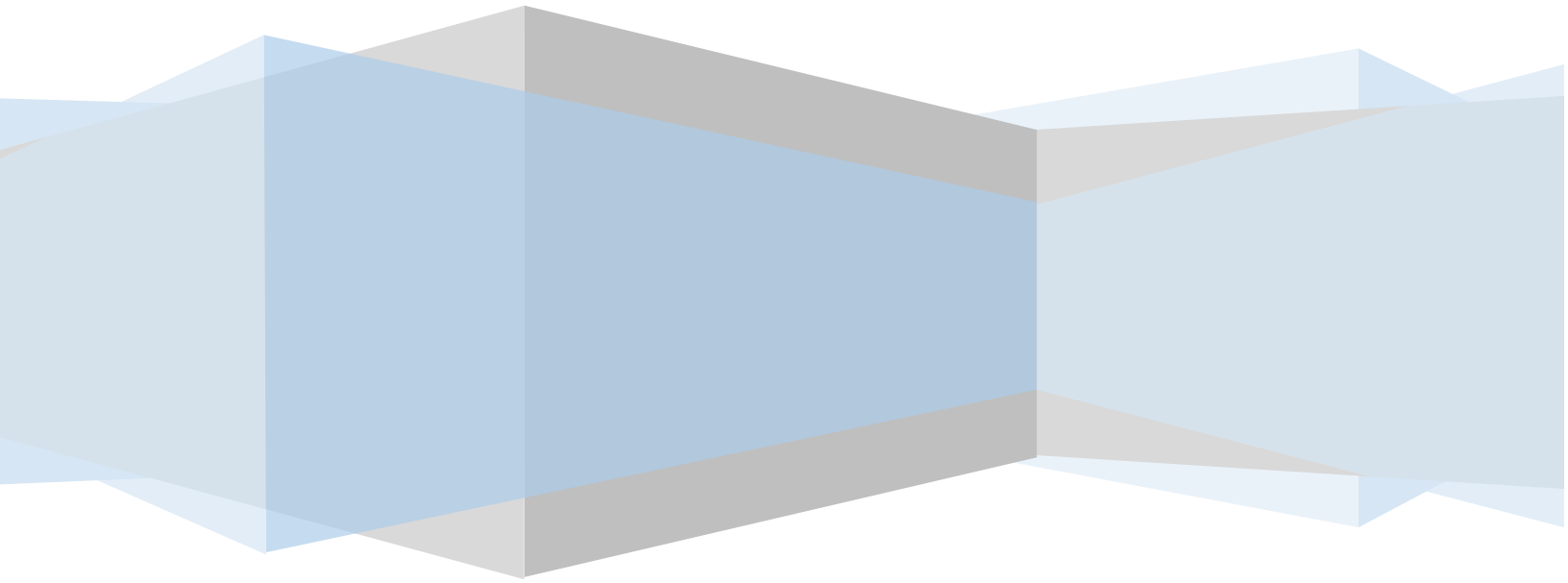
POST OPERATIONS ANALYSIS REPORT

February, 2021

CENTRAL COMMAND CENTER, C-ATFM, DELHI



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A. Executive Summary

International Commercial scheduled flights continue to remain suspended in India till 1829 UTC of 31st March'21(NOTAM G0172/21 replacing NOTAM G0067/21). However, special international flights have been permitted since May last year under the Vande Bharat Mission and under air bubble arrangements formed with around 24 countries since July'20. Under a bilateral air bubble arrangement, airlines of the two countries can operate flights between their territories with certain restrictions.

Domestic flight operations resumed on 24th May'20 and has shown continous recovery. Experts believe that the key factors that will determine the pace of recovery in the domestic market are development and availability of vaccines, people's willingness to undertake leisure travel and recovery in macroeconomic growth.

Total nine (9) number of times ATFM measures were applied to resolve Demand Capacity imbalance in Feb'21. Ground delay measures were applied in Bengaluru to cater to traffic congestion owing to Airspace/Airport Closure during the Aero India Show and Scheduled Runway Maintenance. The average CTOT Compliance has been 85 percent this month.

Traffic Analysis

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 and all other aircraft movements at six major Indian Airports namely Delhi, Mumbai, Bengaluru, Hyderabad, Kolkata and Chennai is plotted for each day of the month of Feb'21.

The data used is the movement data received from Delhi, Mumbai, Bengaluru and Hyderabad Airport. AIMS (Airport Information Management System) data is used for Kolkata and Chennai Airport. Air Traffic movement is also plotted Airline wise for the month for the major Scheduled Operators.

I. Comparison of total ATMs (YoY) and Month wise

The graph below depicts the change in total ATMs in the month of Feb'21 in comparison to the total ATMs in Feb'20 for six major Airports in India. The recovery in February is comparatively slower for all the six major airports. Bengaluru is showing the most recovery among the six airports i.e, the traffic in Feb'21 is only 29.8% less than Feb'20 whereas the traffic handled in Delhi,Mumbai Kolkata,Hyderabad and Chennai are 32.1%, 32.7%, 34.2%, 35.4%and 40.3.% respectively less than the traffic handled in Feb'20.

