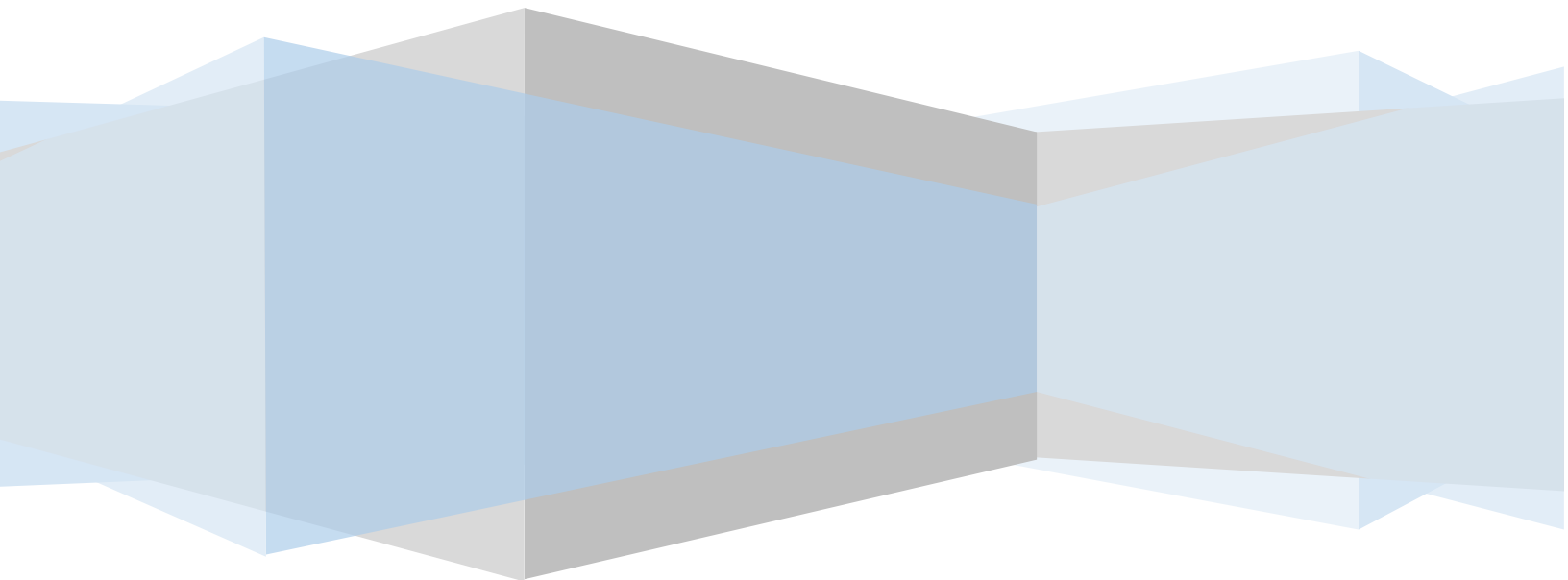


POST OPERATIONS ANALYSIS REPORT

August, 2022

CENTRAL COMMAND CENTER, C-ATFM, DELHI







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A. Executive Summary

Domestic and international air traffic* (as logged by data received by ATFM unit) is estimated to have recorded a 5 % and 10% increase respectively in the month of August 2022 as compared to July'22.

On average, the Indian Airports in the ATFCM area saw 3680 IFR flights per day. The peak day was on 12th August'22 (3973 IFR flights). Tuesday's were the busiest days throughout this month with an average of 3902 flights per day.

Twelve (12)ATFM measures were applied this month for Delhi and Mumbai Airport during periods of congestion.

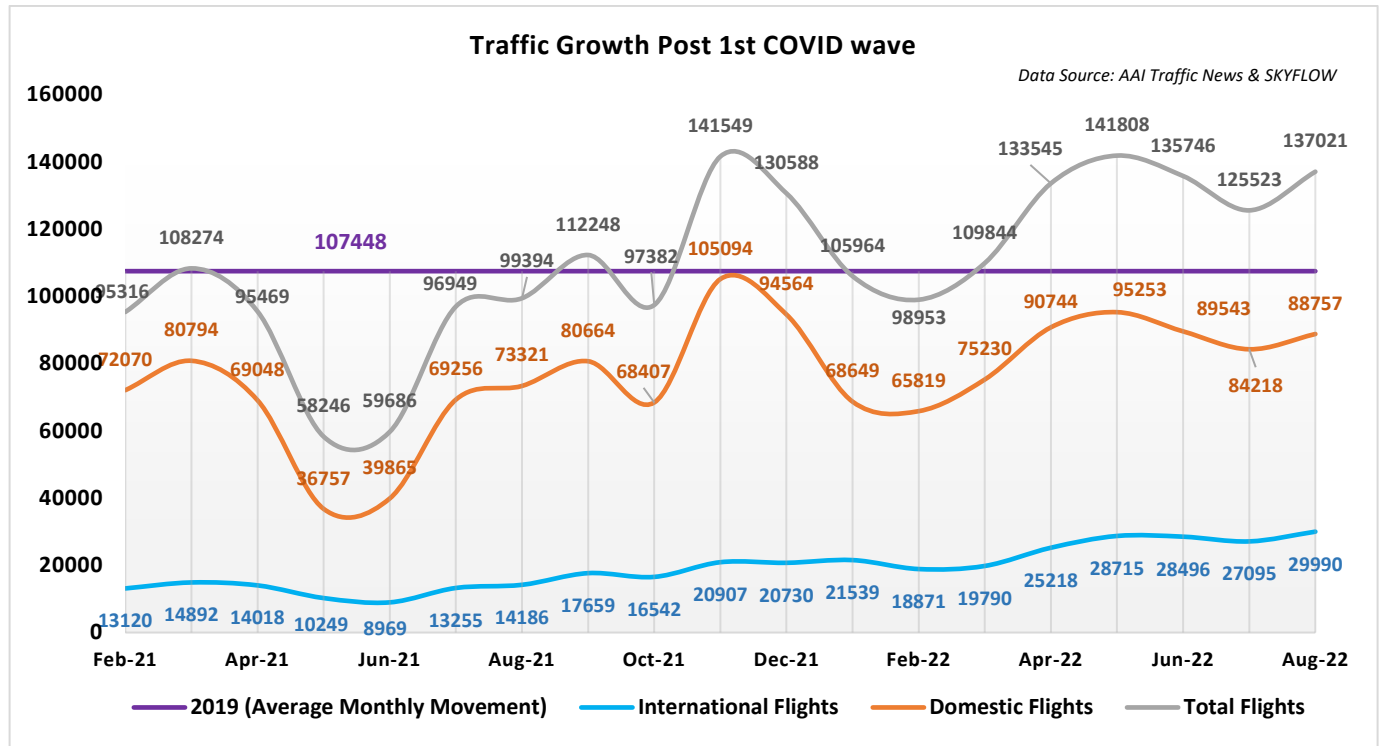


Figure 1: Traffic Growth Post 1st COVID wave

Note: Due to ongoing technical issue, many AFTN messages were not received in SKYFLOW system. Data captured for the whole month is less than the actual movement in Indian Airspace.

