ASICBA
Aviation Safety Improvement using Cost Benefit Analysis

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Introduction

- Funded by European Commission via FP6

- Research organisations (3), Aviation information company (1), University (1), Airlines (2), Airport authority (1)

- Duration: 2 years, finalised by 15 January 2007

- Approach to assess the costs and benefits of safety measures

- Safety effects expressed in monetary terms
Project Consortium

European Commission

Project Co-ordinator (DAPP)

Core-Team (NLR, Airclaims, ECORYS, PoliMI)

Users (Meridiana, GEASAR, LOT)
Project Overall Objective

This project aims at the improvement of aviation safety through a new approach that will allow aviation stakeholders to assess the effects of technical, managerial and political decisions at the safety level, together with the associated costs and benefits.
The **new Safety approach** will consist of a methodology that will be implemented into a **Decision Support System** (a sort of electronic handbook) providing a step-by-step procedure that will support the user throughout the different phases necessary for assessing the cost effectiveness of safety measures.

The **Decision Support System** will incorporate a data pool for the estimation of costs, benefits and risk reduction related to the implementation of specific safety measures.
Why is there a need for this?

• Cost-benefit analysis applied in some subsectors in aviation

• Cost benefit analysis of safety measures is relatively new in aviation

• Opportunity for balanced trade-off between safety improvement and investment

• Comparisons between different safety measures possible
General description of the approach
Risk model

- Scenario based
- Use of Event Sequence Diagrams (ESD)
  - Initiating event
  - Pivotal event
  - End State

- ESD: possible ways in which the effects of an initiating disturbance are handled by the aviation system

- 35 ESDs based on generic accident scenarios; extension of conventional risk techniques, i.e. fault trees and Bayesian Belief Networks

- Impact for each end state is noted as an impact vector
Event Sequence Diagram

Initiating event -> Pivotal event (YES) -> End state

Pivotal event (NO) -> Pivotal event (YES) -> End state

Pivotal event (NO) -> End state
Example of an ESD
## Impact vectors and severity levels

<table>
<thead>
<tr>
<th>Aircraft</th>
<th>Occupants</th>
<th>Operation aircraft involved</th>
<th>Other airlines</th>
<th>Airport</th>
<th>3rd party</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>&gt;75% damage (beyond economical repair)</td>
<td>60% killed</td>
<td>&gt;4hrs delay (Flight aborted)</td>
<td>Many flights cancelled</td>
<td>Closed for 5 days</td>
</tr>
<tr>
<td>3</td>
<td>50% damage</td>
<td>30% killed</td>
<td>2 hrs &lt; delay &lt; 4 hrs</td>
<td>Many delays</td>
<td>Closed for 2 days</td>
</tr>
<tr>
<td>3</td>
<td>15% damage</td>
<td>Some Injuries only</td>
<td>30min &lt; delay &lt; 2hour</td>
<td>Less than many delays</td>
<td>Runway closed for 2 days</td>
</tr>
<tr>
<td>3</td>
<td>1% damage</td>
<td>Few injuries</td>
<td>15min &lt; delay &lt; 30min</td>
<td>Little delays</td>
<td>Runway closed for 12 hours</td>
</tr>
<tr>
<td>6</td>
<td>No Impact</td>
<td>No Impact</td>
<td>No Impact (less than 15min delay)</td>
<td>No Impact</td>
<td>No Impact</td>
</tr>
</tbody>
</table>
Cost model

• Costs resulting from an accident are a key notion
• 24 Heads of cost identified
• Distinction to stakeholders
  • Airline
  • Passengers
  • Airport operator
  • (Safety) Authority
  • Third party / society
  • Other airlines
  • Insurers
  • Aircraft manufacturers
Costs resulting from an accident

Heads of cost
1. Aircraft physical damage
2. Possible loss of resale value
3. Aircraft loss of use
4. Passenger/crew death/injury
5. Loss of cargo, baggage
6. Third party damage
7. Airline costs of delay
8. Suspension of activities
9. Passenger delay
10. Airport closure
11. Airspace closure
12. Site contamination & clearance
13. Search & rescue
14. Airline immediate response
15. Cost of investigation
16. Cost of insurance
17. Loss of reputation & income
18. Loss of company value
19. Wider economic damage
## Example Aircraft related costs

<table>
<thead>
<tr>
<th>Severity level</th>
<th>Heads of costs</th>
<th>Physical damage</th>
<th>Loss of resale value</th>
<th>Loss of use</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>€ 32 m</td>
<td>€ 0</td>
<td>€ 0</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>€ 16 m</td>
<td>€ 4.8 m</td>
<td>€ 3 m</td>
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<tr>
<td>2</td>
<td></td>
<td>€ 5 m</td>
<td>€ 2.4 m</td>
<td>€ 1.5 m</td>
</tr>
<tr>
<td>1</td>
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<td>€ 0.3 m</td>
<td>€ 1.3 m</td>
<td>€ 0.4 m</td>
</tr>
<tr>
<td>0</td>
<td></td>
<td>€ 0</td>
<td>€ 0</td>
<td>€ 0</td>
</tr>
</tbody>
</table>
CBA computation

• Safety value

• Investment costs

• Operational costs

• Operational benefits (if any)

• Trade off
  • Airline / airport
  • Society

• Internal rate of return / net present value
The DSS requirements

• Must be usable by a **generic stakeholder user**, not an expert in risk analysis

• Must be a **WEB** tool, accessible by a standard **internet browser**

• Applies the CBA methodology **to user specific data**, while **user’s data remain private**

• Returns the **results** of the CBA **together the formulas** used to perform the calculations
What the DSS does

• Performs an **interview phase**, asking the user about **conditions and objectives**, in order to **select pertinent ESDs** and default values of events probability from the general model

• Asks the user to **customize parameters** in order to match correct probability for events and correct values for costs

• Asks the user to quantify values involved into **safety measure effects**

• Sends to the user an MS **Excel report** that contains all data inserted, perform calculations and presents final result
How the DSS looks

From the Web User Interface

Trough a Server-Side Expert System over the General Model to the Final CBA Report
Conclusion

• CBA is a useful tool for understanding gains and losses of safety investments

• CBA should be one of the inputs in decision making process

• Safety benefits often disregarded in CBA

• ASI CBA method offers opportunity to include safety benefits in CBA

• Method has been applied to case studies from users in the industry