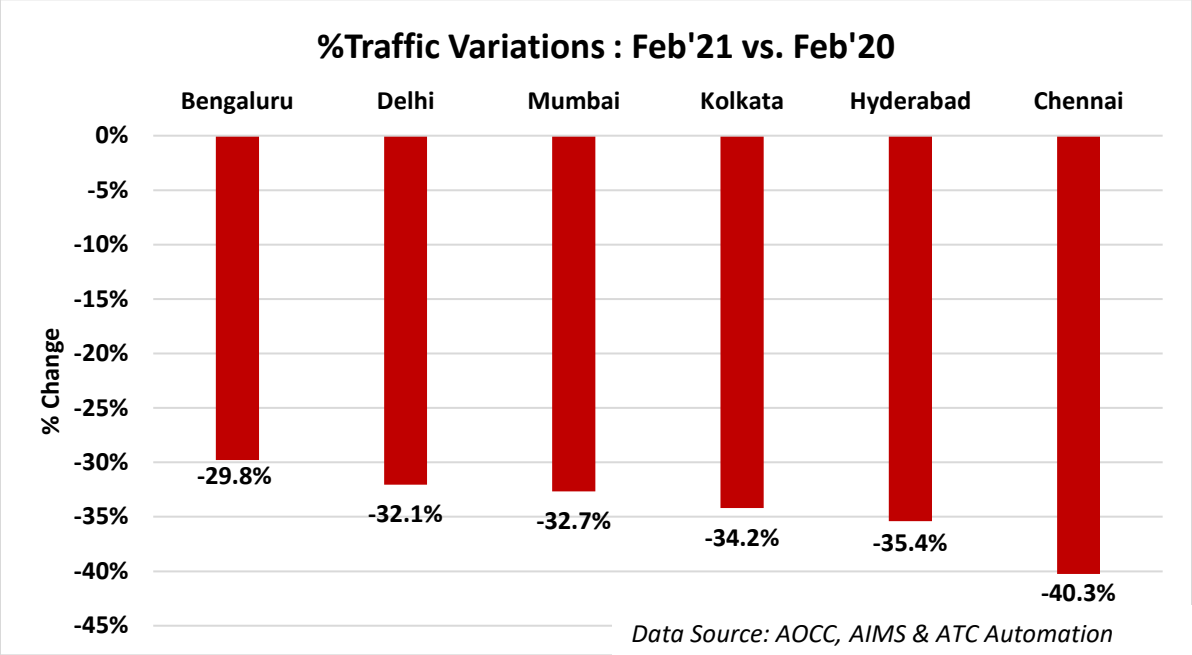
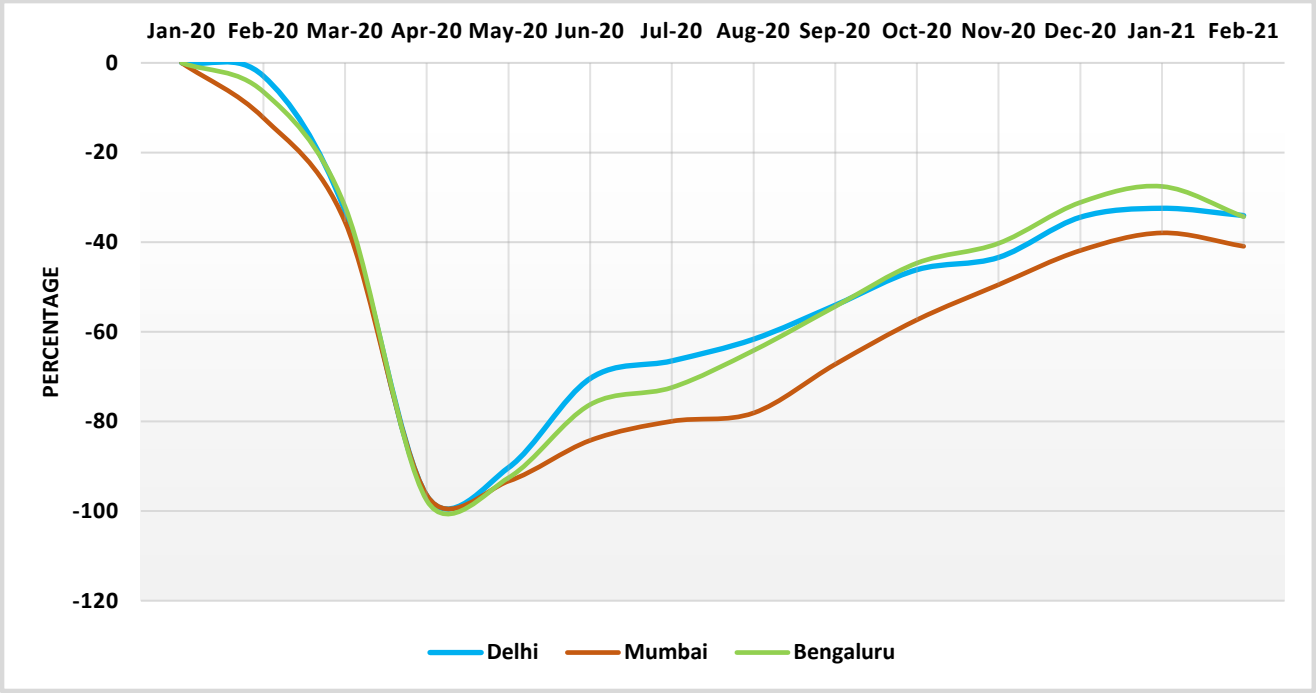


Figure 1: Percentage Traffic Variation (YoY)

Total ATMs (YoY) for six major airports		
Airports\Year	**Feb'21**	**Feb'20**
Bengaluru	**13866**	**19752**
Delhi	**27867**	**41021**
Mumbai	**16466**	**24457**
Kolkata	**9260**	**14079**
Hyderabad	**9994**	**15474**
Chennai	**8713**	**14583**

The graphs below depict the percentage change in ATMs month wise taking Jan'20 as the reference value for the six metro Airports.



