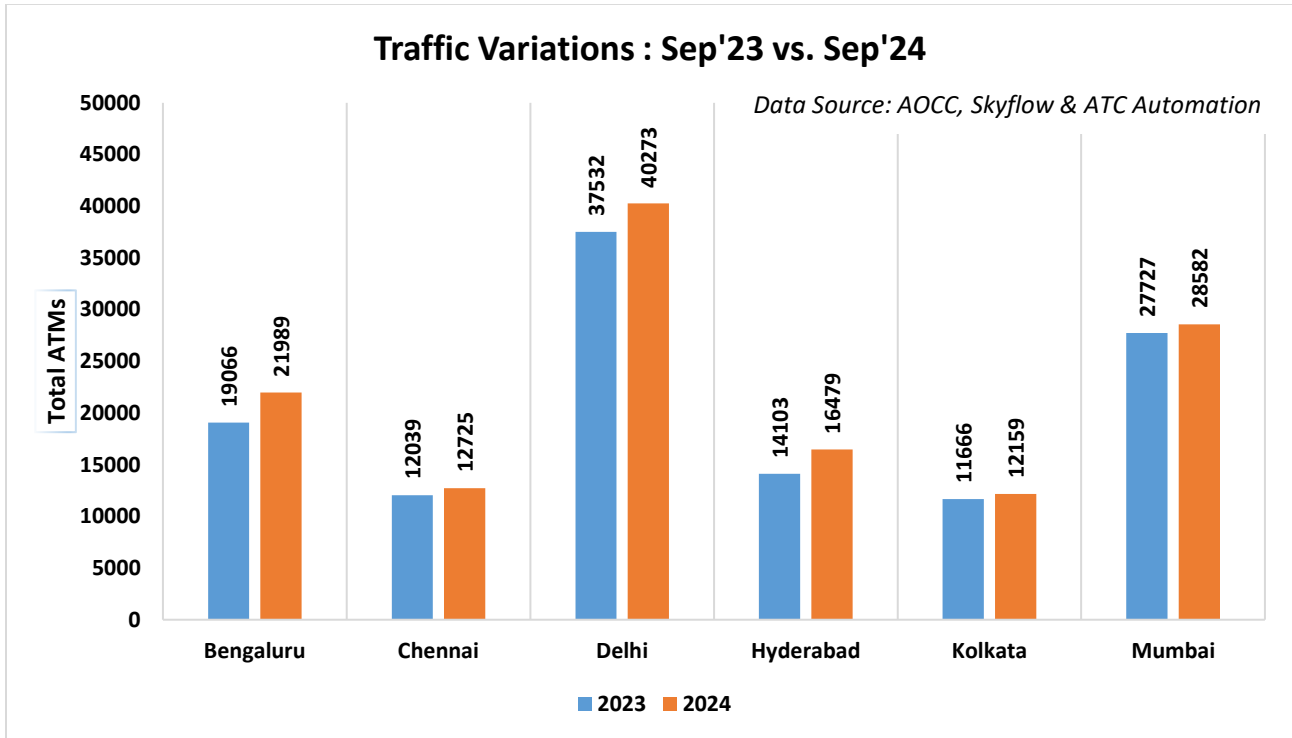


Figure 7: Traffic Variation (YoY)



