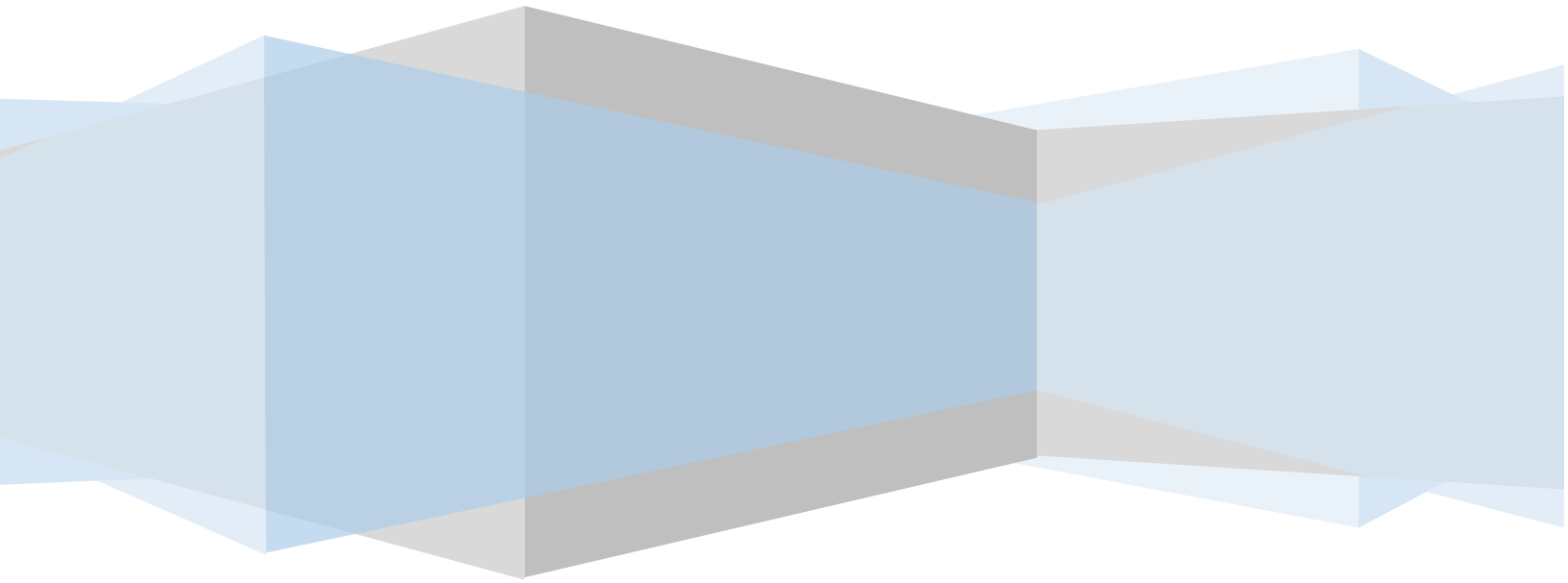
POST OPERATIONS ANALYSIS REPORT

September,2022

CENTRAL COMMAND CENTER, C-ATFM, DELHI



Contents

List of Figures

A. Executive Summary

Domestic and international air traffic(data source-AAI traffic news and SKYFLOW system) is estimated to have recorded a 8 % and 3.3 % decrease respectively in the month of September'22 as compared to August'22.

On average, the Indian Airports in the ATFCM area saw 3603 IFR flights per day.The peak day was on 29th September'22# (3827 IFR flights). Sunday's were the busiest days throughout this month with an average of 3678 flights per day.

Thirty two(32)ATFM measures were applied this month for Delhi, Mumbai and Bengaluru Airport during periods of congestion.

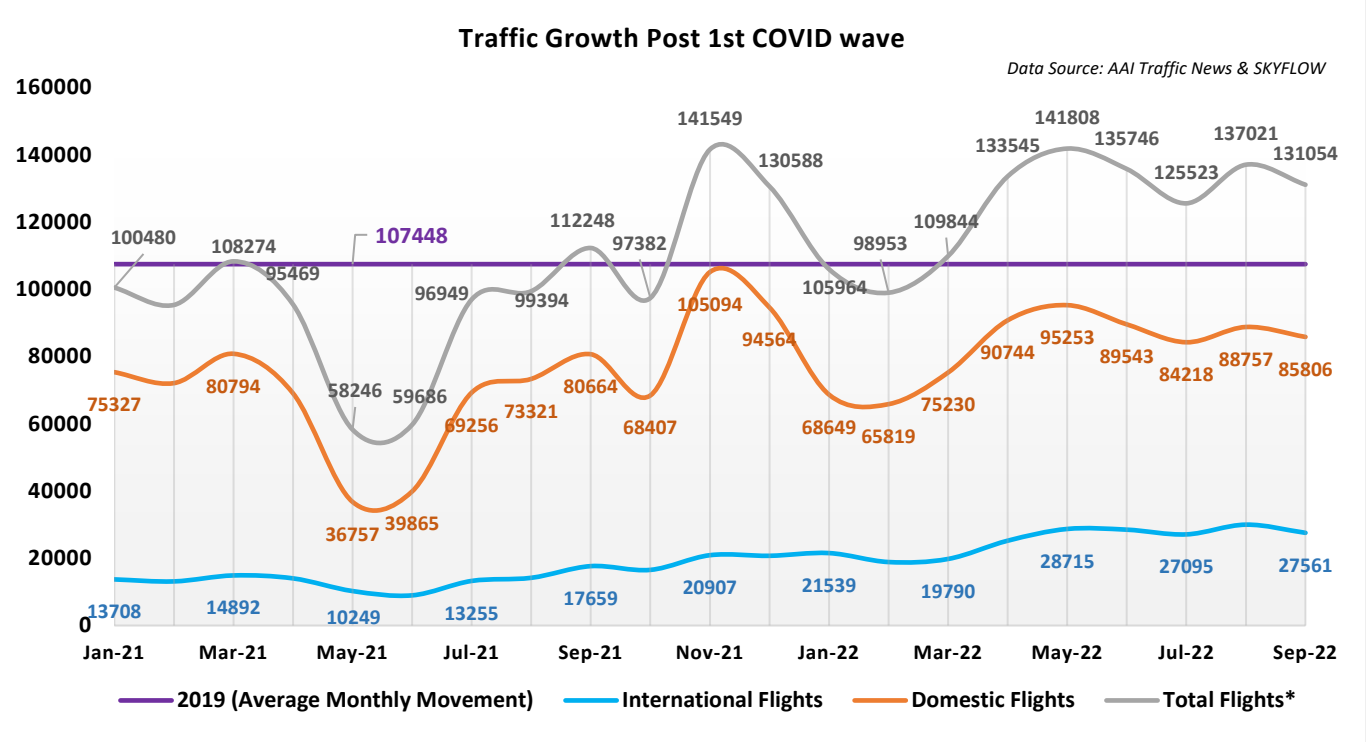


Figure 1: Traffic Growth Post 1st COVID wave

**Total Flights consists of Overflying traffic along with Domestic and International traffic*

 # Due to technical and AMSS issues, many AFTN messages were not received in SKYFLOW system on 1st Sep'22 and 2nd Sep'22. Actual movements at Airports/Airspace are more than that captured in SKYFLOW.