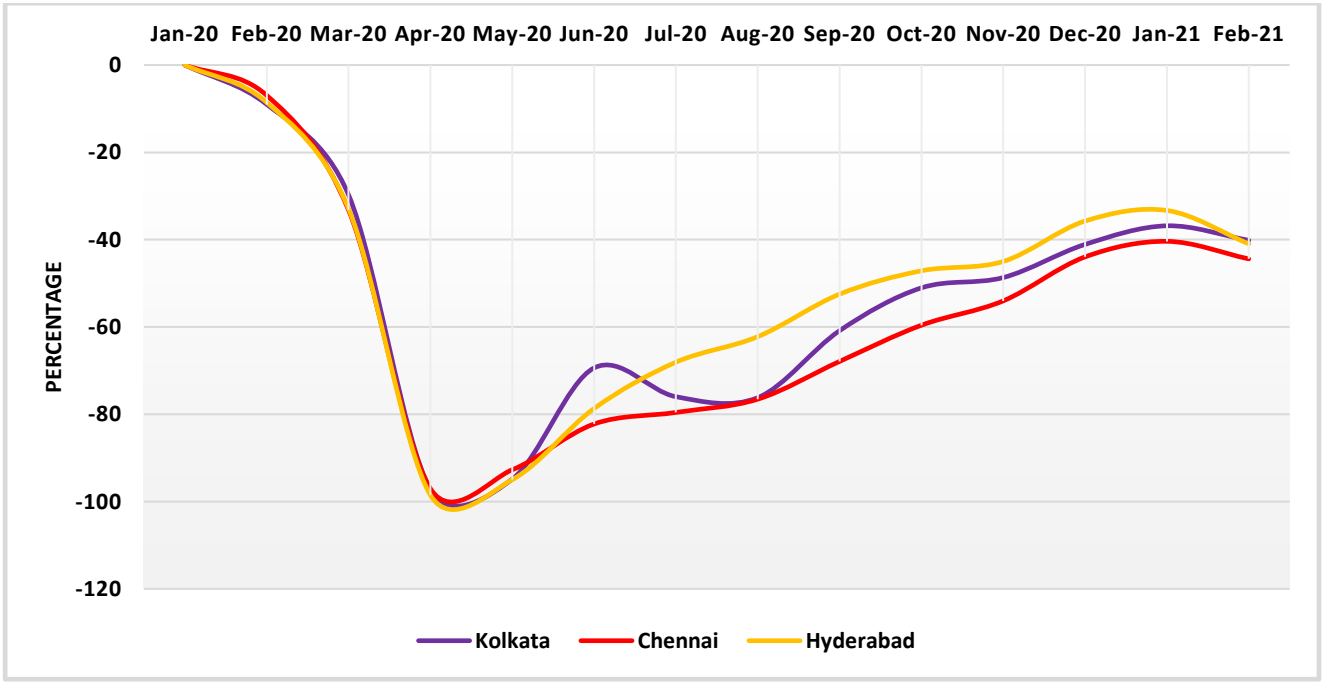


Figure 2: Percentage Traffic Variation

II. Flight Operations – Airline wise

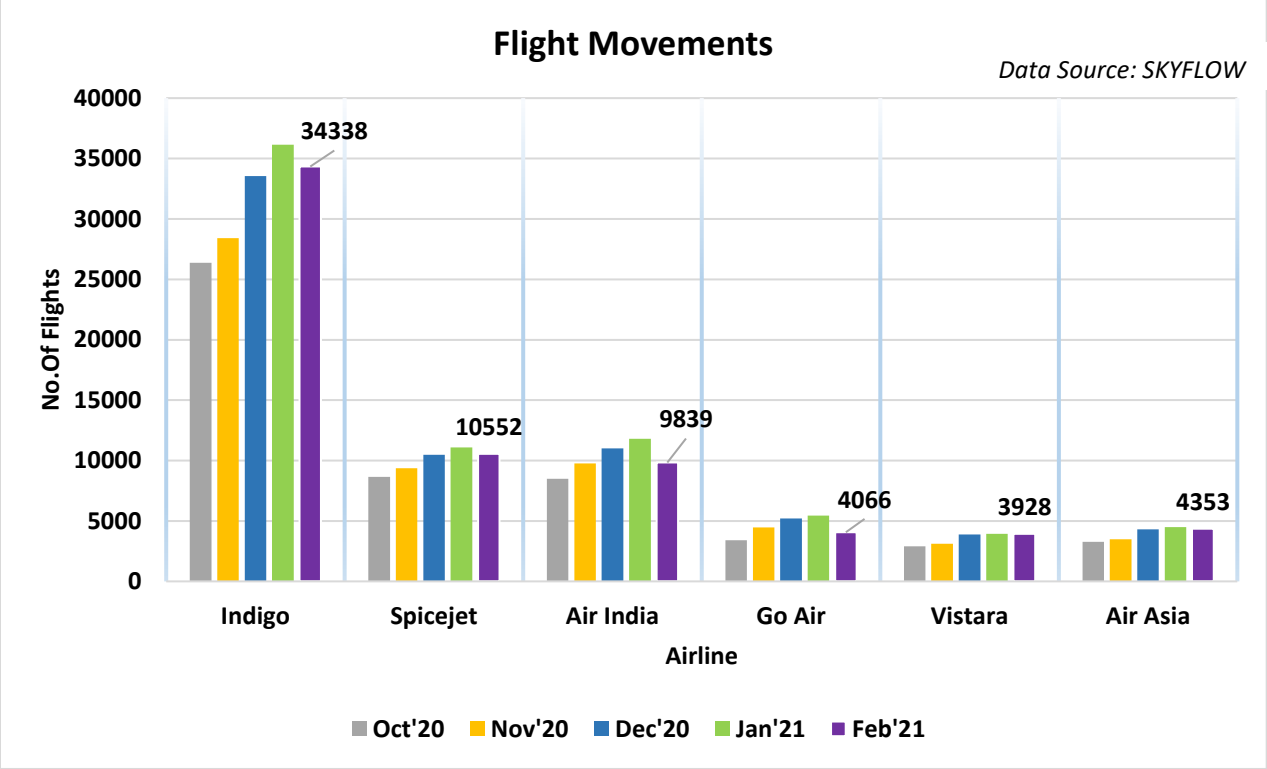


Figure 3: Flight Movements – Airline wise

B. ATFM Post Operations – CDM Analysis

I. Introduction

Analysis Period 1st – 28th February'21

Back Ground During the above mentioned period, ATFM measures were applied **nine(9) times for Bengaluru Airport** due to the following reasons as illustrated in the bar chart below:–

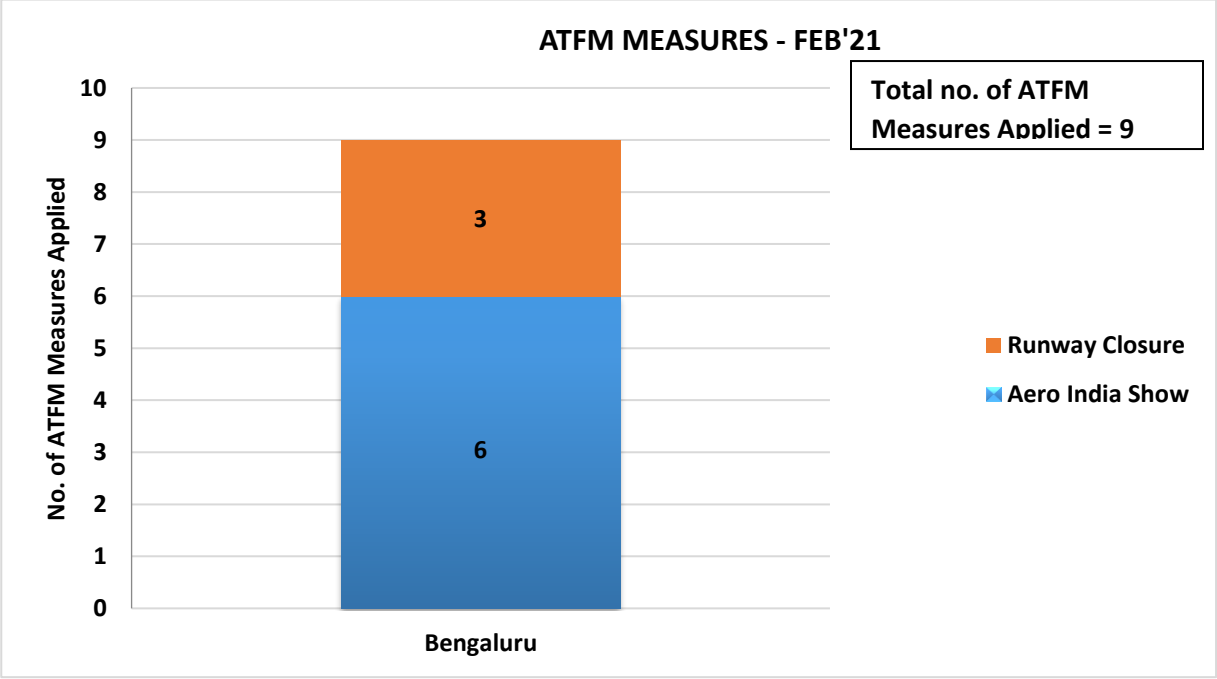


Figure 4: ATFM Measures – Feb'21

II. ATFM Measures Overview

	Bengaluru Airport
Number of ATFM measures applied	9
Average ATFM Ground delay due to measures	17 min
Maximum ATFM Ground delay due to measures	44 min
% Compliance	85