III. Flight Operations – Airlinewise

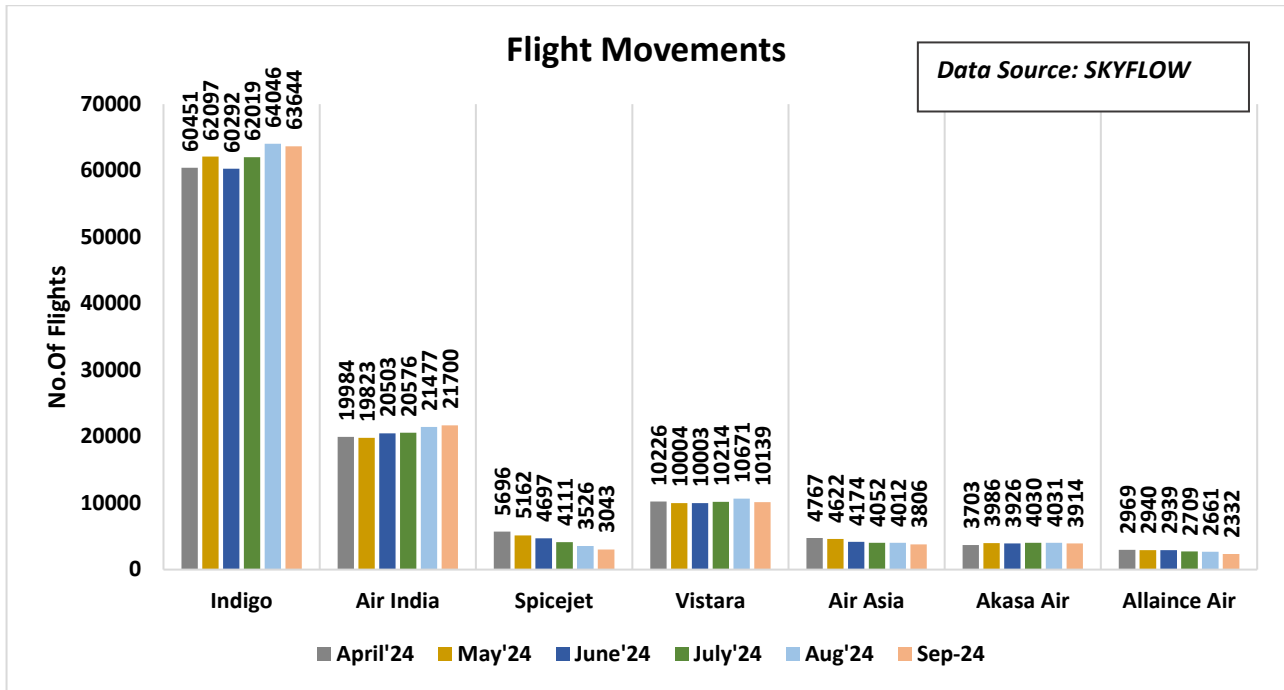


Figure 8: Flight Movements –Airlinewise

Inference:

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



C. ATFM Post Operations – CDM Analysis

I. Introduction

Analysis Period 1st – 30th September 24

Back Ground During the above mentioned period, **Five (05)** ATFM measure was applied for **Bengaluru Airport**, **Two (02)** ATFM measures were applied for **Chennai Airport**, **Thirteen (13)** ATFM measures were applied for **Delhi Airport** and **Thirty Eight (38)** ATFM measures were applied for **Mumbai Airport** due to the following reasons as illustrated in the bar chart below:-

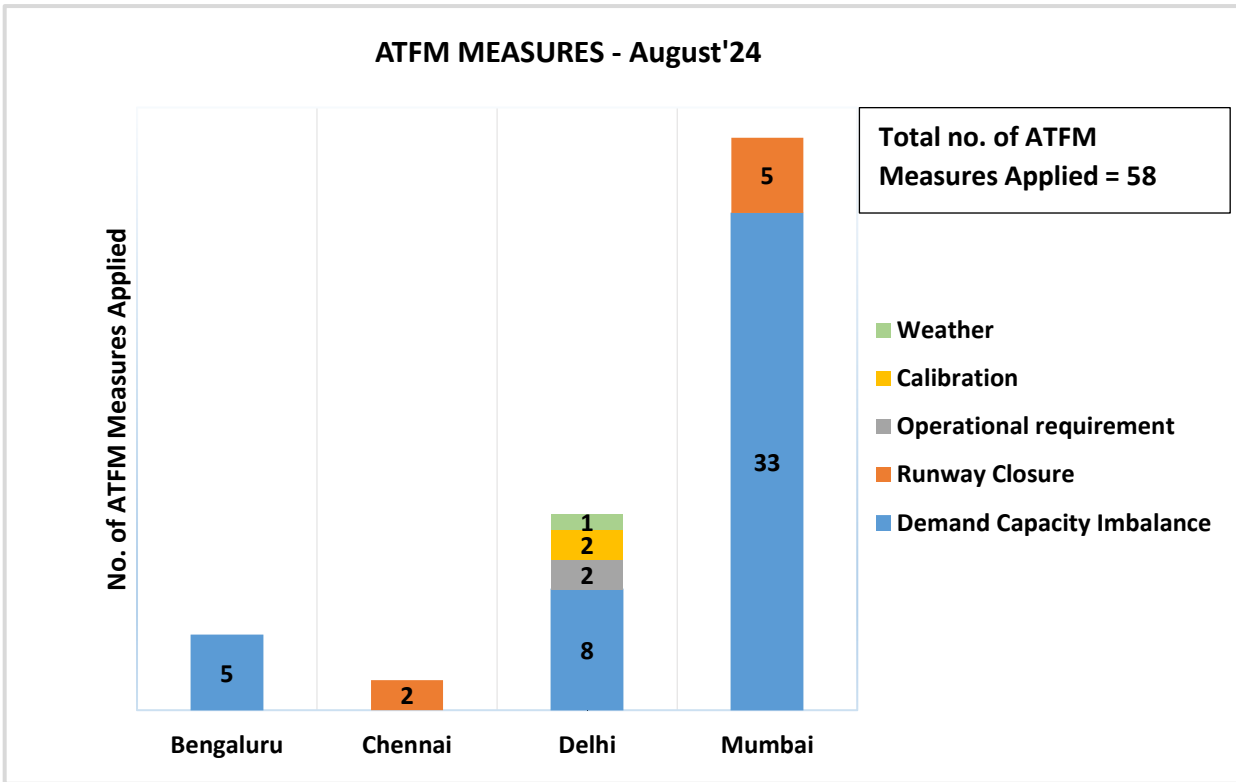


Figure 9: ATFM Measures –Sep'24



II. ATFM Measures Overview

Constrained Airport	Bengaluru	Chennai	Delhi	Mumbai
Number of ATFM measures applied	5	2	13	38
Average ATFM Ground delay(in min) due to measures*	14.8	24.1	23.2	31.3
Maximum ATFM Ground delay(in min) due to measures	51	45	53	158
% Compliance	88.0	80.0	81.2	88.8