*Due to the misinterpretation of AIP Supplement 81/2022, international flights stopped sending flight plans.

The graph above depicts the Domestic and international Air traffic in Indian ATFCM Area during the last 19 months (Jan' 2021 to Aug'2022). The traffic demand is visibly impacted by the Covid-19 infections through out the period.



B. Traffic Analysis

I. Air Traffic Movement at Major Airports in India

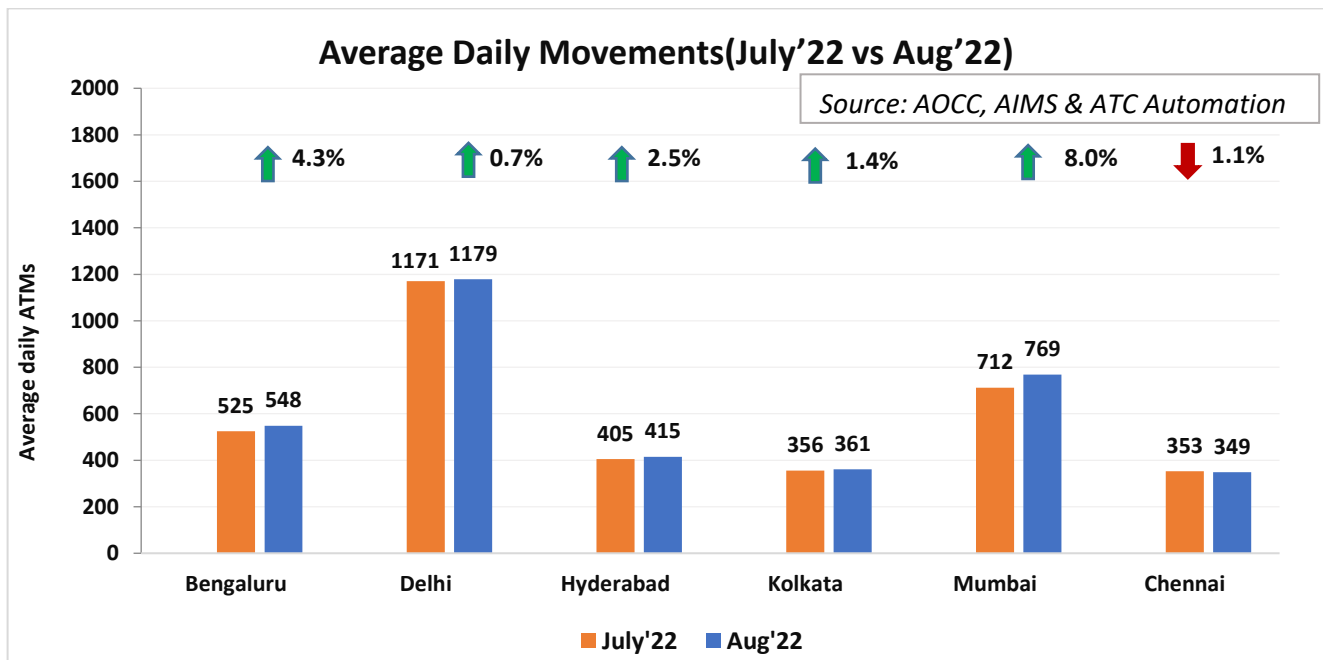


Figure 2: Average Daily Movements(July'22 vs Aug'22)

The above chart depicts the percentage change in average daily ATMs at six major Airports in Aug'22 as compared to the previous month.

Airports\Year	Avg. Daily ATMs (YoY) for six major airports			
	Aug'19	Aug'20	Aug'21	Aug'22
Bengaluru	623	244	389	548
Delhi	1296	523	863	1179
Hyderabad	479	206	314	415
Kolkata	444	118	249	361
Mumbai	875	197	474	769
Chennai	470	119	230	349

Major Airports - Bengaluru ,Delhi, Hyderabad, Kolkata, Mumbai and Chennai recorded average daily movements 88%,91%,87%,81%,88% and 74% respectively of **Aug 2019** levels.



Air Traffic Movement for each day in Aug'22 is plotted for Delhi, Mumbai, Bengaluru and Hyderabad Airport along with the percentage change w.r.t. Avg. Daily Movement for the same month.