The graph above depicts the Domestic and international Air traffic in Indian ATFCM Area during the last 21 months (Jan' 2021 to Sep'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

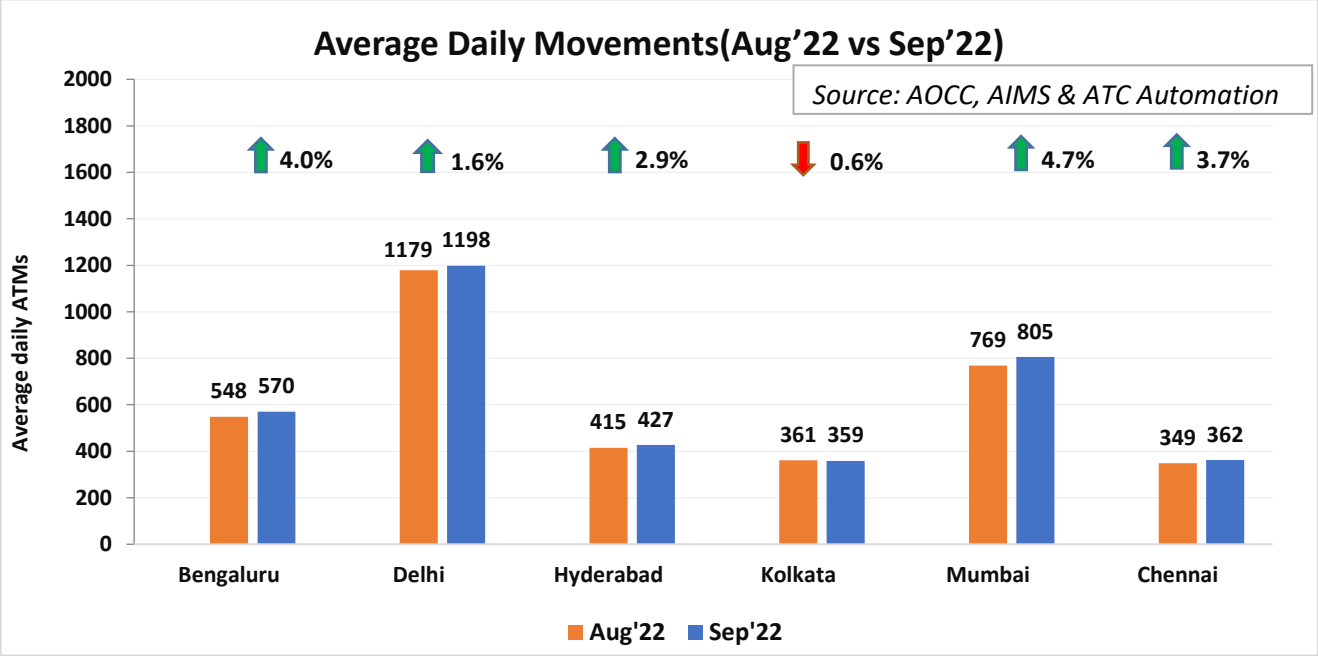


Figure 2: Average Daily Movements(Aug'22 vs Sep'22)

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

Airports\Year	Avg. Daily ATMs (YoY) for six major airports			
	Sep'19	Sep'20	Sep'21	Sep'22
Bengaluru	617	321	412	570
Delhi	1330	647	951	1198
Hyderabad	493	268	328	427
Kolkata	454	202	281	359
Mumbai	878	301	526	805
Chennai	471	168	260	362

Major Airports - Bengaluru ,Delhi, Hyderabad, Kolkata, Mumbai and Chennai recorded average daily movements 92%,90%,87%,79%,92% and 77% respectively of **September 2019** levels.

Air Traffic Movement(ATM) for each day in Sep'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.

