STUDY OF AIRPORT CAPACITY VS. EFFICIENCY
SESAR CHALLENGES

CDM Cost Benefit Analysis for Barcelona Airport

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1 INTRODUCTION

1.1 The CBA analysis

Cost Benefit Analysis (CBA) is an increasingly important tool in the assessment of investment decisions. It is a tool for decision makers, used to evaluate whether the investment is economically viable or not.

There is no formal definition of CBA, but the following interpretation by the FAA: “Benefit-Cost analysis calls for the examination of all costs related to the production and consumption of an output, whether the costs are borne by the producer, the consumer, or third party. Similarly the method requires an examination of all benefits resulting from the production and consumption of the output, regardless who realizes the benefits”

How this is implemented may vary, but basically all procedures are based on:

- Estimating all incremental costs related to the implementation of an application or service
- Estimating all incremental benefits related to the implementation of an application or service
- Taking full account of the times at which costs are paid and at which benefits accrue
- Taking account of uncertainty
- Obtaining a figure of merit and performing sensitivity and risk analysis

Costs are to be understood as the resources used to generate the outputs, while benefits are the utility to the relevant parties of those generated outputs.

1.2 Why Airport CDM for a CBA analysis

The purpose of this CBA is to provide a comprehensive economic analysis of the Costs and Benefits derived from the development, deployment and operation of Airport CDM in the airport of Barcelona.

A recent study reported by Eurocontrol [B1] showed that Airport CDM is a very interesting investment for any airport, not only for its operational advantages but also for its extremely high financial benefits given the low implementing costs.
The Report document shows that CDM will bring a significant improvement on the efficiency of the airport of Barcelona, and it is interesting to analyze at what price this enhancement should be paid, and when this investment would be returned (payback period).


2 BENEFITS AND COSTS KEY VARIABLES

This section describes the name of the variables affecting benefits and costs and the detailed data used in the economic models.

Figure 2.1. Benefits and costs key variables

2.1 Benefits

For the airport operator the following benefits have been identified:

- **Airport new revenues**: based on the net revenue realized through additional flights and passengers (additional movements – flight cancellations avoided) and reduced delays

- **Airport operational efficiency**: better use of airport resources through better information and anticipation. The benefits are the savings on operational costs or reduction of inefficiencies by a certain percentage.

Other two benefits that can be identified are *airport image* (the perception among passengers about a certain airport) and *airport punctuality*. 
2.2 Costs

The investment cost is the sum of:

- **One-off implementation costs**: costs incurred during the implementation period, such as CDM procedures / KPIs definition (the Airport Partner must decide how CDM concept elements will be implemented), project management, training and software development costs
- **IT improvements**: costs related to system refinement once it is operative

The operation costs are expressed as annual operating costs, and contemplate system maintenance and the increase of staff’s salaries due to increased expertise.

2.3 Airport data

The value assigned to every key variable described above is detailed in the following. When no specific data for the Barcelona case was available, given that the Generic Airport considered in [B1] is very similar to Barcelona airport, the same values will be considered:

<table>
<thead>
<tr>
<th>Generic Airport</th>
<th>Barcelona Airport</th>
</tr>
</thead>
<tbody>
<tr>
<td>280.000 movements annually</td>
<td>281.349 movements in 2009</td>
</tr>
</tbody>
</table>

Table 2.1. Airport’s comparison

2.3.1 Benefits data

It is important to remark that benefits are considered to be progressively obtained using a simple linear approach.

Not before the procedures are set up and fully refined, it will not be possible to actually count them. Thus, the impact of the benefits during the first year will be below 100%, about 50%, and it is considered that until 2013 (which is when it is assumed that there is no need for further improvement in the system), the distribution of benefits is:

<table>
<thead>
<tr>
<th>Year</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benefit percentage</td>
<td>50%</td>
<td>62,5%</td>
<td>75%</td>
<td>82,5%</td>
<td>100%</td>
</tr>
</tbody>
</table>

Table 2.2. Impact of benefits over time
Cancellations avoided
According to EMOSIA models, in [B1] it is stated that the value of a cancelled flight for a base case is 600€. In the same document, the number of cancelled flights according to expert’s judgment will be about 200 for the Generic Airport case; so, for the Barcelona case is:

<table>
<thead>
<tr>
<th>Annual departures</th>
<th>Cancellations avoided</th>
</tr>
</thead>
<tbody>
<tr>
<td>Generic Airport</td>
<td>140.000</td>
</tr>
<tr>
<td>Barcelona Airport</td>
<td>140.675</td>
</tr>
</tbody>
</table>

Table 2.3. Number of cancellations avoided per year in Barcelona’s airport

So, yearly, **120,6 k€** are saved.