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

Total affected flights in scenario (Domestic Arrivals)	232
Total Domestic Arrivals with zero ATFM delay	23
Total Domestic Arrivals with ATFM delay	209

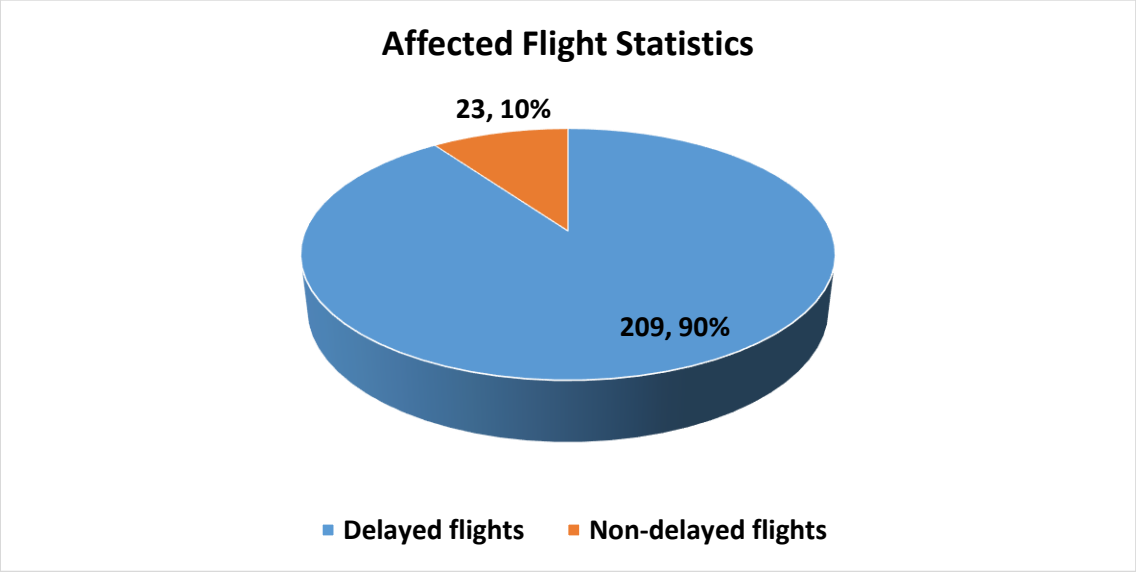


Figure 5: Affected Flight Statistics – Feb'21

III. Overall Compliance

Total Arrivals	250
Domestic arrivals	232
Flights with complete data (ATOT)	229
Flights with incomplete data	2
Flights Not Operated	1
Compliant*	194
Non-Compliant	35

Total No. of Revised CTOTs issued = 40 (Compliance calculation for flights which were issued revised CTOT is w.r.t. new CTOT issued)