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

Total Arrivals	4537
Total International Arrivals(exempted)	984
Total affected flights in scenario (Domestic Arrivals)	3553
Total Domestic Arrivals with zero ATFM delay	255
Total Domestic Arrivals with ATFM delay	3298

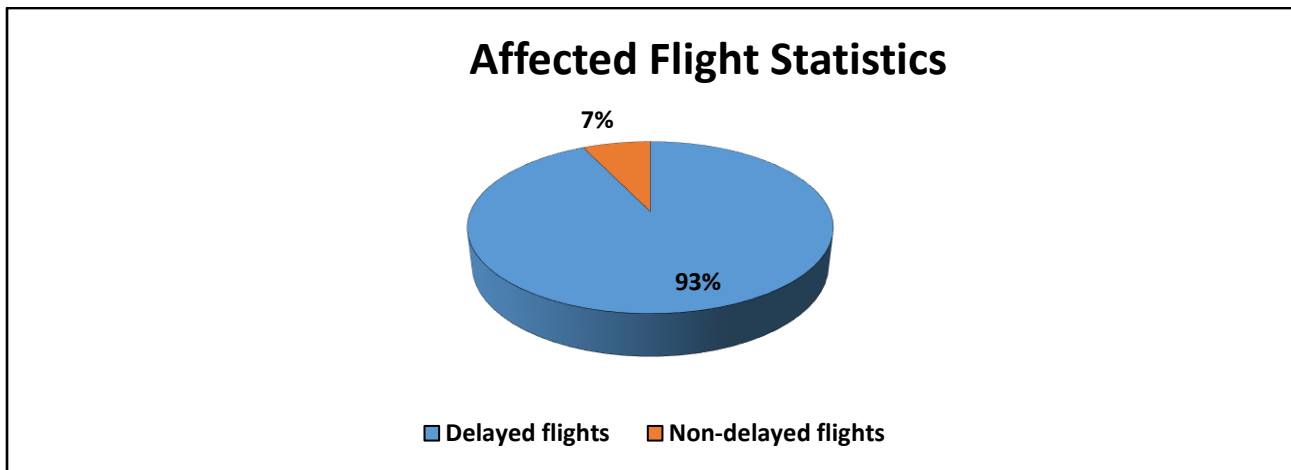


Figure 10: Affected Flight Statistics –Sep’24



III. Overall Compliance

Total arrivals	4537
Domestic arrivals	3553
Flights with complete data (ATOT)	3472
Flights with incomplete data	20
Flights Not Operated	61
Compliant*	2998
Non-Compliant	474

*Total No. of Revised CTOTs issued = 1190 (Compliance calculation for flights which were issued revised CTOT is w.r.t. new CTOT issued)

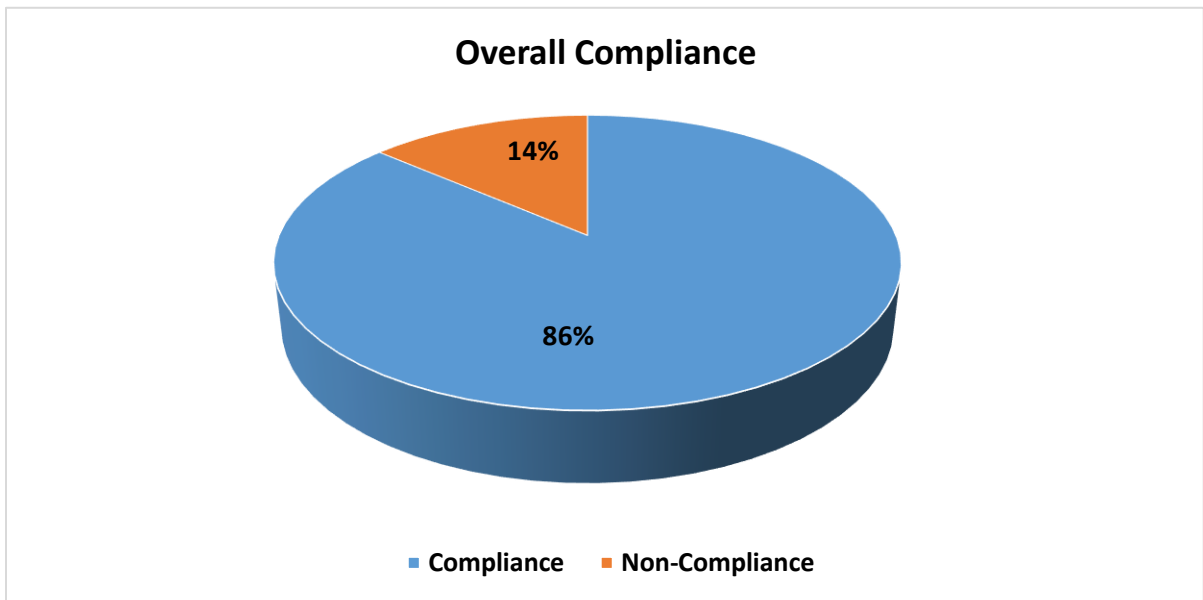


Figure 11: Overall Compliance – Sep’24

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

Out of the total domestic arrivals with complete data in the CDM scenario, 86% arrivals are compliant for the month of September 2024 whereas 84% arrivals were compliant for the month of August 2024 and there has been an increase of 2% in compliance in the month of September’24 with respect to August’24.

