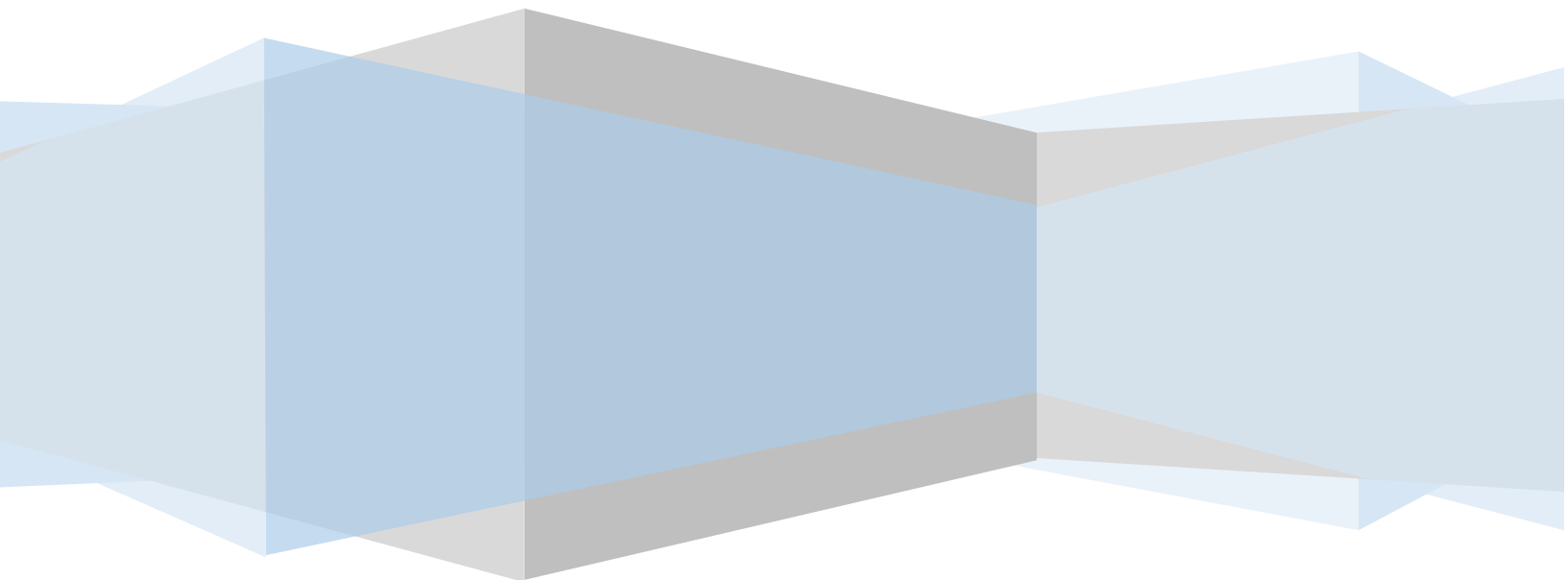


# POST OPERATIONS ANALYSIS REPORT

February, 2024

CENTRAL COMMAND CENTER, C-ATFM, DELHI







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## A. Executive Summary

Average Domestic air traffic has recorded a decrease of 12.7 % whereas the average international air traffic has increased by 6.8% in the month of Feb'24 as compared to Jan'24.

*(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 4444 IFR flights per day in the month of February 2024. The peak day was on 23<sup>rd</sup> February 2024 (4573 IFR flights). Friday's were the busiest days throughout this month with an average of 4502 IFR flights per day.

Total Fifty Nine (59) ATFM measures were applied this month during periods of congestion at Delhi, Chennai and Mumbai Airport.