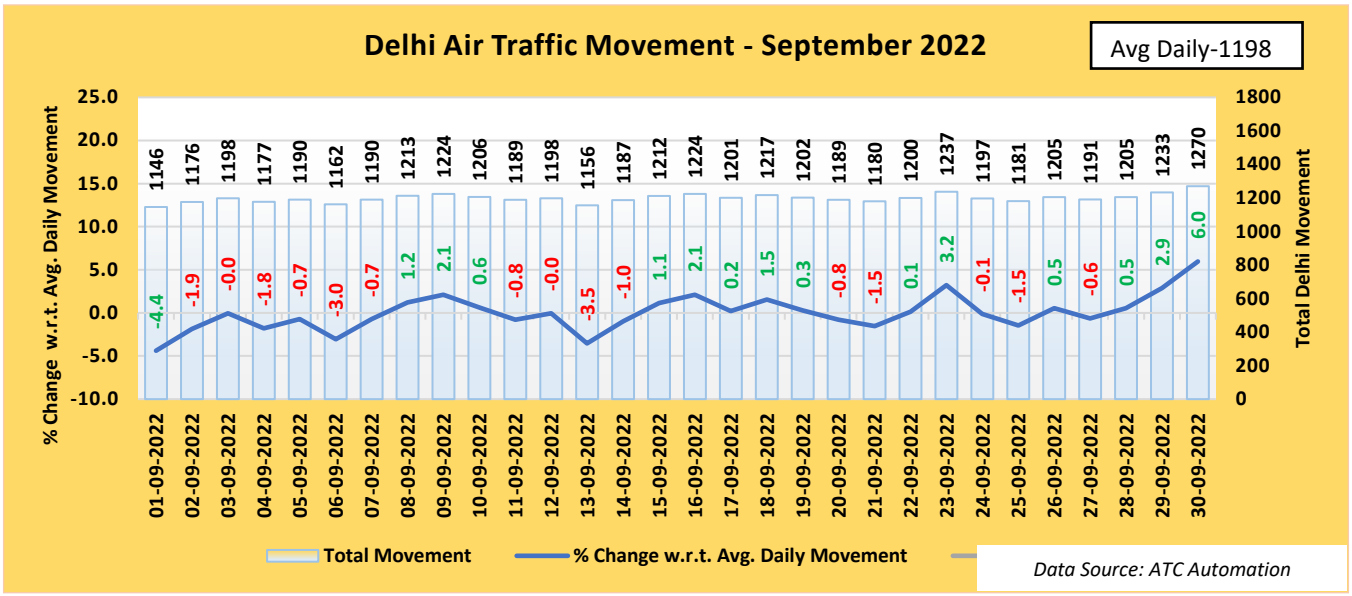


Figure 3: Air Traffic Movement for Delhi –Sep' 22

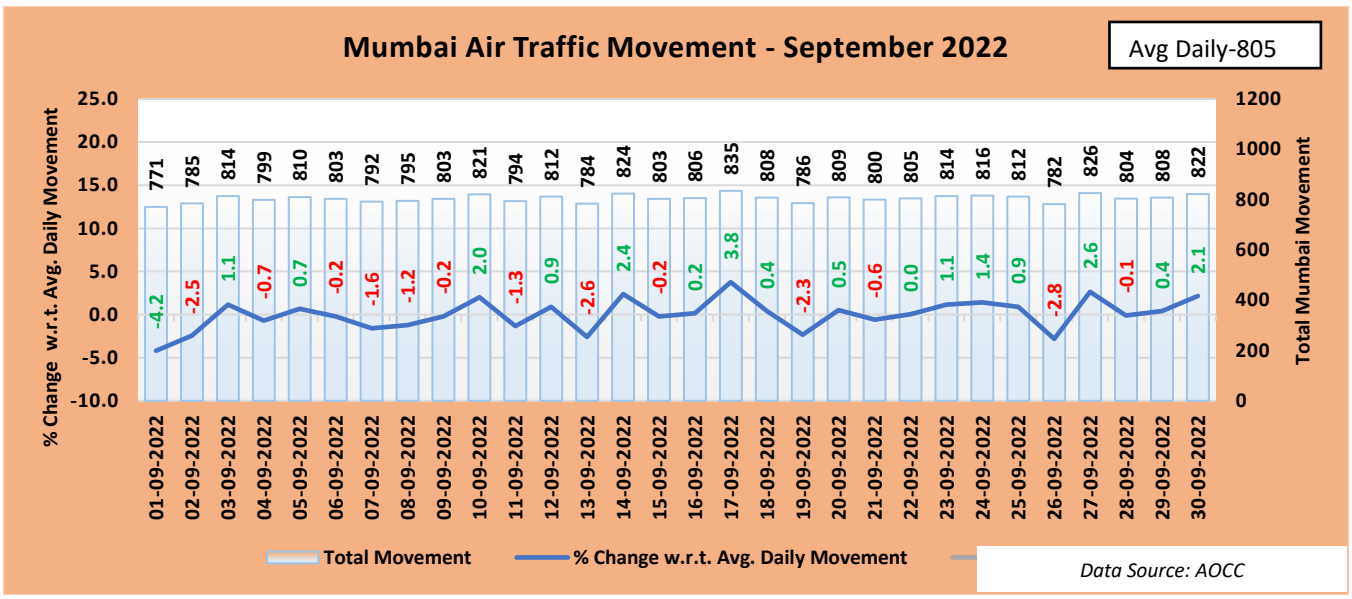


Figure 4: Air Traffic Movement for Mumbai – Sep'22

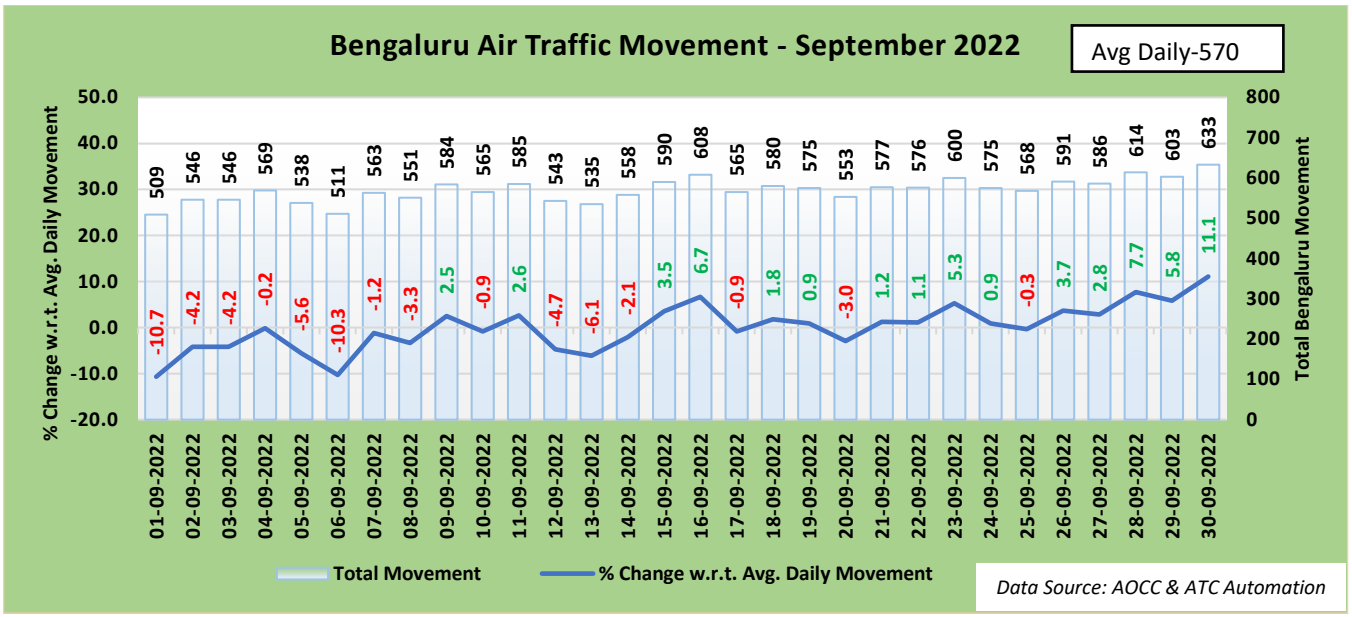


Figure 5: Air Traffic Movement for Bengaluru – Sep'22

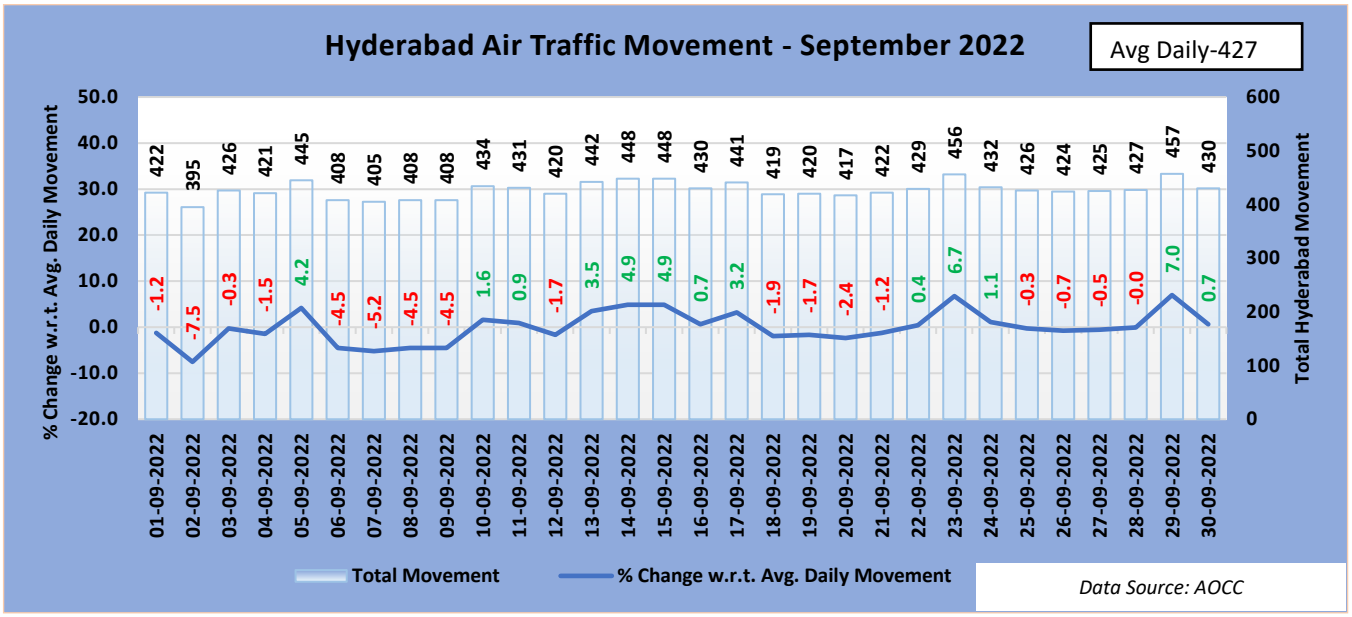


Figure 6: Air Traffic Movement for Hyderabad – Sep'22

It is evident from the above charts that on 30th September'22 the ATMs at Delhi, Mumbai, Bengaluru and Hyderabad saw an increase of 6%, 2.1%, 11.1% and 0.7% respectively as compared to the average daily movement for the month of Sep'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 September for two consecutive years. Air Traffic movement is also plotted Airline wise for the last six months for the major Scheduled Operators.

