Defining Capacity of Airport Passenger Buildings

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Objective: To Present and Explain Standards for Sizing

Topics
- Concepts of Capacity
- Design Concept
- Levels of Service
- IATA Space Standards (New Version in 2004!)
- Dwell Time
- Flow Standards
- Summary
Concepts of Capacity I

1. **Static:** Storage Potential of Facility

2. **Dynamic:** Ability of Facility to Process Flows
   - The Central Concept for the Design of Airport Passenger Buildings
   - Passengers, bags, cargo always Queue for and Move through Services (e.g.: Check-in, inspections, waiting for departures, etc.)

Concepts of Capacity II

- **Dynamic Capacity can be:**
  1. Sustained: Maximum flow over a significant period i.e., a morning arrival period
  2. Maximum: Maximum flow for a brief period

- **Dynamic Capacity is a Variable!!!**
  Unlike Static Capacity, of a bottle
Design Concept

- From Queuing Theory recall:
  More Space, Service => Less Delays

- Design for Dynamic Flows is:
  Tradeoff between Delays and Cost of Service, Space

- Dynamic Capacity depends on:
  1. Acceptable level of Delays and thus:
  2. Length of Period over which delays build up

- For Short Periods, More Delays Tolerable

Level of Service (LOS)

- A verbal description of Quality of Service in terms of Ease of Flow and Delays

- 6 categories (IATA Airport Development Man.):

<table>
<thead>
<tr>
<th>LOS</th>
<th>Flows</th>
<th>Delays</th>
<th>Comfort</th>
</tr>
</thead>
<tbody>
<tr>
<td>A - Excellent</td>
<td>Free</td>
<td>None</td>
<td>Excellent</td>
</tr>
<tr>
<td>B - High</td>
<td>Stable</td>
<td>Very Few</td>
<td>High</td>
</tr>
<tr>
<td>C - Good</td>
<td>Stable</td>
<td>Acceptable</td>
<td>Good</td>
</tr>
<tr>
<td>D - Adequate</td>
<td>Unstable</td>
<td>Passable</td>
<td>Adequate</td>
</tr>
<tr>
<td>E - Inadequate</td>
<td>Unstable</td>
<td>Unacceptable</td>
<td>Inadequate</td>
</tr>
<tr>
<td>F - Unacceptable</td>
<td>--- System Breakdown</td>
<td>---</td>
<td>Unacceptable</td>
</tr>
</tbody>
</table>

- System Managers should Specify LOS, e.g:
  - Level C = standard minimum ; Level D = for crush periods
IATA LOS Space Standards

• Useful intro to more sophisticated new version

• In square meters per person

<table>
<thead>
<tr>
<th>Area</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wait/circulate</td>
<td>2.7</td>
<td>2.3</td>
<td>1.9</td>
<td>1.5</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>Bag Claim</td>
<td>2.0</td>
<td>1.8</td>
<td>1.6</td>
<td>1.4</td>
<td>1.2</td>
<td></td>
</tr>
<tr>
<td>Check-in Queue</td>
<td>1.8</td>
<td>1.6</td>
<td>1.4</td>
<td>1.2</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>Hold-room Inspection</td>
<td>1.4</td>
<td>1.2</td>
<td>1.0</td>
<td>0.8</td>
<td>0.6</td>
<td></td>
</tr>
</tbody>
</table>

• More space needed for movement, with bags

IATA Stds: Wait / Circulate

• Old:

<table>
<thead>
<tr>
<th>Location</th>
<th>Carts</th>
<th>Space M²/pax</th>
<th>Speed m / sec</th>
</tr>
</thead>
<tbody>
<tr>
<td>Airside</td>
<td>None</td>
<td>1.5</td>
<td>1.3</td>
</tr>
<tr>
<td>After check-in</td>
<td>Few</td>
<td>1.8</td>
<td>1.1</td>
</tr>
<tr>
<td>Departure area</td>
<td>many</td>
<td>2.3</td>
<td>0.9</td>
</tr>
</tbody>
</table>

• New:
  → Distinguishes locations, likelihood of carts
  → References speed
### IATA Stds: Passport / Hold

- **Old:**

<table>
<thead>
<tr>
<th>Level</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1.4</td>
<td>1.2</td>
<td>1.0</td>
<td>0.8</td>
<td>0.6</td>
</tr>
</tbody>
</table>

- **New (for hold rooms only):**
  - Assumes 1.7 m²/pax sitting, 1.2 m²/ standee
  - LOS defined in terms of % of space used

<table>
<thead>
<tr>
<th>Level</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOS</td>
<td>40</td>
<td>50</td>
<td>65</td>
<td>80</td>
<td>95</td>
</tr>
</tbody>
</table>

### IATA Stds: Bag Claim Area

- **Old:**

<table>
<thead>
<tr>
<th>Level</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2.0</td>
<td>1.8</td>
<td>1.6</td>
<td>1.4</td>
<td>1.4</td>
</tr>
</tbody>
</table>

- **New:**
  - Assumes 40% of Passengers use carts
  - Has a wider range: more for A, less for E