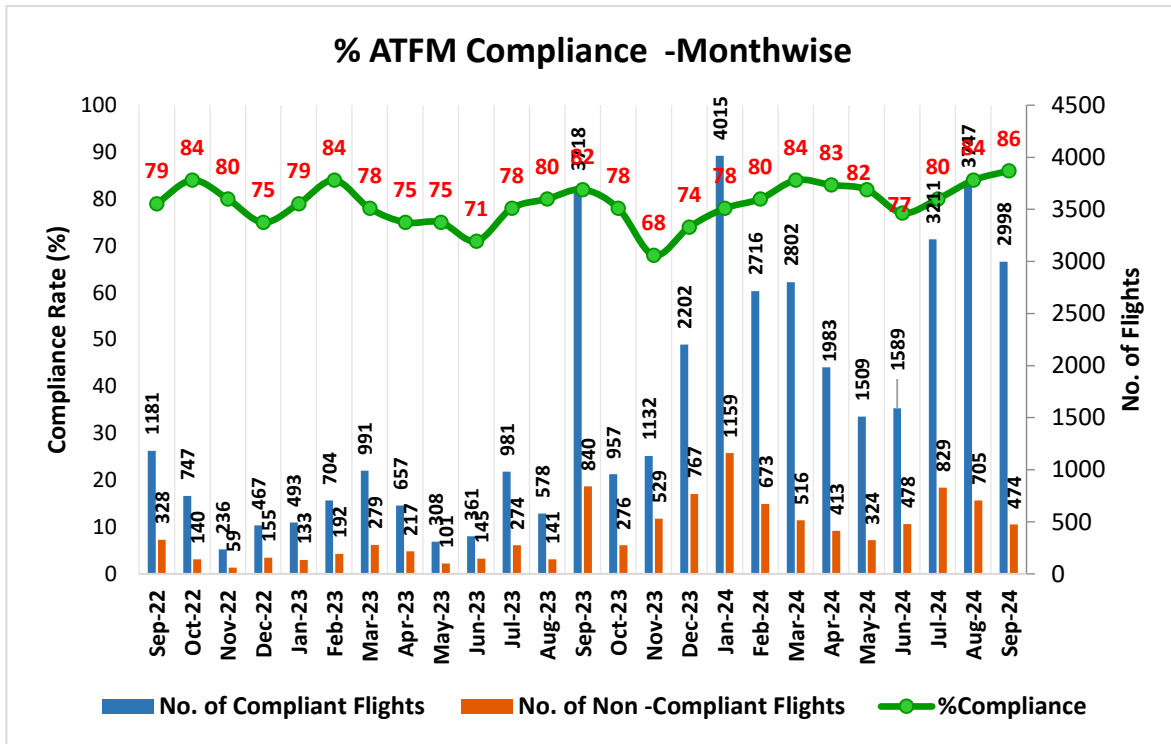


Figure 12: Compliance(Monthwise)

Inference

1. Out of the total arrivals captured(4537flights) during the CDM scenario for the constrained Airports, 78.3% of flights i.e. domestic arrivals(3553 flights) were candidates for ground delay(participating).
2. Out of these Domestic Arrivals(3553), 92.8% (3298 flights) are assigned ATFM ground delay.
3. Out of the total arrivals captured(4537 flights) to the constrained Airport during the ATFM scenario, 72.7% of flights(3298 flights) were assigned ATFM Ground Delay.



IV. CTOT Compliance rate – Airportwise

MUMBAI FIR (84%)*	Compliant	Non Compliant	% Compliant
Ahmedabad	102	16	86%
Aurangabad	22	4	85%
Mumbai	108	35	76%
Vadodara	25	4	86%
Bhopal	39	6	87%
Diu	1	0	100%
Hirasar, rajkot	25	4	86%
Indore	64	6	91%
Jabalpur	8	0	100%
Jalgaon	3	1	75%
Jamnagar	4	2	67%
Kandla	2	0	100%
Kolhapur	5	0	100%
Nagpur	65	5	93%
Ozar	3	1	75%
Pune	39	20	66%
Shirdi	7	1	88%
Surat	24	1	96%
Udaipur	28	5	85%
KOLKATA FIR (89%)*	Compliant	Non Compliant	% Compliant
Prayagraj	12	1	92%
Agartala	6	1	86%
Ayodhya	27	3	90%
Bagdogra	29	4	88%
Varanasi	43	10	81%
Bhubaneswar	70	5	93%
Bilaspur	1	0	100%
Kolkata	167	17	91%
Chakeri	5	0	100%
Durgapur	4	1	80%
Darbhanga	7	2	78%
Deoghar	3	0	100%



