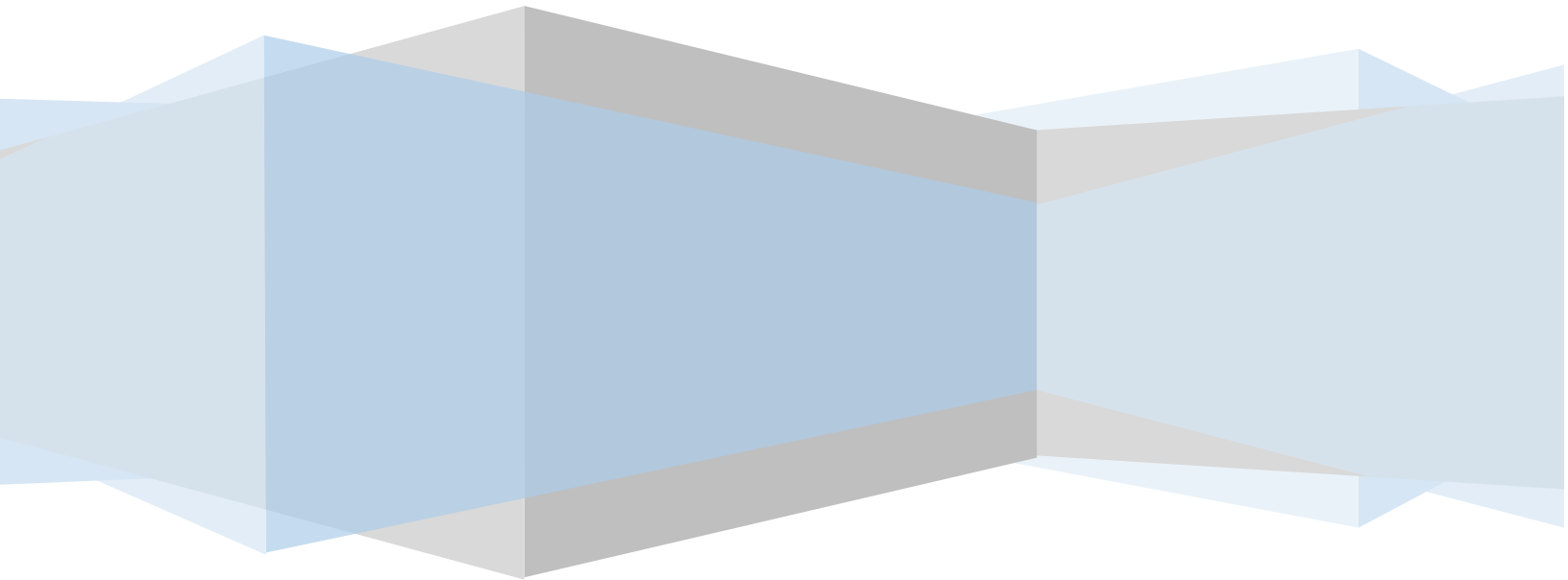


POST OPERATIONS ANALYSIS REPORT

July, 2022

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. Reason For Non Compliance	16
VI. CTOT Compliance rate – Airlinewise	17
VII. Air Delay during the CDM Scenario period	18
VIII. Tangible Benefits due to ATFM Measures	19
D. Glossary.....	21



List of Figures

Figure 1: Traffic Growth Post 1st COVID wave	4
Figure 2: Average Daily Movements(June'22 vs July'22)	5
Figure 3: Air Traffic Movement for Delhi –July 2022	6
Figure 4: Air Traffic Movement for Mumbai - July 2022	6
Figure 5: Air Traffic Movement for Bengaluru - July 2022	7
Figure 6: Air Traffic Movement for Hyderabad - July 2022	7
Figure 7: Traffic Variation (YoY)	8
Figure 8: Flight Movements –Airlinewise	9
Figure 9: ATFM Measures –July'22	10
Figure 10: Affected Flight Statistics –July'22	11
Figure 11: Overall Compliance – July'22	12
Figure 12: ATFM Compliance(Monthwise)	13
Figure 13: Reason for Non-Compliance as provided by FMPs	16
Figure 14: Airline wise Compliance –July'22	17
Figure 15: Air Delay distribution during the CDM period	18



A. Executive Summary

Domestic and international air traffic (as logged by data received by ATFM unit) is estimated to have recorded a 6 % and 5% decrease respectively in the month of July 2022 as compared to June'22.

On average, the Indian Airports in the ATFCM area saw 3480 IFR flights per day. The peak day was on 8th July'22 (3824 IFR flights). Friday's were the busiest days throughout this month with an average of 3625 flights per day.

Thirty seven (37)ATFM measure were applied this month for Delhi, Mumbai and Bhopal Airport during periods of congestion.