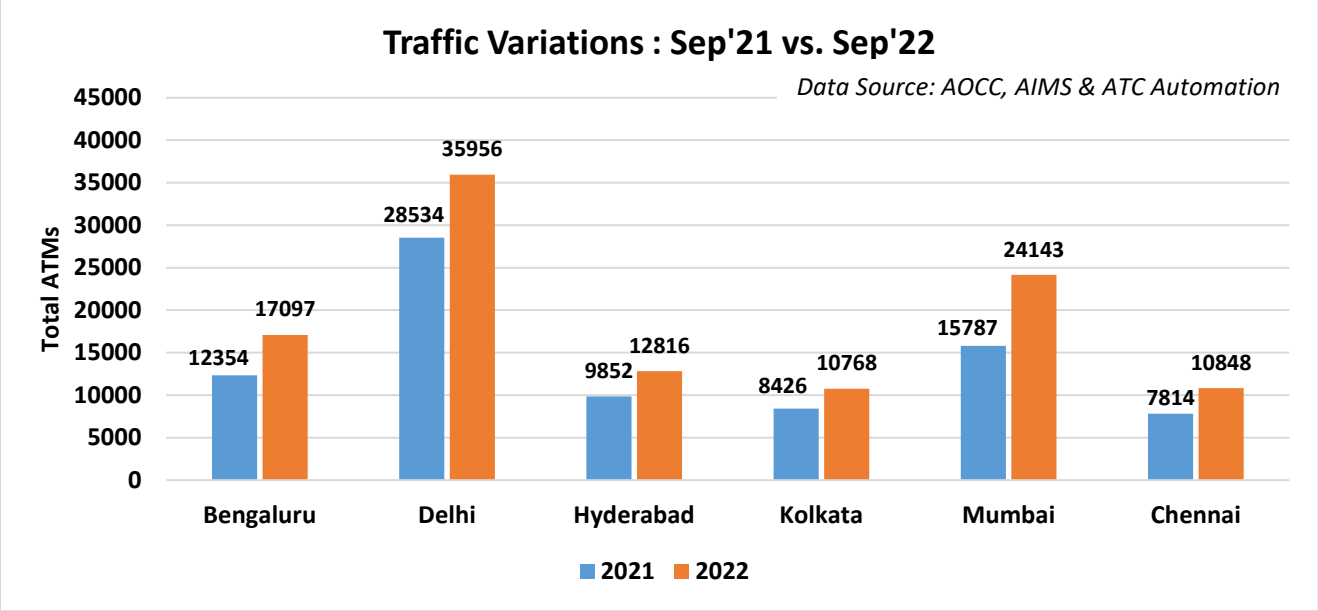


Figure 7: ***Traffic Variation (YoY)***

III. Flight Operations – Airlinewise

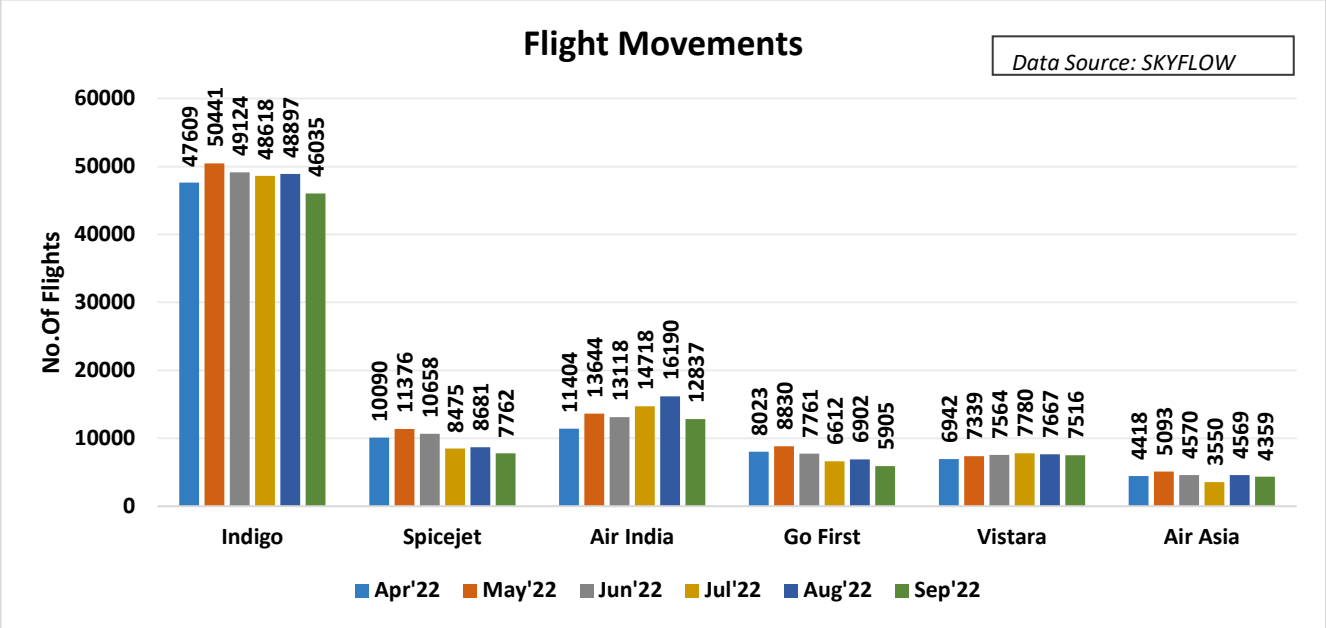


Figure 8: Flight Movements –Airlinewise

C. ATFM Post Operations – CDM Analysis

I. Introduction

Analysis Period 1st – 30th September'22

Back Ground During the above mentioned period, **twenty(20)** ATFM measures were applied **for Delhi Airport, eight(8)** ATFM measures were applied **for Mumbai Airport** and **four(4)** ATFM measures were applied **for Bengaluru Airport** due to the following reason as illustrated in the bar chart below:–

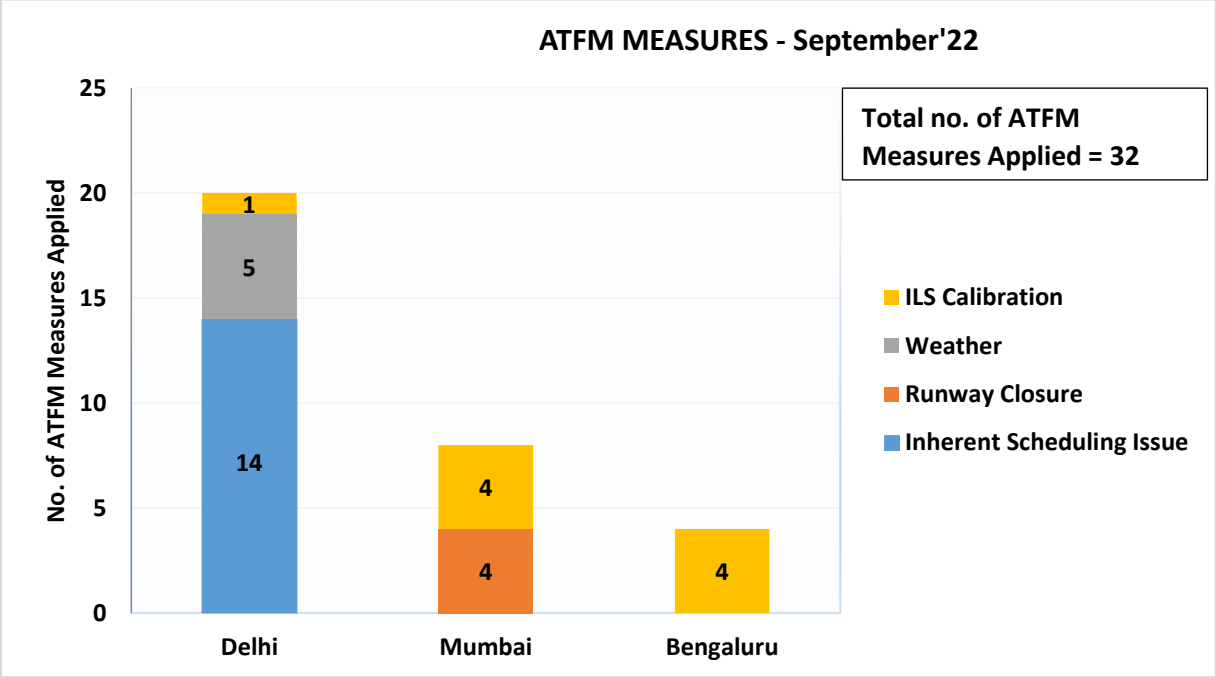


Figure 9: ATFM Measures –Sep'22

II. ATFM Measures Overview

Constrained Airport	Delhi Airport	Mumbai Airport	Bengaluru Airport
Number of ATFM measures applied	20	8	4
Average ATFM Ground delay(in min) due to measures*	12	12	16
Maximum ATFM Ground delay(in min) due to measures	59	34	49
% Compliance	77	80	82

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

Total Arrivals	1791
Total International Arrivals(exempted)	247
Total affected flights in scenario (Domestic Arrivals)	1544
Total Domestic Arrivals with zero ATFM delay	188
Total Domestic Arrivals with ATFM delay	1356

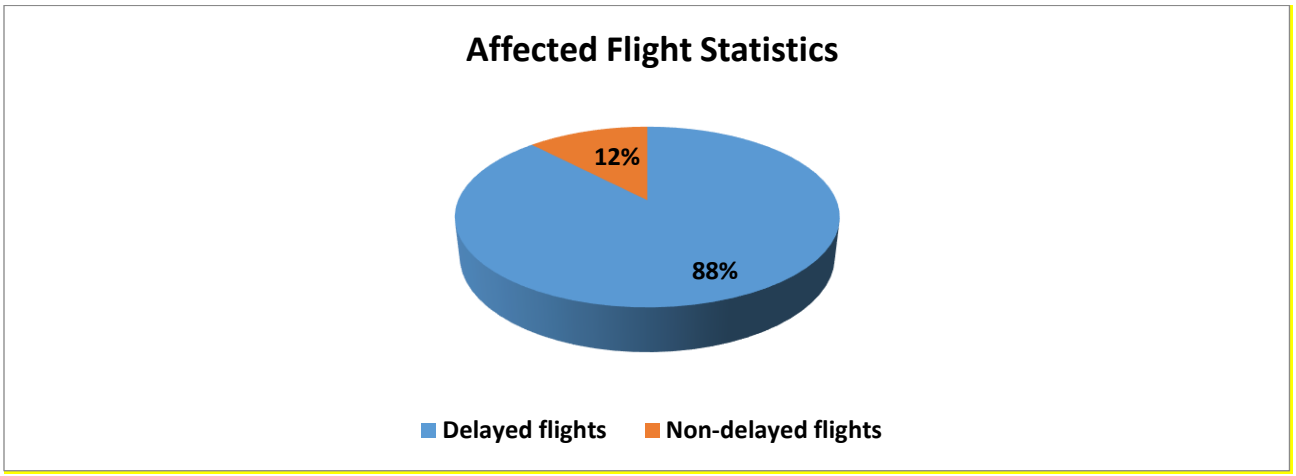


Figure 10: Affected Flight Statistics –Sep'22

III. Overall Compliance

Total arrivals	1791
Domestic arrivals	1544
Flights with complete data (ATOT)	1509
Flights with incomplete data	8
Flights Not Operated	27
Compliant*	1186
Non-Compliant	323