Gorakhpur	15	1	94%
Guwahati	63	10	86%
Gaya	3	0	100%
Itanagar	1	1	50%
Imphal	1	0	100%
Jharsuguda	5	1	83%
Jamshedpur	3	0	100%
Lengpui	0	2	0%
Dibrugarh	7	1	88%
Dimapur	2	0	100%
Patna	56	7	89%
Ranchi	22	2	92%
Raipur	34	7	83%
DELHI FIR (83%)*	Compliant	Non Compliant	% Compliant
Ambala	1	0	100%
Amritsar	29	7	81%
Bhuntar	1	2	33%
Bathinda	1	0	100%
Bareilly	2	1	67%
Chandigarh	55	18	75%
Safdarjung, New Delhi	1	0	100%
Dehradun	22	8	73%
Delhi	373	54	87%
Kangra	0	2	0%
Gwalior	3	4	43%
Jodhpur	4	2	67%
Jaipur	76	11	87%
Jammu	13	5	72%
Kishangarh	0	1	0%
Ludhiana	0	1	0%
Leh	14	5	74%
Lucknow	73	4	95%
Pantnagar	3	1	75%
Suratgarh	1	0	100%
Shimla	1	2	33%
Srinagar	50	23	68%
Udhampur	0	1	0%



CHENNAI FIR (89%)*	Compliant	Non Compliant	% Compliant
HAL Bangalore	1	3	25%
Baldota Koppal	1	0	100%
Bengaluru	263	33	89%
Belgaum	3	0	100%
Vijayawada	25	5	83%
Coimbatore	59	1	98%
Kochi	92	8	92%
Calicut	1	0	100%
MOPA Goa	59	7	89%
Goa	153	17	90%
Hubli	9	0	100%
Shamsabad, Hyderabad	181	20	90%
Begumpet Hyderabad	3	3	50%
Vijaynagar	2	1	67%
Kannur	4	1	80%
Madurai	10	2	83%
Mangalore	29	2	94%
Chennai	164	20	89%
Port Blair	1	1	50%
Rajahmundry	2	0	100%
Sindhudurg	4	1	80%
Tiruchirappally	5	1	83%
Thiruvananthapuram	35	4	90%
Visakhapatnam	9	4	69%

*FIR wise compliance rate (decimals rounded off to nearest integer value).

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(86%) for the month are highlighted in red.



