Benchmarking Airport Efficiency
Regional Airport Terminal Processes

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Content

• **Research initiation**
  - Eindhoven Airport Challenge
  - Literature Study

• **Constructing the tool**
  - Key Efficiency Indicators and Benchmark Methodology

• **Applying the tool**
  - Results

• **Discussing the tool**
  - Conclusions and Recommendations
1. Research Initiation
Challenge by Eindhoven Airport

Some Numbers

- Rapid increase in passengers
  - 2001: 0.3M pax
  - 2009: 1.7M pax
  - 2010: 2.1M pax (expected)

- Ryanair main growth driver
  - 2002: 7 flights/week
  - 2010: ~100 flights/week (summer season)

- Low fare carrier (LFC) pax / total pax = 85% (2009)
Challenge by Eindhoven Airport

Problem Statement

- Rapid growth of airport entirely linked to LFC
- LFC exercise tough airport performance demands
- While generally refusing to pay high airport charges
- Route termination by higher yield ‘traditional’ airlines

Downward pressure on the airport’s aviation revenues!
Strategy by Eindhoven Airport

Operational Excellence

- Continuous improvement of operational cost/quality ratio
  - Delivering generic high quality service for lowest possible cost
  - Resulting in best practice regional airport

Lack of objective data about efficiency of processes
- No clear idea about direction and urgency of process optimization
- Best practice cannot be achieved since best practice is unknown
- Setting efficiency goals limited to extrapolation of past (internal) experience
Research

• Developing a benchmark tool to evaluate the efficiency of the operational processes in the terminal.

• Aim
  • Quantify process efficiency at participating airports
  • Identify best practices amongst participating airports
  • Add external optimization path for airport management
Research

Constraints - 1

• Management decision tool for airport management

• Complete picture of passenger processes in terminal
  • Decision units → Handling and security processes

• Process resource efficiency level of detail
  • Daily operations benchmark
  • Managerial influenceable parameters only

• Equal comparisons → equal processes

• Sample group of (comparable) regional airports
Research

Constraints -2

• Process efficiency driven
  • No cost, quality, strategy influences

• Transparancy for all participating airports

• Limiting data to non-competitive, observable data
Literature Study

Filling the gap

- 32 airport benchmark studies investigated
  - Incl. Gillen and Lall, Barros, Graham, Neufville, Müller, Pels etc.

- All studies consider one unit: complete airport

- Sample groups:
  - Airports in selected country: e.g. Martín and Román (2006, Spain)
  - Airports in two countries: e.g. Müller (2009, Germany and UK)
  - Major/hub airports: e.g. Pels et al. (2003, Europe)

Research constraints: Processes = decision unit
Sample = Regional Airports
Literature Study

Filling the gap

- No airport or terminal process benchmarks, but:

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Times used in 32 studies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total number of passengers</td>
<td>ALL</td>
</tr>
<tr>
<td>Total number of aircraft movements</td>
<td>25</td>
</tr>
<tr>
<td>Invested capital / cost of capital</td>
<td>14</td>
</tr>
<tr>
<td>Total number of employees</td>
<td>13</td>
</tr>
<tr>
<td>Number of runways</td>
<td>12</td>
</tr>
<tr>
<td>Total labor cost</td>
<td>12</td>
</tr>
<tr>
<td>Total sales</td>
<td>13</td>
</tr>
<tr>
<td>Terminal area</td>
<td>12</td>
</tr>
<tr>
<td>Operational cost</td>
<td>9</td>
</tr>
<tr>
<td>Aeronautical / non-aeronautical sales</td>
<td>8</td>
</tr>
<tr>
<td><strong>Number of gates</strong></td>
<td><strong>8</strong></td>
</tr>
<tr>
<td>Airport area</td>
<td>7</td>
</tr>
<tr>
<td><strong>Number of luggage reclaim belts / reclaim hall area</strong></td>
<td>5</td>
</tr>
<tr>
<td>Runway area</td>
<td>4</td>
</tr>
<tr>
<td>Total runway length</td>
<td>5</td>
</tr>
<tr>
<td>Total cost</td>
<td>5</td>
</tr>
<tr>
<td>Number of car parking spots</td>
<td>4</td>
</tr>
<tr>
<td><strong>Apron area</strong></td>
<td><strong>3</strong></td>
</tr>
<tr>
<td>Number of check-in desks</td>
<td>4</td>
</tr>
<tr>
<td><strong>Number of aircraft parking stands</strong></td>
<td><strong>3</strong></td>
</tr>
<tr>
<td>Profitability</td>
<td>2</td>
</tr>
<tr>
<td>Departure lounge area</td>
<td>1</td>
</tr>
</tbody>
</table>
Literature Study