*Total No. of Revised CTOTs issued = 270 (Compliance calculation for flights which were issued revised CTOT is w.r.t. new CTOT issued)

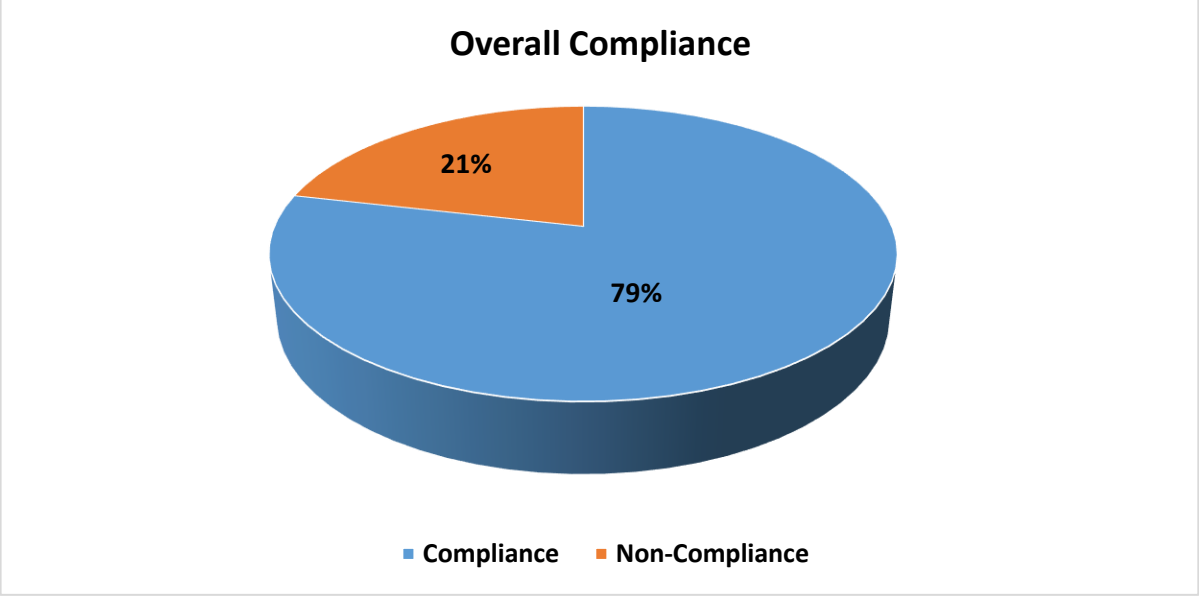


***Figure 11*: Overall Compliance – Sep'22**

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

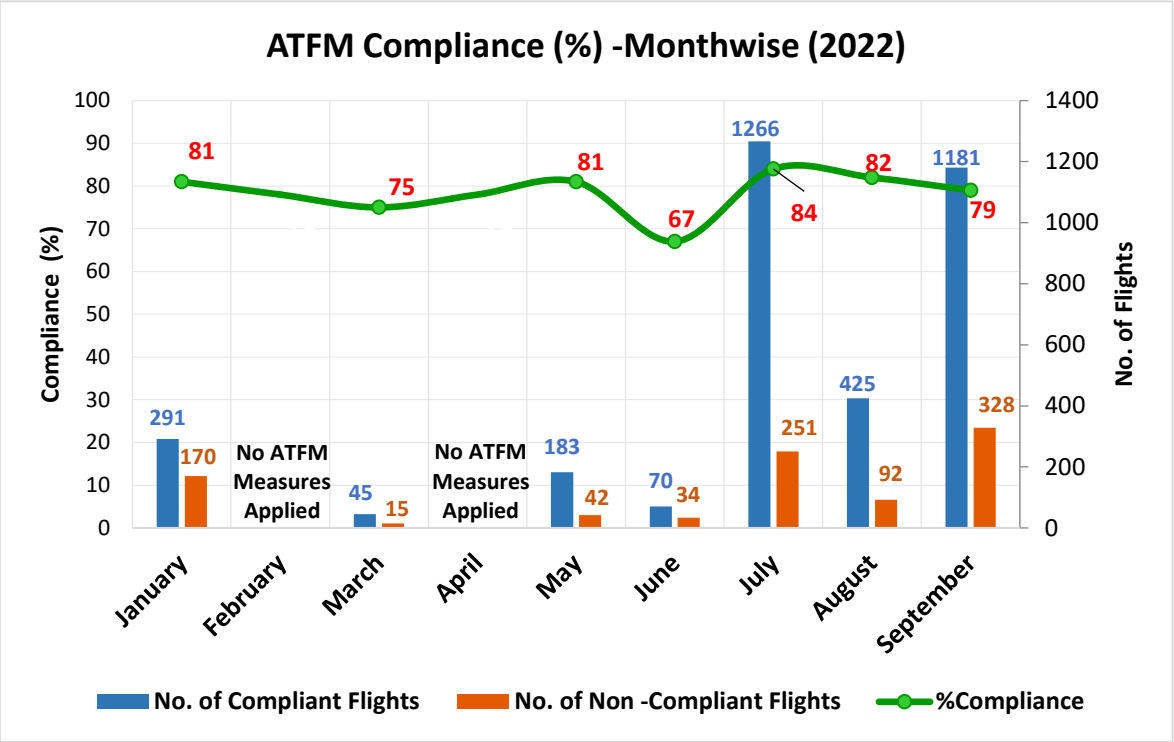


Figure 12: ATFM Compliance(Monthwise)

Inference

1. Out of the total arrivals(international + domestic) captured for the constrained Airports during the CDM scenario, 86% of flights i.e. most domestic arrivals, are participating.
2. Out of these Domestic Arrivals, 88% are assigned ATFM ground delay.
3. Out of the total arrivals captured to the constrained Airport during the ATFM scenario, 76% of flights are assigned ATFM Ground Delay.