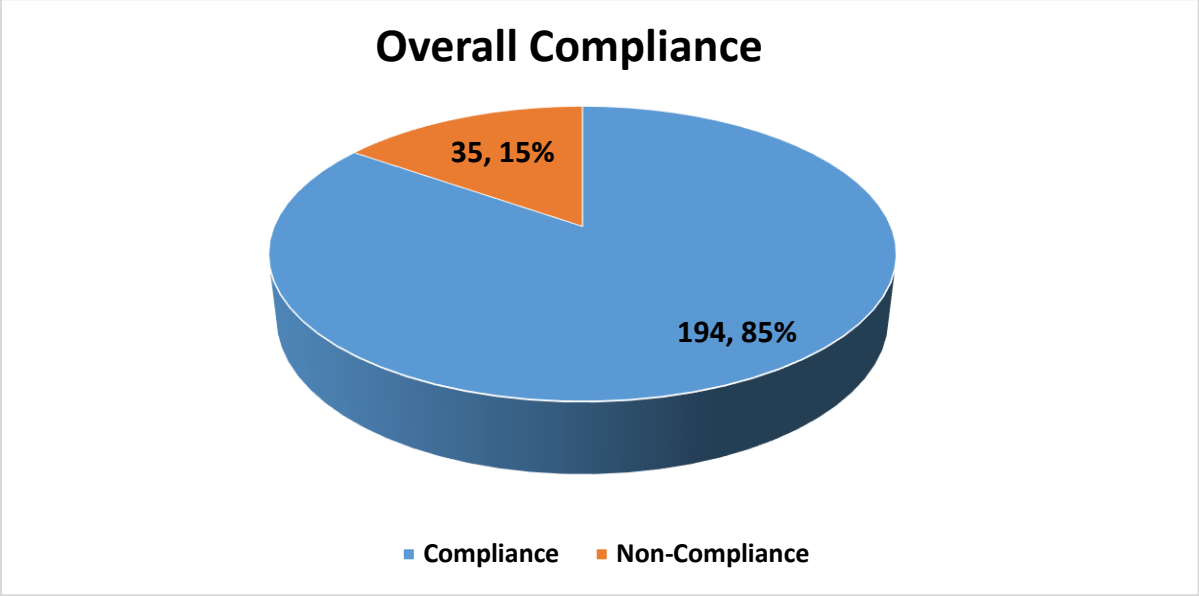


Figure 6: Overall Compliance – Feb'21

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

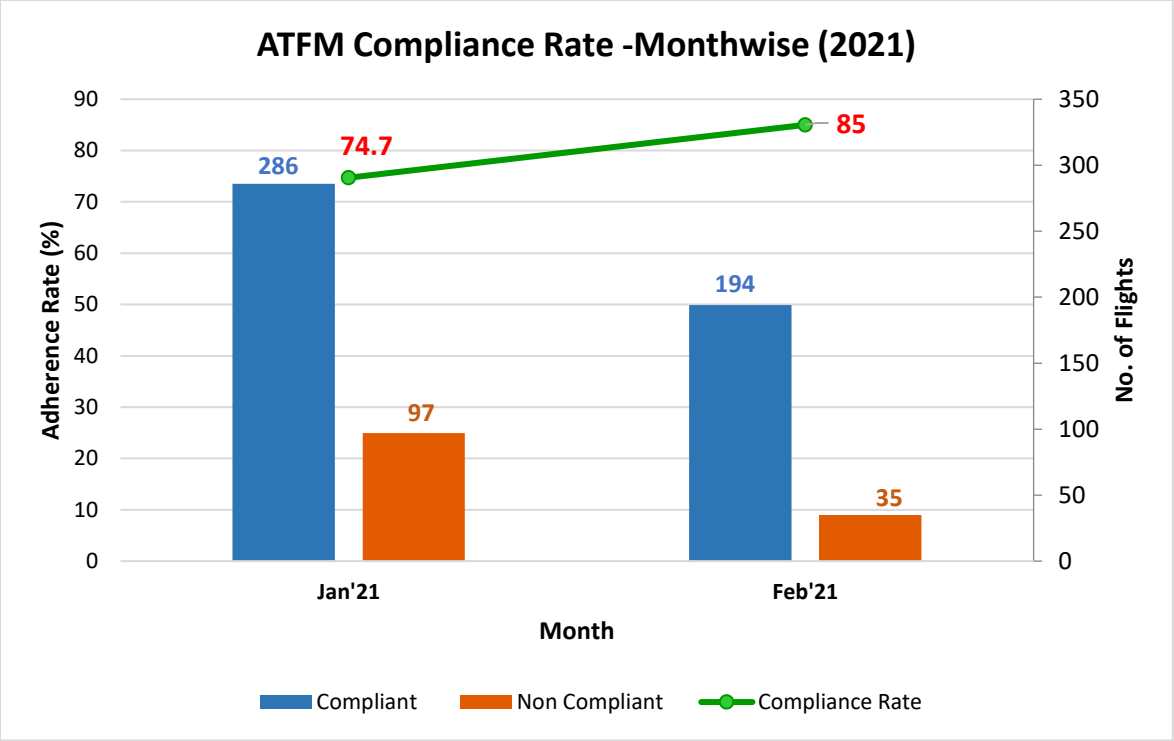


Figure 7: ATFM Compliance-Monthwise

Inference

1. Out of the total arrivals captured for the constrained Airports during the CDM scenario , 93% of flights i.e. Domestic arrivals, are participating.

2. Out of these Domestic Arrivals, 90% of arrivals are assigned ATFM ground delay & 10% of flights are without any ATFM ground delay.

3. Out of the total arrivals captured to the constrained Airport during the ATFM scenario, 84% of flights are assigned ATFM Ground Delay.

IV. CTOT Compliance rate – Airport wise

MUMBAI FIR (81%)*	Compliant	Non Compliant	%Compliant
Mumbai	11	2	85
Pune	1	1	50
Shirdi	1	1	50
Bhopal	3	0	100
Ahmedabad	5	2	71
KOLKATA FIR (78.2%)*			
Kolkata	14	1	93
Guwahati	10	2	83
Allahabad	2	2	50
Gorakhpur	0	2	0
Darbangha	0	1	0
Patna	8	3	73
Bagdogra	5	4	56
Bhubhaneshwar	5	2	71
DELHI FIR (86%)*			
Delhi	19	3	86
Jaipur	8	0	100
Gwalior	1	1	50
Lucknow	6	2	75
Chandigarh	4	1	80
Dehradun	3	0	100
CHENNAI FIR (93%)*			
Chennai	13	0	100
Belgaum	7	0	100
Hyderabad	12	1	92
Mangalore	5	0	100
Kannur	1	0	100
Vijayawada	0	1	0
Kalaburagi	4	1	80
Hubli	0	1	0
Vishakhapatnam	3	1	75
Cochin	7	0	100

**FIR wise compliance rate*

V. CTOT Compliance rate – Airline wise

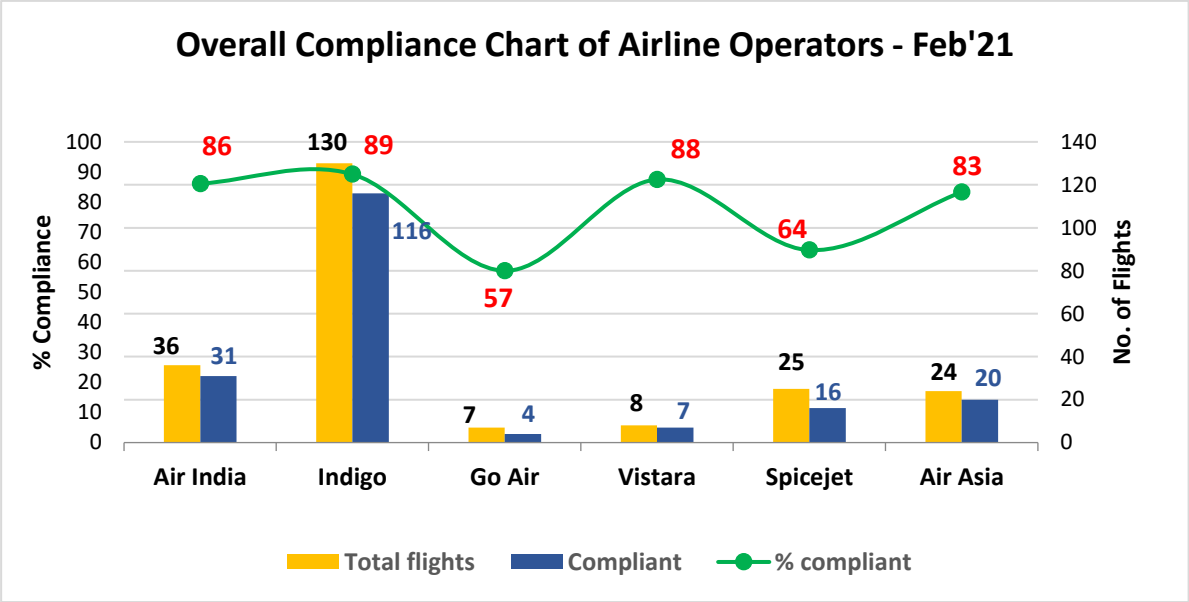


Figure 8: Airlines Overall Compliance – Feb'21

Inference

1. Out of the total domestic arrivals with complete data in the CDM scenario, 85% arrivals are compliant.
2. Chennai region has the highest compliance rate of 93% whereas Kolkata region has the lowest compliance rate of 78.2%.
3. Air India, Indigo and Vistara have a compliance rate above the average recorded 85% compliance.