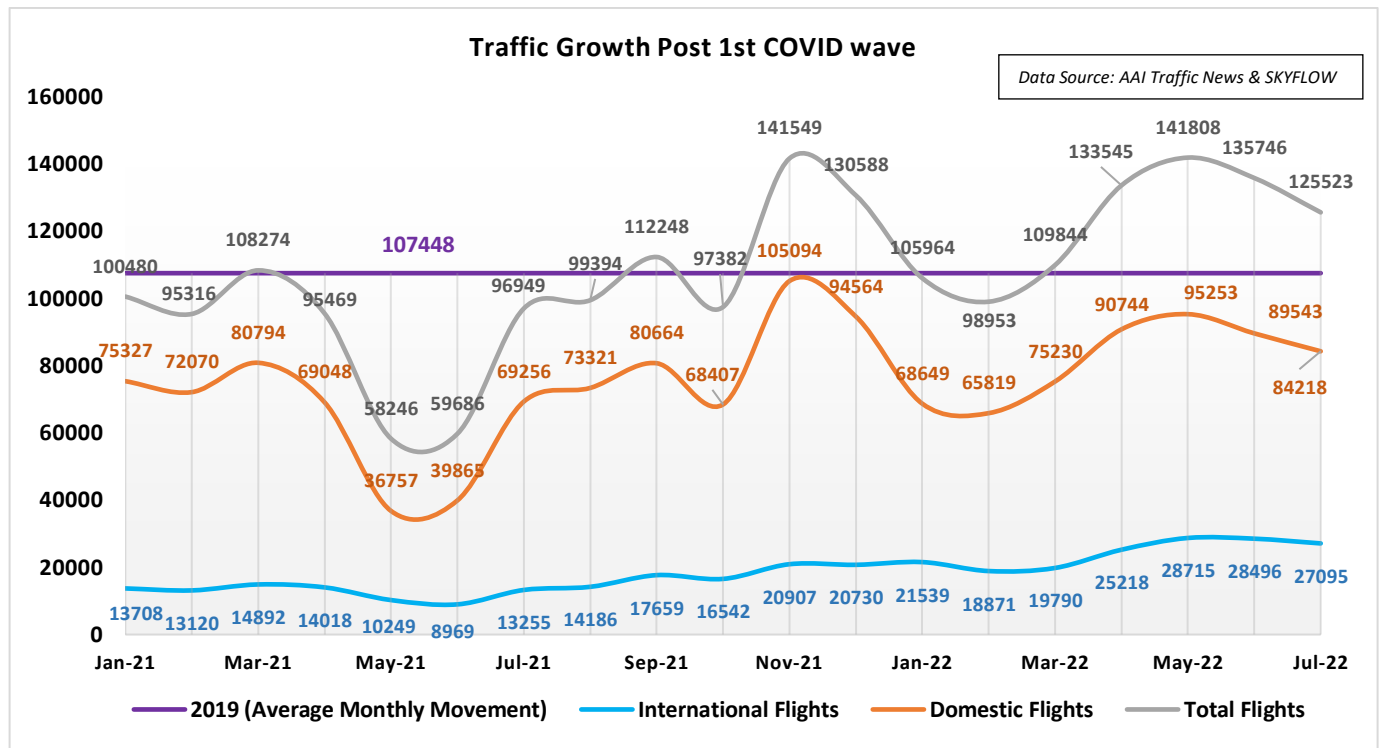


Figure 1: Traffic Growth Post 1st COVID wave

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.

The graph above depicts the Domestic and international Air traffic in Indian ATFCM Area during the last 19 months (Jan' 2021 to July'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

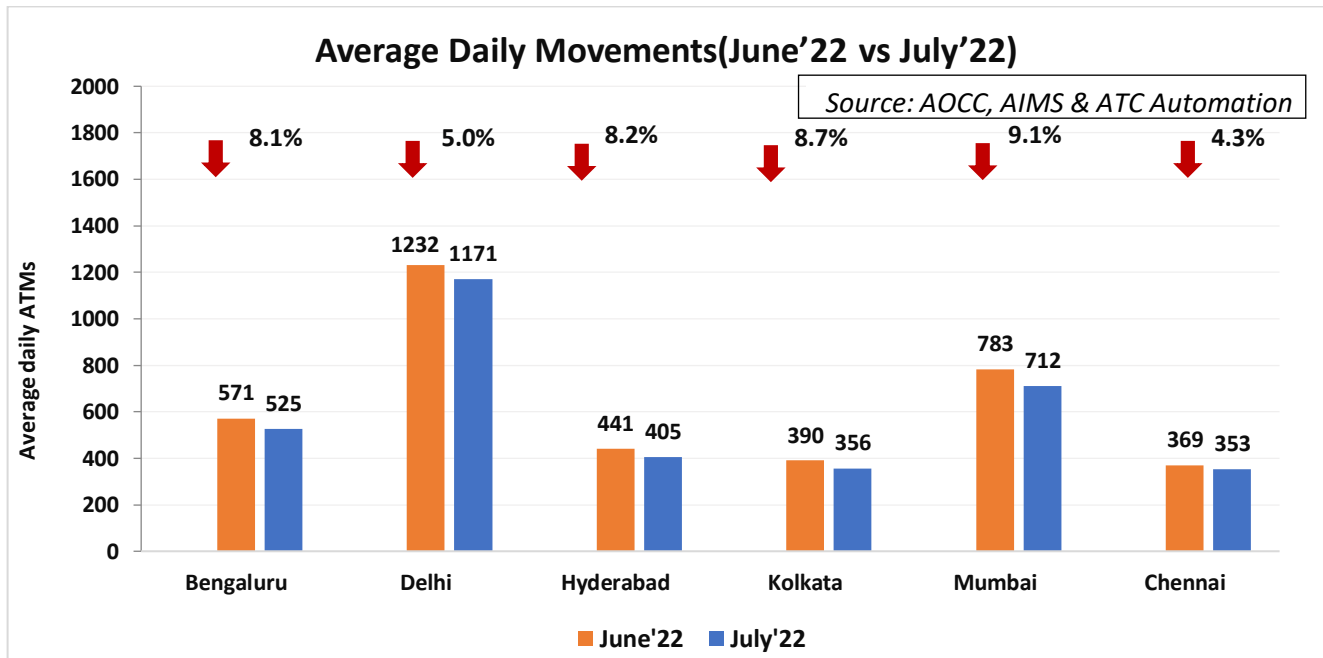


Figure 2: Average Daily Movements(June'22 vs July'22)

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

Airports\Year	Avg. Daily ATMs (YoY) for six major airports			
	July'19	July'20	July'21	July'22
Bengaluru	621	188	314	525
Delhi	1265	457	728	1171
Hyderabad	493	174	265	405
Kolkata	445	120	203	356
Mumbai	841	180	395	712
Chennai	464	103	200	353

Major Airports - Bengaluru ,Delhi, Hyderabad, Kolkata, Mumbai and Chennai recorded average daily movements 85%,93%, 82%, 80%,85% and 76% respectively of **July 2019** levels.



Air Traffic Movement for each day in July'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.

