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Agenda Item 3: **Performance Framework for Regional Air Navigation Planning and Implementation**

3.0: **Regional and National Performance Framework**

DATA-DRIVEN PERFORMANCE-BASED APPROACH TOWARDS ENHANCING EFFICIENCY AND CAPACITY TO MEET FUTURE AIR TRAFFIC DEMANDS

(Presented by Singapore on behalf of China and Singapore)

SUMMARY

At the recent 59th Conference of Directors General of Civil Aviation Asia and Pacific regions held in Cebu, Philippines on 14-18 October 2024, the Conference noted that air traffic was expected to triple that of today over the next 20 years. At the same time, the advent of drones, air taxis, High-Altitude Operations and commercial space vehicles through controlled airspace would increase demand on airspace and add operational complexities for air navigation service providers and airlines. This paper provides an executive view with examples of how the monitoring of Key Performance Indicators specifically in the area of Air Traffic Management had supported States and the region to identify and proactively address issues concerning safety, capacity, efficiency and environmental impact.

Strategic Objectives:

B: ***Air Navigation Capacity and Efficiency*** *— Increase the capacity and improve the efficiency of the global aviation system*

E***: Environmental Protection*** *— Minimize the adverse environment effects of civil aviation activities.*

1. INTRODUCTION

1.1 At the recent 59th Conference of Directors General of Civil Aviation (DGCA) Asia and Pacific Regions (APAC) held in Cebu, Philippines on 14-18 October 2024, the Conference noted that air traffic was expected to triple that of today over the next 20 years. At the same time, the advent of drones, air taxis, High-Altitude Operations and commercial space vehicles through controlled airspace would increase demand on airspace and add operational complexities for air navigation service providers (ANSPs) and airlines, increasing workload for air traffic controllers (ATCOs) and pilots.

1.2 This paper provides an executive view of how the monitoring of Key Performance Indicators (KPIs) specifically in the area of Air Traffic Management (ATM) had supported States and the region in identifying and proactively addressing issues concerning safety, capacity, efficiency and environmental impact.

2. DISCUSSION

2.1 The Global ATM Operational Concept (Doc 9854) envisages a performance-based global air navigation system. Greater details are provided in the Manual on Air Traffic Management System Requirements (Doc 9882) and the Manual on Global Performance of the Air Navigation System (Doc 9883). The Global Air Navigation Plan (GANP, Doc 9750) includes a segment on KPIs. These were developed for consideration by the region and member States to facilitate the Performance-Based Approach (PBA).

2.2 The following examples demonstrate the importance of monitoring ATM KPIs.

Example 1: Enhanced taxi-out performance

2.3 Efficiency of taxi operations at an aerodrome is an important factor contributing to its overall efficiency, including its impact on on-time performance of flights. This in turn is dependent on various factors, such as the size of the aerodrome, complexity of aerodrome layout, and the management of aircraft and ground vehicles. Over time, inefficiencies could creep in which may not be easily noticeable. The Additional Taxi-out Time is a KPI that measures surface efficiency.

2.4 Taxi-out time is the time taken for an aircraft to move from off-block to lift-off, whereas the unimpeded taxi-out time is the time taken by the fastest 20th percentile flight. The Additional Taxi-out Time KPI is measured by taking the difference between the actual and the unimpeded taxi-out time. Using the 20th percentile as the unimpeded flight takes into account the operational conditions of the airport and also eliminates outliers. If the data for departure gate ID and the taxi-off runway ID were present, a separate unimpeded time could be calculated for each runway/gate cluster combination to increase the accuracy of the unimpeded time measurement. The data needed for measurement can be extracted from the ATC system. The detailed methodology can be found in the Annex A.

2.5 One ANSP's experience in monitoring the Additional Taxi-out Time KPI enabled it to identify a spike in taxi-out delays in end-2022, during the early phase of post-COVID air traffic recovery. Considering that air traffic was still relatively light at that time, the spike in delays was unexpected, and prompted a multi-disciplinary team to investigate the cause. This approach enabled the identification of certain inefficiencies such as increased taxiway closures resulting in a more complex taxi-out procedures and longer taxi-out. The ANSP and the airport operator agreed to enforce stricter discipline in minimising the duration of taxiway closures, thus reducing overall taxi-out times.