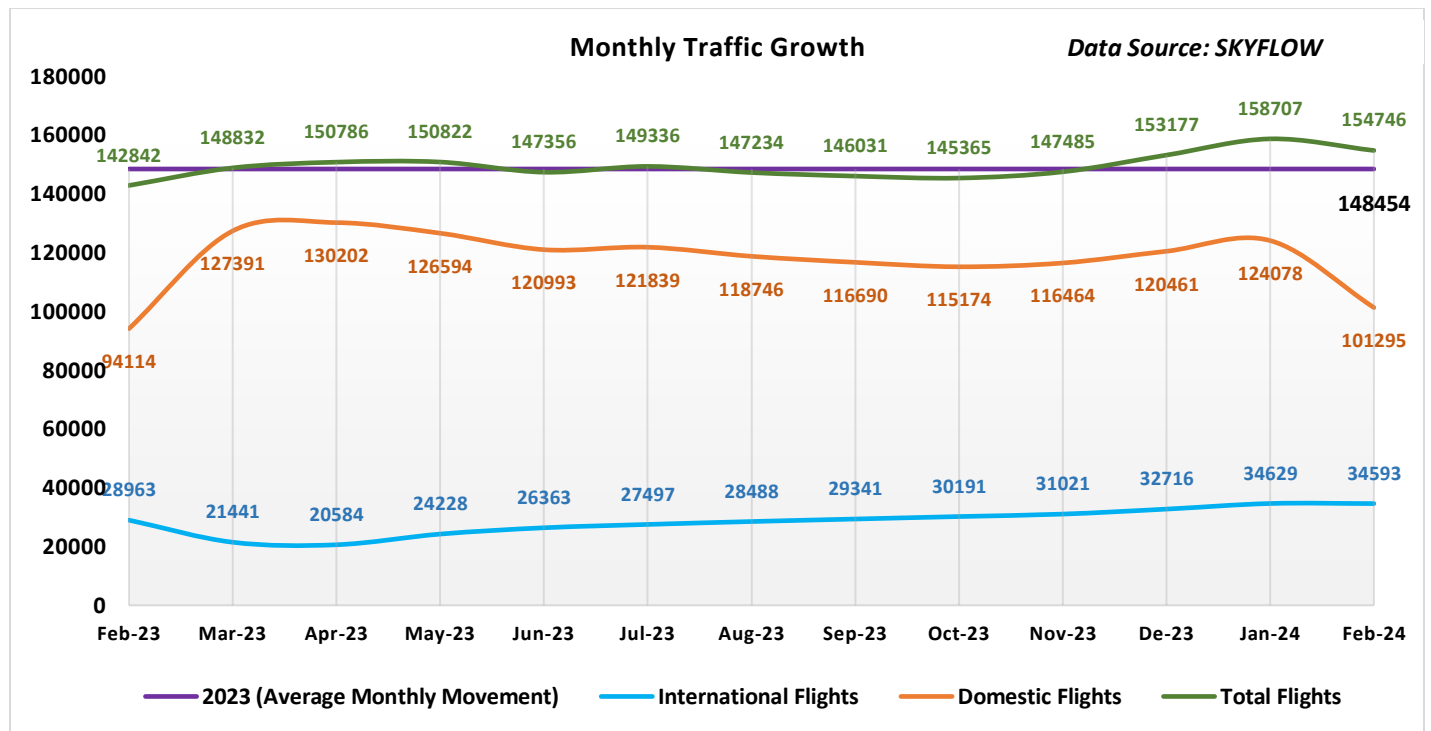


Figure 1: Monthly Traffic Growth

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



## B. Traffic Analysis

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

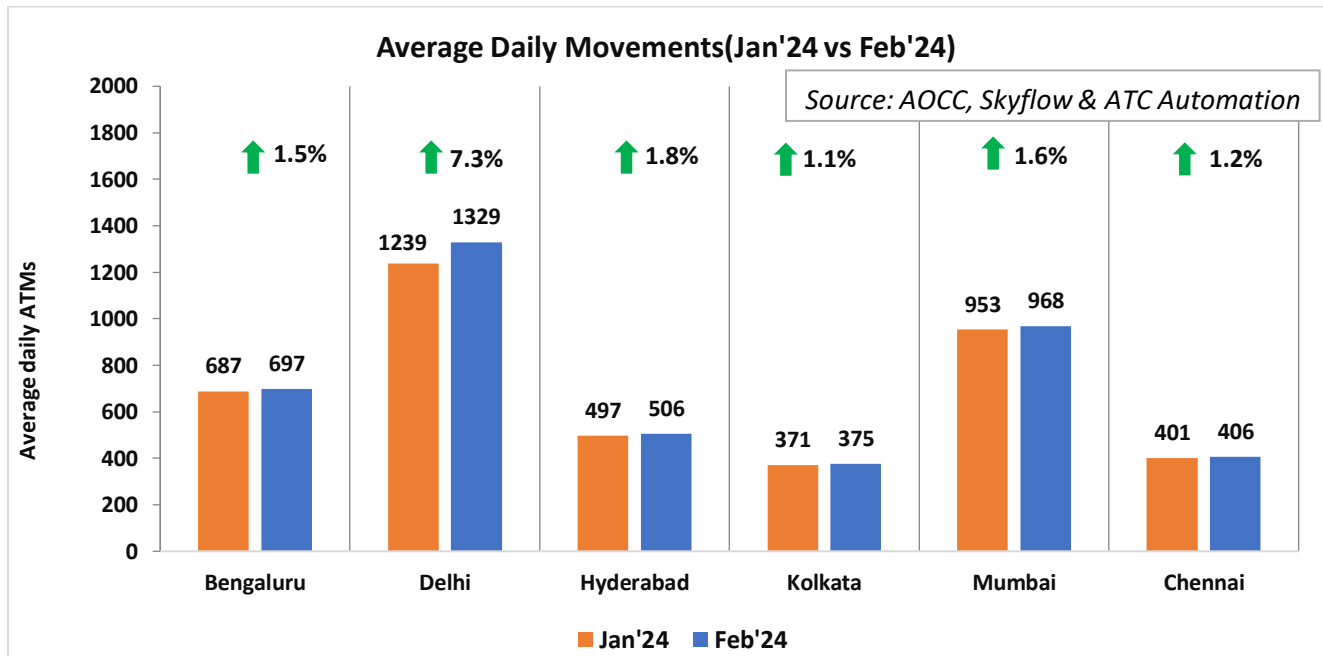


Figure 2: Average Daily Movements ( Jan '24 vs Feb'24 )

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

Airports\Year	Avg. Daily ATMs (YoY) for six major airports				
	Feb'20	Feb'21	Feb '22	Feb'23	Feb'24
Bengaluru	681	495	390	678	697
Delhi	1414	995	1006	1306	1329
Hyderabad	533	357	324	486	506
Kolkata	485	331	285	392	375
Mumbai	843	588	604	936	968
Chennai	502	311	265	411	406



Air Traffic Movement for each day in Feb'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.