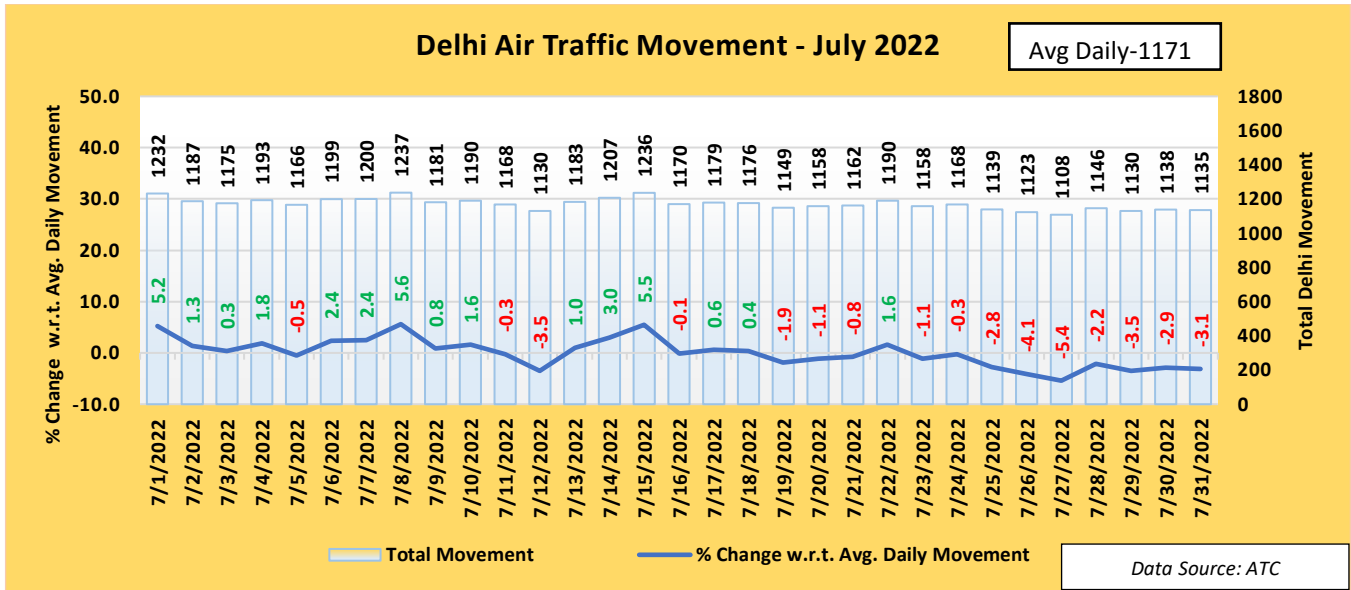


Figure 3: Air Traffic Movement for Delhi –July 2022

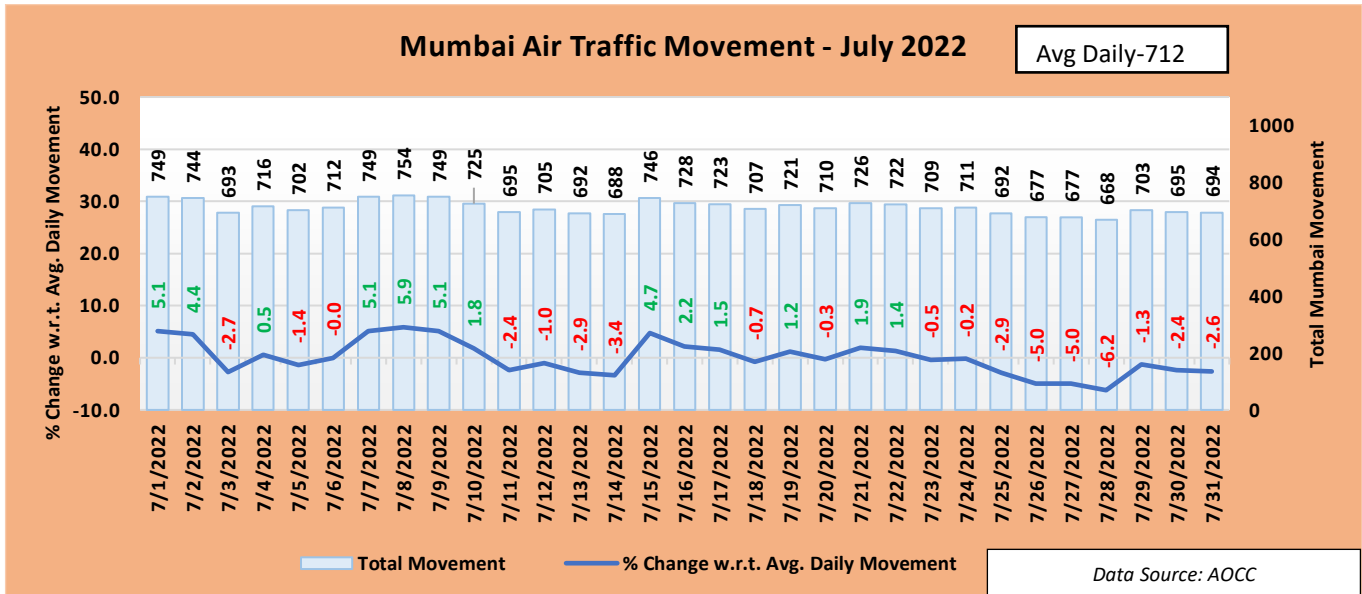


Figure 4: Air Traffic Movement for Mumbai - July 2022

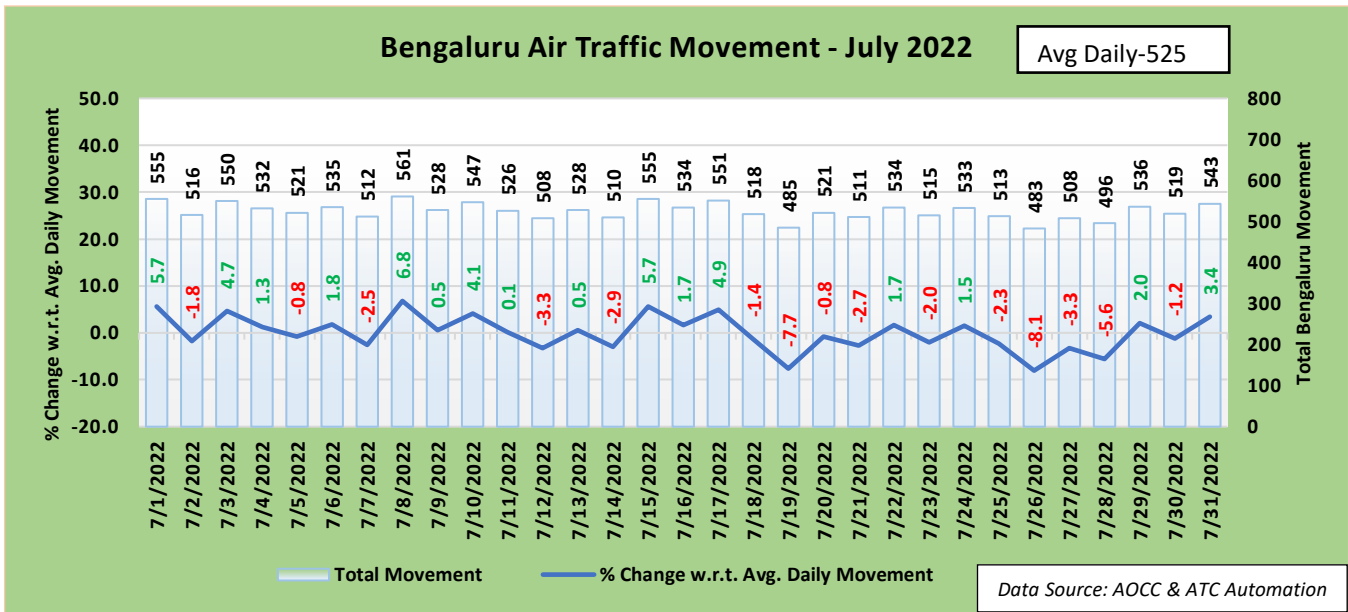


Figure 5: Air Traffic Movement for Bengaluru - July 2022

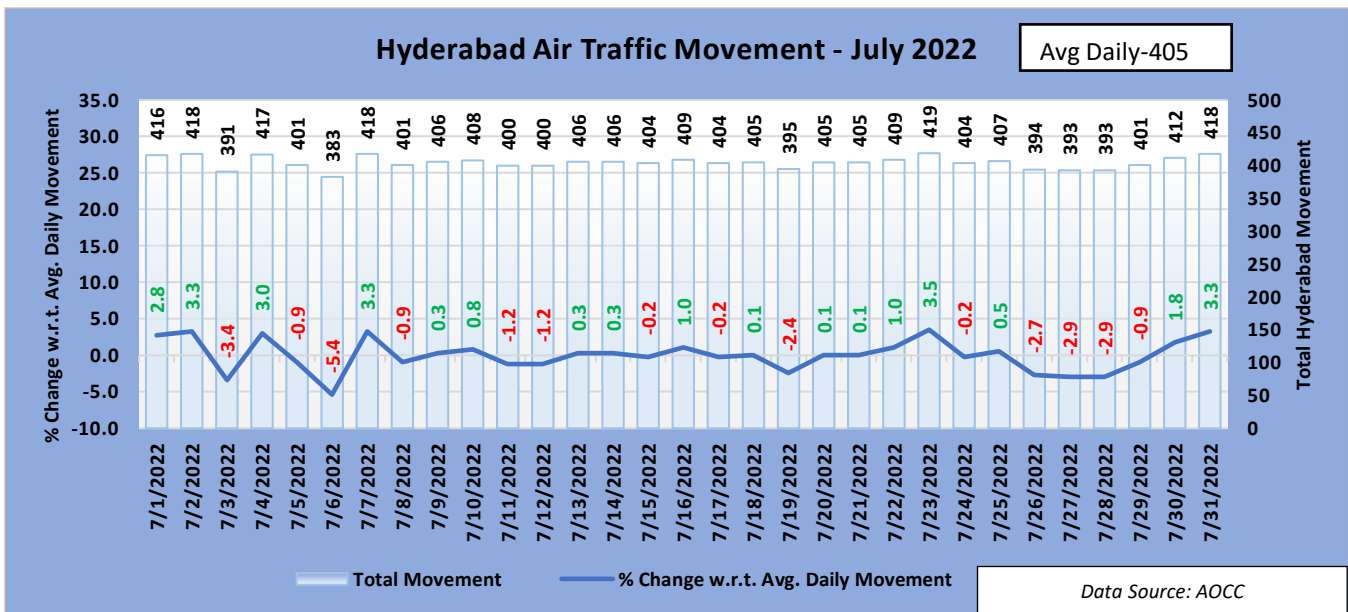


Figure 6: Air Traffic Movement for Hyderabad - July 2022

It is evident from the above charts that on 31st July'22 the ATMs at Delhi and Mumbai saw a decrease of 3.1% and 