2.6 As air traffic returned, the Additional Taxi-out Time KPI revealed yet another spike in taxi delays. The multi-disciplinary team again set out to identify the causal factors and found that some flights were delayed at the runway due to enroute restrictions imposed in the adjacent flight information region. To avoid unnecessary delays to takeoff, the ANSP implemented a process with the airlines which involved proactive communication of traffic demands on relevant ATS routes. This allowed airlines to make informed decisions to either accept such constraints or file for alternative routes which could allow for on-time departures. The ANSP also emphasised the need for compliance with Target Start-Up Time (TSAT) to minimise delays on taxiways.

Example 2: Enhancing airspace performance

2.7 Efficiency in the airspace is an important indicator for maximising the current utilisation of the airspace capacity. An ANSP uses the Actual En-route Extension KPI for measuring air operation efficiency. The Actual En-route Extension KPI measures the difference between the actual en-route distance flow against the reference ideal distance based on great circle distance.

2.8 To reduce the actual en-route distance flown, the ANSP applied measures such as the utilisation of temporary flight routes and establishment of new air routes. Actual En-route Extension KPI was tracked, which showed reduction in actual en-route distances flown, i.e. enhanced airspace capacity utilisation and reduced aircraft fuel consumption.

2.9 The ANSP continues to monitor and publishes the actual en-route extension of all flights on its 20 busiest domestic routes per year and has continuously demonstrated improvements in the KPI after the implementation of these measures.

Example 3: Green ATM by collaborating between ANSPs

2.10 Two ANSPs recognised the importance of sustainable aviation, and agreed to collaborate on a trial on Green ATM operations for flights between two of their major airports.

2.11 For the trial, the partner ANSPs facilitated continuous climb and descent operations as well as optimal cruising flight levels for their flights. They examined the KPI on fuel savings and also tracked the proportions of flights performing continuous climb and descent operations and those operating at optimal cruise flight level. Fuel savings was determined by measuring the difference in total fuel burn before and during the trial. A descent was considered continuous if the rate of descent was at least 5ft/sec for every rolling 20-second interval, while a climb was considered continuous if the rate of climb was at least 5ft/sec for every rolling 20-second interval. The flight was assessed to be cruising at optimal flight level if it operated at the user preferred altitude.

2.12 The results showed a concerted effort was needed to facilitate continuous climb and descent operations, and optimal cruising flight level; and a data-driven approach to examining flight trajectories, route adherence, and vertical cruise profiles could provide insight into how to improve cross-border operational procedures to fulfil ICAO's Long-Term Aspirational Goal (LTAG) for international aviation of net-zero carbon emissions by 2050.

3. ACTION BY THE MEETING

3.1 The Meeting is invited to:

a) note that monitoring of KPIs specifically in the area of ATM could support States and the region in identifying and addressing issues concerning safety, capacity, efficiency and environmental impact, thus ensuring better preparedness to handle anticipated traffic growth in the region; and

b) discuss if it would be beneficial for training on the development / monitoring of KPIs to be provided to support States in developing KPIs in ATM.

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Encl.

Annex A – HARMONISED PERFORMANCE METHODOLOGIES (BY DATA ANALYTICS GROUP)

ANNEX A – HARMONISED PERFORMANCE METHODOLOGIES (BY THE DATA ANALYTICS GROUP)

1. INTRODUCTION

The Data Analytics Group (DAG) is formed under the ATM Sub-Group of APANPIRG. This document contains the definitions and calculation methodologies to be used for the DAG's performance management and data collection purposes.

2. GENERAL NOTES

The KPIs are based on GANP KPIs and organized by the GANP Performance Objectives (https://www4.icao.int/ganpportal/ASBU/KPI). Deviations from GANP definitions are italicized (if applicable). Only KPI variants considered by the DAG will have their definitions listed here. KPI variants will be identified by suffixing the main KPI identifier. For example, Variant 2A of KPI01 will be referred to as KPI01-2A. Data will be collected at a resolution of once a month. Cut-offs will be determined by Actual Take-off Time (ATOT) and Actual Landing Time (ALDT) in UTC.