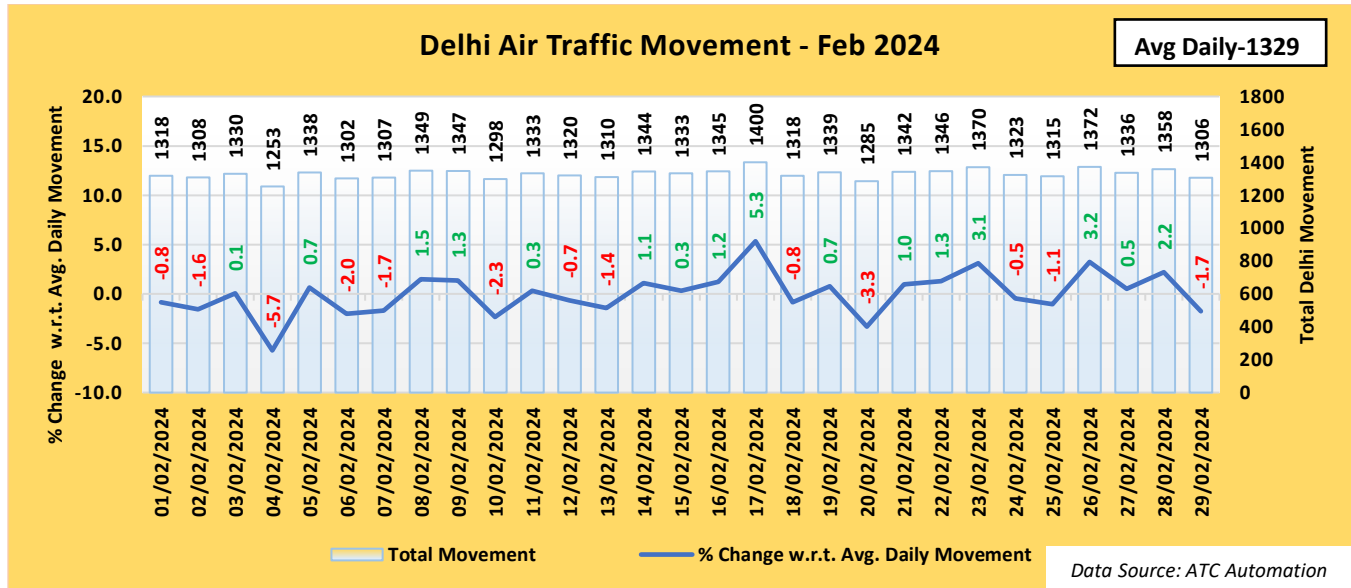


Figure 3: Air Traffic Movement for Delhi –Feb 2024

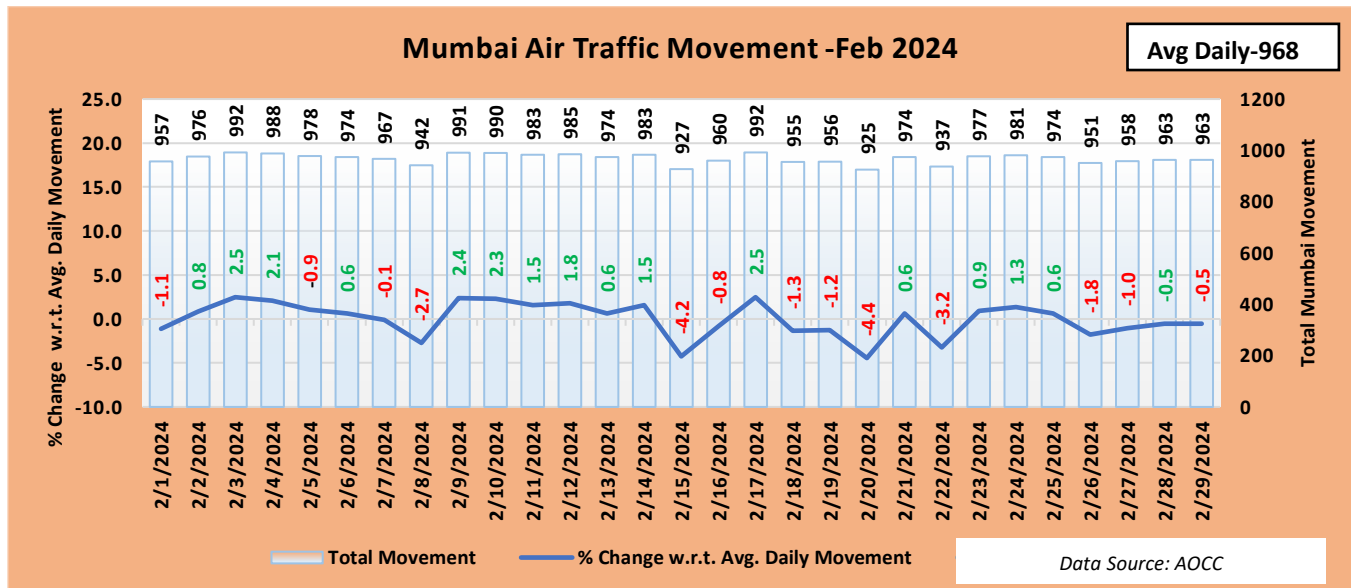


Figure 4: Air Traffic Movement for Mumbai - Feb 2024

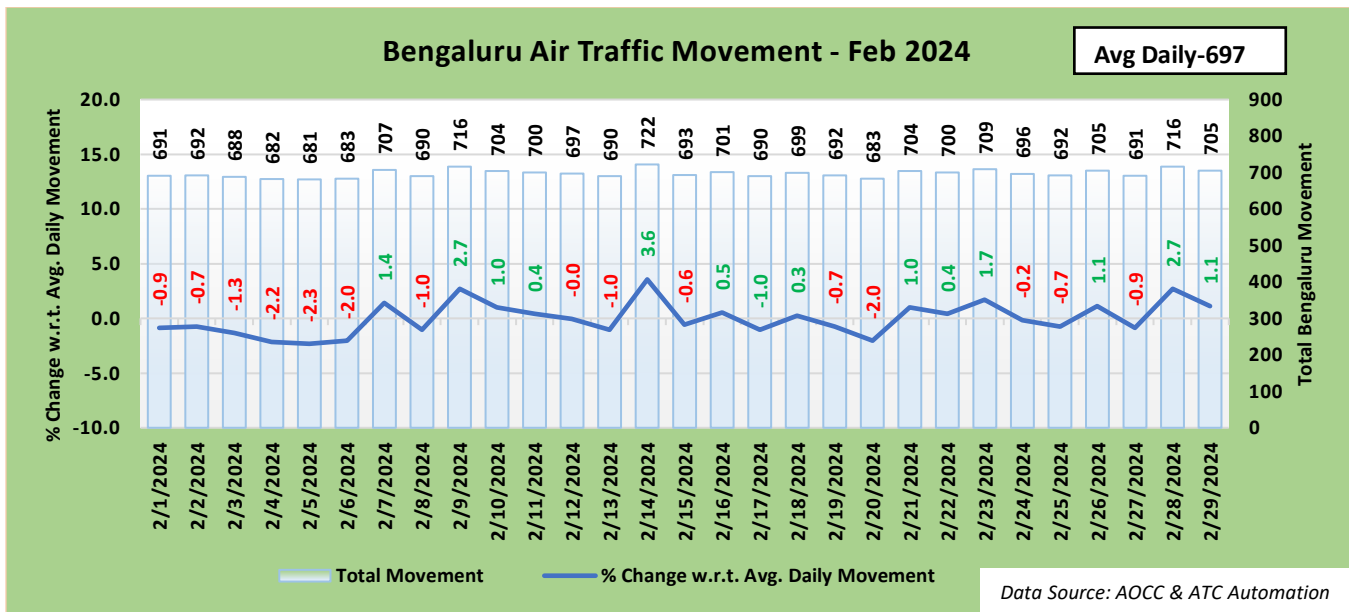


Figure 5: Air Traffic Movement for Bengaluru – Feb 2024

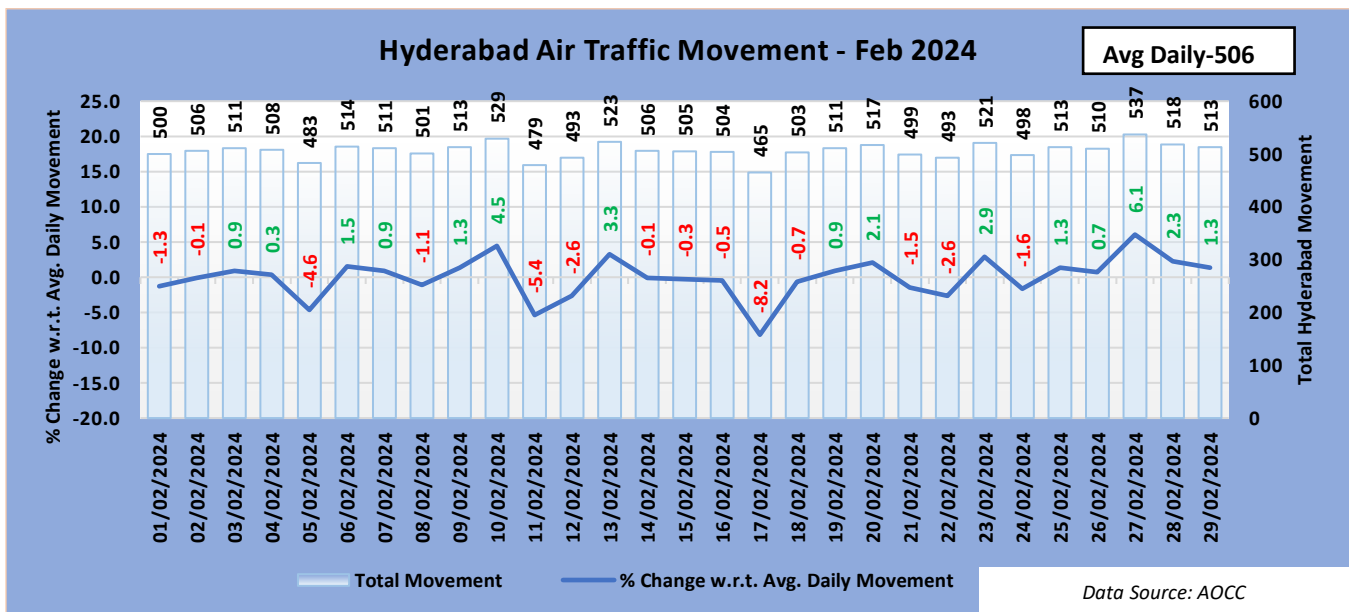


Figure 6: Air Traffic Movement for Hyderabad - Feb 2024

It can be concluded from the above charts that on 29<sup>th</sup> Feb 2024 (month end), the ATM at Bengaluru and Hyderabad saw an increase of 1.1%, 1.3%, respectively whereas the ATM at Delhi and Mumbai saw a decline of 1.7% and 0.5% respectively in comparison to the average daily movement for Feb'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 February 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.