2.6% respectively as compared to the average daily movement for the month of July'22 whereas Bengaluru



and Hyderabad on the same day witnessed an increase of 3.4 % and 3.3% respectively w.r.t. average daily movement captured for the month.

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 July for two consecutive years. Air Traffic movement is also plotted Airline wise for the last six months for the major Scheduled Operators.

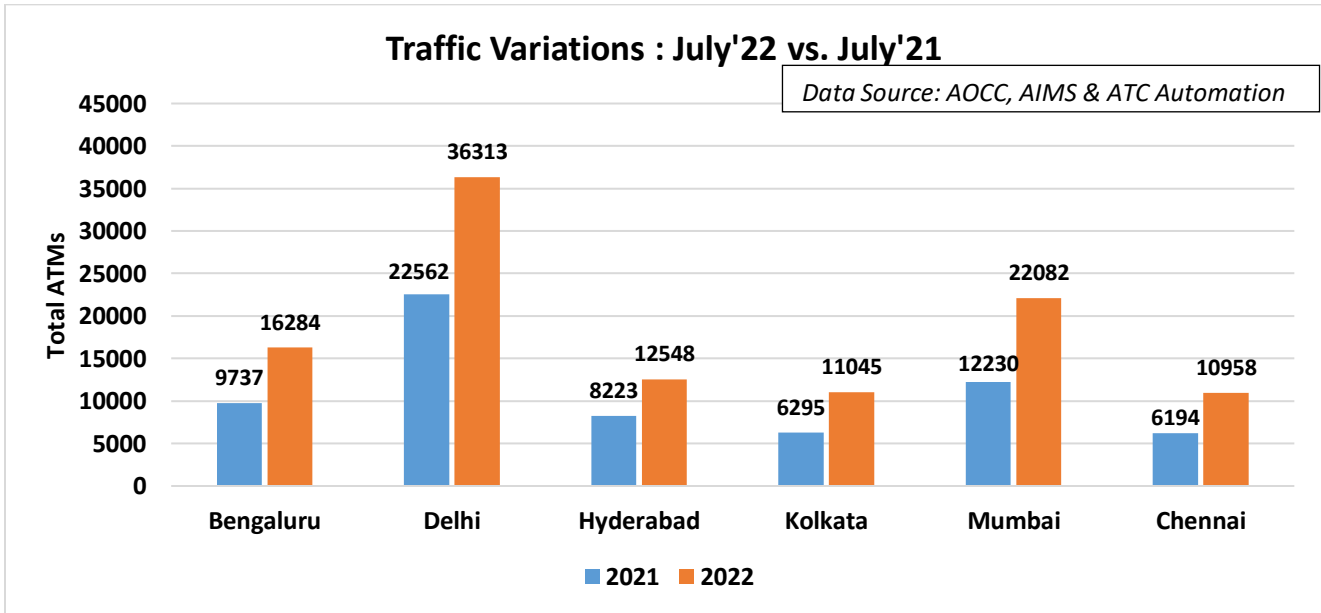


Figure 7: Traffic Variation (YoY)