Filling the gap

• Some indicators of process level of detail are found, although not coupled to process

• Most relevant indicators found in
  • Gillen and Lall (1997)
  • Pels et al. (2003)
  • Müller et al. (2009)

<table>
<thead>
<tr>
<th>Area</th>
<th>Number of</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apron</td>
<td>Aircraft parking stands (1x)</td>
</tr>
<tr>
<td>Departure lounge</td>
<td>Check-in desks (2x)</td>
</tr>
<tr>
<td>Reclaim Hall</td>
<td>Gates (2x)</td>
</tr>
<tr>
<td></td>
<td>Luggage reclaim belts (2x)</td>
</tr>
</tbody>
</table>
2.

Constructing the tool
Methodology

Research

Step 1: Defining standard terminal processes

Step 2: Deriving (input and output) efficiency drivers per process

Step 3: Selecting sets of Key Efficiency Indicators (KEI)

Step 4: Benchmarking between sample airports
  - On individual weighed KEI level
  - On process level from set of KEI

Literature Study (steps 1,2)
Observations of processes (steps 1,2)
Expert opinions via discussion sessions (steps 1,2,3)
Methodology
Benchmark tool

- Airport benchmarking literature
  - Partial Fraction Analysis (PFA)
  - Data Envelopment Analysis (DEA)
  - Stochastic Frontier Analysis (SFA)

- PFA with Surface Measure of Overall Performance (SMOP)
  - Easy interpretable radar plot with KEI at axes
  - Total enclosed area is measure for total efficiency
  - Real, unbiased picture of measured KEI
  - One plot for each process at each measured time period
  - Small sample group (three airports), large decision unit group (processes)
Terminal Processes

Check-in/drop-off → Information/service

Security screening → Pre-security check

Passport Control → Waiting

Waiting → Boarding (terminal)

Arrival (terminal)
Terminal Processes

Efficiency Drivers

• Input efficiency drivers
  • “Infrastructure” (dedicated terminal area)
  • “Equipment” (number of desks, lanes, gates, reclaim belts)
  • “Labor” (number of staff)

<table>
<thead>
<tr>
<th>Type efficiency driver</th>
<th>Peak measurement</th>
<th>Year measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infrastructure</td>
<td>Dedicated terminal area [m²]</td>
<td>Dedicated terminal area [m²]</td>
</tr>
<tr>
<td>Equipment</td>
<td>Maximum # in use</td>
<td>Total # available</td>
</tr>
<tr>
<td>Labor</td>
<td>Maximum # in use</td>
<td>Total fte available</td>
</tr>
</tbody>
</table>
Terminal Processes
An example: Check-in/drop-off process

Complete Check-in/drop-off process at the airport

Passenger checks information screen for desk number → passenger moves to check-in/drop-off terminal area

<START TERMINAL PROCESSES>
<START PROCESS>
→ passenger joins queuing line
→ passenger arrives at desk
→ staff handling company:
  - performs passenger check-in process
  - performs luggage check-in process
  - checks hand luggage for airline requirements
  - issues boarding pass and bag tag receipt
  - provides flight information
<END PROCESS>
## Terminal Processes
### Efficiency Drivers Selection

<table>
<thead>
<tr>
<th>Process</th>
<th>Output efficiency driver(s)</th>
<th>Input efficiency drivers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passport Control</td>
<td>TotalPax_nonschengen</td>
<td>Area</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Desks</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Staff</td>
</tr>
<tr>
<td>Waiting</td>
<td>DepPax</td>
<td>Departure lounge area</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Commercial use area</td>
</tr>
<tr>
<td>Boarding (terminal)</td>
<td>DepPax</td>
<td>Area</td>
</tr>
<tr>
<td></td>
<td>DepFlights</td>
<td>Gates</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Staff</td>
</tr>
<tr>
<td>Arrival (terminal)</td>
<td>ArrPax_luggage</td>
<td>Area</td>
</tr>
<tr>
<td></td>
<td>ArrFlights</td>
<td>Reclaim belts</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lost &amp; found Staff</td>
</tr>
</tbody>
</table>
Key Efficiency Indicators (KEI)