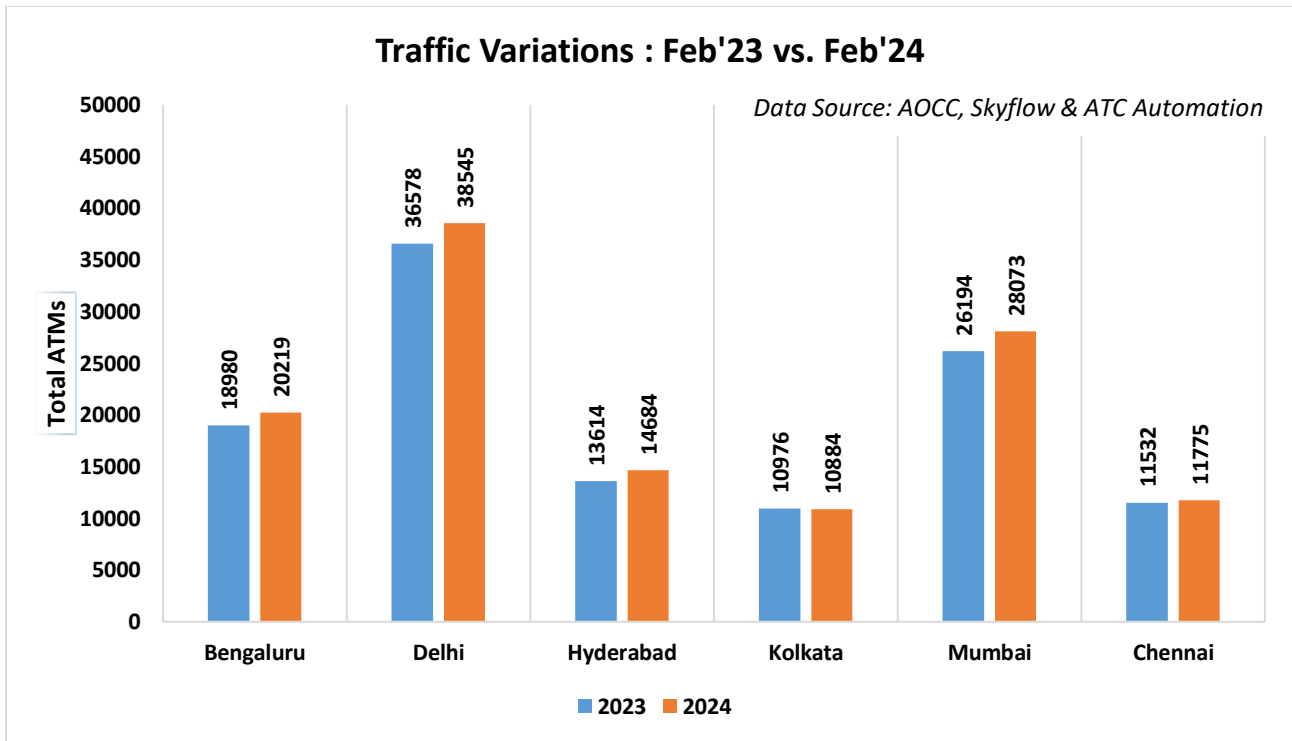


Figure 7: Traffic Variation (YoY)



### III. Flight Operations – Airlinewise

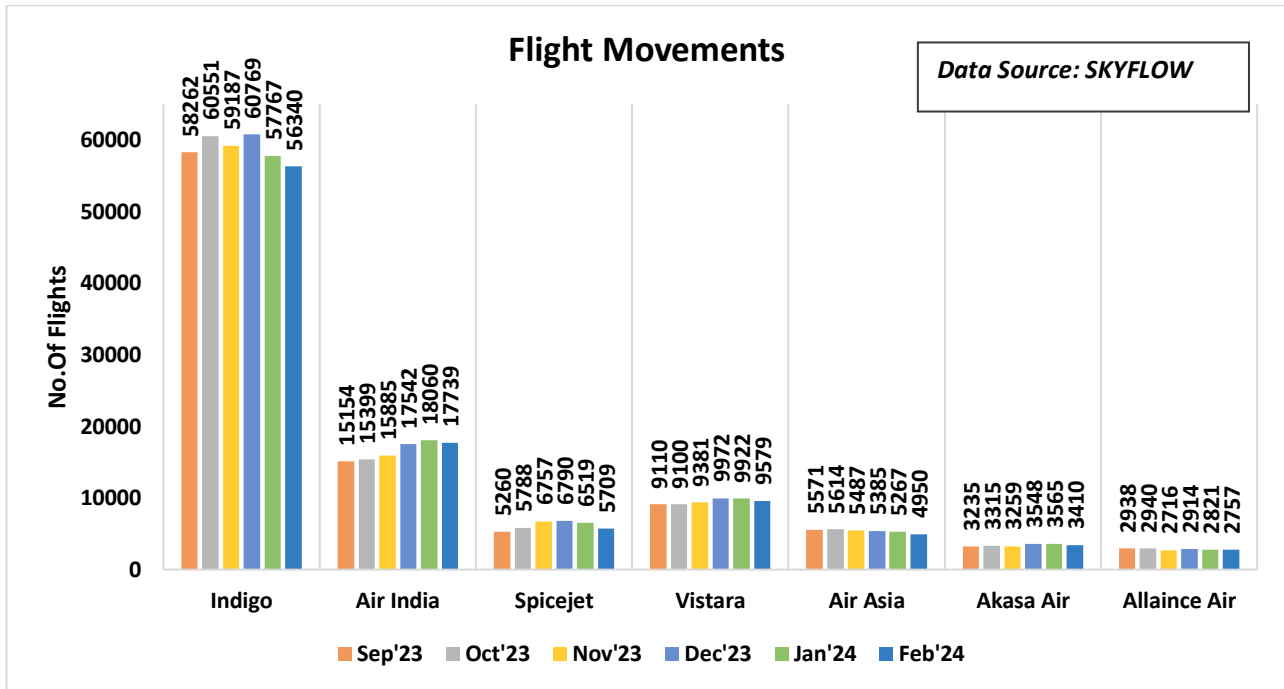


Figure 8: Flight Movements –Airlinewise

#### Inference:

1. Indigo, Air India, Vistara, Air Asia, Akasa and Alliance air Airlines have recorded an increase in the monthly average Flight movement in Feb'24( 29 days) as compared to Jan'24(31 days) while Spicejet Airline has recorded a decline during the same period.



## C. ATFM Post Operations – CDM Analysis

### I. Introduction

**Analysis Period** 1<sup>st</sup> – 29<sup>th</sup> February 24

**Back Ground** During the above mentioned period, **Eight (08)** ATFM measures were applied for **Delhi Airport**, **Forty Seven (47)** ATFM measures were applied for **Mumbai Airport** and **Four (04)** ATFM measures were applied for **Chennai airport** due to the following reasons as illustrated in the bar chart below:-