III. Flight Operations – Airlinewise

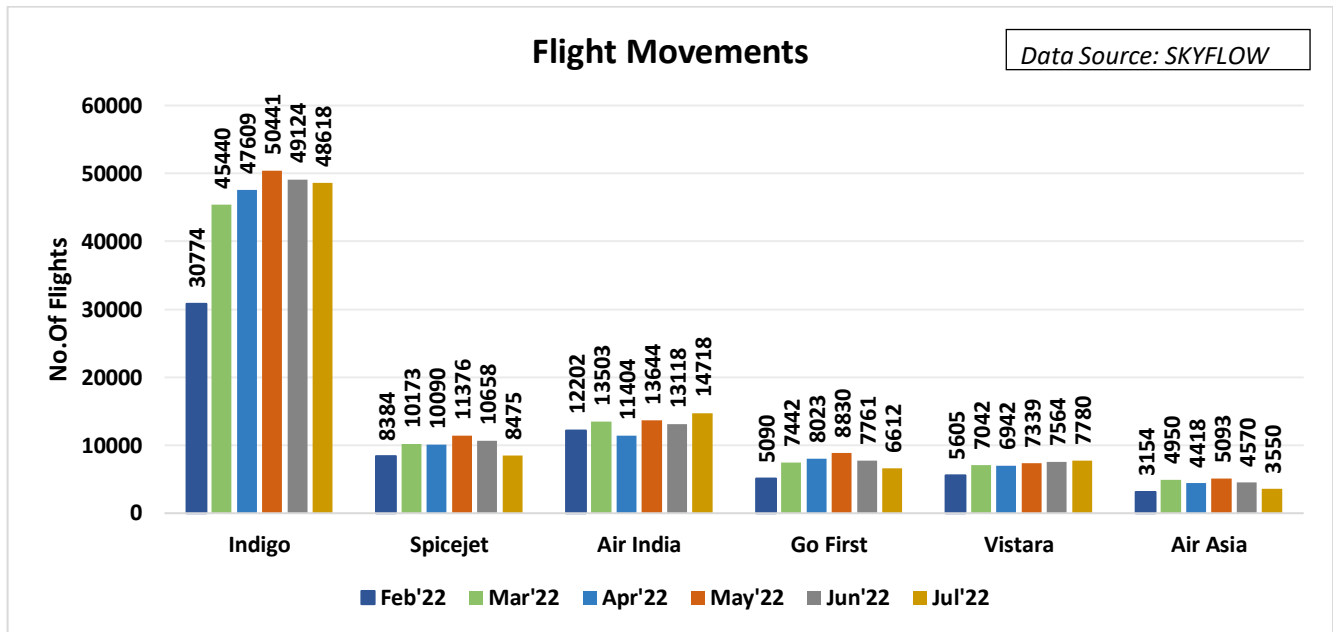


Figure 8: Flight Movements –Airlinewise



C. ATFM Post Operations – CDM Analysis

I. Introduction

Analysis Period 1st – 31st July'22

Back Ground During the above mentioned period, **twenty-eight(28)** ATFM measures were applied **for Delhi Airport, four(4)** ATFM measures were applied **for Mumbai Airport** and **five(5)** ATFM measures were applied **for Bhopal Airport** due to the following reason as illustrated in the bar chart below:–

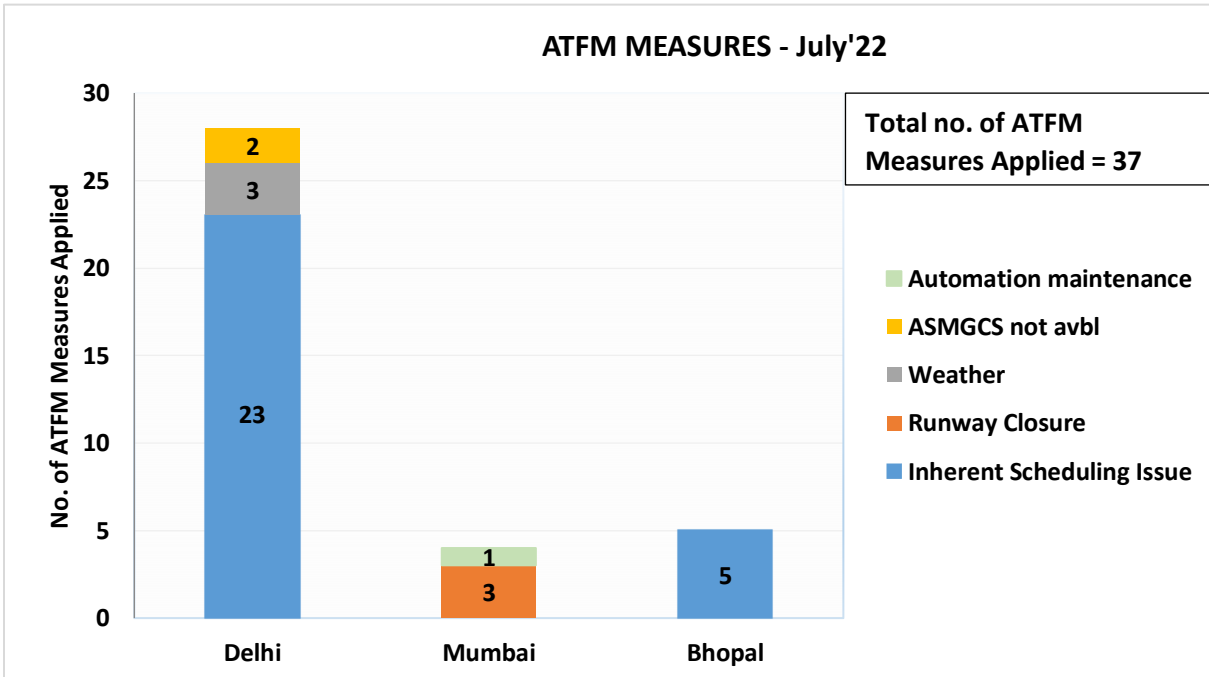


Figure 9: ATFM Measures –July'22



II. ATFM Measures Overview

Constrained Airport	Delhi Airport	Mumbai Airport	Bhopal Airport
Number of ATFM measures applied	28	4	5
Average ATFM Ground delay due to measures*	8 Min	9 Min	12 Min
Maximum ATFM Ground delay due to measures	47 Min	20 Min	35 Min
% Compliance	84	74	80

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

Total Arrivals		2068
Total Exempted Arrivals	International	303
	Domestic(Srinagar,Jammu & Leh)	206
Total affected flights in scenario (Domestic Arrivals)		1559
Total Domestic Arrivals with zero ATFM delay		201
Total Domestic Arrivals with ATFM delay		1358

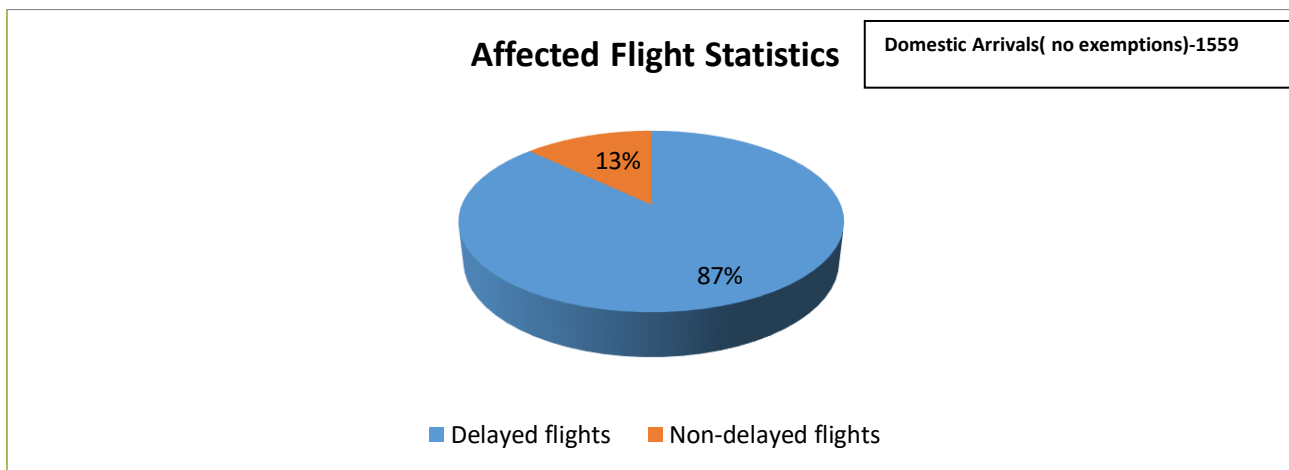


Figure 10: Affected Flight Statistics –July'22



III. Overall Compliance

Total arrivals	2068
Domestic arrivals (without exemptions)	1559
Flights with complete data (ATOT)	1517
Flights with incomplete data	13
Flights Not Operated	29
Compliant*	1266
Non-Compliant	251