The Concept

- Indicates efficiency level of resource usage only
  - Process quality and cost are neglected (basic quality assumed)
  - Airport management strategy is neglected

\[
KEI = \frac{\text{output efficiency driver}}{\text{input efficiency driver}}
\]

; max. 2 outputs, 3 inputs

- Is directly influenceable on (daily) operations level
  - Via input efficiency drivers

- Is readily obtainable for benchmarking!

\[\text{KEI (efficiency)} \neq \text{KPI (performance, quality)}\]
Key Efficiency Indicators (KEI)
Benchmarking - 1

- Relative efficiency benchmarking

Airport sample group \{A, B, C\}

\(j\) decision making units (processes, \(j = 1,2,\ldots,8\))

Each process described by \(i\) inputs (\(i = 1,2,3\))

Each process described by 1 or 2 outputs

\(KEI_{i,j} = KEI\) with input \(i\) for process \(j\) (1 output)

\(KEI_{i,j-1} / KEI_{i,j-2} = KEI\) input \(i\), process \(j\) (2 outputs)

- Most efficient KEI in process \(j\) for input \(i\):

\[
KEI_{i,j}^* = \max \left\{ (KEI_{i,j})_A, (KEI_{i,j})_B, (KEI_{i,j})_C \right\} \quad ; \quad KEI_{i,j}^* = 1
\]
Key Efficiency Indicators (KEI)

Benchmarking -2

- Say $KEI_{i,j}^\star$ at airport A:

$$
(KEI_{i,j})'_A = KEI_{i,j}^\star = 1
$$

- The relative efficiency value for \{B,C\} are:

$$
(KEI_{i,j})'_B = (KEI_{i,j})_B / (KEI_{i,j})_A \\
(KEI_{i,j})'_C = (KEI_{i,j})_C / (KEI_{i,j})_A
$$
Key Efficiency Indicators (KEI)

Benchmarking -3

• For all processes \((j = 1, 2, \ldots, 8)\) for peak and year periods:

**KEI level benchmark**

• Sample group in radar plot with \(\{\text{KEI}_{i,j}\}_{A,B,C}^j\) at axes for each output

**Process level benchmark**

• SMOP calculation for process radar plot
• Largest surface area = “best-in-class” efficiency
• Weighed against \(\{\text{KEI}_{i,j}\} = 1, 1, 1\) (for \(i = 1, 2, 3\))
Key Efficiency Indicators (KEI)

Benchmarking - 4

**PEAK - Pax output**

**PEAK - Flights output**
Key Efficiency Indicators (KEI)

Benchmarking - 5

<table>
<thead>
<tr>
<th>Eindhoven Airport</th>
<th>Charleroi BS Airport</th>
<th>Rotterdam TH Airport</th>
</tr>
</thead>
<tbody>
<tr>
<td>( i )</td>
<td>PEAK - pax output</td>
<td>( KEI'_{i,1-1} )</td>
</tr>
<tr>
<td>1</td>
<td>Pax/area</td>
<td>0.81</td>
</tr>
<tr>
<td>2</td>
<td>Pax/staff</td>
<td>88.52</td>
</tr>
<tr>
<td>3</td>
<td>Pax/desk</td>
<td>88.52</td>
</tr>
</tbody>
</table>

| | PEAK - flights output | \( KEI'_{i,1-2} \) | PEAK - flights output | \( KEI'_{i,1-2} \) | PEAK - flights output | \( KEI'_{i,1-2} \) |
|-------------------|----------------------|----------------------|----------------------|----------------------|----------------------|
| 1 | Flights/area | 0.008 | 0.545 | 1 | Flights/area | 0.012 | 0.830 |
| 2 | Flights/staff | 0.857 | 1.000 | 2 | Flights/staff | 0.535 | 0.624 |
| 3 | Flights/desk | 0.857 | 1.000 | 2 | Flights/desk | 0.595 | 0.694 |

| Total -pax | 0.649 | 74.6% | Total -pax | 0.548 | 62.9% | Total -pax | 0.295 | 33.9% |
| Total -flights | 0.607 | 69.7% | Total -flights | 0.443 | 50.9% | Total -flights | 0.437 | 50.2% |