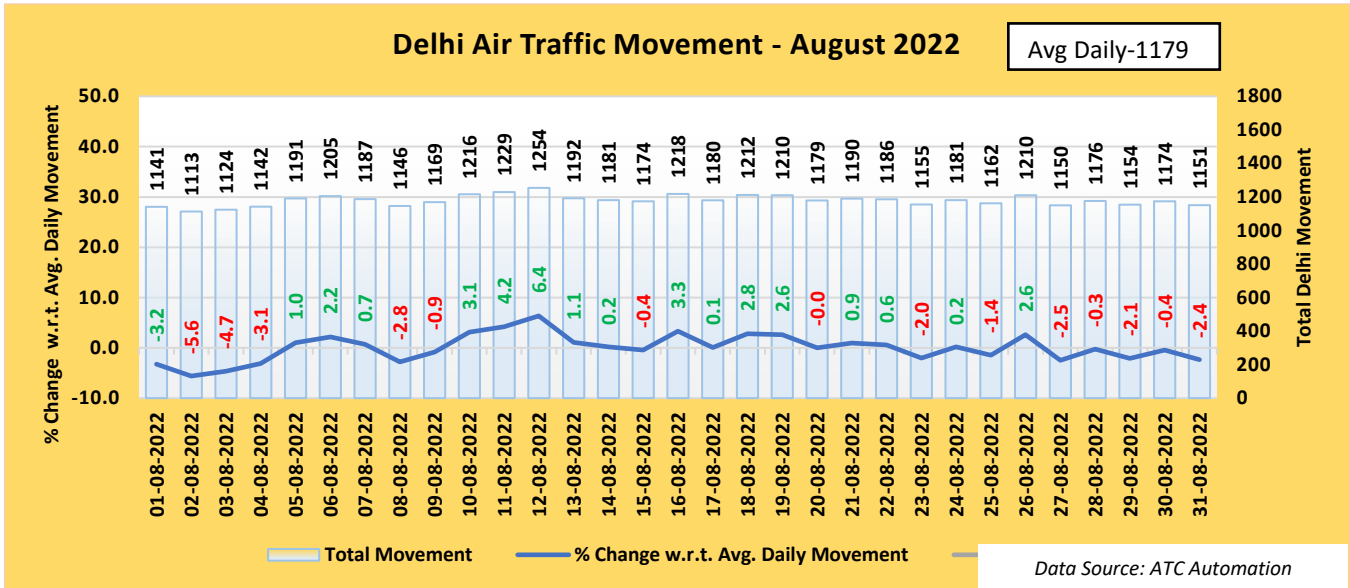


Figure 3: Air Traffic Movement for Delhi –August 2022

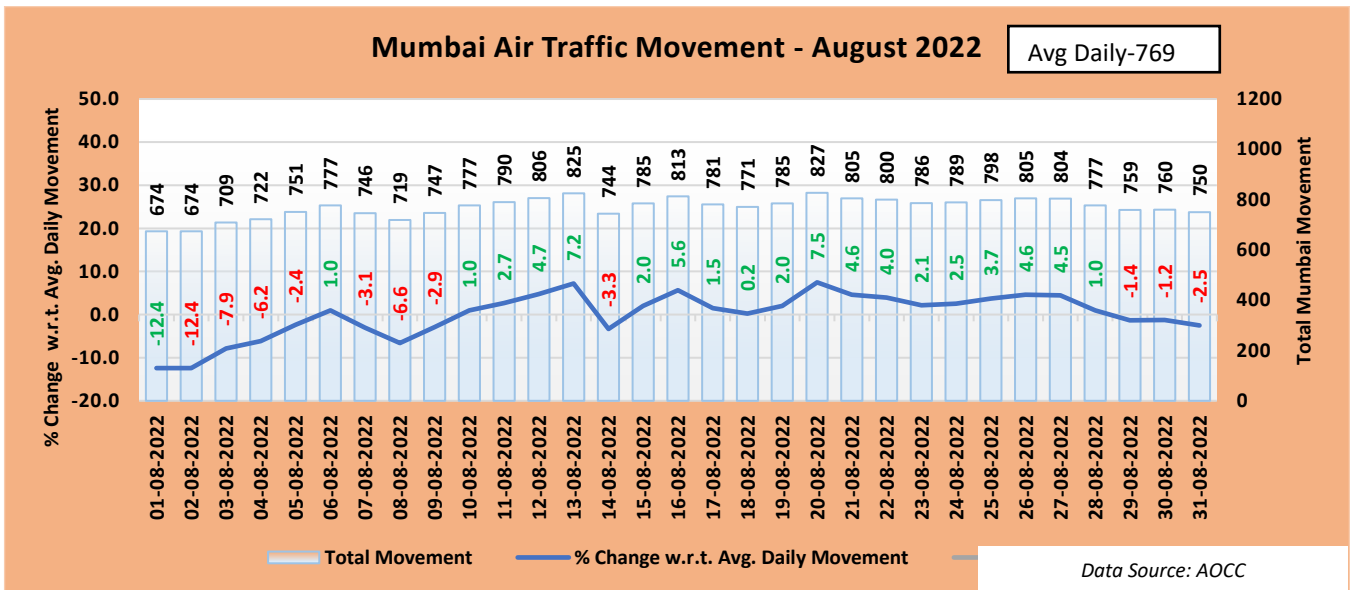


Figure 4: Air Traffic Movement for Mumbai - August 2022

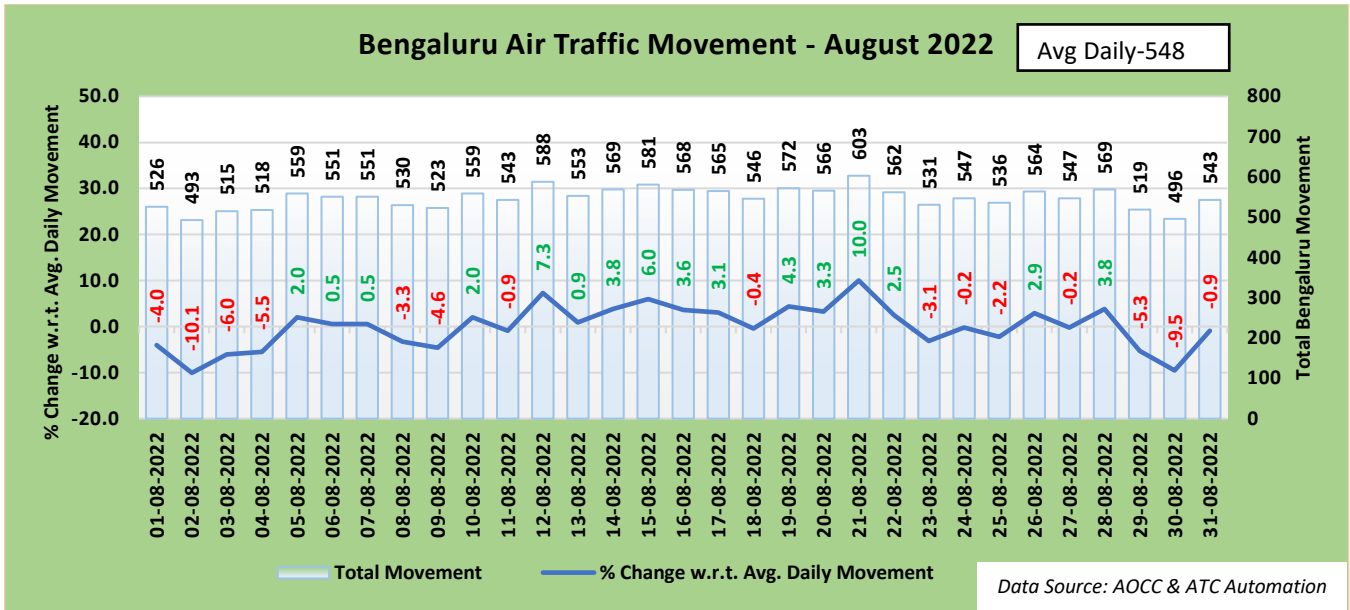


Figure 5: Air Traffic Movement for Bengaluru - August 2022

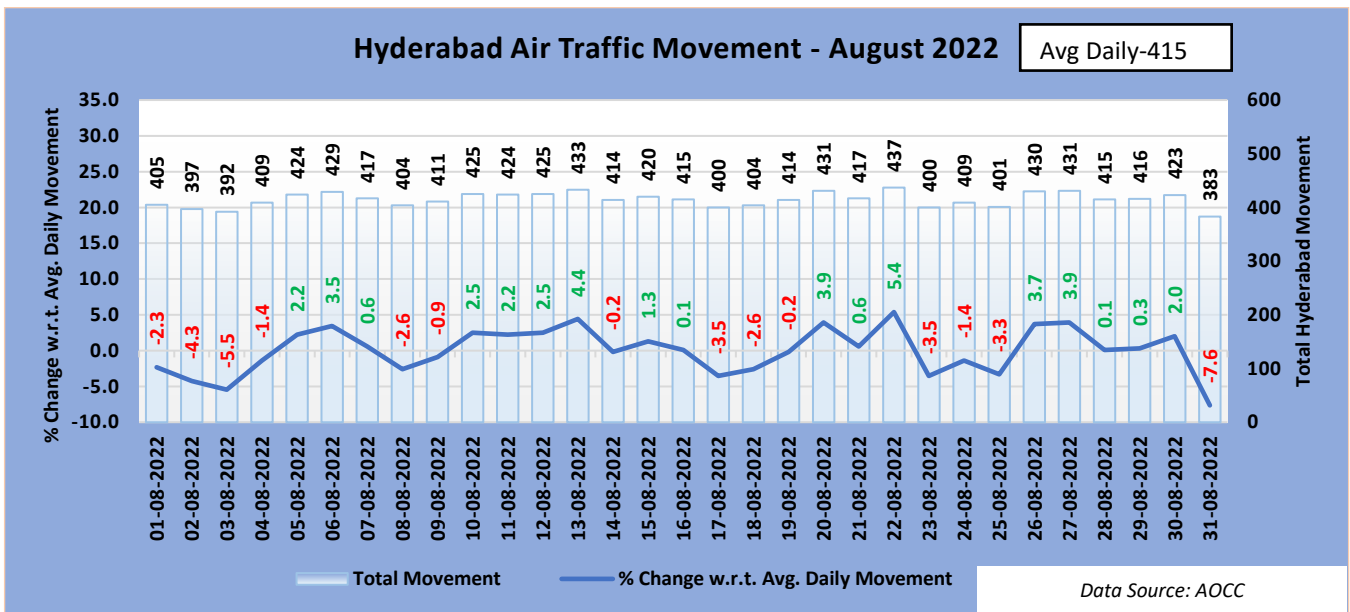


Figure 6: Air Traffic Movement for Hyderabad - August 2022



It is evident from the above charts that on 31st August'22 the ATMs at Delhi, Mumbai, Bengaluru and Hyderabad saw a decrease