*Total No. of Revised CTOTs issued = 205 (Compliance calculation for flights which were issued revised CTOT is w.r.t. new CTOT issued)

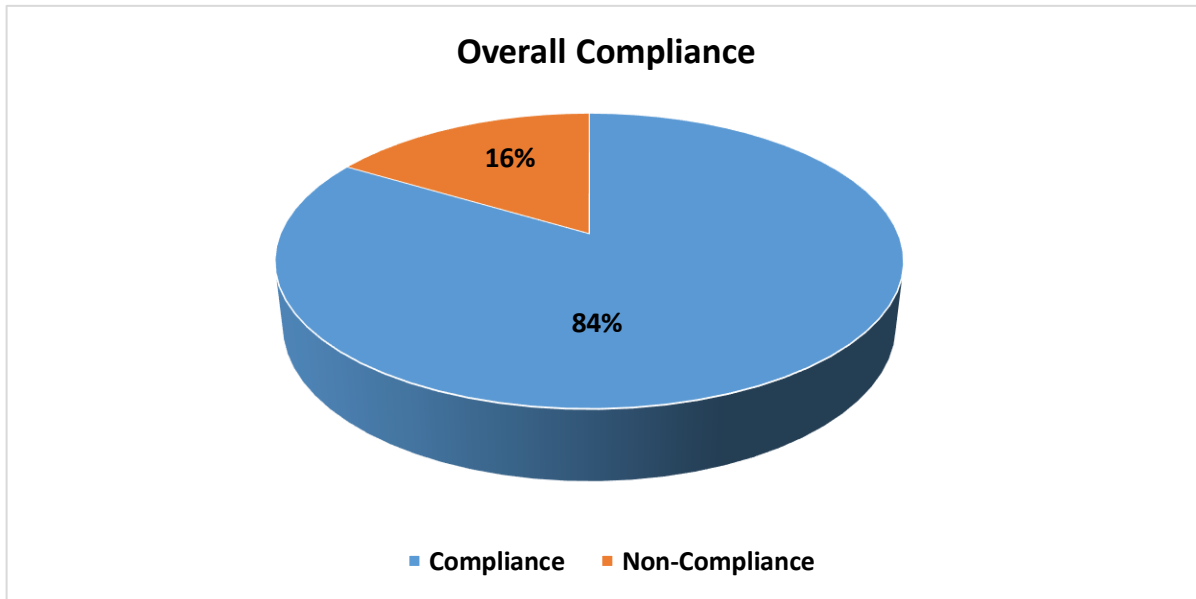


Figure 11: Overall Compliance – July'22

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

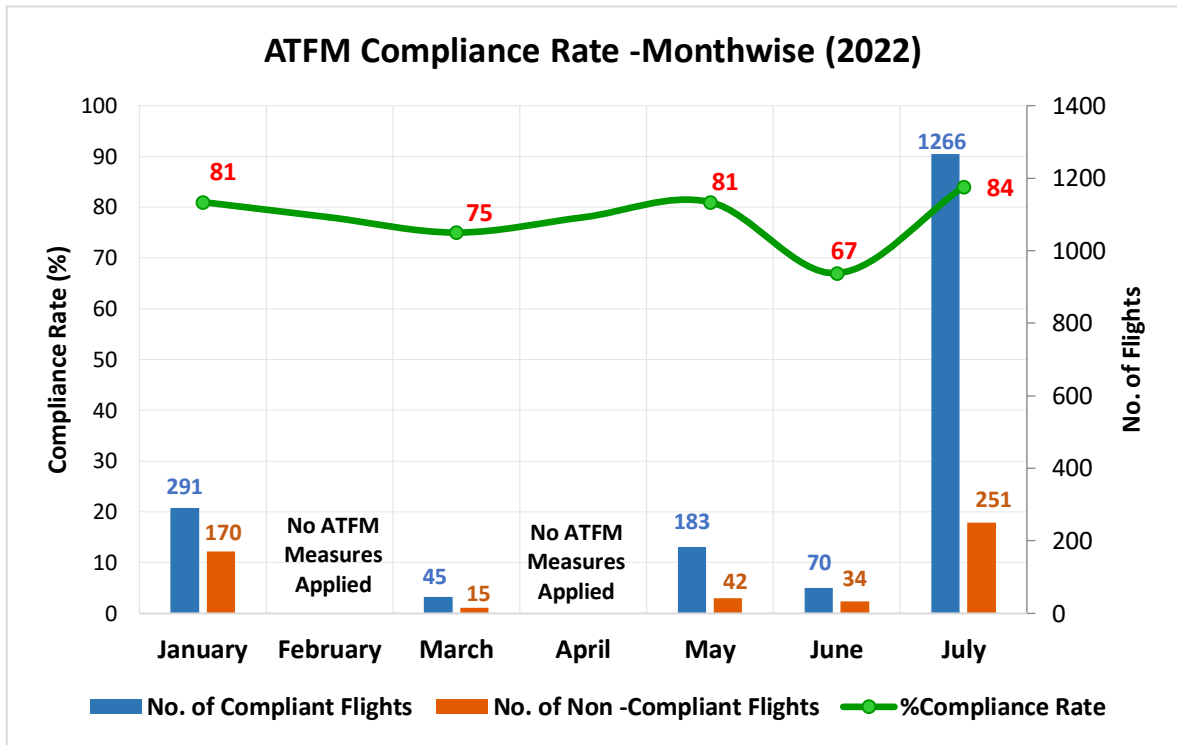


Figure 12: ATFM Compliance(Monthwise)

Inference

1. Out of the total arrivals captured for the constrained Airports during the CDM scenario, 75% of flights i.e. most domestic arrivals, are participating.
2. Out of the total Domestic arrivals, 11.7 % of Domestic flights were exempted from ATFM Measures.
3. Out of the total participating Domestic Arrivals, 87% are assigned ATFM ground delay.
4. Out of the total arrivals captured to the constrained Airport during the ATFM scenario, 66% of flights are assigned ATFM Ground Delay.