V. CTOT Compliance rate – Airlinewise

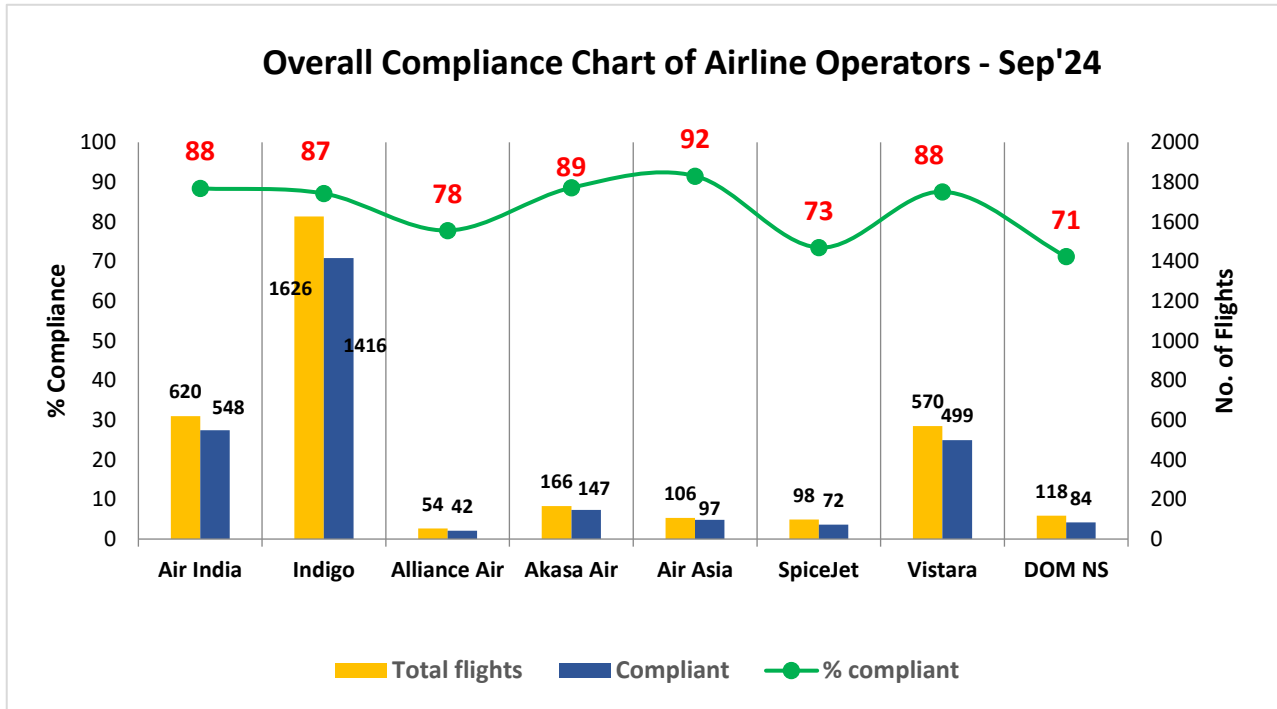


Figure 13: Airline wise Compliance –Sep’24

Inference

1. Chennai and Kolkata region record the highest compliance of 89% whereas Delhi region has the lowest percentage compliance of 83%.
2. Air India, Indigo, Akasa Air, Air Asia and Vistara Airlines have a CTOT compliance higher than the average recorded compliance for the month of September’24.

VI. Reason For Non Compliance

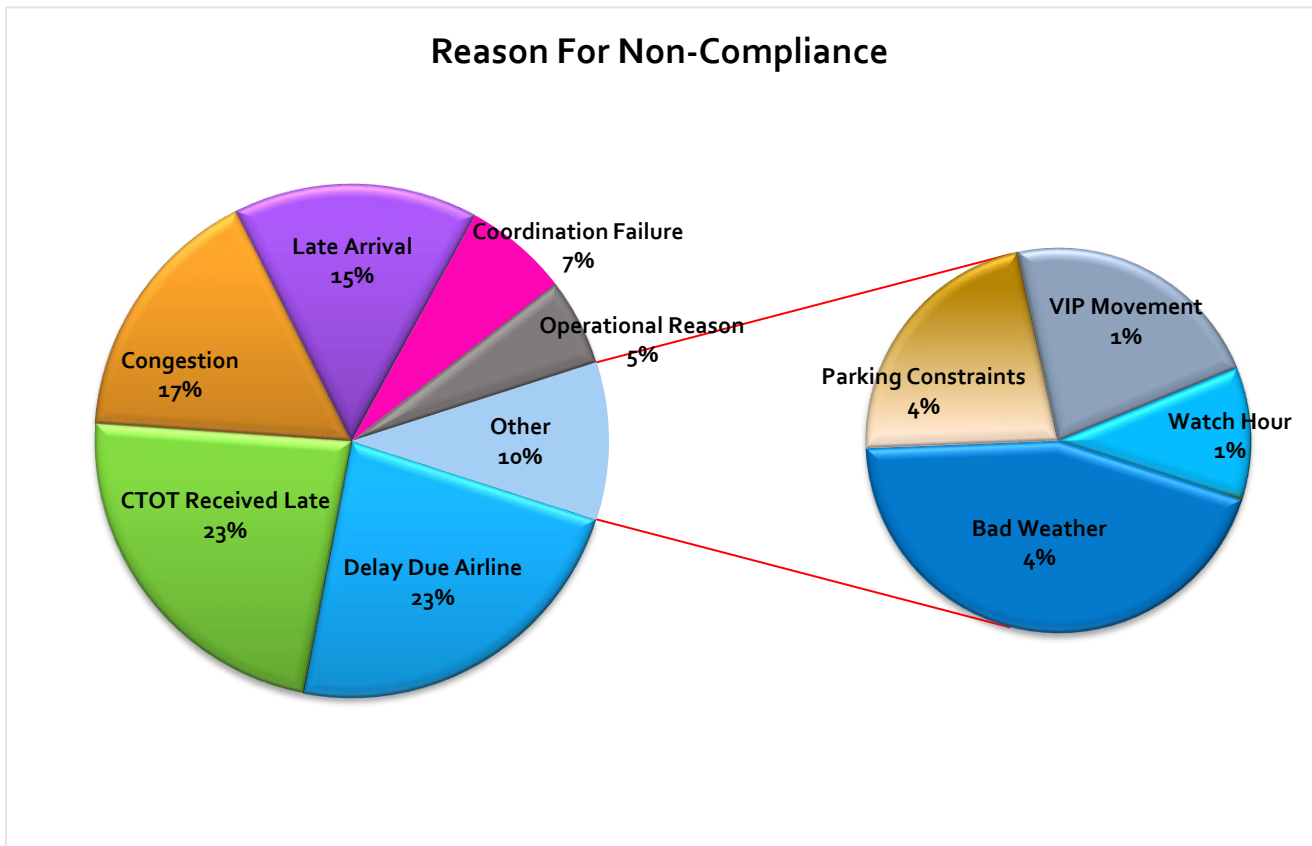


Figure 14: Reason for Non-Compliance as provided by FMPs

Inference:

1. 23 % of CTOT Non- Compliance was reported by concerned FMPs to be due to delay by Airlines.
2. 23 % 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. 17 % of the CTOT Non- compliance was reported to congestion at airports while 15% non -compliance was 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 Bengaluru, Chennai, Delhi and Mumbai was 8.0, 10.3, 10.9 and 10.6 minutes respectively.