of 2.4%, 2.5%, 0.9% and 7.6% respectively as compared to the average daily movement for the month of Aug'22.

II. Comparison of total ATMs (YoY) and Monthwise

The total Air traffic movement including Passenger and Combination of other flights i.e. All-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 August for two consecutive years. Air Traffic movement is also plotted Airline wise for the last six months for the major Scheduled Operators.

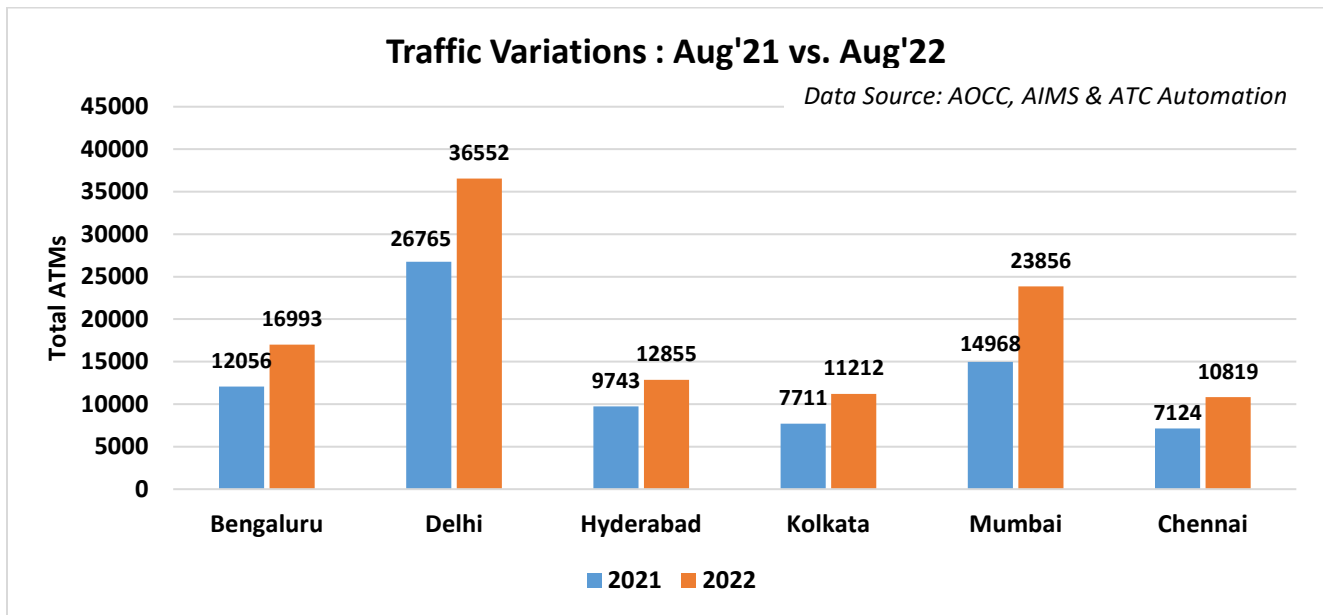


Figure 7: Traffic Variation (YoY)