IV. CTOT Compliance rate – Airportwise

MUMBAI FIR (88%)*	Compliant	Non Compliant	%Compliant
Rajkot	10	5	67
Ahmedabad	49	9	84
Vadodra	17	1	94
Aurangabad	3	0	100
Udaipur	23	3	88
Mumbai	163	24	87
Shirdi	5	3	63
Jabalpur	6	1	86
Nagpur	41	1	98
Indore	17	2	89
Pune	52	9	85
Bhopal	44	1	98
Bhavnagar	0	1	0
Surat	27	4	87
Ozar	0	1	0
Jamnagar	4	1	80
Kandla	5	0	100
KOLKATA FIR (85%)*			
Agartala	1	0	100
Bagdogra	30	5	86
Kolkata	79	15	84
Allahabad	1	2	33
Varanasi	14	1	93
Bhubnaeshwar	21	3	87
Chakeri	1	1	50
Durgapur	2	1	67
Darbangha	3	0	100
Guwahati	13	4	76
Gaya	7	1	88
Gorakhpur	7	4	64
Imphal	5	2	71
Jharsuguda	5	0	100
Lengpui	1	0	100
Dibrugarh	1	2	33
Dimapur	5	1	83
Bilaspur	1	0	100
Khushinagar	0	1	0
Niranjanpur	0	1	0



Kalaikunda	1	0	100
Jorhat	0	1	0
Raipur	28	1	97
Patna	63	6	91
Ranchi	18	4	82
DELHI FIR (71%)*			
Chandigarh	18	20	47
Dehradun	27	8	77
Amritsar	12	2	86
Gaggal	5	3	63
Jodhpur	10	10	50
Jaipur	20	3	87
Kishanganh	3	4	43
Agra	1	1	50
Sirsa	1	0	100
Bhuntar	0	1	0
Pantnagar	4	0	100
Lucknow	33	4	89
Bareilly	2	1	67
Delhi	14	6	70
Allahabad	1	0	100
CHENNAI FIR (84%)*			
Goa	26	28	48
Bengaluru	107	10	91
Chennai	75	13	85
Begumpet	2	3	40
Shamshabad	79	5	94
Madurai	4	0	100
Belagavi	1	0	100
Cochin	1	1	50
Coimbatore	4	0	100
Trivandrum	20	2	91
Vijayawada	3	0	100
Hubli	3	1	75
Mangaluru	4	0	100
Vishakhapatnam	13	2	87

*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

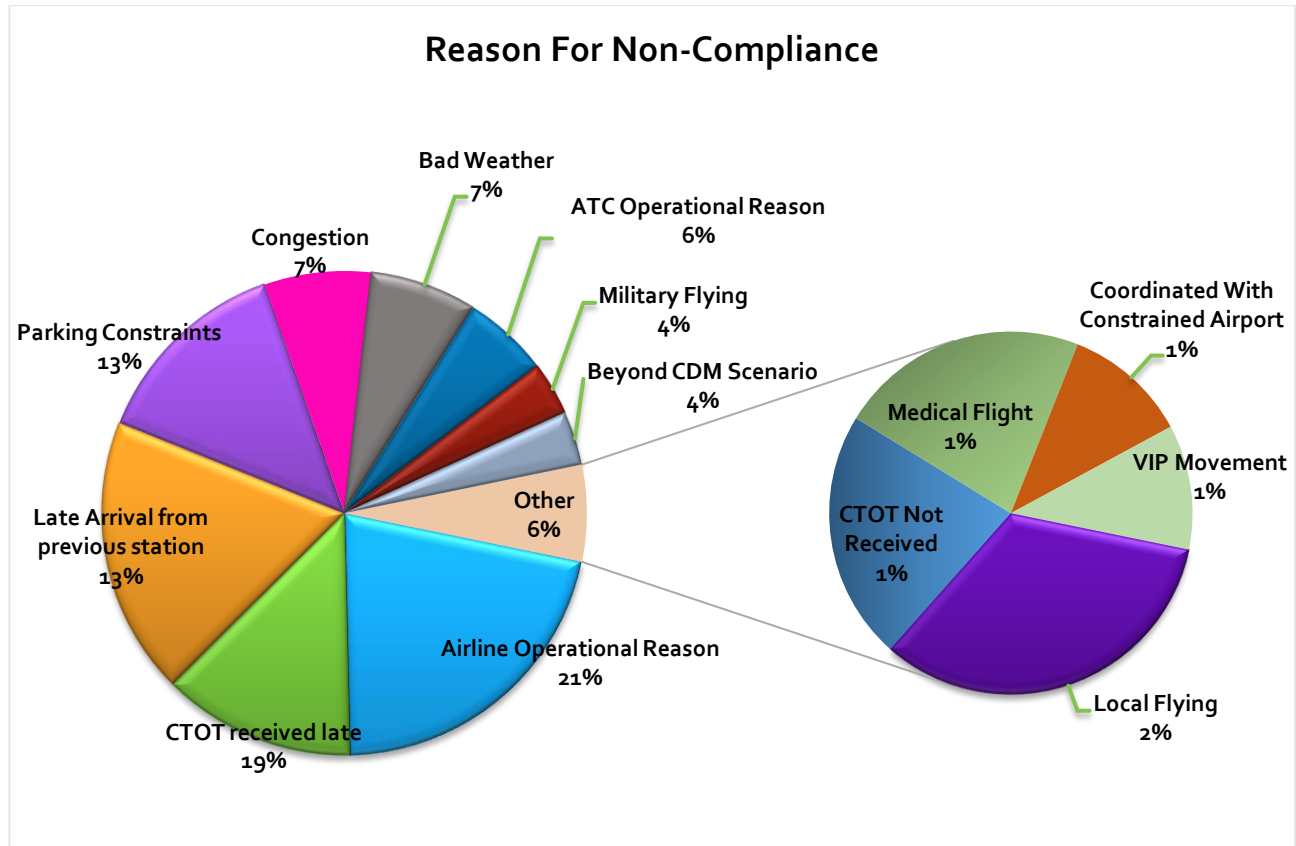


Figure 13: Reason for Non-Compliance as provided by FMPs

Inference

- 21% of the CTOT Non-compliance was reported by concerned FMP to be because of Airline Operational reason.
- 19% of Non-Compliance is reported to be because of late receipt of CTOT by the departure station.
- 13% of flights didn't comply with the issued CTOT and didn't timely inform their revised EOBT to CCC. Such action leads to wastage of unused slots.
- 13% of the flights could not comply with the issued CTOT due to parking constraint at the departure station.