Reduced delays
To calculate the delay savings, only departures have been taken into account (the same as [B1]; conservative approach).

According to [B1], it is forecasted that the traffic growth will be 4% per year according to a base case. In Barcelona there was a traffic of 281,349 movements in 2009. Considering this traffic growth, the yearly incoming traffic to Barcelona will be:

<table>
<thead>
<tr>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>292,603</td>
<td>304,307</td>
<td>316,479</td>
<td>329,139</td>
<td>342,304</td>
<td>355,996</td>
<td>370,236</td>
<td>385,046</td>
<td>400,447</td>
<td>416,465</td>
<td>433,124</td>
</tr>
</tbody>
</table>

Table 2.4. Barcelona’s airport future traffic

According to Eurocontrol, CDM can bring a reduction of 3% of delays in a base case.

In the Report, a delay of **0,7 min** per flight was estimated for the current case of Barcelona.

From the Westminster study, in [B1] it is considered that 1 minute of delay costs 77€ in the base case.

With this, it is calculated that the delay saving is **1,6€ / minute / flight**. Considering the flight traffic above, the reduced delays benefit is obtained.

Operating costs avoidance
In [B1] it is considered that that annual Airport Operating Costs are 300 M€. According to expert’s judgment, the operating costs avoidance ranges from 0 – 4%. In this case 1% has been considered. So, in total **3M€** are saved yearly.
### Costs Data

#### Project Management
According to [B1] is \(1\text{M€} \) during 4 years.

#### Software Development
According to [B1] is \(0.25\text{M€} \) for a base case during implementation period. In this case 2 years have been considered.

#### CDM procedures definition
Considering 2 persons dedicated 100% of time during one year to define the required CDM procedures for Barcelona’s airport:

\[
2 \text{ persons} \times 12 \text{ months} \times 20 \text{ days} \times 8 \text{ hours} \times 65 \text{ €/man-hour} = 0.25 \text{ M€}
\]

#### Staff Training
CDM tasks would not require extremely specialized staff. Considering a base salary and a training of 1 year:

\[
12 \text{ months} \times 20 \text{ days} \times 8 \text{ hours} \times 50\text{ €/man-hour} = 100 \text{ k€}.
\]

Considering as well meeting trips and documentation costs, it is estimated that staff training costs are about **125 k€**.

#### Annual IT improvements
According to [B1] is \(0.1\text{M€} \) per year. In this case it has been considered that it will take 4 years to completely refine the system.

### Table 2.5. Variable values for Barcelona’s CBA

<table>
<thead>
<tr>
<th>COSTS</th>
<th>Value [€]</th>
<th>Duration [years]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Investment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>One-off implementation costs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Project management</td>
<td>250.000</td>
<td>4</td>
</tr>
<tr>
<td>Software development</td>
<td>250.000</td>
<td>2</td>
</tr>
<tr>
<td>CDM procedures definition</td>
<td>250.000</td>
<td>1</td>
</tr>
<tr>
<td>Staff training</td>
<td>125.000</td>
<td>1</td>
</tr>
<tr>
<td>IT improvements</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annual IT improvements</td>
<td>100.000</td>
<td>4</td>
</tr>
<tr>
<td>Operation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operating costs</td>
<td>500.000</td>
<td>12</td>
</tr>
<tr>
<td>Annual CDM operating costs</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| BENEFITS                      |           |                  |
| Airport new revenues          |           |                  |
| Increased number of movements |           |                  |
| Cancellations avoided         | 120.600   | 12               |
| Extra allowed movements       | -         | 12               |
| Reduced delays                |           |                  |
| Varies                        |           | 12               |
| Op. efficiency                |           |                  |
| Op. costs avoidance           | 3.000.000 | 12               |
Annual CDM operating costs
According to [B1] is 0,5M€ per year for a base case. It is mentioned that this value can be considered as high by some airports, but this can be justified for those cases that the airport buys a new system and attributes the investment to CDM. This is the case considered here.
3 RESULTS FROM ANALYSIS

3.1 Return on investment period or payback period

In the case of Barcelona, it achieves its return of investment in the second year of Airport CDM implementation. This result completely agrees with the results obtained by Eurocontrol in [B1]:

![Figure 3.1. Cumulative Net Benefits for Barcelona airport](image1)

The graphs above illustrate how the cumulative benefits are higher than the cumulative costs from the second year onwards.

