Aviation and the Belgian Climate Policy – Integration options and Impacts “ABC Impacts”

A Multicriteria analysis (MCA) of policy options to reduce the total aviation climate impact

Workshop on aviation scenarios and climate impacts
Brussels, 26 March 2010

Annalia Bernardini, Cathy Macharis, Tom Van Lier, Ellen Van Hoeck
Department MOSI - Transport and Logistics
Overview

1. The ABC project and MCA

2. MCA methods

2.1 Analytical Hierarchy Process (AHP)
2.2 PROMETHEE

3. PROMETHEE software applied to ABC project example

4. Conclusions and perspectives
1. The ABC project and MCA

**ABC**

Policy options groups:

- Technology R&D investments
- Operational efficiencies/Infrastructures
- Market based measures

**MCA**

- Provides a framework to evaluate these climate policy options (alternatives) through a set of criteria:
  - Environmental performances
  - Achievements
  - Impacts advantages-benefits

- By applying the MCA, it is possible to some extent to outline an appropriate platform for future compromises.
2. MCA methods

MCA ➔

- definition of the problems/goals to be achieved

- identification of the criteria

- prioritization of the alternatives
2. MCA methods

2.1 Analytical Hierarchy Process (AHP), developed by Prof. T. L. Saaty (1970)

- hierarchy levels
  - based on pairwise comparisons:
    - between the goal and the criteria and sub-criteria
    - between alternatives and criteria
    - classification of the alternatives
2. MCA methods

2.1 Analytical Hierarchy Process (AHP), developed by Prof. T. L. Saaty (1970)


ABC-AHP ➔

With AHP, the user is forced to perform a high number of comparisons: \( n(n-1)/2 \)
2. MCA methods

2.2 PROMETHEE & GAIA, developed by Prof. J.P. Brans and Prof. B. Mareschal at the (U.L.B. and V.U.B., 1983), Prof. C. Macharis, Prof. J.P. Brans and Prof. B. Mareschal, PROMETHEE GDSS, (1998)

PROMETHEE →

- allows the user to directly exploit the data (alternatives \( a_n \), criteria \( f_k \)) of the problem in a simple evolutive multicriteria table (Performance Matrix)

- extensive sensitivity analyses as well as visual representations (GAIA) of the data are available to the decision-maker

- particularly userfriendly software, used for the ABC Impacts policy options assessment
3. PROMETHEE software applied to ABC project

**Goal**

Policy options to reduce the total aviation climate impact

```markdown
<table>
<thead>
<tr>
<th>Name</th>
<th>ShortN.</th>
<th>Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Airframe technology (engines, materials, design)</td>
<td>a1</td>
<td>Technology R&amp;D investments</td>
</tr>
<tr>
<td>Energy efficiency (alternative fuels)</td>
<td>a2</td>
<td>Technology R&amp;D investments</td>
</tr>
<tr>
<td>Air Traffic Management</td>
<td>a3</td>
<td>Operational efficiencies/Infrastructure</td>
</tr>
<tr>
<td>Emission/fuel content standard</td>
<td>a4</td>
<td>Operational efficiencies/Infrastructure</td>
</tr>
<tr>
<td>Operational improvements/Infrastructure</td>
<td>a5</td>
<td>Operational efficiencies/Infrastructure</td>
</tr>
<tr>
<td>Fuel tax (CO2)</td>
<td>a6</td>
<td>Market based measures</td>
</tr>
<tr>
<td>Emission Trading (and similar mechanism)</td>
<td>a7</td>
<td>Market based measures</td>
</tr>
<tr>
<td>Extended Emission Trading (non-CO2)</td>
<td>a8</td>
<td>Market based measures</td>
</tr>
</tbody>
</table>
```

**Example**
3. PROMETHEE software applied to ABC project

<table>
<thead>
<tr>
<th>Name</th>
<th>ShortN.</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO2</td>
<td>c1</td>
<td>Environmental performances</td>
</tr>
<tr>
<td>AIC</td>
<td>c2</td>
<td>Environmental performances</td>
</tr>
<tr>
<td>non-CO2</td>
<td>c3</td>
<td>Environmental performances</td>
</tr>
<tr>
<td>Feasibility</td>
<td>c4</td>
<td>Achievements</td>
</tr>
<tr>
<td>Probability implementation</td>
<td>c5</td>
<td>Achievements</td>
</tr>
<tr>
<td>Achievements objectives</td>
<td>c6</td>
<td>Achievements</td>
</tr>
<tr>
<td>Time horizon-delay</td>
<td>c7</td>
<td>Achievements</td>
</tr>
<tr>
<td>Aviation sector</td>
<td>c8</td>
<td>Impacts advantages-benefits</td>
</tr>
<tr>
<td>Other Stakeholders</td>
<td>c9</td>
<td>Impacts advantages-benefits</td>
</tr>
</tbody>
</table>
3. PROMETHEE software applied to ABC project

Performance Matrix

<table>
<thead>
<tr>
<th>Qualitative Scores</th>
<th>Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Little efficient</td>
</tr>
<tr>
<td>2</td>
<td>Moderately efficient</td>
</tr>
<tr>
<td>3</td>
<td>Satisfactory</td>
</tr>
<tr>
<td>4</td>
<td>More than satisfactory</td>
</tr>
<tr>
<td>5</td>
<td>Very efficient</td>
</tr>
</tbody>
</table>

Example
3. PROMETHEE software applied to ABC project

Example
3. PROMETHEE software applied to ABC project
3. PROMETHEE software applied to ABC project

Example
3. PROMETHEE software applied to ABC project

GAIA

Example
3. PROMETHEE software applied to ABC project

Walking Weights

Example

Environmental performances - Relative value : 50%
3. PROMETHEE software applied to ABC project

Walking Weights sensitivity analysis

Example
4. Conclusions and perspectives

PROMETHEE outcome → top five alternatives assessment

Stakeholders opinions:

- The stakeholders can provide feedback by indicating their assessments
- Provide weights for criteria (PROMETHEE)
- AHP online stakeholders evaluation
- PROMETHEE online stakeholders evaluation (in progress)
4. Conclusions and perspectives

AHP online stakeholders assessment

Decision making online software based on AHP
“Our present day values come from the past. But we need others that come from a simulated future into which we are marching even now. We need ways to forecast that future to improve our actions today compatible with whatever values we have.”

Thomas L. Saaty