IV. CTOT Compliance rate – Airportwise

MUMBAI FIR (81%)*	Compliant	Non Compliant	%Compliant
Ahmedabad	66	10	86
Bhopal	24	2	92
Indore	25	4	86
Jabalpur	9	1	90
Kandla	5	3	63
Nagpur	19	5	79
Surat	11	4	73
Udaipur	20	0	100
Jamnagar	5	2	71
Aurangabad	10	1	91
Rajkot	15	4	79
Shirdi	5	2	71
Mumbai	129	31	81
Vadodara	9	3	75
Pune	31	19	62
KOLKATA FIR (84%)*			
Allahabad	4	1	80
Kolkata	67	11	86
Bhubnaeshwar	27	1	96
Chakeri	0	1	0
Durgapur	2	2	50
Darbangha	3	2	60
Imphal	2	0	100
Jharsuguda	2	1	67
Dibrugarh	3	2	60
Dimapur	1	0	100
Ranchi	23	1	96
Raipur	17	2	89
Deogarh	0	1	0
Pakyong	1	0	100
Agartala	0	2	0
Bagdogra	21	10	68
Varanasi	19	4	83
Gorakhpur	3	2	60
Guwahati	26	5	84
Gaya	2	0	100
Patna	39	3	93

DELHI FIR (68%)*			
Amritsar	13	1	93
Hindon	0	2	0
Gaggal	6	3	67
Jodhpur	8	4	67
Jaipur	21	5	81
Jammu	8	4	67
Bareily	1	3	25
Agra	1	1	50
Bhunter	0	3	0
Pantnagar	1	1	50
Gwalior	2	1	67
Bikaner	0	2	0
Thoise	0	3	0
Chandigarh	14	16	47
Dehradun	16	5	76
Delhi	31	10	76
Leh	20	10	67
Lucknow	39	12	76
Srinagar	42	18	70
Pathankot	1	0	100
Bathinda	0	1	0
CHENNAI FIR (81%)*			
Goa	47	20	70
Bengaluru	68	10	87
Chennai	61	10	86
Porbandar	1	0	100
Shamshabad	65	10	87
Begumpet	1	0	100
Calicut	2	1	67
Vijaywada	5	1	83
Madurai	2	1	67
Coimbatore	8	3	73
Trivandrum	5	2	71
Vishakhapattnam	15	4	79
Belgaum	2	0	100
Mangaluru	8	2	80
Vijaynagar	2	0	100
Rajahmundry	1	0	100
Cochin	12	2	86
Tirupati	2	0	100
Mysore	0	1	0

Tiruchipalli	0	1	0
Kalaburagi	1	0	100
Cuddapah	1	0	100
Tuticorin	1	1	50
Kurnool	1	0	100
Kannur	0	1	0
Hubli	3	3	50
Sindhudurg	3	0	100

**FIR wise compliance rate*

Note: The above list contains only those airports which had flights to the Constrained Airport and were advised ground delay (affected by ATFM measures).

V. Reason For Non Compliance

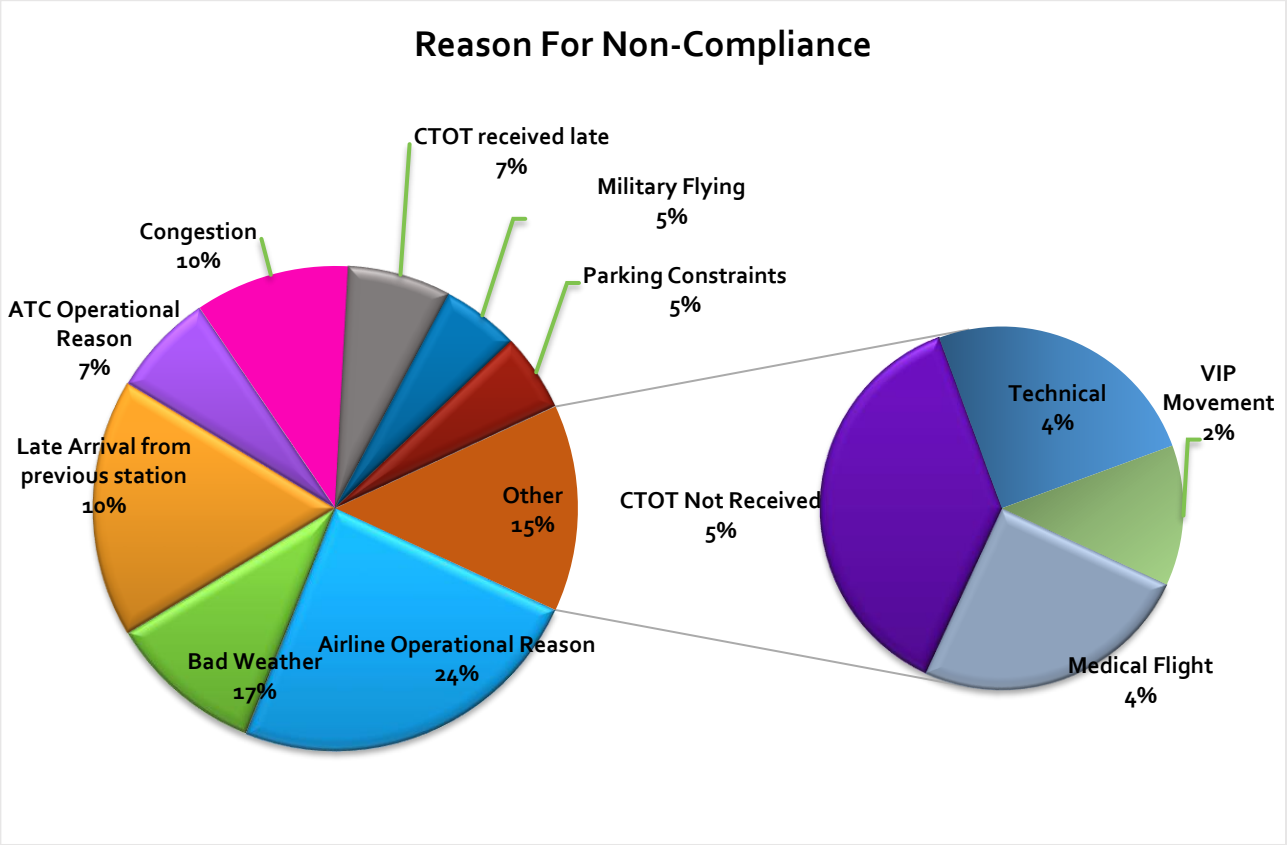


Figure 13: Reason for Non-Compliance as provided by FMPs

Inference

1. 24% of the CTOT Non- compliance was reported to be because of Airline Operational reason.
2. Bad weather at the departure Airport is identified as an important contributing factor for Non-Compliance by the FMP.
3. 10% of the CTOT Non- compliance was reported by concerned FMP to be because of late arrival of the flight from the previous station.The same was not intimated to CCC for any slot revision.