VI. Air Delay during the CDM Scenario period

Average Air Delay to domestic arrivals* within the CDM Scenario period for Bengaluru is 4 minutes .

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

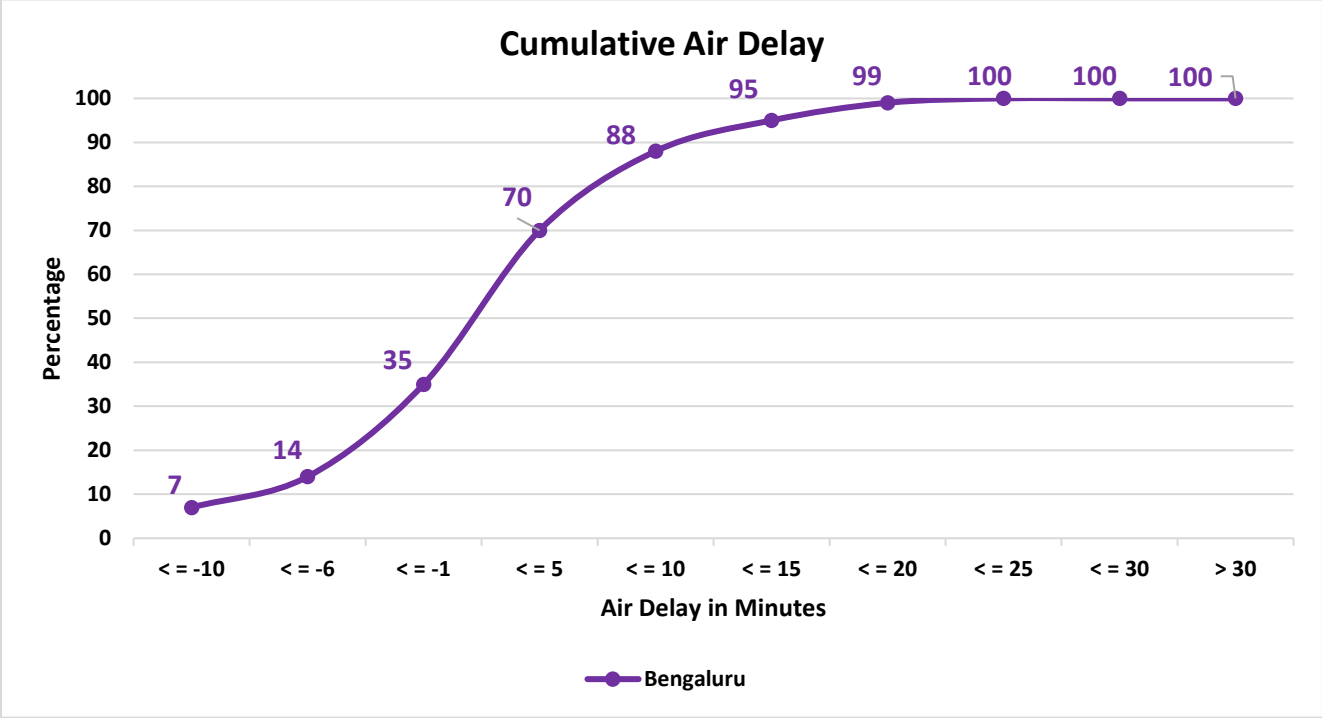


Figure 9: Cumulative Air Delay during CDM period

Inference

1. 88% of arriving flights to Bengaluru had an Air delay of equal to or less than 10 minutes during the CDM period.

C. 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 the ATFM 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, 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** 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*

ANNEXURE-I

CASE STUDY

Bengaluru Aero India show (2021)

A. Introduction:

Aero India is a biennial air show organised by the Defence Exhibition Organisation, Ministry of Defence. The 13th edition of AERO INDIA 2021 which included an Aerospace, Defence and Civil Aviation Exhibition was held from 03 - 05 February 2021, at Air Force Station, Yelahanka, Bengaluru.

Bengaluru Kempegowda Airport was closed from 30th Jan'21 to 5th Feb'21 during the following hours of the day as a consequence of Airspace closure in connection with Aero India show 2021 vide Notam no. A0171/21 and A0172/21

(A0171/21 NOTAMN

Q) VOMF/QFALC/IV/NBO/A/000/999/
A) VOBL B) 2101300800 C) 2102051130
D) JAN 30-31 0800-1100
FEB 01 0430-0630, 0830-1130
FEB 02-03 0330-0630, 0830-1130
FEB 04-05 0430-0630, 0830-1130
E) AS A CONSEQUENCE OF AIRSPACE CLOSURE IN CONNECTION WITH AERO INDIA SHOW 2021 KEMPEGOWDA INTERNATIONAL AIRPORT, BENGALURU WILL REMAIN CLSD FOR ACFT OPS)

(A0172/21 NOTAMN
Q) VOMF/QRALW/IV/NBO/W/000/150/
A) VOMF B) 2101300800 C) 2102051130
D) JAN 30-31 0800-1100
FEB 01 0430-0630, 0830-1130
FEB 02-03 0330-0630, 0830-1130
FEB 04-05 0430-0630, 0830-1130
E) AIRSPLACE BOUNDED BY 125930N0773616E TO 131155N 0771401E ALONG
WITH CLOCK WISE ARC CENTERED AT HAL AP VOR BBG TILL131143N 0780737E 125930N 0774520E ALONG WITH ANTICLOCKWISE ARC CENTERED AT HAL AP VOR BBG TILL 125930N 0773616E CLSD DUE AERO INDIA SHOW 2021
F) GND G) FL150)

B. Executive Summary

The flight schedule was prompltly shared by Bengaluru AOCC but as it consists of scheduled off block and in block time, all domestic airlines were requested to share their flight intent well in advance in the light of the Aero India show.
The flight data was received in parts from the Airlines and the same was updated twice in the SKYFLOW sytem. Inspite of the best efforts, many flights were observed to be operating during the closure period and the airlines

were requested to amend their flight intent based on the discrepancy observed.CCC officers also cross-checked the flight intent on the "D" day against the schedule received from AOCC.
Bengaluru ATC was requested to appoint a nodal officer for effective coordination. The coordinator was responsible for communicating the Airport acceptance rate, the availabilty of Airport/Airspace and any operational matter impacting efficiency and capacity.
Operations were observed to be smooth on most days of the exercise with slight airborne holdings on some days.

ATFM measures for the afternoon closure (0830-1130 UTC)were withdrawn after application of CDM measures on 3rd and 4th Feb'21 due to early availability of Airspace. The closure for 0830 to 1130 UTC was extended upto 1145 UTC on 5th Feb'21 and the same was communicated before the CDM measures were applied.