VI. CTOT Compliance rate – Airlinewise

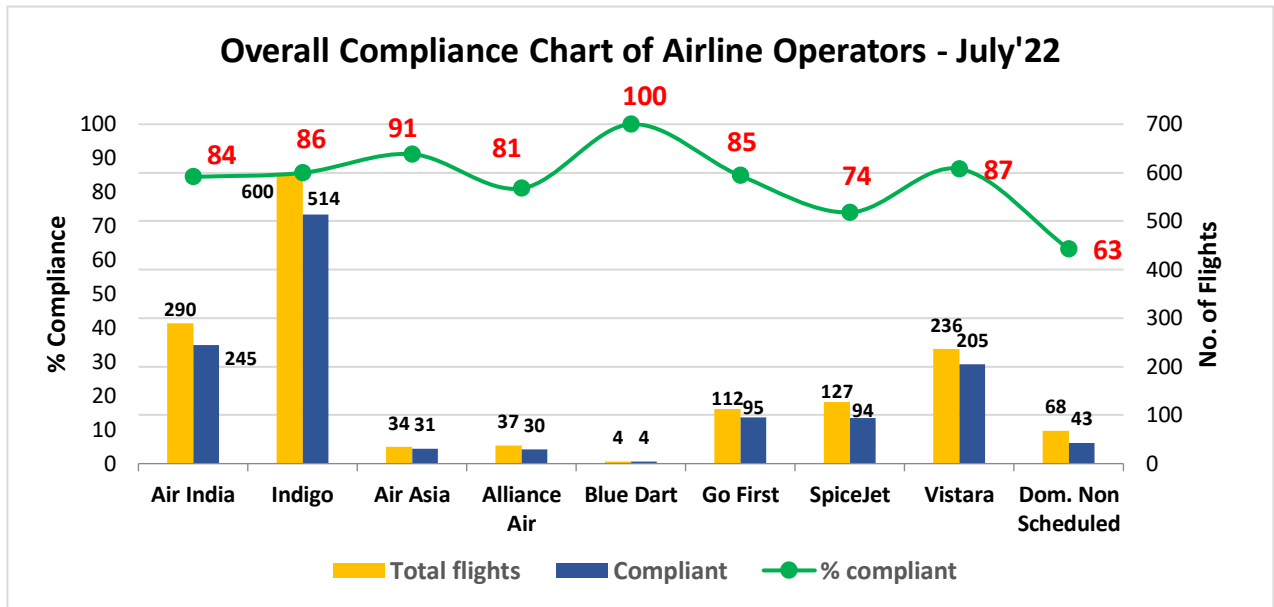


Figure 14: Airline wise Compliance –July'22

Inference

1. Out of the total domestic arrivals with complete data in the CDM scenario, 84% arrivals are compliant.
2. Mumbai region has the highest compliance rate of 88% whereas Delhi region has the lowest compliance rate of 71%.
3. Indigo, Air Asia, Blue Dart, GoFirst and Vistara Airlines have a CTOT compliance higher than the average recorded compliance for the month of July'22.

VII. Air Delay during the CDM Scenario period

Average Air Delay to domestic arrivals* within the CDM Scenario period for Delhi, Bhopal and Mumbai is 5 minutes, 11 minutes and 7 minutes respectively.

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

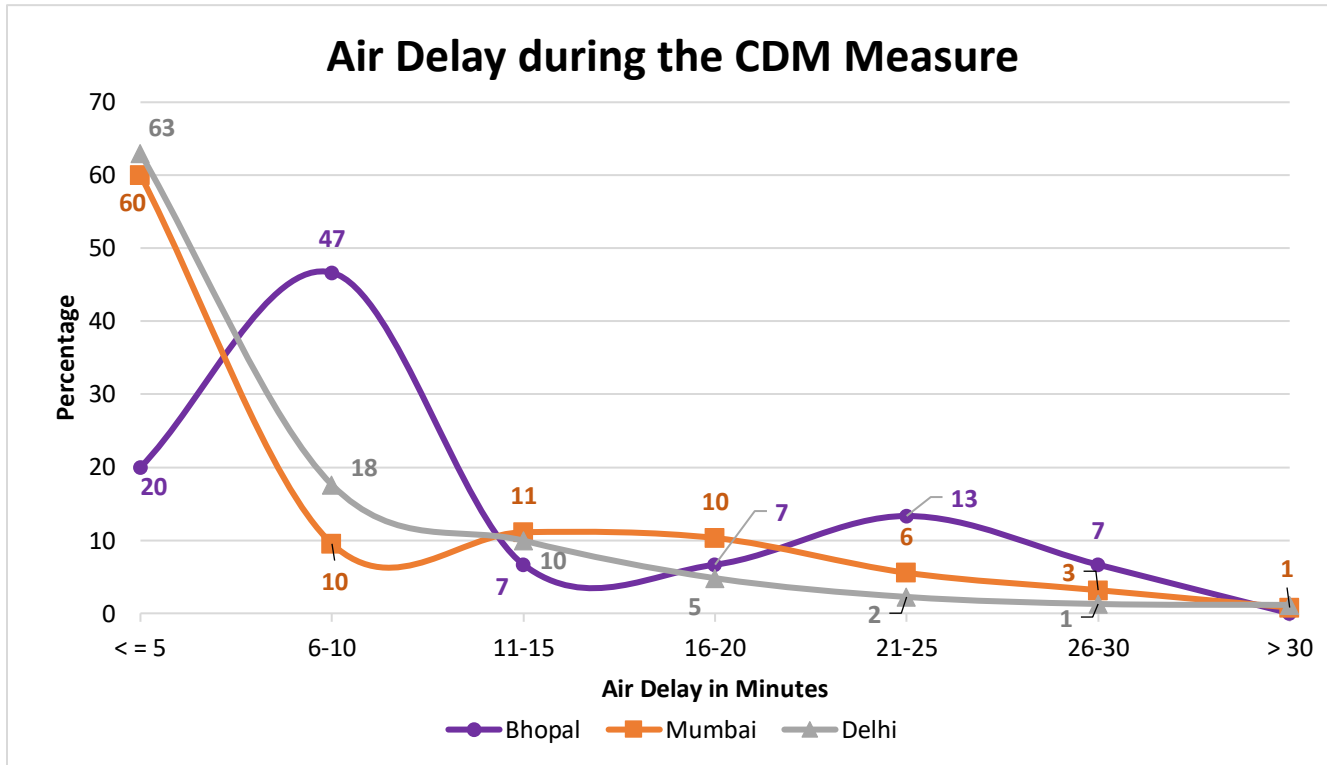


Figure 15: Air Delay distribution during the CDM period

Inference

1. 81% 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.
3. 67% of domestic arriving flights to Bhopal 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 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)= 2444 mins

Total Air Delay (with no ATFM measures) = 13498 mins

Reduction in Air delay due to ATFM measures= (13498-2444) = **11054 mins**

Fuel Saving Calculation:

Total Fuel saved during the ATFM Measure: **6,01,386.50 Kgs**

Total reduction in CO₂ emission : 3.16(KgCO₂/kg fuel)*601386.50 Kgs= 19,00,381.34 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>