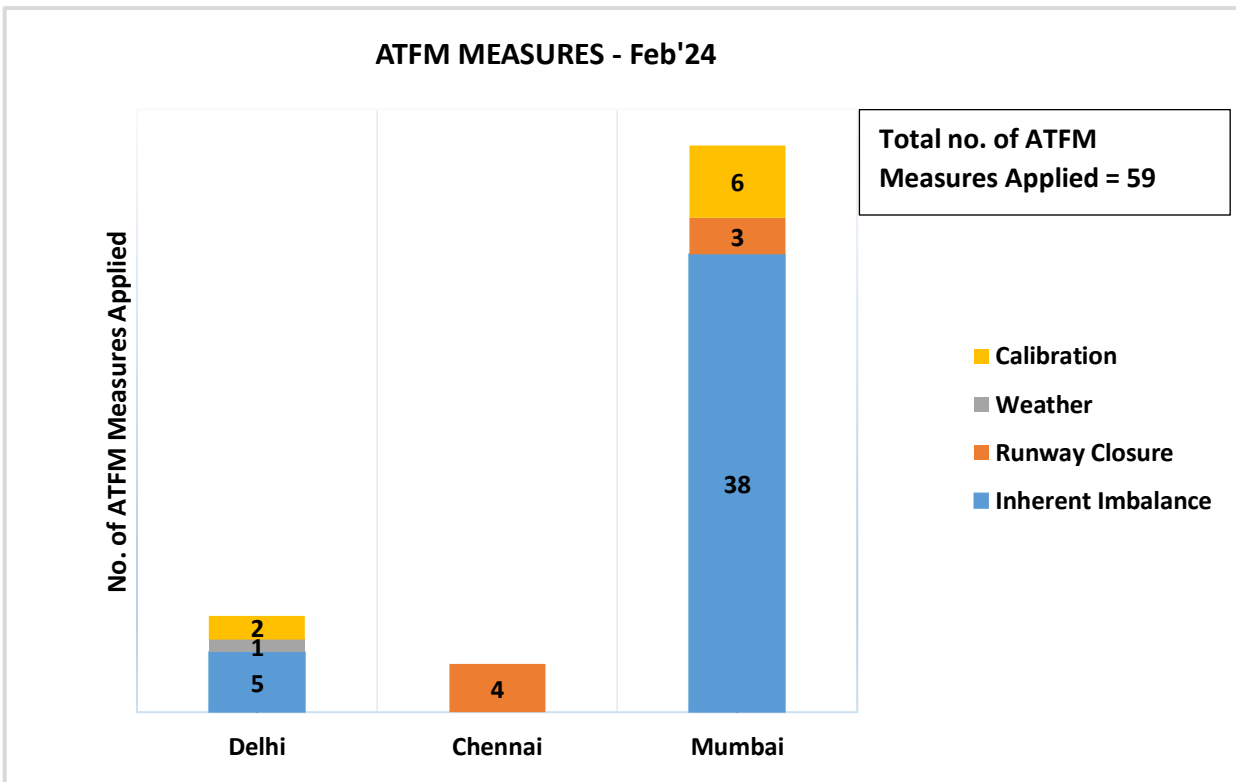


Figure 9: ATFM Measures –Feb’24



## II. ATFM Measures Overview

Constrained Airport	Delhi	Mumbai	Chennai
Number of ATFM measures applied	8	47	4
Average ATFM Ground delay(in min) due to measures*	35.8	28.9	21.2
Maximum ATFM Ground delay(in min) due to measures	114	94	41
% Compliance	59.3	86.3	77.6

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

Total Arrivals	4592
Total International Arrivals(exempted)	1107
Total affected flights in scenario (Domestic Arrivals)	3485
Total Domestic Arrivals with zero ATFM delay	218
Total Domestic Arrivals with ATFM delay	3267

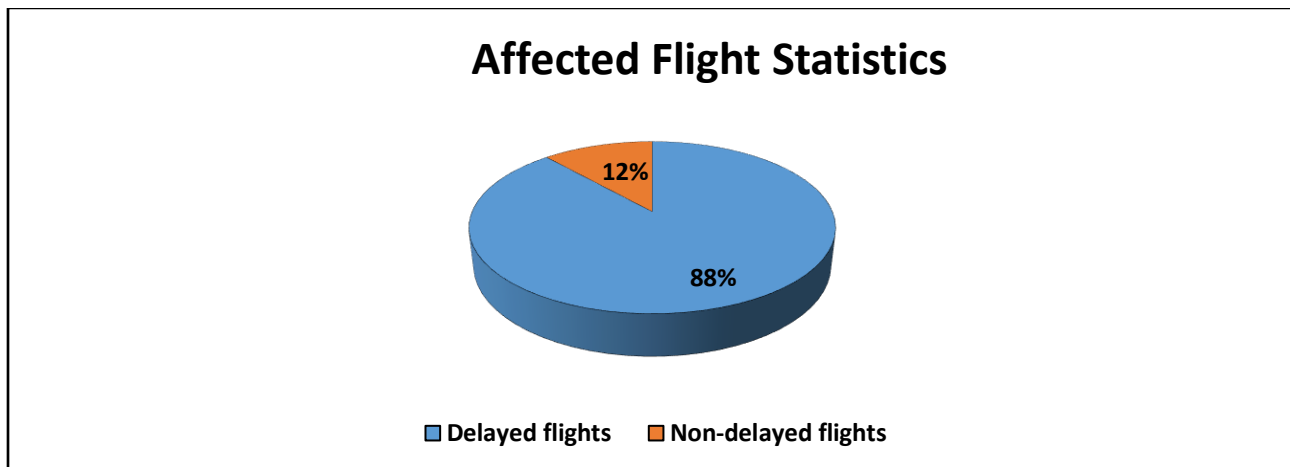


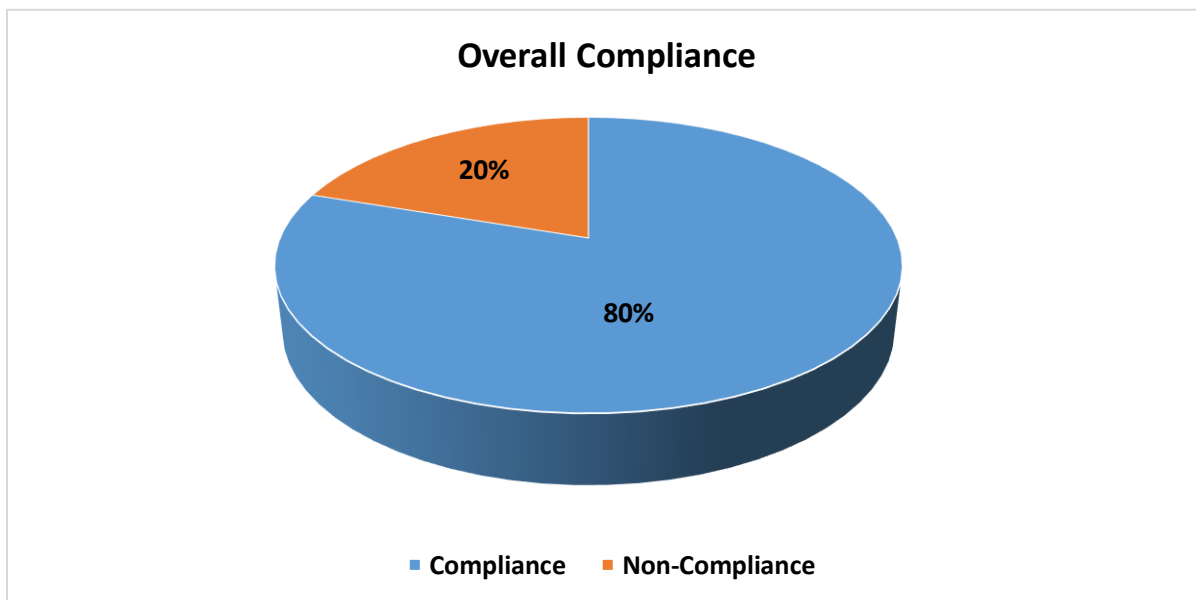
Figure 10: Affected Flight Statistics –Feb'24



### III. Overall Compliance

<b>Total arrivals</b>	4592
<b>Domestic arrivals</b>	3485
<b>Flights with complete data (ATOT)</b>	3389
<b>Flights with incomplete data</b>	17
<b>Flights Not Operated</b>	79
<b>Compliant*</b>	2716
<b>Non-Compliant</b>	673

\*Total No. of Revised CTOTs issued = 1001 (Compliance calculation for flights which were issued revised CTOT is w.r.t. new CTOT issued)