III. Flight Operations – Airlinewise

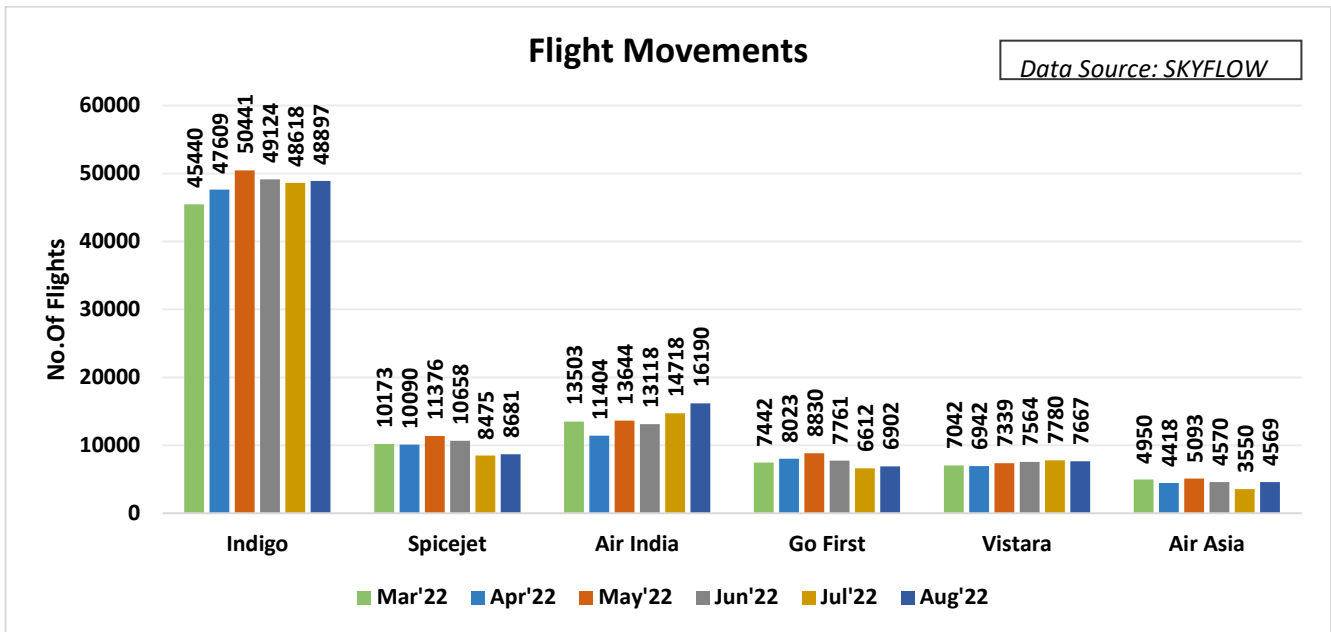


Figure 8: Flight Movements –Airlinewise



C. ATFM Post Operations – CDM Analysis

I. Introduction

Analysis Period 1st – 31st August'22

Back Ground During the above mentioned period, **ten(10)** ATFM measures were applied for **Delhi Airport** and **two(2)** ATFM measures were applied for **Mumbai Airport** due to the following reason as illustrated in the bar chart below:–

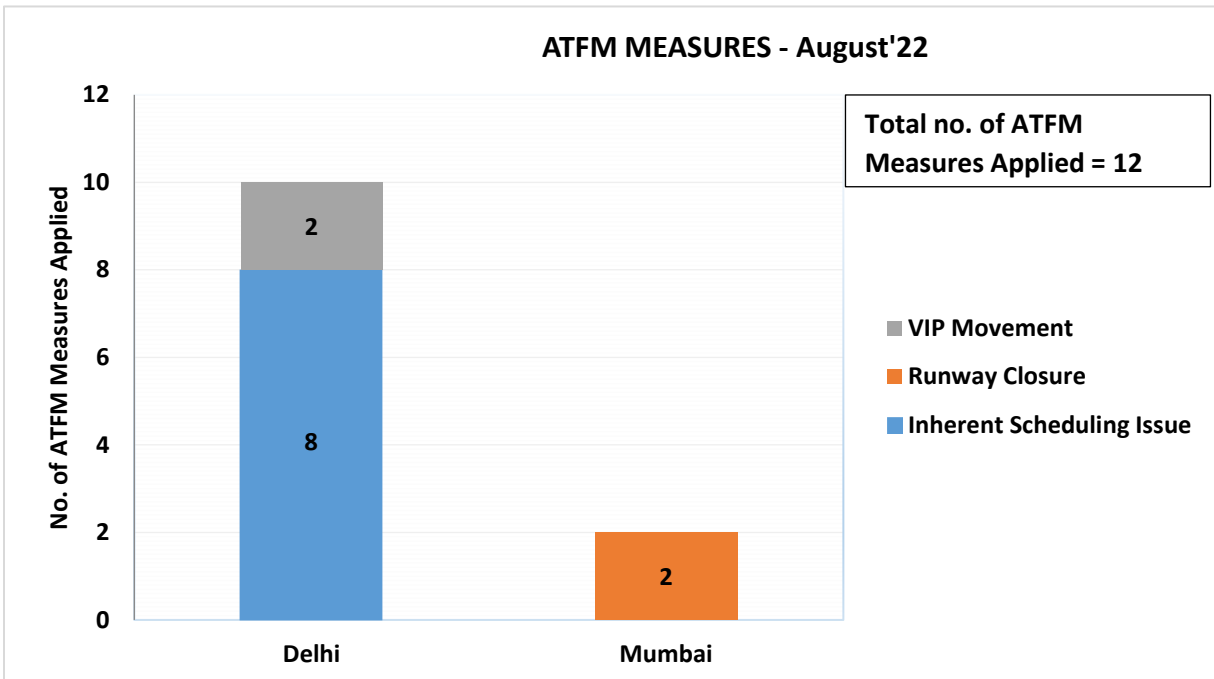


Figure 9: ATFM Measures –August'22



II. ATFM Measures Overview

Constrained Airport	Delhi Airport	Mumbai Airport
Number of ATFM measures applied	10	2
Average ATFM Ground delay due to measures*	11 Min	16 Min
Maximum ATFM Ground delay due to measures	53 Min	26 Min
% Compliance	82	86

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

Total Arrivals		678
Total Exempted Arrivals	International	101
	Domestic(Srinagar,Jammu & Leh)	41
Total affected flights in scenario (Domestic Arrivals)		536
Total Domestic Arrivals with zero ATFM delay		49
Total Domestic Arrivals with ATFM delay		487

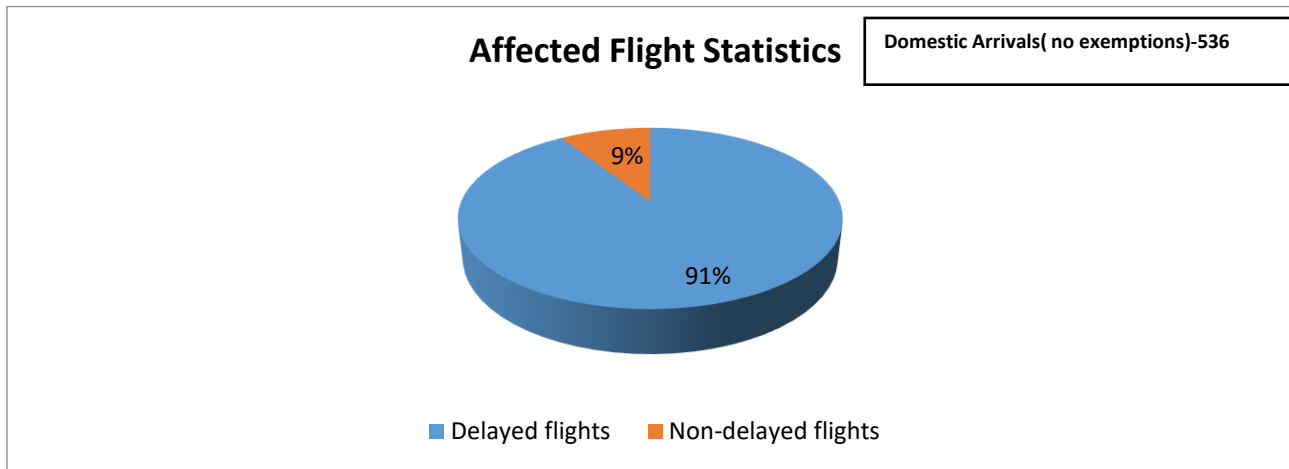


Figure 10: Affected Flight Statistics –Aug'22



III. Overall Compliance

Total arrivals	678
Domestic arrivals (without exemptions)	536
Flights with complete data (ATOT)	517
Flights with incomplete data	8
Flights Not Operated	11
Compliant*	425
Non-Compliant	92

