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INTERNATIONAL CIVIL AVIATION ORGANIZATION

A UN SPECIALIZED AGENCY

RUNWAY CAPACITY ASSESSMENT METHODOLOGY

SAM MODEL

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OUTLINE

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INTRODUCTION

Airport operations efficiency requires knowledge of the capacity of each airport components:

- Landside capacity
- Terminal capacity
- Airside capacity including
  - ✓ Runway capacity
  - ✓ Taxiway capacity
  - ✓ Apron capacity

INTRODUCTION

CONTEXT

- Runway capacity determination requires the use of a selected suitable methodology.

- Several methodologies for determining runway capacity exist worldwide. However, there is no regionally agreed such methodologies for the AFI region.

- South America region has developed a methodology which is regionally accepted by its members as a guide on how to apply a common methodology to calculate the runway capacity.
- The review of the various methodologies will provide a range of options for AFI States in selecting and adapting the most suitable methodologies.

INTRODUCTION

DEFINITIONS

- ✓ **AIRPORT CAPACITY:** the total number of movements that an airport can handle during a given period of time.
- ✓ **RUNWAY CAPACITY** represents the total number of movements that a runway can handle during a given period of time.
- ✓ **RUNWAY MOVEMENT:** Any take off, landing or crossing on the runway.
- ✓ **RUNWAY OCCUPANCY TIME:** The time frame during which the runway is occupied by one aircraft and no other aircraft movement is allowed.
- ✓ **AIRCRAFT MIX:** Percentage of each category of aircraft utilizing the runway.
- ✓ **REGULATORY SEPARATION MINIMUM (RSM):** Minimum Separation distance applied between two consecutive movements on the runway as provided by the State's regulation.
- ✓ **SAFETY SEPARATION:** Distance value added to the RSM to allow a take off between two consecutive landings.

ASSUMPTION OF THE MODEL

❑ FACTOR TO CONSIDER

✓ **PLANNING FACTOR:**

a) Ideal air traffic sequencing and coordination conditions;

b) All personnel is considered to have the same training and same operational performance;

c) All navaids and visual aids are considered to be technically and operationally unrestricted; and

d) All (VHF/telephony) communication equipment considered operational is operating normally

ASSUMPTION OF THE MODEL

❑ FACTORS TO CONSIDER

✓ **FACTORS RELATED TO LANDING AND TAKE-OFF OPERATIONS:**

a) Average runway occupancy times;

b) Aircraft mix;

c) Percentage of threshold utilisation;

d) Length of the final approach segment;

e) Regulatory aircraft separation minima applied;

f) Runway and taxiway layout; and

g) Final approach speed.

MODEL COMPONENTS AND OUTPUT

✓ **MODEL OUTPUT:** the runway capacity is the total number of take off and landings in 60 minutes.

$$(1) \quad TRC = N_{LDG} + N_{TKO}$$

$$N_{LDG} = \frac{3600s}{MTTS}$$

$$N_{TKO} = N_{LDG} - 1$$

MTTS: Mean weighted time between to consecutive landings

MODEL COMPONENTS AND OUTPUT

❑ CALCULATING THE MTTS

Components to calculate

1. The Aircraft mix ($MIX_{CAT\ A}$, $MIX_{CAT\ B}$, $MIX_{CAT\ C}$, $MIX_{CAT\ D}$)
2. The Mean runway occupancy time (MROT for take off and landing)
3. The Physical capacity per runway (PCR)
4. The Mean flight time between the runway lock-in-position (MT)
5. The mean speed in the final approach (MV)
6. The safety separation (SS)
7. The total separation (TS)

DATA SAMPLING TECHNIQUE

❑ DATA TO COLLECT

a) aircraft registration,

b) type of aircraft,

c) aircraft category (A, B, C, D, E),

d) duration on runway (from runway entry to airborne for take-off and from OM (runway lock in position to runway vacated for landing),

e) the length of the final approach segment of each instrument flight procedure attached to the observed runway

f) the regulatory separation minimum (RSM) applied in the State

g) data of annual movement of aircraft per runway

— DATA SAMPLING TECHNIQUE

❑ DETERNIMING THE MINIMUM NUMBER OF OBSERVATION OF EACH PARAMETER

- ✓ Data for each runway threshold.
- ✓ Traffic Data for five busiest days of the busiest month.
- ✓ Traffic data for 12 consecutive months for each airport runway

COLLECTION OF FLIGHT TIME BETWEEN OM (Or RWY Lock in position) AND THE THRESHOLD DURING 3 BUSIEST DAYS																								
AIRPORT:					Lenght of the final Approach Segment (FAS) (in NM) RWY#1:			RWY#2:		RWY#3:														
DAY 1					DAY 2					DAY 3					DAY 4					DAY 5				
Aircraft Registration	Aircraft TYPE	Aircraft Catergory[1]	Runway used	Flight time OM-THR (in Seconds)	A/C Registration	Aircraft TYPE	Aircraft Catergory[1]	Runway used	Flight time OM-THR (in Seconds)	A/C Registration	Aircraft TYPE	Aircraft Catergory[1]	Runway used	Flight time OM-THR (in Seconds)	A/C Registration	Aircraft TYPE	Aircraft Catergory[1]	Runway used	Flight time OM-THR (in Seconds)	A/C Registration	Aircraft TYPE	Aircraft Catergory[1]	Runway used	Flight time OM-THR (in Seconds)

STEPS OF THE METHODOLOGY

- **STEP 1: COLLECTION, PROCESSING AND STORAGE OF DATA FOR THE CALCULATION OF RUNWAY HOURLY CAPACITY**

-Classify data based on their subsequent utilization : Data related to runway characteristics, data related to fleet, data related to instrument flight procedure and separation.