<table>
<thead>
<tr>
<th>Level</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2.6</td>
<td>2.0</td>
<td>1.7</td>
<td>1.3</td>
<td>1.0</td>
</tr>
</tbody>
</table>
IATA Stds: Check-in Area

- Old:

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1.8</td>
<td>1.6</td>
<td>1.4</td>
<td>1.2</td>
<td>1.0</td>
</tr>
</tbody>
</table>

- New:

  Reflects impact of number of bags, carts

<table>
<thead>
<tr>
<th>Row width</th>
<th>Carts bags</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.2m</td>
<td>few</td>
<td>1.7</td>
<td>1.4</td>
<td>1.2</td>
<td>1.1</td>
<td>0.9</td>
</tr>
<tr>
<td></td>
<td>more</td>
<td>1.8</td>
<td>1.5</td>
<td>1.3</td>
<td>1.2</td>
<td>1.1</td>
</tr>
<tr>
<td>1.4 m</td>
<td>high</td>
<td>2.3</td>
<td>1.9</td>
<td>1.7</td>
<td>1.6</td>
<td>1.5</td>
</tr>
<tr>
<td></td>
<td>heavy</td>
<td>2.6</td>
<td>2.3</td>
<td>2.0</td>
<td>1.9</td>
<td>1.8</td>
</tr>
</tbody>
</table>

Snake Line at LOS = C
Snake line at LOS = E

Note: Kiosks change process

- Kiosks = automated check-in machines => CUSS (Common Use Self Service) if common
- Speeds up check-in
  → Automated data entry (try to enter “de Neufville”)
- Less Staff, Less counter Space
  → => Old layouts obsolete: e.g., Boston Internatl. Bldg
- Disperses Queues
  → Latest standards do not apply easily...
- CUSS at Las Vegas, Tokyo, in Canada
Dwell Time

- Determines Capacity of any space or process
- A Central Concept: Source of Major Problems

- It is the Average Time a person is in a space or process
- When a person leaves a space, Replacement can use it
- As people move faster
  - Dwell time is shorter
  - More replacements can use space in any period

Formula for Space Required

- Space Required, sq. meters =
  \[(\text{Load, pers./hour}) \times (\text{Std, sq.m./person}) \times (\text{Dwell time, hours})\]
  \[= (\text{Persons/Time}) \times (\text{Area/Person}) \times (\text{Time}) = \text{Area}\]

- Example:
  
  What space is required for passport inspection of 2000 passengers per hour when maximum wait is 20 minutes?

  Space Needed = 2000 \((1) \times (1/3)\) = 667 sq. m.
Formula for Capacity of a Space

- **Load, persons per hour** =  
  \[(\text{Space, sq. m.}) / (\text{Std, sq. m. per pers})(\text{Dwell time, hrs})\]

- **Examples:**
  - What is the recommended load (LOS = C) for a 30m. by 50m. waiting room, in which transit passengers average 90 minutes?
    
    \[
    \text{Recommended load} = (30) \times (50) / (1.9) \times (1.5) = 1500 / 2.85 = 527
    \]
  - What is the crush capacity of the same space?
    
    \[
    \text{Crush load} = (30) \times (50) / (1.5) \times (1.5) = 667 \text{ pers. per hr.}
    \]

Flow Standards

**In terms of PMM = Persons/Minute/Meter**

<table>
<thead>
<tr>
<th>Type of Passageway</th>
<th>Level of Service Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
</tr>
<tr>
<td>Corridor</td>
<td>10</td>
</tr>
<tr>
<td>Stairs</td>
<td>8</td>
</tr>
</tbody>
</table>
**Assumptions of Flow Standards**

- **Two Factors**
  - 1. Space per Person
    - e.g.: 1.9 sq. m. per person for LOS = C
  - 2. Walking Speed
    - e.g.: 66 meters/min = 4 km/hour
    - => Low Dwell Time
    - => High Capacity

- **Example:**
  - Capacity of Corridor, 5m. wide, 40m. long
    - Dwell time = 40 / 4000 = 0.01 hour
    - Recommended Load, persons per hour
    - = (5) (20) / (1.9) (0.01) = 5,000
Formula for Flow Areas

- Total Corridor Width Needed, meters = Effective Width + 1.5m. for edge effects
- Eff. width = (Persons /Minute) / (PMM)
- Example: What is recommended width of corridor to handle 600 persons per quarter hour, in both directions?
  Effective width = 80 / 20 = 4.0m
  Required width = 4.0 + 1.5 = 5.5m

- Note: Corridor capacity is very great!
  ▶ Most corridors > need ; Architectural considerations dominate

LOS varies over day, year!

- Example Distribution from Toronto
Summary

- **Key concepts about capacity:**
  1. Not purely technical issue
  2. Management decision about tradeoffs Cost vs. LOS
  3. Financial and Service Objectives of Airport critical

- **Key technical details:**
  1. Dwell time critical factor
  2. Through flows slash dwell time
  3. Capacity of corridors enormous