*Total No. of Revised CTOTs issued = 75 (Compliance calculation for flights which were issued revised CTOT is w.r.t. new CTOT issued)

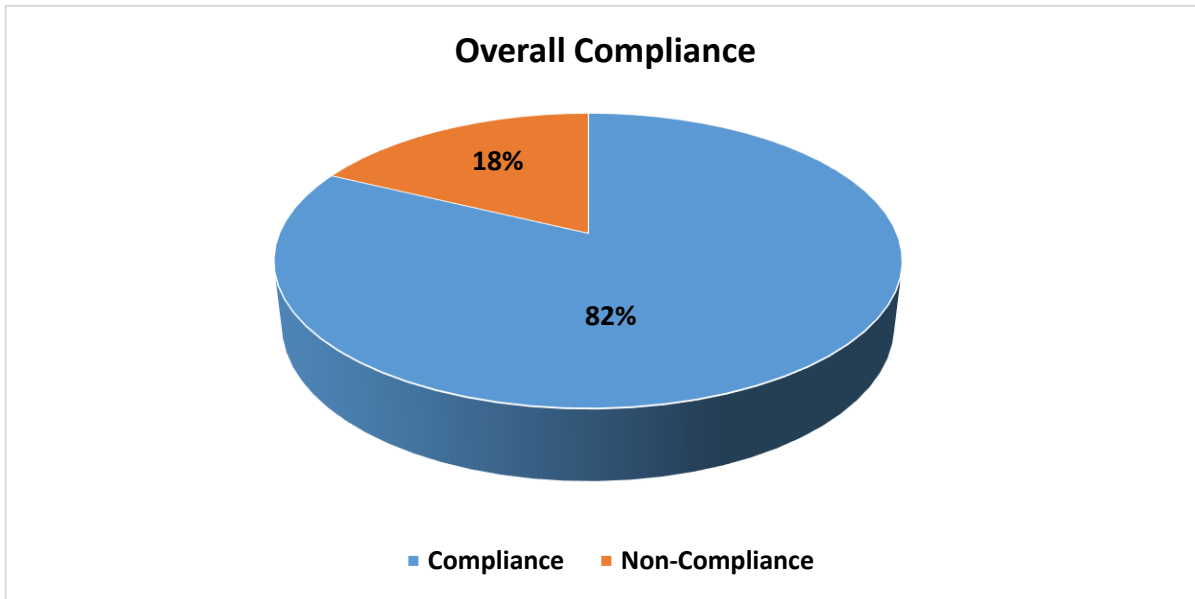


Figure 11: Overall Compliance – Aug'22

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

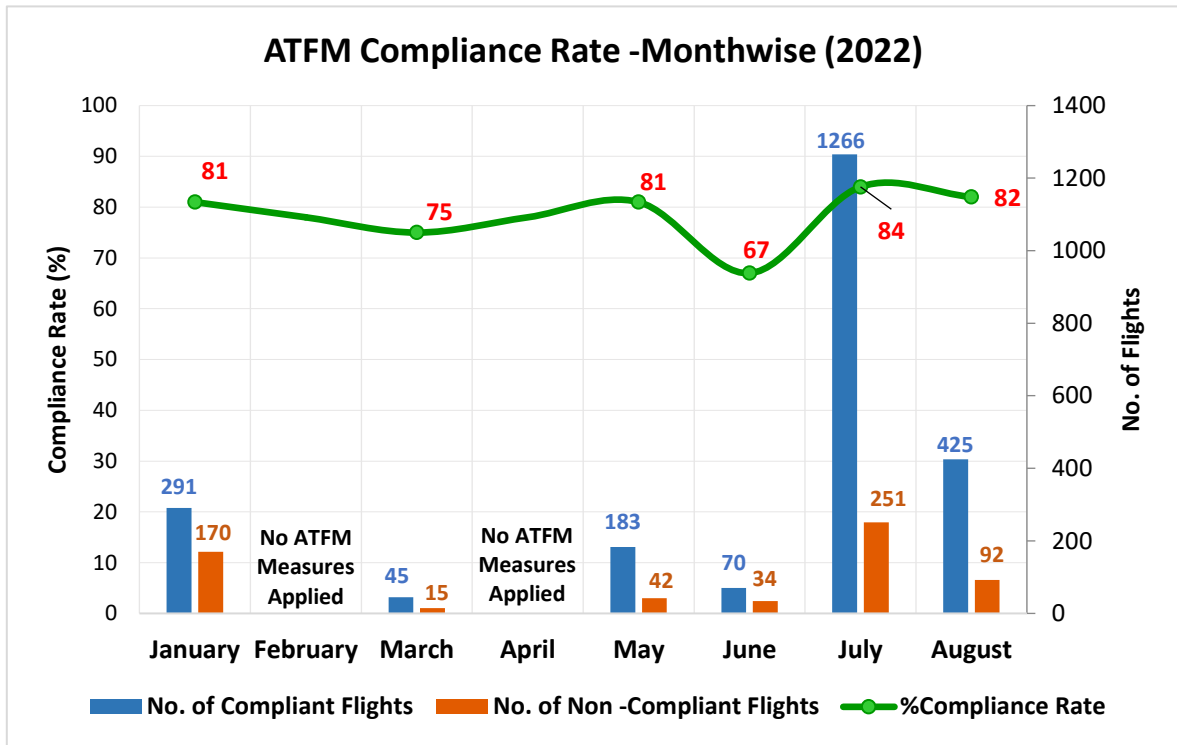


Figure 12: ATFM Compliance(Monthwise)

Inference

1. Out of the total arrivals captured for the constrained Airports during the CDM scenario, 79% of flights i.e. most domestic arrivals, are participating.
2. Out of the total Domestic arrivals, 7% of Domestic flights were exempted from ATFM Measures.
3. Out of the total participating Domestic Arrivals, 91% are assigned ATFM ground delay.
4. Out of the total arrivals captured to the constrained Airport during the ATFM scenario, 72% of flights are assigned ATFM Ground Delay.