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

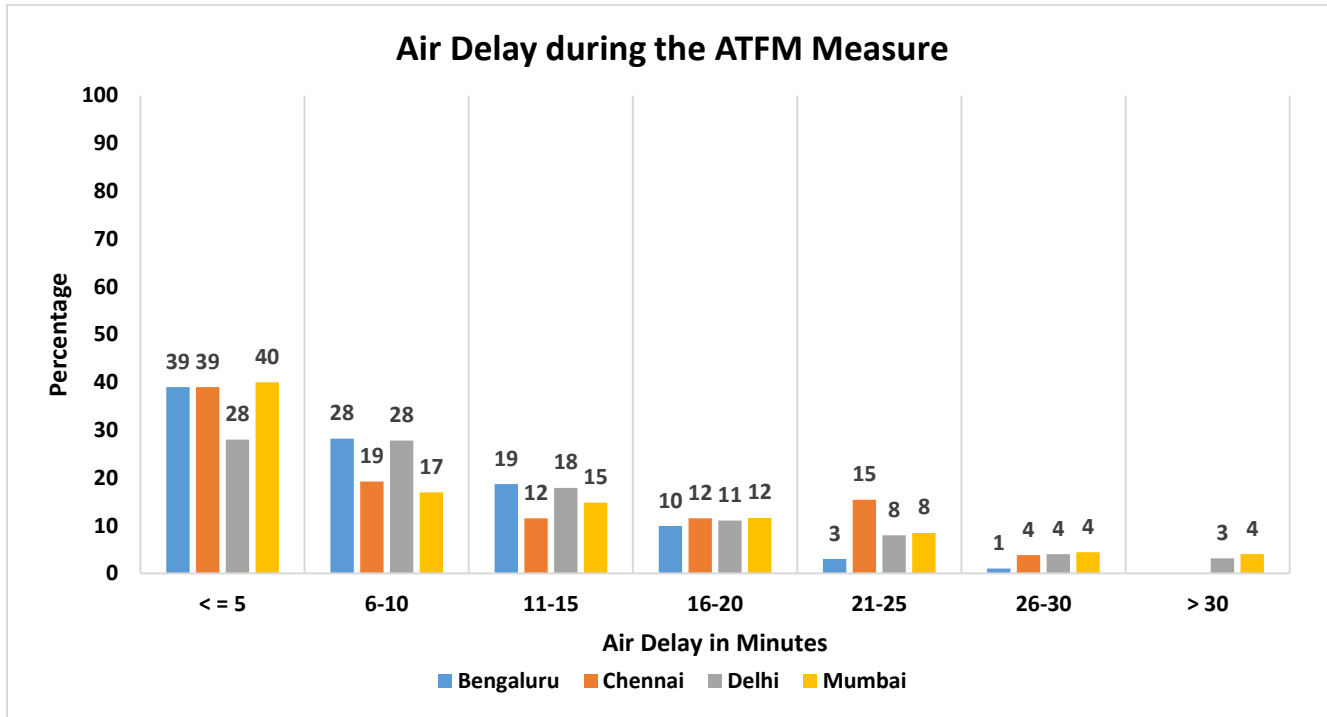


Figure 15: Air Delay distribution during the CDM period

Inference

1. 67% of domestic arriving flights to Bengaluru had an Air delay of equal to or less than 10 minutes during the CDM period.
2. 58% of domestic arriving flights to Chennai had an Air delay of equal to or less than 10 minutes during the CDM period.
3. 56% of domestic arriving flights to Delhi had an Air delay of equal to or less than 10 minutes during the CDM period.
4. 57% of domestic arriving flights to Mumbai 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)= 37258 mins

Total Air Delay (with no ATFM measures) = 75239 mins

Reduction in Air delay due to ATFM measures= (75239-37258) = **37981 mins**

Fuel Saving Calculation:

Total Fuel saved during the ATFM Measure: **22,73,537.67 Kg**

Total reduction in CO₂ emission : 3.16(KgCO₂/kg fuel)* 22,73,537.67 Kg = 71,84,379.04 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
<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)- September 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.