![Figure 3.2. Cumulative Net Benefits (3 years) [B1]](image2)
3.2 Benefits obtained and total costs

The benefits obtained and the total costs incurred each year of the project are represented in the following graph:

![Benefits to total costs graph](image)

**Figure 3.3. Benefits and total costs for Barcelona airport**

Note: in the previous figure, investment costs are considered during the first year, but as shown before, one-off implementation costs are spread over 4 years.

The main insight is that costs are very small compared to the benefits, but quite constant through the implementation and post-implementation phases.

3.3 Cost effectiveness

The following table shows that the investment required for the airport of Barcelona is modest compared to benefits obtained:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Benefits</td>
<td>36,7 M€</td>
</tr>
<tr>
<td>Investment Costs</td>
<td>1,9 M€</td>
</tr>
<tr>
<td>Operating Costs</td>
<td>7,9 M€</td>
</tr>
</tbody>
</table>

**Table 3.1. Benefits, Investment Costs and Operating Costs**

The overall cost of the project is 9,78 M€, distributed as follows:
- 1,88 M€ investment spread over 4 years
- 7,91 M€ operating costs spread over 12 years

The Present Value of the benefits is 36,7 M€ over 12 years.

A benefit to cost ratio of 3,74 is obtained for the Barcelona case, as shown below:
This means that the total benefits of implementing Airport CDM are almost 4 times higher than the total costs. However, in [B1] a B/C ratio of 9 is obtained. The reason is that it was not possible to consider absolutely all the possible benefits, like for instance those from extra allowed movements, given that the % of improvement due to airport CDM of this increase was unknown. It is to say that the benefits due to extra allowed movements were considerably high.
4  CDM IMPLEMENTATION OVER TIME

For setting up an airport CDM project, the following tasks were identified:

1. Definition Phase
   a. Setting the objectives
   b. Selecting airport CDM concept elements
   c. Inventory of what is needed and what is available
   d. Business case elaboration
   e. Educating and convincing all partners
   f. Staff training
   g. Software development

2. Implementation Phase
   a. IT improvements

3. Post-Implementation Phase

This, translated into a Gantt chart, turns into (see next page).

As it can be seen, the project is considered to start its implementation in 2009, coinciding with the traffic statistics available for Barcelona’s airport.
5 CONCLUSIONS

This CBA shows that Airport CDM is a solid investment. It is very strong not only from the quantitative point of view but also from the qualitative. Of all the various improvements possible, the introduction of Airport CDM appears to be one of the most important to achieve a quick, cost-effective situation.

The business case for Airport CDM is extremely positive, showing a benefit to cost ratio of 4 to 1. The costs incurred for the Barcelona case project (over 12 years; typical Airport CDM project is over 10 years) are in the order of 9,8 M€, from which the initial implementation investment is only in the order of 1,9 M€ and the related recurrent operational costs are of the order of €7,9Mn.

The full return of investment or payback period for all stakeholders is within 2 years.

It should be noted that the analysis reported in this document is a conservative approach: when a benefit is shown, it is always considered as a minimum and in most cases more positive results can be expected.

Regarding the sensitivity analysis the results show that the key uncertainties are related to the key assumptions of the project and the expert judgment given in some of the cases. Each sensitive variable can be studied further to obtain a more accurate picture. However, in [B1] a risk analysis is made, and results show that the risk of financial loss is practically non-existent for the airports case. Consequently, there is no need to undertake further study to reduce uncertainties.

As a result, Airport CDM is a highly recommended investment for all European airports:

- Given its technical applicability for the T1 terminal of Barcelona airport;

- The enhancements it introduces in the efficiency of the airport by contributing to reduce delays (demonstrated in the Report);

- And finally, because of its economic viability: it offers substantial benefits for minimal investment at a low financial risk.
6 BIBLIOGRAPHY