IV. CTOT Compliance rate – Airportwise

MUMBAI FIR (82%)*	Compliant	Non Compliant	%Compliant
Rajkot	7	0	100
Ahmedabad	16	3	84
Vadodara	6	0	100
Aurangabad	2	0	100
Udaipur	5	2	71
Mumbai	45	15	66
Shirdi	3	0	100
Jabalpur	1	1	50
Nagpur	14	1	93
Indore	7	3	70
Pune	14	5	74
Bhopal	12	0	100
Surat	9	0	100
Ozar	1	0	100
Porbandar	1	0	100
Jamnagar	1	1	50
Kandla	2	0	100
KOLKATA FIR (85%)*			
Bagdogra	7	0	100
Kolkata	24	1	96
Allahabad	1	0	100
Varanasi	5	1	83
Bhubnaeshwar	6	2	75
Chakeri	1	0	100
Durgapur	1	0	100
Darbangha	0	1	0
Guwahati	8	1	89
Gaya	1	0	100
Gorakhpur	2	0	100
Imphal	1	0	100
Jharsuguda	1	0	100
Dibrugarh	1	0	100
Dimapur	1	0	100
Deoghar	1	0	100
Pakyong	1	0	100
Jorhat	2	0	100
Patna	10	3	77



Raipur	8	0	100
Ranchi	5	6	45
DELHI FIR (74%)*			
Chandigarh	5	4	56
Dehradun	8	0	100
Amritsar	6	1	86
Gaggal	1	2	33
Jodhpur	3	1	75
Jaipur	7	1	87
Jammu	0	1	0
Leh	8	1	89
Hindon	0	1	0
Bikaner	0	1	0
Srinagar	8	4	67
Gwalior	1	1	50
Pantnagar	0	1	0
Lucknow	16	3	84
Adampur	0	1	0
Delhi	5	1	83
CHENNAI FIR (85%)*			
Goa	11	4	73
Bengaluru	40	7	85
Chennai	29	3	90
Porbandar	1	0	100
Shamshabad	24	2	92
Calicut	0	1	0
Madurai	1	0	100
Belagavi	2	0	100
Cochin	2	0	100
Coimbatore	1	0	100
Kannur	0	1	0
Trivandrum	4	0	100
Sulur	1	0	100
Hubli	1	1	50
Mangaluru	2	1	67
Vishakhapatnam	4	1	80
Sindhudurg	1	0	100

*FIR wise compliance rate

Note: The above list contains only those airports which had flights to the Constrained Airport and affected by ATFM measures.



V. Reason For Non Compliance

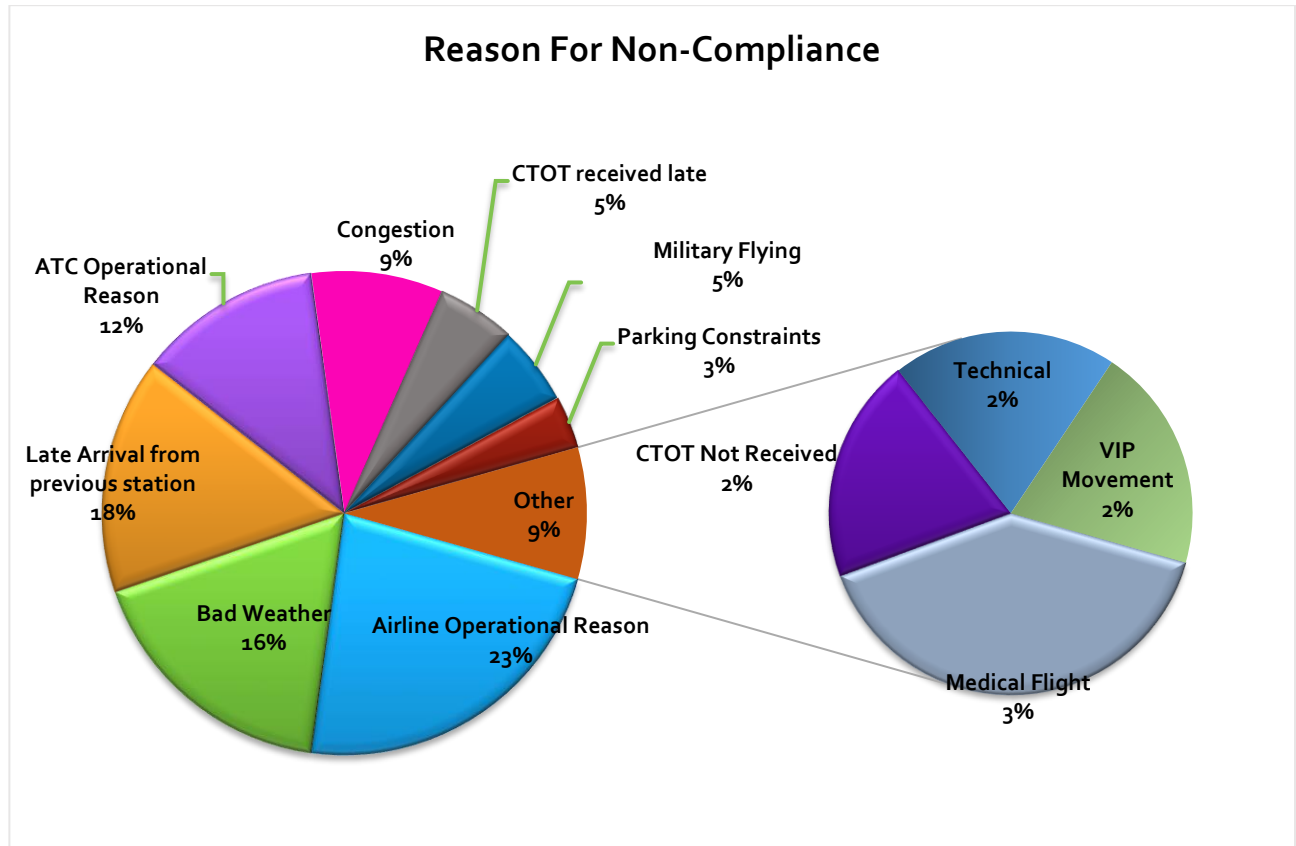


Figure 13: Reason for Non-Compliance as provided by FMPs

Inference

1. 23% of the CTOT Non-compliance was reported by concerned FMP to be because of Airline Operational reason.
2. Bad weather and late arrival of the flight from previous station is identified as another important contributing factor for Non-Compliance by the FMP.
3. 13% of the CTOT Non-compliance was reported by concerned FMP to be because of ATC Operational reason.