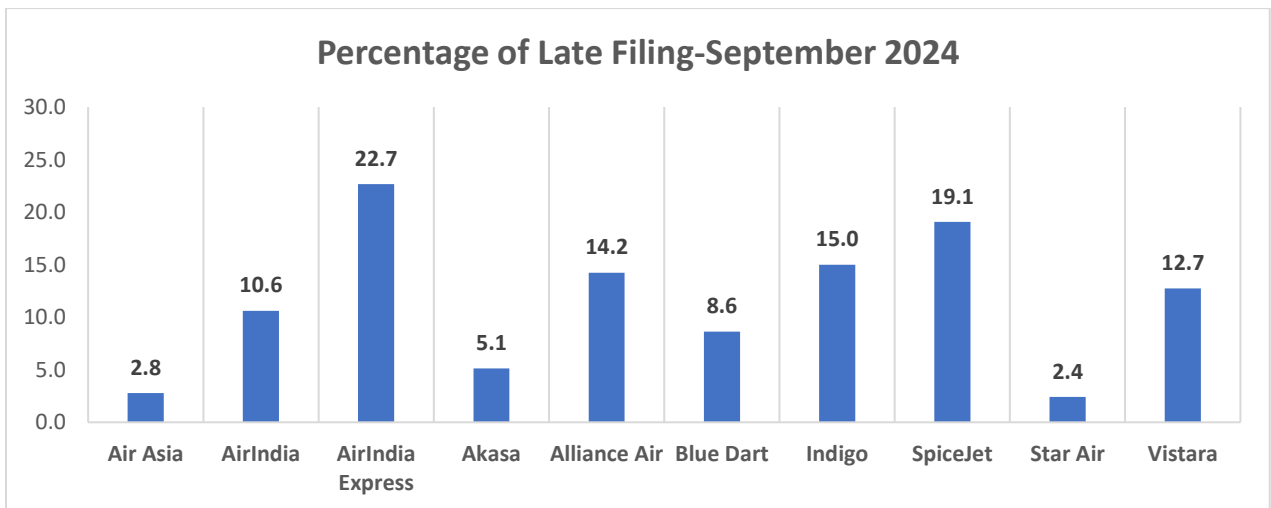
AIP India, ENR 1.9 section 4 on Flight Planning in the context of ATFM recommends Flight Planning requirements for all Airline Operators –

- 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 receipt time and filed EOBT for all the FPLs received at ATFM system from 1st September 2024 to 30th September 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:

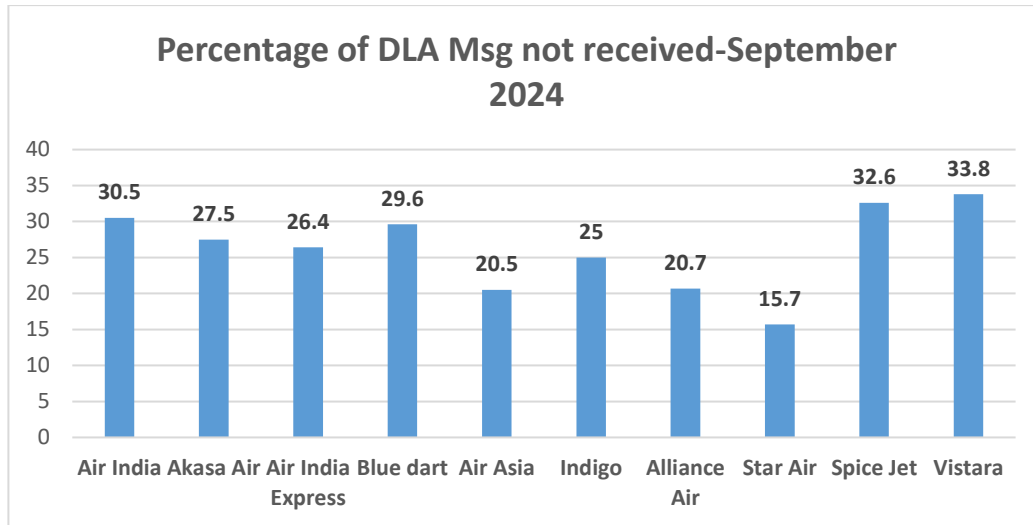
Name of Airline	Late Filed FPL	Total No. Of FPL	% Delayed Filing
Air Asia	105	3794	2.8
AirIndia	1512	14256	10.6
AirIndia Express	1866	8236	22.7
Akasa	200	3893	5.1
Alliance Air	309	2171	14.2
Blue Dart	54	625	8.6
Indigo	9524	63705	15.0
SpiceJet	618	3241	19.1
Star Air	28	1157	2.4
Vistara	1296	10170	12.7
Total no. of FPLs for Scheduled Airlines	15512	111248	13.9

Note: The figure shown above might be slightly elevated due to a technical issue, which caused the SKYFLOW System to receive AFTN messages with significant delays between 26th September, 1325 UTC, and 28th September, 0405 UTC.

- 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 September 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	3296	10801	30.5
Akasa Air	698	2538	27.5
Air India Express	1325	5019	26.4
Blue dart	156	527	29.6
Air Asia	504	2455	20.5
Indigo	12149	48679	25
Alliance Air	253	1224	20.7
Star Air	73	466	15.7
Spice Jet	496	1521	32.6
Vistara	2655	7857	33.8



Note: The figure shown above might be slightly elevated due to a technical issue, which caused the SKYFLOW System to receive AFTN messages with significant delays between 26th September 1325 UTC and 28th September, 0405 UTC.

- C. For analysis of non-receipt of CNL (cancel) messages for September 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.
- D. The table below lists the number of Flights for which no CNL Msg. was received in September 2024:

Name of Airline	CNL message not received	No. of flights annulled
Air India	19	87
Akasa Air	15	21
Air India Express	33	143
Blue dart	4	19
Air Asia	7	21
Indigo	152	390
Alliance Air	137	148
Star Air	48	70
Spice Jet	70	123
Vistara	76	118

-End of Report-