- **STEP 2: CALCULATE THE AIRCRAFT MIX (MIX)**

-For each category: Divide the total number of aircraft of the category by the total movement recorded then time by 100.

- **STEP 3: CALCULATE THE MROT**

-Calculate the MROTL (MROT for landing aircraft)
-Calculate the MROTT (MROT for taking off aircraft).
-Calculate the MROT =MROTL + MROTT

STEPS OF THE METHODOLOGY

❑ **STEP 4: CALCULATING THE PCR**

-Divide 1h=3600sec by the MROT.

❑ **STEP 5: CALCULATING THE UTILISATION PERCENTAGE OF EACH RUNWAY (UP)**

For each airport runway: divide the annual total movement of the runway by the annual movement of the airport then time by 100.

Note: For single runway airport UP=100%

❑ **STEP 6: CALCULATING THE AERODROME PHYSICAL CAPACITY (APC)**

-is calculated as the sum of weighted PCR by timing each runway PCR by its corresponding UP and summing up all the results.

STEPS OF THE METHODOLOGY

❑ **STEP 7: CALCULATING THE MEAN FLIGHT TIME ON FINAL**

The flight time from OM to THR represents the duration between the time of passing over the OM (or the runway lock in point) and the time of passing over the runway threshold.

-Calculate the total flight time per category of landing aircraft.

-Calculate the mean flight time (MT) as the mean flight time per category

❑ **STEP 8: CALCULATING THE MEAN LANDING APPROACH SPEED (MV)**

The mean landing approach speed represents the approach speed of each aircraft category between the OM (or runway lock in point) and the runway threshold.

-Calculate MV-CATA, MV-CATB, MV-CATC, MV-CATD

-Calculate the MV for the runway as weighted mean approach speed of all aircraft category utilizing the runway

❑ **STEP 9: CALCULATING THE SAFETY SEPARATION (SS)**

The safety separation is the minimum safe distance that can allow an aircraft to take off between two consecutive landing aircraft.

-Calculate SS=MROT x MV

STEPS OF THE METHODOLOGY

❑ **STEP 10: CALCULATING THE TOTAL SEPARATION (TS)**

-Calculate TS=SS + RSM

❑ **STEP 11: CALCULATING THE MEAN WEIGHTED TIME BETWEEN TWO CONSECUTIVE LANDINGS (MTTS)**

-Calculate MTTS= $\frac{\mathrm{TS}}{MV}$.

❑ **STEP 12: CALCULATING THE HOURLY NUMBER OF POSSIBLE LANDINGS (N_{LDG}) & TAKE OFF (N_{TKO})**

$N_{LDG} = \frac{3600}{MTTS}$ **&** $N_{TKO} = N_{LDG} - 1$

❑ **STEP 13: CALCULATING THE RUNWAY HOURLY CAPACITY (TRC)**

For each threshold: TRC= N_{LDG} + N_{TKO}

STEPS OF THE METHODOLOGY

❑ **DEMO**

Scenario: In sector A, the average hourly workload is 36min. 5 Aircraft (V1=480Kts) spend 20min, 3 aircraft (V2=440Kts) spend 30min, 2 aircraft (V3=400Kts) spend 35min in average in the sector during which ATC communicates for 5s of entry communication with each, 5s for 3 level changes, 10s for one conflict resolution and 5s for each transfer of control. Calculate the capacity of sector A.

- Availability factor **ϕ**= 100%-(36/60)x100%=(100-60)%=**40%**
- Average flight time:

-For aircraft in V1: 20X5=100min
-For aircraft in V2: 30X3=90min
-For aircraft in V3: 35X2=70min

T=(100 + 90 + 70)/10= **26 minutes in sector A=26min x60s= 1560s**

- **Average weighted communication time:**

-For entry communication: 5sX10= 50s
-For level change: 5sX3= 15s
-For conflict resolution: 10sX1=10s
-For Transfer of control: 5sX10= 50s

τ_m = (50+15+10+50)/24=5.2s η=24/10=3 messages per aircraft

$\eta.\tau_m$ = 5.2x3= **15.6s**

$$N = \frac{40\% \times 1560}{15.6} = 40 \text{ aircraft/hour}$$

ADJUSTMENT FACTORS

❑ **FACTORS TO CONSIDER**

- Weather (VMC or IMC): Impact on the total separation and the runway occupancy time.
- Position and number of taxiways:
- Type of operations: take off, landing, crossing, touch and go, backtrack tow etc.
- Runway configurations: Crossing runways, parallel staggered.
- Landing equipment

❑ **ADJUSTMENT FACTORS TO APPLY**

percentage? Relative values?

❑ **ATC SECTOR CAPACITY ADJUSTED**

ATC SECTOR CAPACITY ADJUSTED = DECLARED ATC CAPACITY +/- ADJUSTMENT VALUE

Thank You!

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