**Figure 11: Overall Compliance – Feb’24**

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

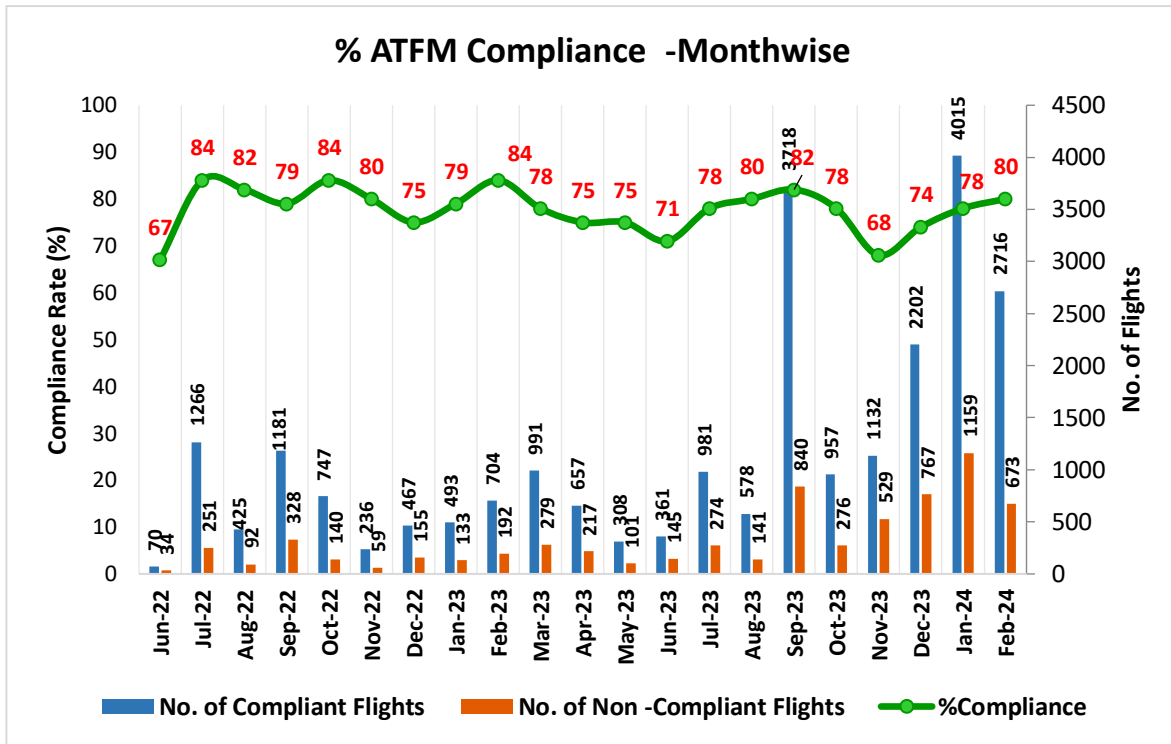


Figure 12: Compliance(Monthwise)

### Inference

1. Out of the total arrivals captured(4592 flights) during the CDM scenario for the constrained Airports, 75.9% of flights i.e. domestic arrivals(3485 flights) were candidates for ground delay(participating).
2. Out of these Domestic Arrivals(3485), 93.7% (3267 flights) are assigned ATFM ground delay.
3. Out of the total arrivals captured(4592 flights) to the constrained Airport during the ATFM scenario, only 71.1% of flights(3267 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	100	15	87%
Aurangabad	6	2	75%
Mumbai	56	26	68%
Bhuj	1	0	100%
Vadodara	18	6	75%
Bhopal	38	5	88%
Bhavnagar	4	2	67%
Diu	5	2	71%
Hirasar	16	1	94%
Indore	48	12	80%
Jabalpur	6	0	100%
Jamnagar	27	15	64%
Kandla	2	1	67%
Kolhapur	3	0	100%
Mundra	57	8	88%
Nasik	0	3	0%
Pune	11	10	52%
Porbandar	0	1	0%
Shirdi	6	0	100%
Surat	2	5	29%
Udaipur	30	6	83%
<b>KOLKATA FIR (77%)*</b>	<b>Compliant</b>	<b>Non Compliant</b>	<b>% Compliant</b>
Prayagraj	2	5	29%
Agartala	0	1	0%
Ayodhya	10	4	71%
Bagdogra	23	10	70%
Shillong	1	0	100%
Varanasi	37	12	76%
Bhubaneswar	51	9	85%
Kolkata	130	30	81%
Chakeri	3	1	75%
Durgapur	2	1	67%



Darbhanga	3	1	75%
Gorakhpur	13	6	68%
Guwahati	39	14	74%
Gaya	4	0	100%
Imphal	0	1	0%
Jharsuguda	1	2	33%
Jamshedpur	1	0	100%
Uttar Satali	1	1	50%
Khajuraho	1	1	50%
Aizawl	0	1	0%
Dibrugarh	4	1	80%
Patna	45	12	79%
Ranchi	9	7	56%
Raipur	36	7	84%
<b>DELHI FIR (74%)*</b>	<b>Compliant</b>	<b>Non Compliant</b>	<b>% Compliant</b>
Agra	1	2	33%
Amritsar	29	16	64%
Bikaner	0	2	0%
Bhuntar	0	1	0%
Bathinda	0	2	0%
Bareilly	2	0	100%
Chandigarh	35	19	65%
Dehradun	11	6	65%
Delhi	380	62	86%
Kangra	5	4	56%
Gwalior	4	6	40%
Jodhpur	4	10	29%
Jaipur	77	9	90%
Jaisalmer	6	4	60%
Jammu	15	9	63%
Leh	10	13	43%
Lucknow	66	23	74%
Pantnagar	0	2	0%
Shimla	0	2	0%
Sarsawa Air Force Station	0	1	0%
Srinagar	23	37	38%





CHENNAI FIR (86%)*	Compliant	Non Compliant	% Compliant
Hal Bangalore	3	4	43%
Baldota koppal	0	1	0%
Bangalore	313	32	91%
Belgaum	7	2	78%
Bidar	0	1	0%
Vijayawada	6	1	86%
Coimbatore	67	5	93%
Kochi	103	4	96%
Calicut	14	0	100%
MOPA Goa	80	7	92%
Goa	109	33	77%
Hubli	2	4	33%
Hakimpet	1	0	100%
Hyderabad	185	34	84%
Begumpet Hyderabad	3	1	75%
Kannur	5	0	100%
Madurai	14	4	78%
Manglore	37	5	88%
Chennai	185	34	84%
Port Blair	6	2	75%
Salem	1	0	100%
Sindhudurg	1	0	100%
Sulur	1	0	100%
Tuticorin	0	1	0%
Tirupati	0	1	0%
Tiruchirappally	12	5	71%
Thiruvananthapuram	40	5	89%
Visakhapatnam	4	7	36%

\*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(80%) for the month are highlighted in red.