VI. CTOT Compliance rate – Airlinewise

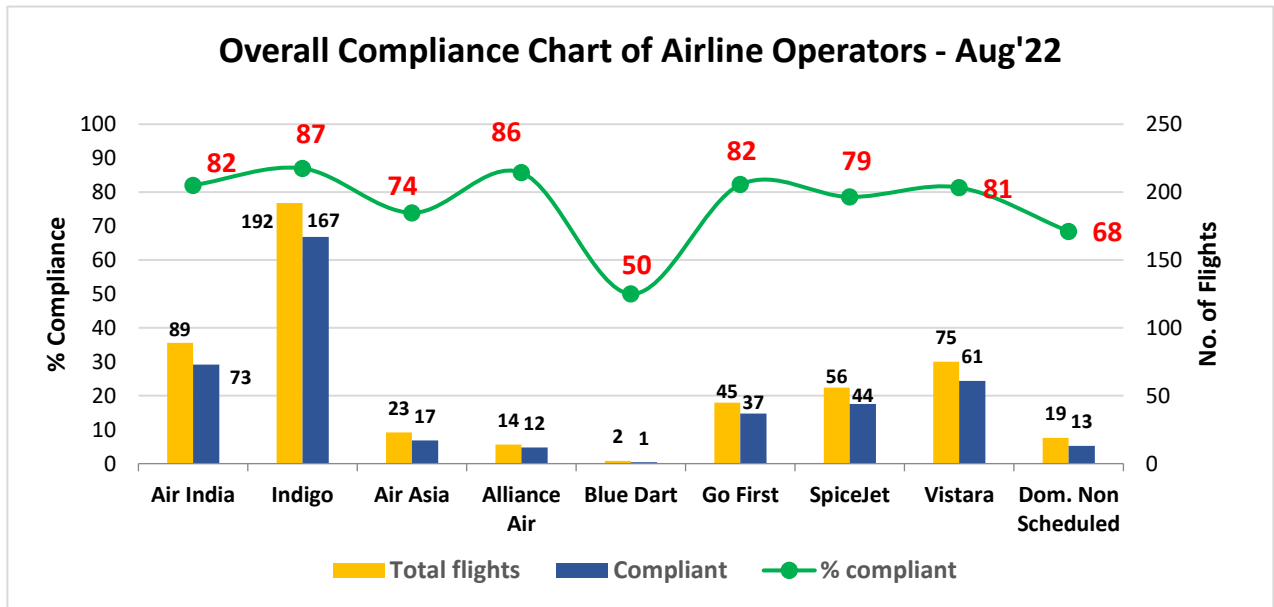


Figure 14: Airline wise Compliance –Aug'22

Inference

1. Out of the total domestic arrivals with complete data in the CDM scenario, 82% arrivals are compliant.
2. Kolkata and Chennai region has the highest compliance rate of 85% whereas Delhi region has the lowest compliance rate of 74%.
3. Indigo and Alliance Air have a CTOT compliance higher than the average recorded compliance for the month of August'22.



VII. Air Delay during the CDM Scenario period

Average Air Delay to domestic arrivals* within the CDM Scenario period for Delhi and Mumbai is 6 minutes and 7 minutes respectively.

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

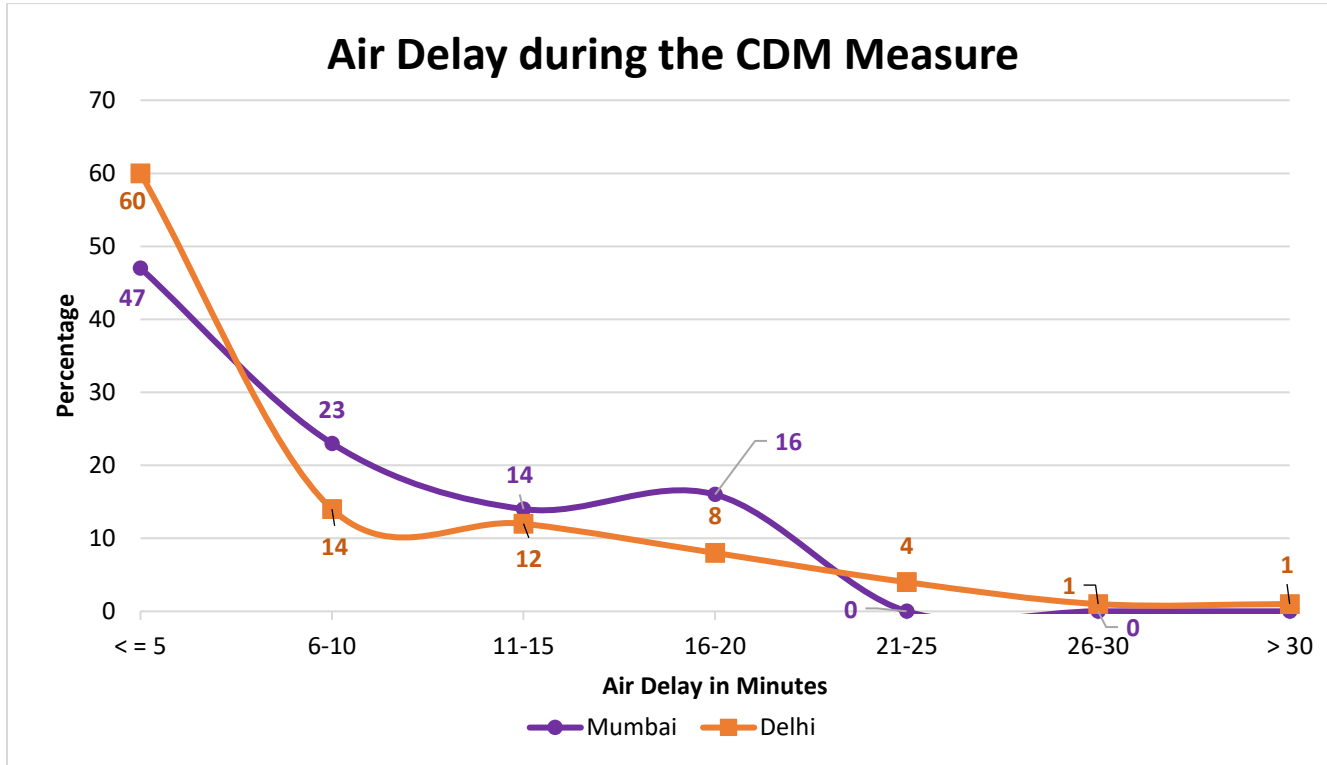


Figure 15: Air Delay distribution during the CDM period

Inference

1. 74% of domestic arriving flights to Delhi had an Air delay of equal to or less than 10 minutes during the CDM period.
2. 70% 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 domestic 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)= 1221 mins
Total Air Delay (with no ATFM measures) = 5165 mins
Reduction in Air delay due to ATFM measures= (5165-1221) = **3944 mins**

Fuel Saving Calculation:

Total Fuel saved during the ATFM Measure: **2,09,169.33 Kgs**

Total reduction in CO₂ emission : 3.16(KgCO₂/kg fuel)*2,09,169.33 Kgs= 6,60,975.07 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
Air delay statistics	<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>