For calculation of unimpeded or reference times, a full year of data from 2019 shall be utilized, unless otherwise specified.

3. PREDICTABILITY

For the predictability performance objective, the informal group will be collecting data to calculate variants 2A and 2B of the KPIs, i.e. KPI01-2A, KPI01-2B, KPI14-2A, KPI14-2B.

3.1 DEFINITIONS

KPI Name	**Departure Punctuality (KPI01)**
Definition	Percentage of flights departing from the gate on-time (compared to schedule).
Measurement	% of scheduled flights
Variants	Variant 2A – % of departures delayed within ± 15 mins of scheduled time of departure Variant 2B – % of departures delayed <= 15 mins versus schedule
Parameters	On-time threshold (maximum positive or negative deviation from scheduled departure time) which defines whether a flight is counted as on-time or not. Recommended values: 5 minutes and 15 minutes.
Data Requirement	For each departing scheduled flight: • Scheduled time of departure (STD) • Actual off-block time (AOBT)
Formula	At the level of individual flights: • Exclude non-scheduled departures • Categorize each scheduled departure as on-time or not At aggregated level: • Compute the KPI: number of on-time departures divided by total number of scheduled departures

Table 1 – Departure punctuality definition

KPI Name	**Arrival Punctuality (KPI14)**
Definition	Percentage of flights arriving at the gate on-time (compared to schedule).
Measurement	% of scheduled flights

Variants	Variant 2A – % of arrivals delayed within ± 15 mins of scheduled time of arrival Variant 2B – % of arrivals delayed <= 15 mins versus schedule
Parameters	On-time threshold (maximum positive or negative deviation from scheduled arrival time) which defines whether a flight is counted as on-time or not. Recommended values: 5 minutes and 15 minutes.
Data Requirement	For each arriving scheduled flight: • Scheduled time of arrival (STA) • Actual in-block time (AIBT)
Formula	At the level of individual flights: • Exclude non-scheduled arrivals • Categorize each scheduled departure as on-time or not At aggregated level: • Compute the KPI: number of on-time departures divided by total number of scheduled departures

Table 2 – Arrival punctuality definition

3.2 DATA COLLECTION

To calculate the predictability KPIs, we would require the breakdown of flights by Arrival, Departure, and time buckets. There will be three time buckets and $x = \text{Actual} - \text{Scheduled}$ for the below definitions:

- (-INF, -15) Flights arriving or departing when $x < -15$ minutes.
- [-15,15] Flights arriving or departing when $-15 \leq x \leq 15$ minutes.
- (15, INF) Flights arriving or departing when $x > 15$ minutes.

Table 3 shows a sample of the data collection template with dummy data for illustration.

Airport	Date	Phase	No. of Flights	(-INF, -15)	[-15,15]	(15, INF)
ZZZZ	2022-11	DEP	12,345	190	8,386	3,769
ZZZZ	2022-12	DEP	12,346	114	8,064	4,168
ZZZZ	2023-01	DEP	12,347	137	8,886	3,324
ZZZZ	2022-11	ARR	12,348	2,203	6,887	3,258
ZZZZ	2022-12	ARR	12,349	2,038	6,237	4,074
ZZZZ	2023-01	ARR	12,350	2,347	6,619	3,384

Table 3: Data collection template for predictability with dummy data

3.3 CALCULATION METHODOLOGY

For departures,

1. Exclude non-scheduled flights and cancelled flights.
2. Calculate the time difference $\text{AOBT} - \text{STD}$.
3. Categorize each flight into the 3 buckets of (-INF, -15), [-15,15], (15, INF).
4. Sum up the number of flights in each bucket for every month.

For arrivals,

1. Exclude non-scheduled flights and cancelled flights.
2. Calculate the time difference $\text{AIBT} - \text{STA}$.
3. Categorize each flight into the 3 buckets of (-INF, -15), [-15,15], (15, INF).
4. Sum up the number of flights in each bucket for every month.