### V. CTOT Compliance rate – Airlinewise

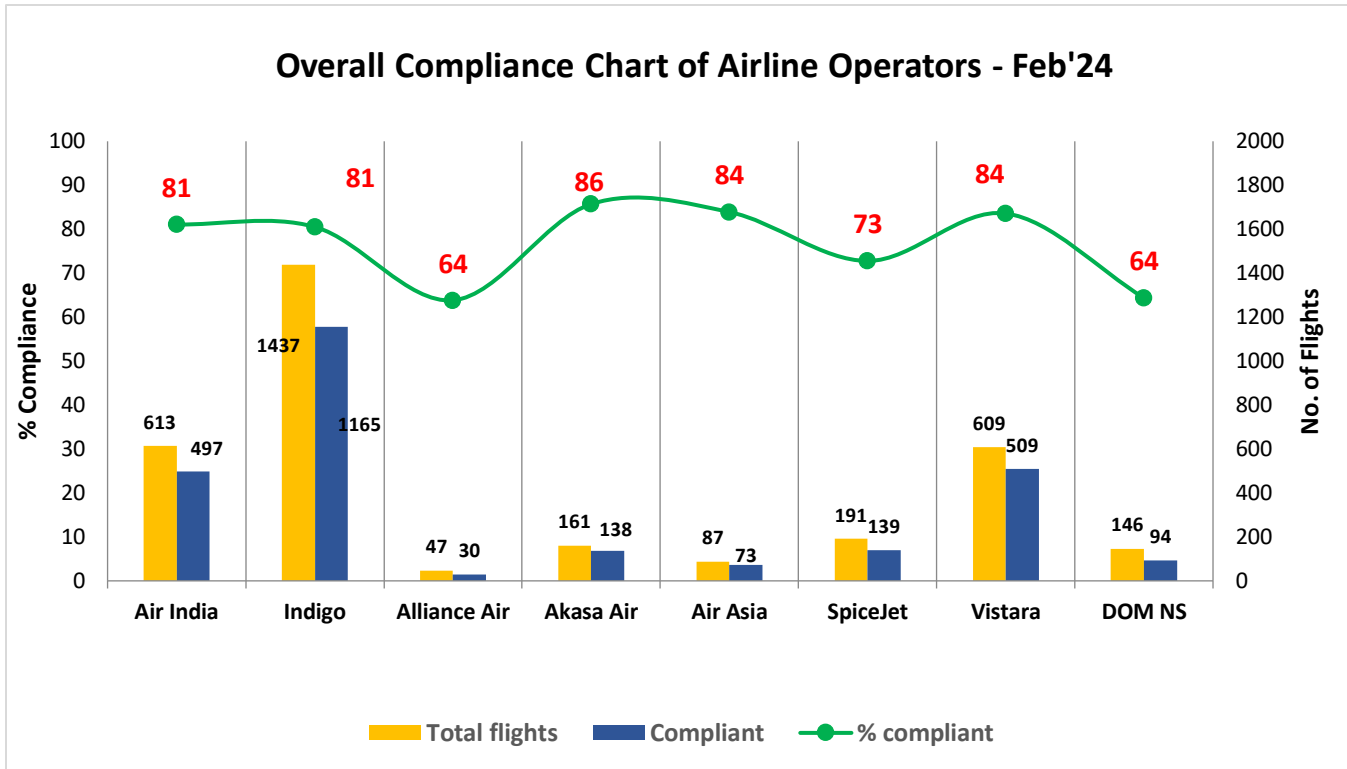


Figure 13: Airline wise Compliance –Feb’24

#### Inference

1. Out of the total domestic arrivals with complete data in the CDM scenario, 80 % arrivals are compliant.
2. Chennai region record the highest compliance of 86% whereas Delhi region has the lowest percentage compliance of 74%.
3. Indigo(1165 Out Of 1437),Air India, Akasa Air, Air Asia and Vistara Airlines have a CTOT compliance higher than the average recorded compliance for the month of Feb’24.



## VI. Reason For Non Compliance

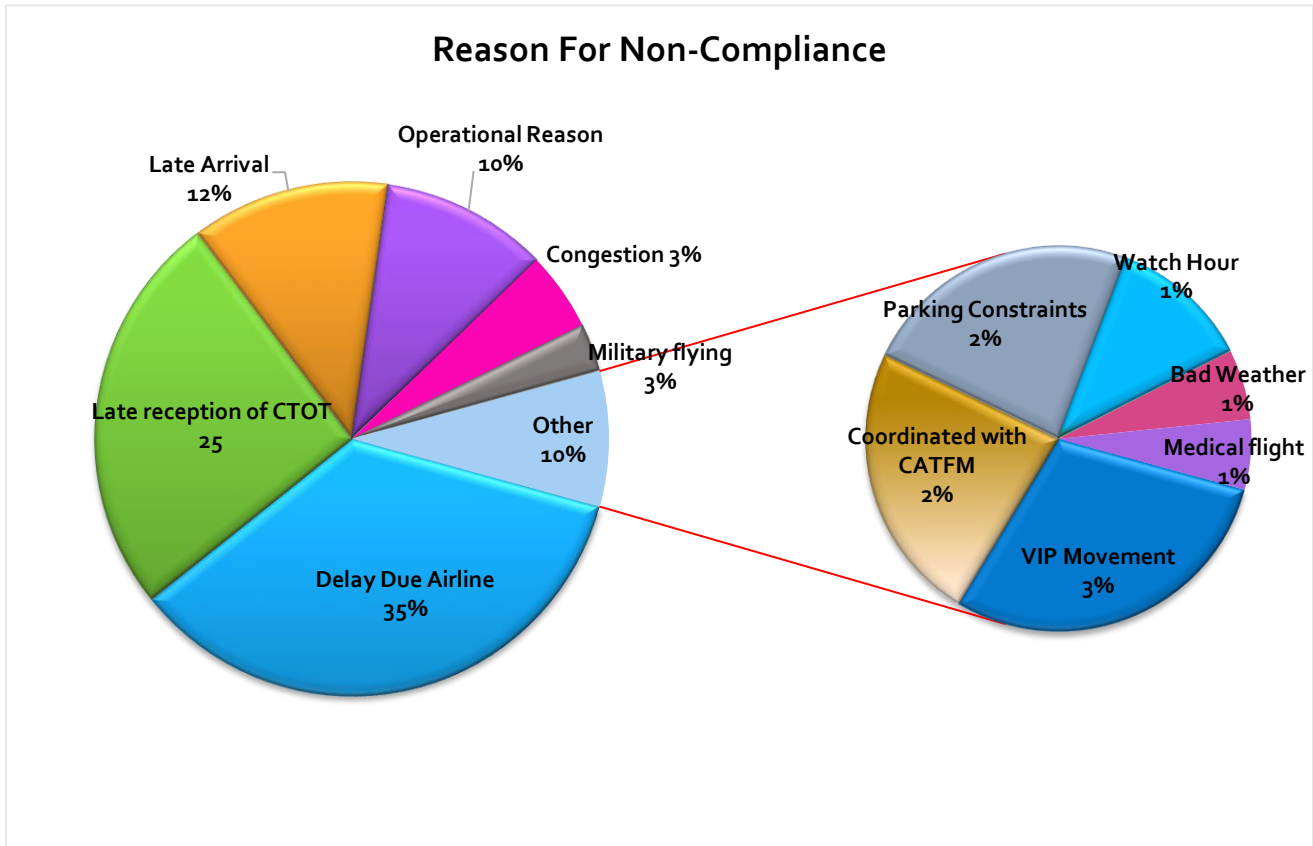


Figure 14: Reason for Non-Compliance as provided by FMPs

### Inference:

1. 35 % of CTOT Non- Compliance was reported by concerned FMPs to be due to delay by Airlines.
2. 25% 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 and Chennai was 9.8, 12.5 and 6.3 minutes respectively.