VI. CTOT Compliance rate – Airlinewise

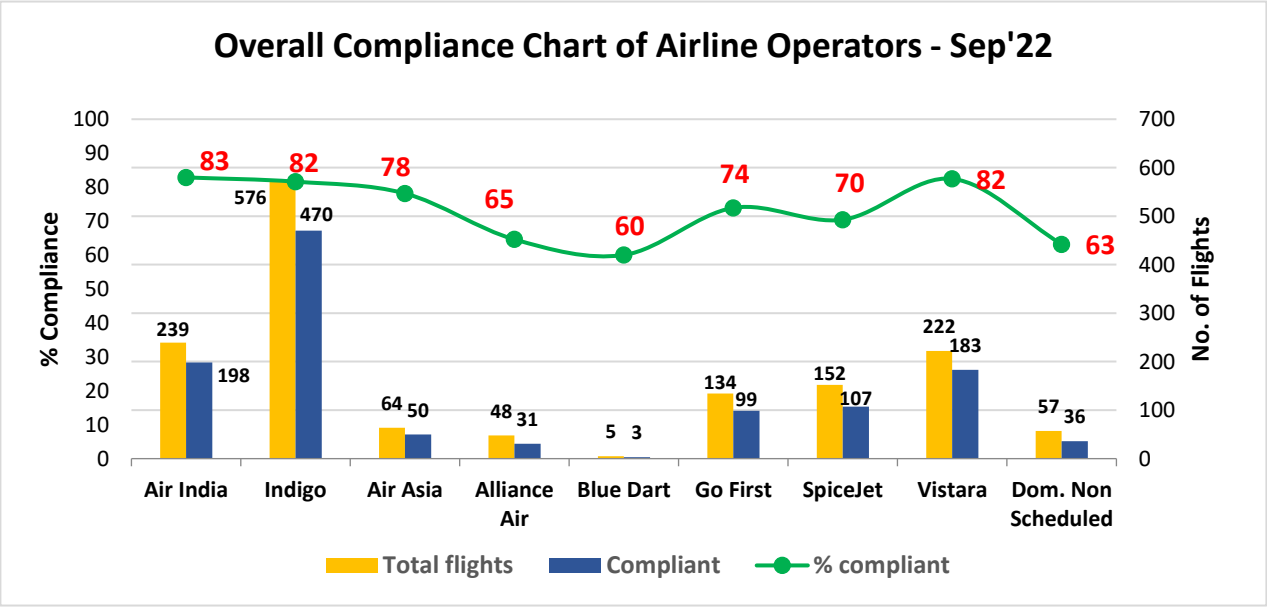


Figure 14: Airline wise Compliance –Sep'22

Inference

1. Out of the total domestic arrivals with complete data in the CDM scenario, 79% arrivals are compliant.
2. Kolkata region has the highest compliance rate of 84% whereas Delhi region has the lowest compliance rate of 68%.
3. Air India, Indigo and Vistara have a CTOT compliance higher than the average recorded compliance for the month of September'22.

VII. Air Delay during the CDM Scenario period

Average Air Delay to domestic arrivals* within the CDM Scenario period for Delhi, Mumbai and Bengaluru is 8 minutes, 17 minutes and 10 minutes respectively.

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

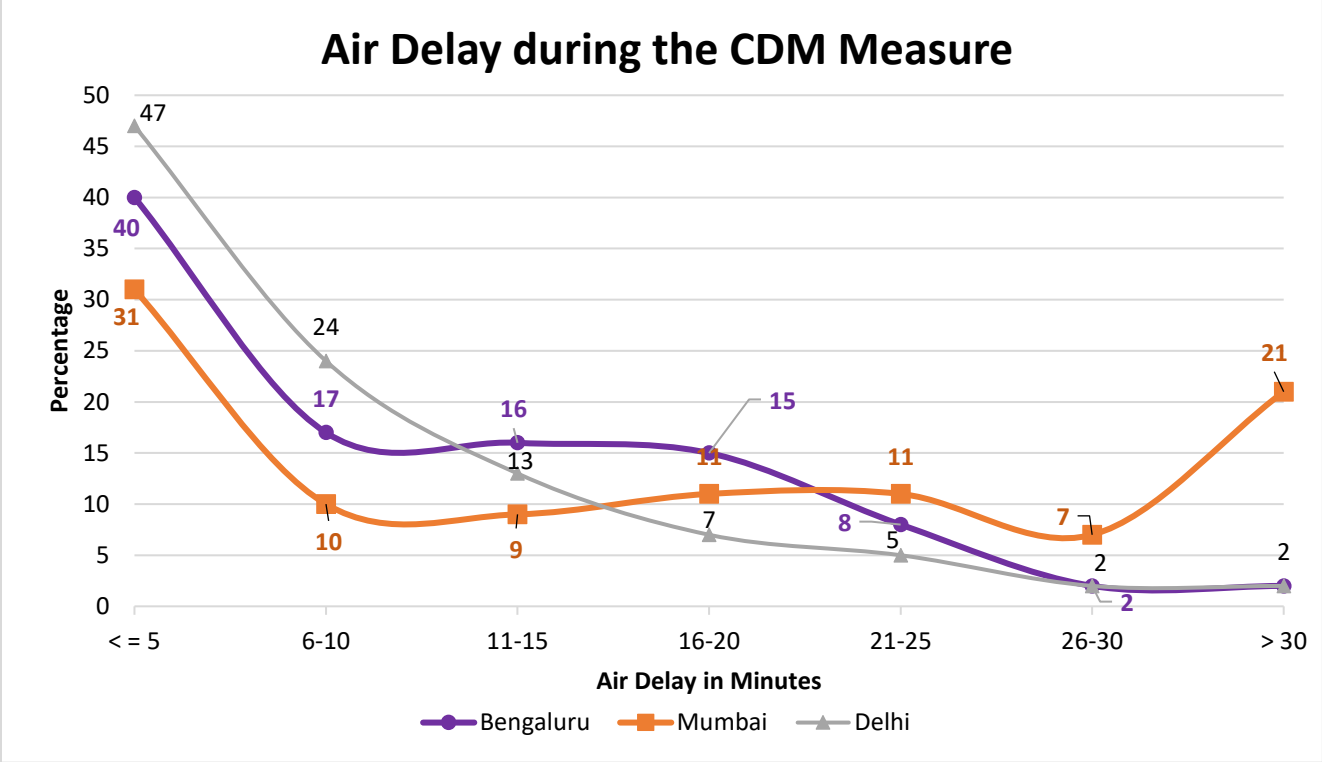


Figure 15: Air Delay distribution during the CDM period

Inference

1. 71% of domestic arriving flights to Delhi had an Air delay of equal to or less than 10 minutes during the CDM period.
2. 41% of domestic arriving flights to Mumbai had an Air delay of equal to or less than 10 minutes during the CDM period.
3. 57% 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 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)= 8531 mins

Total Air Delay (with no ATFM measures) = 15719 mins

Reduction in Air delay due to ATFM measures= (15719-8531) = **7188 mins**

Fuel Saving Calculation:

Total Fuel saved during the ATFM Measure: **3,94,192.80 Kg**

Total reduction in CO_2 emission : 3.16(KgCO_2/kg fuel)* 3,94,192.80 Kg = 12,45,649.24 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**
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*