4. EFFICIENCY

For the predictability performance objective, the group will be collecting data to calculate both the basic and advanced variants of the KPIs. i.e. KPI02-1, KPI02-2, KPI13-1, KPI13-2.

4.1 DEFINITIONS

KPI Name	**Additional taxi-out time (KPI02)**
Definition	Actual taxi-out time compared to an unimpeded/reference taxi-out time.
Measurement	Minutes/flight
Variants	Variant 1 – Basic (computed without departure gate and runway data) Variant 2 – Advanced (computed with departure gate and runway data)
Parameters	Unimpeded/reference taxi-out time: • Recommended approach for the basic variant of the KPI: A single value at airport level, e.g. the 20th percentile of actual taxi times recorded at an airport, sorted from the shortest to the longest. *[For basic variant, reporting can be done at runway level if data is available]* • Recommended approach for the advanced variant of the KPI: A separate value for each runway/gate cluster combination, e.g. the average actual taxi-out time recorded during periods of non-congestion (needs to be periodically reassessed). *[For advanced variant, the reference taxi-out time will be set at 20th percentile of actual taxi times recorded. To prevent issues with low sample sizes, data may be reported at runway and gate cluster level instead of at the individual gate level.]*
Data Requirement	For each departing flight: • Actual off-block time (AOBT) • Actual take-off time (ATOT) In addition, for the advanced variant: • Departure gate ID • Take-off runway ID
Formula	At the level of individual flights: 1. Select departing flights, exclude helicopters 2. Compute actual taxi-out duration: ATOT minus AOBT 3. Compute additional taxi-out time: actual taxi-out duration minus unimpeded taxi-out time At aggregated level: 4. Compute the KPI: sum of additional taxi-out times divided by number of IFR departures

Table 4 – Additional taxi-out time definition

KPI Name	**Additional taxi-in time (KPI13)**
Definition	Actual taxi-in time compared to an unimpeded/reference taxi-in time.
Measurement	Minutes/flight
Variants	Variant 1 – Basic (computed without landing runway and arrival gate data) Variant 2 – Advanced (computed with landing runway and arrival gate data)
Parameters	Unimpeded/reference taxi-in time: • Recommended approach for the basic variant of the KPI: A single value at airport level, e.g. the 20th percentile of actual taxi times recorded at an airport, sorted from the shortest to the longest. *[For basic variant, reporting can be done at runway level if data is available]*

	• Recommended approach for the advanced variant of the KPI: A separate value for each runway/gate cluster combination, e.g. the average actual taxi-in time recorded during periods of non-congestion (needs to be periodically reassessed). *[For advanced variant, the reference taxi-in time will be set at 20th percentile of actual taxi times recorded. To prevent issues with low sample sizes, data may be reported at runway and gate cluster level instead of at the individual gate level.]*
Data Requirement	For each arriving flight: • Actual in-block time (AIBT) • Actual landing time (ALDT) In addition, for the advanced variant: • Arrival gate ID • Landing runway ID
Formula	At the level of individual flights: 1. Select arriving flights, exclude helicopters 2. Compute actual taxi-in duration: AIBT minus ALDT 3. Compute additional taxi-in time: actual taxi-in duration minus unimpeded taxi-in time At aggregated level: 4. Compute the KPI: sum of additional taxi-in times divided by number of IFR arrivals

Table 5 – Additional taxi-in time definition

4.2 DATA COLLECTION

The Efficiency KPIs will be collected with the following data collection template.

Airport	Date	KPI02-1	KPI02-2	KPI13-1	KPI13-2
ZZZZ	2022-11	10.03	4.85	2.07	1.75
ZZZZ	2022-12	11.71	5.27	2.34	1.83
ZZZZ	2023-01	11.89	5.32	2.40	1.90

Table 6 – Data collection template for efficiency with dummy data

4.3 CALCULATION METHODOLOGY

Reference Time

1. Only include IFR flights.
2. Calculate actual taxi-out or taxi-in times for each flight: ATOT – AOBT or AIBT – ALDT respectively.
3. Group flights by runway and gate cluster.
4. For each group, obtain the 20th percentile taxi-out or taxi-in time as the runway and gate cluster combination's reference time.