C. Salient Points:

As informed by the Bengaluru coordinator following points were to be kept in mind by CCC officers while preparing ATFM measures for the closure

- First landing post reopening of Airspace could happen only 9 minutes after the availability of Airspace
- Last Landing before closure had to be 5 minutes prior to the closure time(to accommodate any missed approaches)

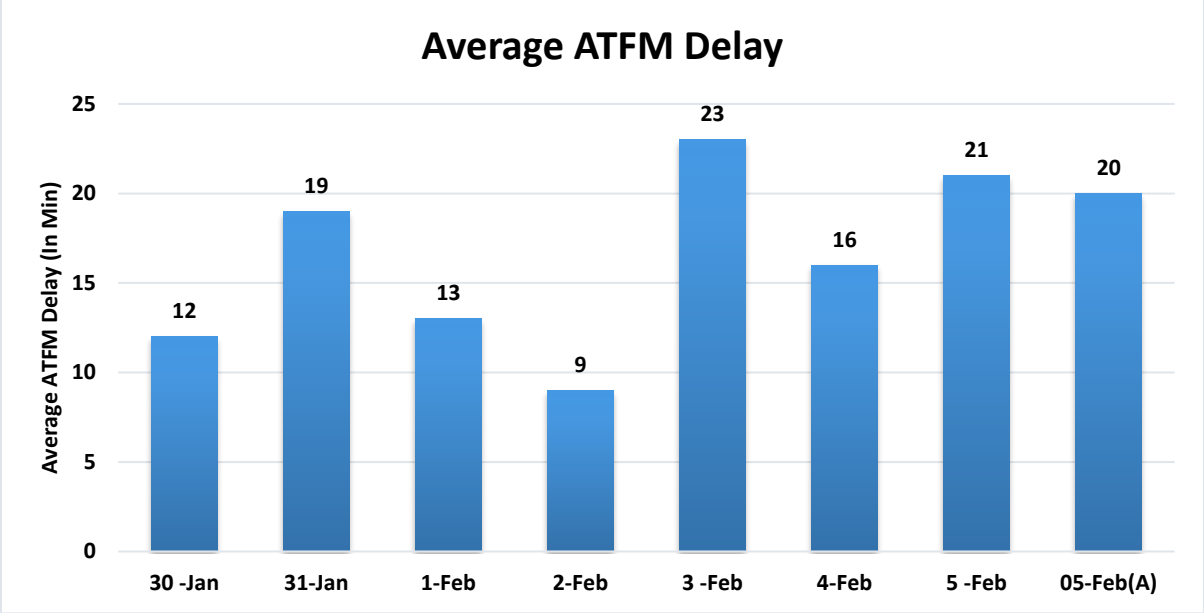
D. Challenges:

1. Non-compliance of CTOT was observed from Pune,Ahmedabad,Patna,Lucknow,Gwalior,Bagdogra, Chandigarh, Hubli etc. It was followed up by CCC officers.
2. Few flights which were scheduled to operate pre -closure were observed to be operating after the Airspace closure and had to be manually allotted a CTOT.
3. CTOT was not applied through the SKYFLOW system on few days. The CTOTs were manually downloaded and passed to all concerned through emails, WhatsApp and telephone. It was also uploaded on the portal.
4. CTOT dissemination to satellite remote stations still remains a challenge. Airlines are also faltering in their responsibility of apprising Air Crew about CTOT through their respective Operation Control Center.

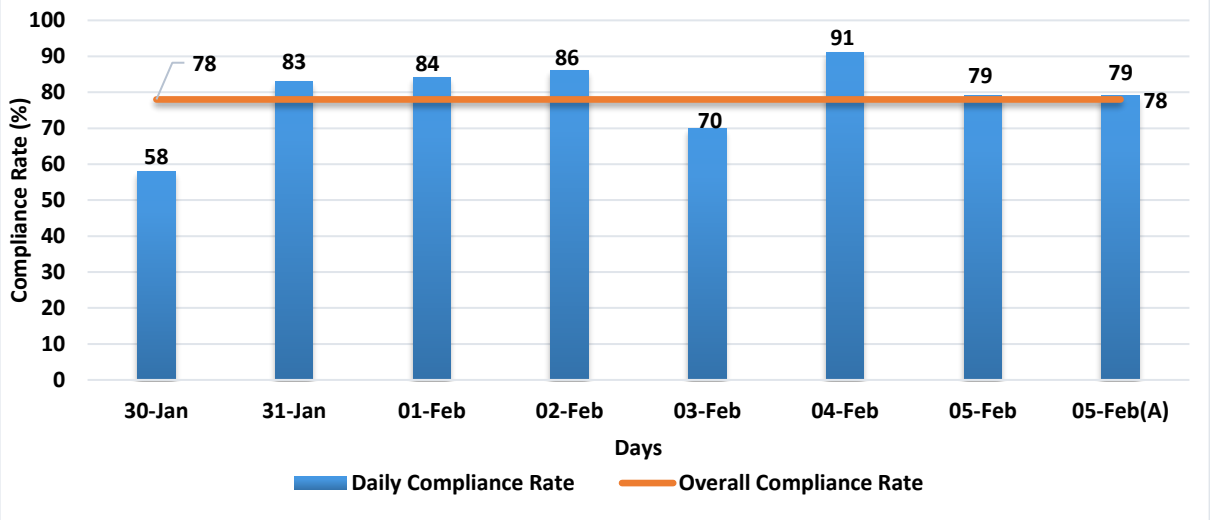
ATFM Measures Overview:

Only Flights with complete data i.e. ATOT, ALDT etc. are taken into consideration for calculation of ATFM parameters.

