Motivation: Systematic problems in impact assessment

1. Input data and impact estimates are not reliable
   – Account for fuzzyness, don’t pretend „accuracy“.

2. Sum up heterogeneous effects
   – Compare in pairs, hence natural units, don’t „sum up“.

3. Conflicting targets and values
   – Identify compromise, make judgements explicit.

4. (Technical treatments put off public and policy maker
   – Simple, discursive approach: Get them involved)

Some lessons from Multi-criteria Decision Aiding theory,
here a particular outranking method ELECTRE applied to EU transport.
1. Vague data & knowledge demand general treatment

„Is the environmental performance of Europe's road transport improving?“

Data too imprecise for
• noise + air pollution,
• fragmentation + land take

=> Qualitative, fuzzy judgement

„Does case A perform at least as good as case B for indicator x?“
• Cannot say,
• maybe,
• definitely.

2. Compare heterogeneous impacts individually, don't sum up

Begin with performance table – preference direction: The less, the better.

<table>
<thead>
<tr>
<th>Indicator</th>
<th>CO2-E.</th>
<th>Accident</th>
<th>Noise</th>
<th>Particle pot.</th>
<th>Fragmentg</th>
</tr>
</thead>
<tbody>
<tr>
<td>unit</td>
<td>Mt CO2-eq</td>
<td>fatalities</td>
<td>Exposure</td>
<td>kt PM10-eq</td>
<td>Δ(-1%)</td>
</tr>
<tr>
<td>Case A</td>
<td>720</td>
<td>65000</td>
<td>High</td>
<td>High</td>
<td>1,20%</td>
</tr>
<tr>
<td>Case B</td>
<td>780</td>
<td>54000</td>
<td>High</td>
<td>A bit less</td>
<td>0,90%</td>
</tr>
<tr>
<td>Uncertainty</td>
<td>5%</td>
<td>1%</td>
<td>HIGH</td>
<td>HIGH</td>
<td>10%</td>
</tr>
</tbody>
</table>

part. concordance

Case A at least as good as case B
Yes No Cannot say Maybe No

Judge the relative performance per indicator and its reliability for all cases in dialogue. => Construct a matrix of qualitative reliability judgements per indicator.
3. Identify values, conflicts and compromise in dialogue

Use value profiles to emulate different positions – derive from dialogue with stakeholders.

<table>
<thead>
<tr>
<th>Overall objective</th>
<th>Protection of human health</th>
<th>Protection of structure and function of ecosystems</th>
<th>Protection of resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Impact category</td>
<td>Accidents</td>
<td>Noise</td>
<td>Air pollution</td>
</tr>
<tr>
<td>a) Equal weights</td>
<td>33/3</td>
<td>33/3</td>
<td>33/3</td>
</tr>
<tr>
<td>b) Health dominant</td>
<td>50/3</td>
<td>50/3</td>
<td>50/3</td>
</tr>
<tr>
<td>c) Ecosystems dom.</td>
<td>25/3</td>
<td>25/3</td>
<td>25/3</td>
</tr>
<tr>
<td>d) Resources dom.</td>
<td>25/3</td>
<td>25/3</td>
<td>25/3</td>
</tr>
</tbody>
</table>

Values capture the - explicit and implicit – trade-offs
=> Make discussion transparent.

4. Overall ranking and compromise identification

ELECTRE, because compromise oriented:

Case A is globally preferred to case B IFF

1. there are sufficiently strong criteria in favour of A AND
2. there is no strong opposition or veto for single criteria.

This way, minority votes can be systematically integrated!

Sensitivity analysis:
Rank reversal IFF climate change and energy resources receive at least 60% of overall weight.
**Qualitative assessments can advance in vague contexts**

- Qualitative relative assessments can structure and advance discussion
  - Accounts for fuzzyness
  - Treats heterogeneous data
  - Names conflict of values in clear language
  - Can open the door for participation

- Multi-criteria decision aiding methods can help to identify compromise

**Limits:**
- Ordinal no cardinal evaluation -> „distance“ not defined.
- Fuzzy input -> no precise output
- Compensation excluded
- Of course, the results depend on the method (Arrow’s theorem)!

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**References on ELECTRE / MCDA methods (French):**

**MCDA methods (in English):**

**Application of ELECTRE to Transport EIA (in German):**
Start with 24 real-world indicators, here TERM indicators of EU Environ. Agency
Reduce to 7 key indicators for road transport:
- Representative,
- pertinent,
- relevant,
- non-redundant

Completeness and significance from LCA theory

Assign relative importance to the various targets / impact categories

But data are incomplete, imprecise, not homogeneous.

First result: 7 top indicators in information pyramid

Significance criteria:
- representative for transport,
- specific for environmental impact,
- relevant, i.e. sufficient overall contribution,
- non-redundant.

TERM (EEA): ++14 environmental indicators (30)
Ranking results for different value profiles

when HEALTH most important:
Safety + noise + air poll.: 50% weight

when ECOSYSTEMS most important:
Biodiversity + climate: 50% weight

Evaluation (4): Different assessment profiles

when RESOURCES most important:
Land + energy: 50% weight

when ALL EQUAL:

Institutbezeichnung: J. Borken - Transportation Research, Berlin/DE
Evaluation (4): Different assessment profiles

Ranking impossible:
CO2 and energy > 40% weight.

Rank reversal:
CO2 and energy > 60% weight.

Summary (1): Focus on common points

Given TERM’s simple data structure

- Other parameters do not influence the order, but its resolution.
- Common assessment:
  - Less environmental stress in future from EU road transport
    

- Other ranking IF AND ONLY IF
  - Single criterion receives a dominant weight,
  - Veto, or
  - Different future development.

- KEY indicators (= relevant + precise + decisive):
  - CO2 emission + energy consumption -> fossil fuel consumption,
  - Land take + fragmentation -> road construction.