Additional Taxi Time

1. Only include IFR flights.
2. Calculate actual taxi-out or taxi-in times for each flight: ATOT – AOBT or AIBT – ALDT respectively.
3. Group flights by runway and gate cluster.

4. For each group, subtract the reference time from the actual times to obtain the additional taxi-out or taxi-in time, using a different reference time for each runway and gate cluster combination.
5. Obtain the average additional taxi-out or taxi-in times for the month across all flights.

5. CAPACITY

For the capacity performance objective, the informal group will be collecting data to calculate all variants of KPI09, i.e. KPI09-A, KPI09-D, KPI09-AD. For KPI10, variant 1 on IFR operations will be calculated, i.e. KPI10-1A, KPI10-1D, KPI10-1AD

5.1 DEFINITIONS

KPI Name	**Airport Peak Capacity (KPI09)**
Definition	The highest number of operations an airport can accept in a one-hour time frame (also called declared capacity). Can be computed for arrivals, departures, or arrivals + departures.
Measurement	Number of departures / hour, Number of landings / hour, Number of (departures + landings) / hour
Variants	Variant A – Airport peak arrival capacity Variant D – Airport peak departure capacity Variant AD – Airport peak movement capacity (departures + arrivals)
Parameters	None
Data Requirement	Scheduling parameters for slot controlled airports Airport acceptance rates (AAR) Airport departure rates (ADR)
Formula	At the level of an individual airport: 1. Select highest value from the set of declared capacities 2. Compute the KPI: convert the value to an hourly rate, if the declaration is at smaller time intervals

Table 7 – Airport peak capacity definition

KPI Name	**Airport Peak Throughout (KPI10)**
Definition	The 95th percentile of the hourly number of operations recorded at an airport, in the "rolling" hours sorted from the least busy to the busiest hour. Can be computed for arrivals, departures, or arrivals + departures.
Measurement	Number of departures / hour, Number of landings / hour, Number of (departures + landings) / hour
Variants	Variant 1 – IFR operations only To be combined with: Variant A – Airport peak arrival capacity Variant D – Airport peak departure capacity Variant AD – Airport peak movement capacity (departures + arrivals)
Parameters	Time interval for "rolling" hours. Recommended value: 15 minutes The percentile chosen to exclude outliers. Recommended value: 95th percentile
Data Requirement	For each flight: Actual landing time (ALDT) Actual take-off time (ATOT)

Formula	At the level of an individual flights: 1. Select flights, exclude helicopters 2. Convert the set of landings to hourly landing / departure rates by "rolling" hour 3. Sort the "rolling" hours from the least busy to the busiest hour 4. Compute the KPI: it equals the landing rate value of the 95th percentile of the "rolling" hours

Table 8 – Airport peak throughput definition

5.2 DATA COLLECTION

Data will be collected for all variants of KPI09. For KPI10, data will be collected for KPI10-1A, KPI10-1D, and KPI10-1AD.

Airport	Date	KPI09-AD	KPI10-1AD	KPI09-A	KPI10-1A	KPI09-D	KPI10-1D
WSSS	2022-11	73	45	38	27	40	24
WSSS	2022-12	73	47	38	28	40	25
WSSS	2023-01	73	47	38	27	40	24

Table 9 – Data collection template for capacity with sample data

5.3 CALCULATION METHODOLOGY

This section will focus on KPI10 only as KPI09 consists of declared capacities.

Rolling Hours

The time interval for rolling hours will be set at 15 minutes. To illustrate rolling hours, consider the below example where we begin from 0900. Hourly peak throughputs will be calculated for the following time periods, where a new hourly period is considered every 15 minutes:

- 0900 – 1000
- 0915 – 1015
- 0930 – 1030

… and so on

Airport Peak Throughput

1. Restrict the hours considered to 0600 – 2259 local time for all airports.
2. For each month, calculate the number of flights per rolling hour for arrivals, departures, and arrivals + departures.
3. Arrange these rolling hours from the least number of flights to the greatest number of flights.
4. The 95th percentile rolling hour will be taken as the peak throughput

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