I. Average ATFM Delay – Day wise:



II. CTOT Compliance – Day wise:



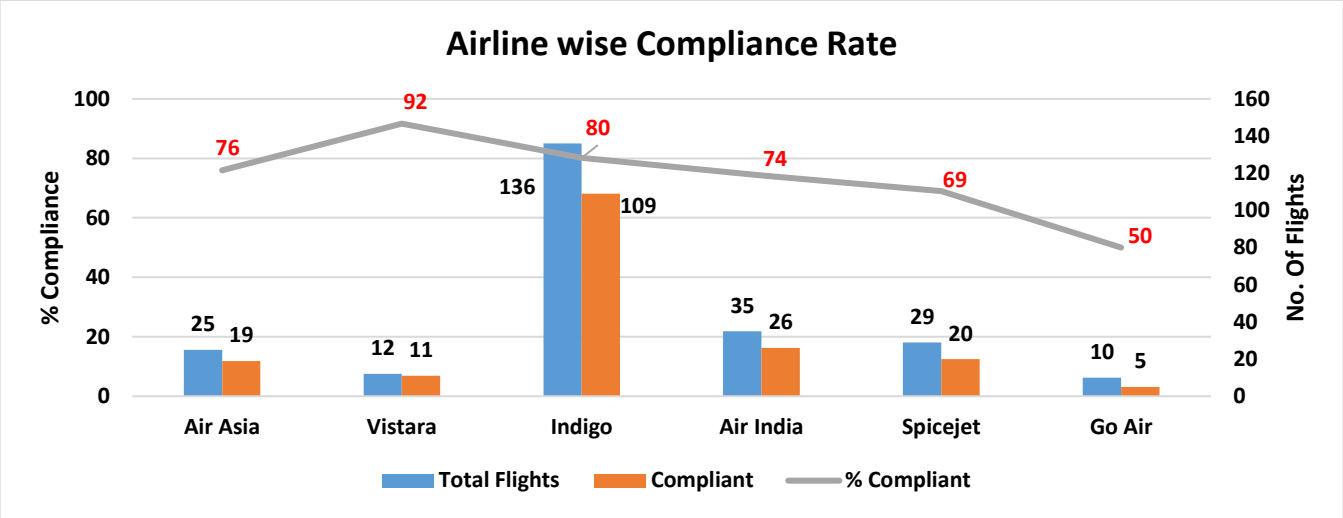
III. CTOT Compliance – FIR wise:

MUMBAI FIR (76%)*	Compliant	Non Compliant	%Compliant
Mumbai	12	3	80
Pune	1	3	25
Shirdi	5	1	83
Kolhapur	1	1	50
Udaipur	3	0	100
Indore	2	1	67
Ahmedabad	5	2	71
KOLKATA FIR (74%)*			
Kolkata	11	3	78
Guwahati	7	2	77
Allahabad	2	2	50
Gorakhpur	0	3	0
Darbhanga	0	1	0
Patna	8	4	66
Bagdogra	8	3	72
Bhubhaneshwar	7	2	77
DELHI FIR (78%)*			
Delhi	21	5	80
Jaipur	5	0	100
Gwalior	2	2	50
Lucknow	4	3	57
Chandigarh	4	2	66
Dehradun	3	0	100
CHENNAI FIR (84%)*			
Chennai	13	1	93
Belgaum	3	0	100
Hyderabad	9	2	81
Mangalore	4	0	100
Kannur	2	1	67
Vijayawada	0	1	0
Kalaburagi	6	1	85
Hubli	0	1	0
Vishakhapatnam	3	0	100
Cochin	7	1	87
Goa	1	3	25

Inference

- Chennai FIR had the highest compliance rate of 84% whereas Kolkata FIR had the minimum compliance rate of 74%.

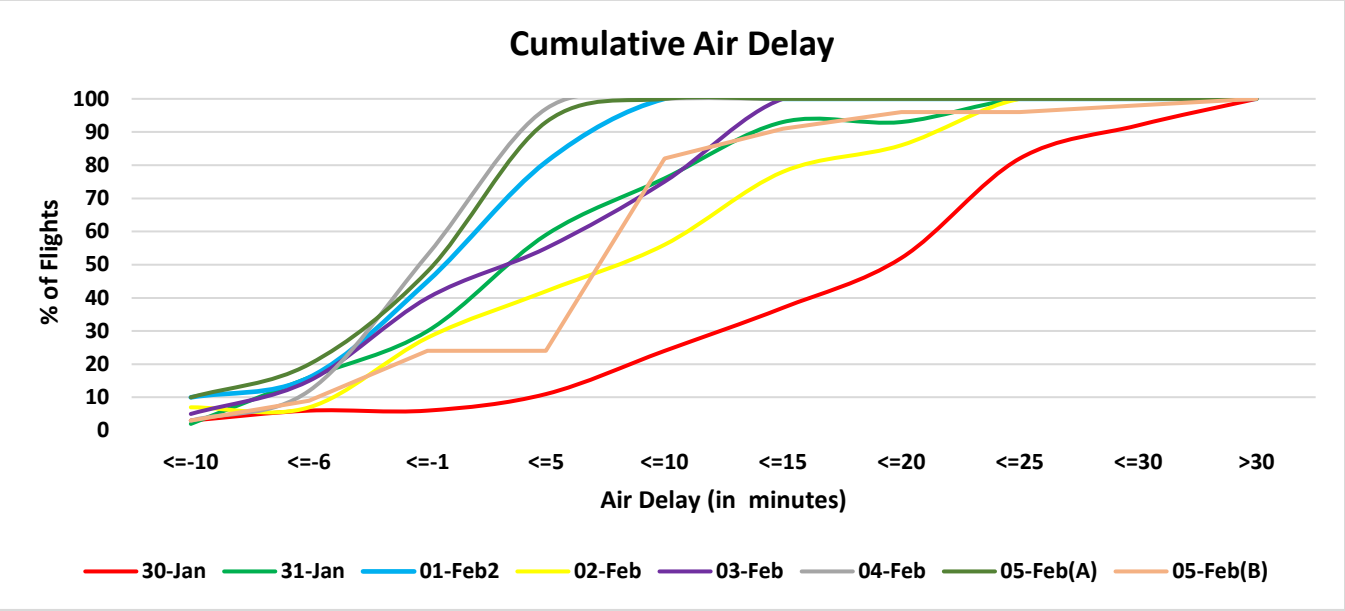
IV. CTOT Compliance – Airline wise:



Inference

- Vistara had the highest compliance rate of 92% whereas Go Air had the lowest compliance of 50%.

V. Cumulative Air Delay:



Inference

1. 24% of arriving flights to Bengaluru had an Air delay of equal to or less than 10 minutes during the CDM period on 30th Jan'21.
2. 76% of arriving flights to Bengaluru had an Air delay of equal to or less than 10 minutes during the CDM period on 31st Jan'21.
3. 100% of arriving flights to Bengaluru had an Air delay of equal to or less than 10 minutes during the CDM period on 01st Feb'21.
4. 56% of arriving flights to Bengaluru had an Air delay of equal to or less than 10 minutes during the CDM period on 02nd Feb'21.
5. 75% of arriving flights to Bengluru had an Air delay of equal to or less than 10 minutes during the CDM period on 03rd Feb'21.
6. 100% of arriving flights to Bengaluru had an Air delay of equal to or less than 10 minutes during the CDM period on 04th Feb'21.
7. 100% of arriving flights to Bengluru had an Air delay of equal to or less than 10 minutes during the CDM period on 05th Feb'21.
8. 82% of arriving flights to Bengaluru had an Air delay of equal to or less than 10 minutes during the CDM period on 05th Feb'21.