SMOP: max surface 3 axes \( \{1,1,1\} = 0.87 \)
### Key Efficiency Indicators (KEI)

#### KEI Selection by Process

<table>
<thead>
<tr>
<th>$j$</th>
<th>Two outputs</th>
<th>Process</th>
<th>KEI</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>X</td>
<td>Check-in/drop-off</td>
<td>Pax/area: KEI_{1,1-1}</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Pax/staff: KEI_{1,1-2}</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Pax/desk: KEI_{1,1-3}</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>Information/service</td>
<td>Flights/area: KEI_{1,1-2}</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>Pre-security check</td>
<td>Flights/staff: KEI_{1,2-2}</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>Security screening</td>
<td>Flights/desk: KEI_{1,3-2}</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>Passport control</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>Waiting</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>X</td>
<td>Boarding (terminal)</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>X</td>
<td>Arrival (terminal)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>$j$</th>
<th>Process</th>
<th>KEI</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>Waiting</td>
<td>Pax/area: KEI_{1,6}</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Comm. area/area: KEI_{2,6}</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>$j$</th>
<th>Process</th>
<th>KEI</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Security screening</td>
<td>Pax/area: KEI_{1,4}</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pax/staff: KEI_{2,4}</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pax/lane: KEI_{3,4}</td>
</tr>
</tbody>
</table>
Applying the tool
Sample Group

- Questionnaire efficiency drivers processes:
  - Peak (during summer 2010)
  - Year (August 2009-July 2010)

| Total movements (8/09-7/10) | 14.764 | 33.121 | 13.305 |
| Total pax (8/09-7/10) | 1.944.280 | 4.628.625 | 969.936 |
| Pax/flight | 132 | 140 | 73 |
| Pax via check-in | 50% | 40% | 92% |
| Peak DEP.FLIGHTS | 9 | 11 | 6 |
| (6x FR / 2x W6 / 1x XQ) | (10x FR / 1x JAF) | (3x HV / 3x VG) |
Results
Peak (Check-in/drop-off)
Results

Year (Check-in/drop-off)
## Results

### Peak vs. Year (Check-in/drop-off)

<table>
<thead>
<tr>
<th>PAX output</th>
<th>Peak</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eindhoven Airport</td>
<td>74.6%</td>
<td>50.7%</td>
</tr>
<tr>
<td>Charleroi Brussels South Airport</td>
<td>62.9%</td>
<td>93.4%</td>
</tr>
<tr>
<td>Rotterdam The Hague Airport</td>
<td>33.9%</td>
<td>79.1%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>FLIGHTS output</th>
<th>Peak</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eindhoven Airport</td>
<td>69.7%</td>
<td>100.0%</td>
</tr>
<tr>
<td>Charleroi Brussels South Airport</td>
<td>50.9%</td>
<td>44.7%</td>
</tr>
<tr>
<td>Rotterdam The Hague Airport</td>
<td>50.2%</td>
<td>33.7%</td>
</tr>
</tbody>
</table>
4.

*Discussing the tool*
Conclusions

• Tool quantifies efficiency of terminal processes using KEI
  • At detail levels: KEI (PFA) & Process (SMOP)

• Best practices for each process and KEI are identified
  • But: only best practices amongst the 3 sample airports

• Strategic improvement fields identified by non-best-practice scores
  • Allows for collaboration between airports

• Agenda: discussion meeting EIN/CRL/RTM further interpretation results
Discussion and Recommendations

- Good scoring KEI may indicate bad process quality (within concept KEI)
  - Crowded areas, queuing lines due to few staff or desks
  - But processes are comparable and quality differences mentioned

First time terminal process benchmark
- Coupling to (internal) KPI and cost structure -> complete picture
  - Efficiencies (KEI) coupled to obtaining (KPI) and cost
  - But processes are comparable and quality differences mentioned
- Once participating, very satisfied by results and method!

- Fte for staff in year measurement difficult to achieve

- Peak measurement method (max # in use) lacks time variable
- More comparable sample airports (preferably with Ryanair)
Questions?