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

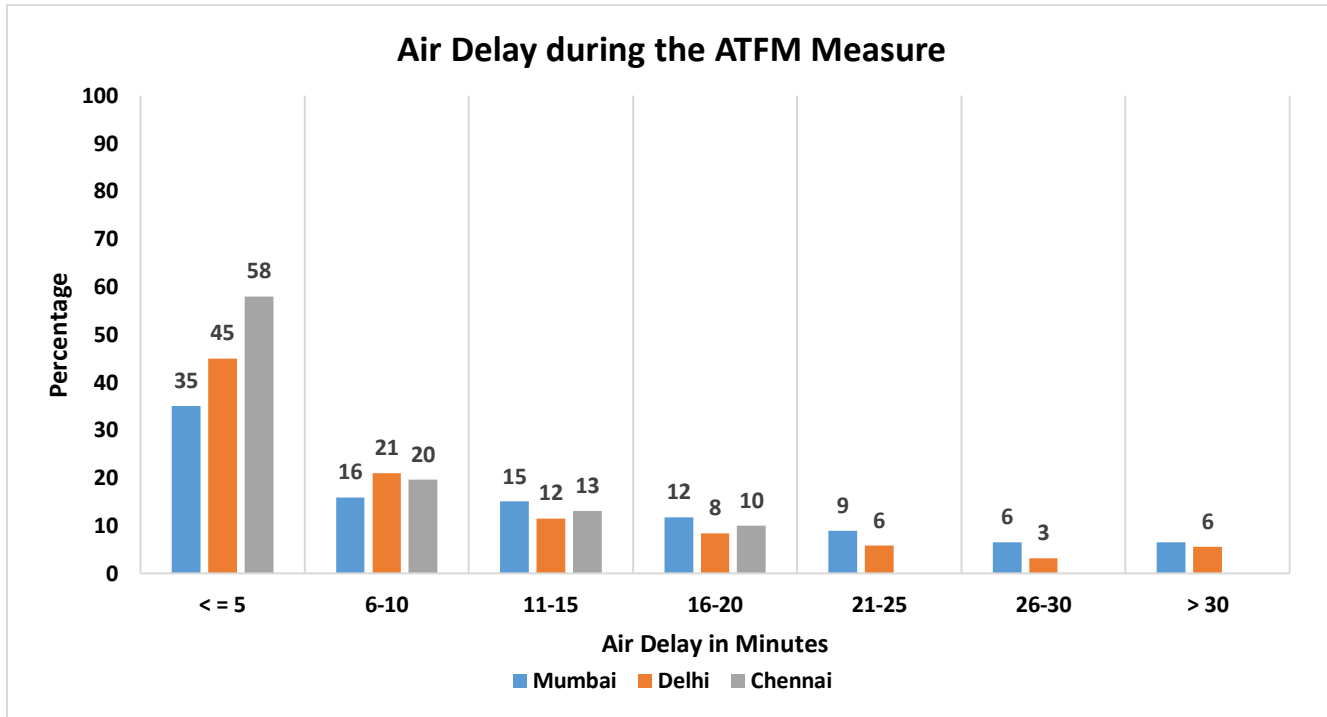


Figure 15: Air Delay distribution during the CDM period

### Inference

1. 51% of domestic arriving flights to Mumbai had an Air delay of equal to or less than 10 minutes during the CDM period.
2. 66% of domestic arriving flights to Delhi had an Air delay of equal to or less than 10 minutes during the CDM period.
3. 78% of domestic arriving flights to Chennai 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)= 45103 mins

Total Air Delay (with no ATFM measures) = 88486 mins

Reduction in Air delay due to ATFM measures= (88486-45103) = **43383 mins**

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

Total Fuel saved during the ATFM Measure: **24,57,938.19 Kg**

**Total reduction in CO<sub>2</sub> emission : 3.16(KgCO<sub>2</sub>/kg fuel) \* 24,57,938.19 Kg = 77,67,084.68Kg**

*\*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>	<b><i><math display="block">\frac{\text{Total monthly ATFM delay (in minutes)}}{\text{Total Domestic Arrivals}}</math></i></b>
<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> <p><b><i>Average Air Delay</i></b>  <b><i><math display="block">= \frac{\text{Total Air Delay to domestic arrivals (with values greater than zero)}}{\text{Total Domestic Arrivals}}</math></i></b></p> <p><i>CLDT: Calculated Landing Time</i>  <i>CTOT: Calculated Take off Time</i>  <i>ALDT: Actual Landing Time</i>  <i>ATOT: Actual Take off Time</i></p>



## Annexure-A

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

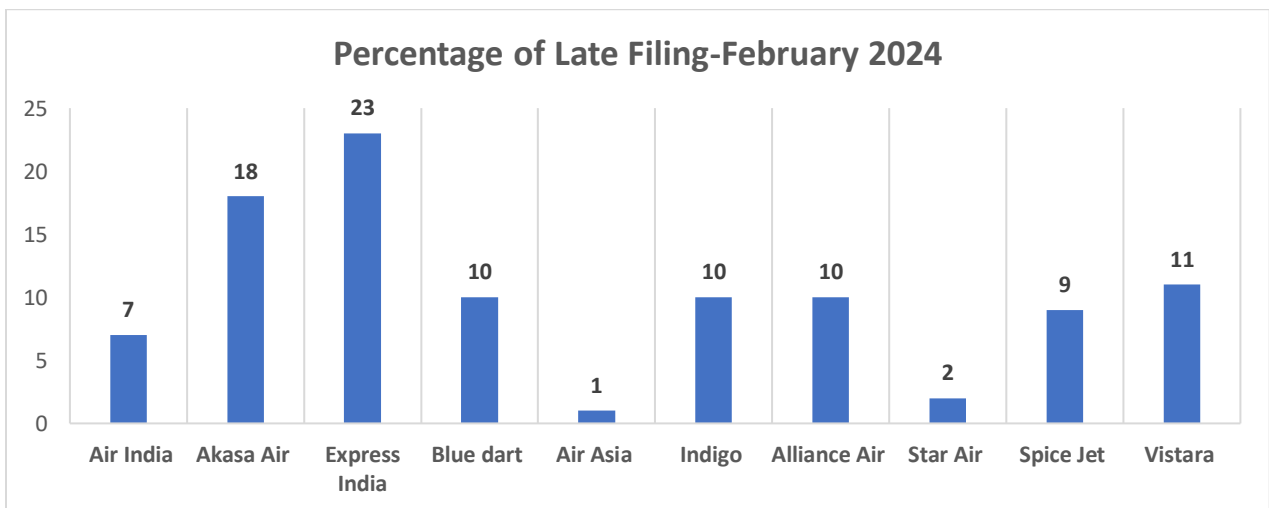
AIP India, ENR 1.9 section 4 on Flight Planning in the context of ATFM recommends Flight Planning requirements for all Airline Operators –

- “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> February 2024 to 29<sup>th</sup> February 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.





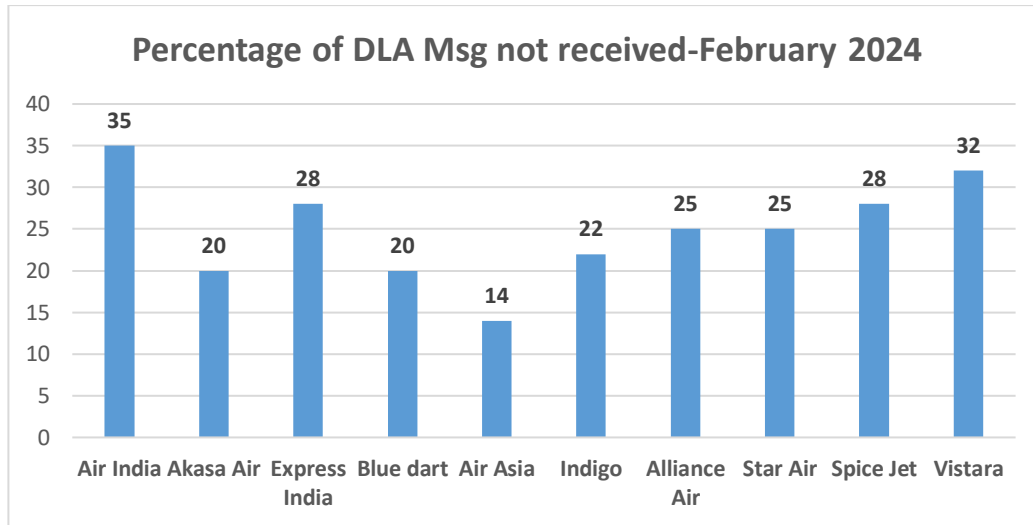
The table below lists number of filed flight plans (FPLs) with less than 3 Hours prior to EOBT:

Name of Airline	Late Filed FPL	Total No. Of FPL	% Delayed Filing
Air India	976	13536	7
Akasa Air	606	3405	18
Express India	1273	5497	23
Blue dart	63	633	10
Air Asia	40	5335	1
Indigo	5610	56896	10
Alliance Air	302	2907	10
Star Air	19	1035	2
Spice Jet	543	5967	9
Vistara	1066	9826	11
<b>Total no. of FPLs for Scheduled Airlines</b>	<b>10498</b>	<b>105037</b>	<b>10</b>

- 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 February 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	3342	9491	35
Akasa Air	490	2432	20
Express India	975	3472	28
Blue dart	101	497	20
Air Asia	489	3502	14
Indigo	9573	43622	22
Alliance Air	426	1737	25
Star Air	111	438	25
Spice Jet	975	3467	28
Vistara	2379	7409	32



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

Name of Airline	CNL message not received	No. of flights annulled
Air India	92	182
Akasa Air	0	10
Express India	21	70
Blue dart	5	9
Air Asia	26	40
Indigo	60	343
Alliance Air	6	173
Star Air	4	16
Spice Jet	31	162
Vistara	3	15

-X-