The use of MCDA for the evaluation of transport projects: a review

Prof. Dr. Cathy Macharis and Jeroen Ampe

Vrije universiteit Brussel, Belgium
Department MOSI-Transport and Logistics

preliminary version, Prague EURO 2007 conference

The use of MCDA for the evaluation of transport projects: a review

Scope of this review:

• Transport projects & MCDA from 1980-2006

We interpret ‘transport projects’ as a set of human activities that organise, optimise or facilitate the movement of persons or freight from location a to location b.
Why this review?

- To get insight in the appliance of MCDA for transport projects
- Several articles (Bristow & Nellthorp 2000; Morisugi 2000; Grant-Muller et al. 2001;...) report a growing attention for MCDA for the evaluation of transport projects:
  - MCDA copes with several criteria besides the economic aspects
  - MCDA is able to deal with several decision makers (stakeholders)
  - MCDA structures complex problems for the decision maker

Structure of this review

- Structure of the review based on Cooper (1989) in 5 phases:
  1) Formulation of the problem
  2) Determination of the data collection strategy
  3) Evaluation of the retrieved data
  4) Analysis and interpretation of the literature
  5) Presentation of the results
1) Formulation of the problem:

With this review, we seek to address the following questions:

1. Which **subjects** or kind of decisions are studied?

2. What is (/are) the **characteristic MCDA method(s)** used for transport project evaluation?

3. Are multiple actors or **stakeholders** included in the decision analysis and to what extend?

Structure of this review

- **Structure of the review based on Cooper (1989) in 5 phases:**
  1) Formulation of the problem (questions working as guidelines)
  2) **Determination of the data collection strategy**
  3) Evaluation of the retrieved data
  4) Analysis and interpretation of the literature
  5) Presentation of the results
2) Data collection strategy:

Determination of the data collection strategy:

- Covered period 1980 – 2006
- Computerized search
  - VUB library catalogue, VUBIS, V-spaces, VUB Article database, e-sources
  - KUL library catalogue, LIBIS, KUL Article Database, e-sources
  - LAMSADE, online MCDA bibliography index,
  - Commercial search robots (e.g. Google) to track articles and references for further lookup in university library catalogues
- Search terms automated search
  - multicriteria and transport
  - multi-criteria and transport
- LAMSADE index also manual search
- The search was conducted during March and April 2007

Structure of this review

- Structure of the review based on Cooper (1989) in 5 phases:
  1) Formulation of the problem (questions working as guidelines)
  2) Determination of the data collection strategy
  3) Evaluation of the retrieved data
  4) Analysis and interpretation of the literature
  5) Presentation of the results
3) Evaluation of the data:

- We retrieved 143 articles titles, 136 within our scope
- From those 136 -> 118 articles available for further analysis
- Growing yearly amount of publications on MCDA for transport
  - Bias towards period after 1988?
  - Fast increase last 10 years

Structure of this review

- Structure of the review based on Cooper (1989) in 5 phases:
  1) Formulation of the problem (questions working as guidelines)
  2) Determination of the data collection strategy
  3) Evaluation of the retrieved data
  4) Analysis and interpretation of the literature
  5) Presentation of the results
4) Analysis and interpretation of the literature:

- We made a pre-selection of publications selecting on title, abstract, keywords and type of media
- then we first divided the publications in a range of type of decision subject:
  - Non-applied publications
  - Applied publications
    - Infrastructure
    - Technology and environment
    - Organizational
    - Financial
- second, we differentiated on the MCDA method used,
- third, we looked at the stakeholder involvement

Structure of this review

- Structure of the review based on Cooper (1989) in 5 phases:
  1) Formulation of the problem (questions working as guidelines)
  2) Determination of the data collection strategy
  3) Evaluation of the retrieved data
  4) Analysis and interpretation of the literature
  5) Presentation of the results
5) Presentation of the results:

The three formulated guiding research questions:

1. Which subjects or kind of decisions are studied?

2. What is (/are) the characteristic MCDA method(s) used for transport project evaluation?

3. Are multiple actors or stakeholders included in the decision analysis and to what extend?

1. Which subjects / Kind of decisions? Divided by category

We first differentiated between the applied and the non applied publications:

- Non-applied (31%)
- Applied (69%)
1. Which subjects / Kind of decisions? Divided by category

Within the applied publications, we differentiated 4 categories of possible decision subjects:

- Decision problem

- Technology: 29%
- Organizational: 27%
- Infrastructure: 38%
- Financial: 6%

2. Characteristic MCDA method

<table>
<thead>
<tr>
<th>MCDA methods all subjects</th>
<th>all %</th>
<th>all</th>
<th>app%</th>
<th>app</th>
</tr>
</thead>
<tbody>
<tr>
<td>ELECTRE</td>
<td>14,4</td>
<td>17</td>
<td>16,3</td>
<td>15</td>
</tr>
<tr>
<td>PROMETHEE</td>
<td>5,9</td>
<td>7</td>
<td>7,3</td>
<td>6</td>
</tr>
<tr>
<td>REGIME Analysis</td>
<td>7,6</td>
<td>9</td>
<td>7,3</td>
<td>6</td>
</tr>
<tr>
<td>AHP</td>
<td>36,4</td>
<td>43</td>
<td>40,2</td>
<td>33</td>
</tr>
</tbody>
</table>

| UTA / Inverse Preference Method | 3,4 | 4 | 4,9 | 4 |
| MAVT / MAVF / MAUT / SMART / SMARTER / VISA / MACBETH | 10,2 | 12 | 9,8 | 8 |
| TOPSIS / VIKOR               | 1,7  | 2  | 2,4  | 2  |
| non-traditional MCDA / fuzzy set | 7,6  | 9  | 7,3  | 6  |
| several methods / m comparisons | 12,7 | 15 | 2,4  | 2  |
| total                       | 100,0| 118 | 100,0| 82 |
2. Characteristic MCDA method / subject

2. Characteristic MCDA method

- AHP (or a variant of AHP) is used in 36.4% of all and 40.2% of the applied publications we analyzed. It is the dominant method in our sample. It is present in all categories.

- AHP is considered to be a trustworthy and not too complex platform to start from.

- “AHP’s success as a consequence of its simplicity and robustness” (Vargas, 1990).
3. Stakeholders?

Stakeholders participation as an important asset for transport project appraisal:

- Different priorities of stakeholders (policymakers)
- The analyst cannot always guarantee the quality of the decision
- To increase the acceptance rate of the project
- Overcomes problems with weights
- Adds robustness

3. Stakeholders?

The concept of stakeholders gains more attention:
An evolution in GDSS and MCDA:

3 types of group MCDA (Springael and Dekeyser, 2004):

1) Group discussion to agree on collective DM specific data, next MCDA
2) DM separate data aggregated to group data at intermediate level, MCDA
3) For each DM opinion a separate MCDA (n mcda’s), second step MCDA to order them. (e.g. GDSS PROMETHEE)

→ MAMCA
MAMCA (Macharis et al., 2004)

MAMCA examples (transport)

- Intermodal terminal location (Lambit) (Macharis, 2000)
- Advanced driver assistance (Macharis et al., 2004)
- Waste transport in the Brussels Region (Macharis and Boel, 2004)
- Location of a new HST terminal (Meeus et al., 2004)
- Sustainable traction battery technologies (Macharis et al., 2005)
- DHL’s hub strategy (Dooms and Macharis, 2006)
- Aviation CO2 mitigation strategies (Festraets en Macharis, 2007)
Conclusions

• A shift towards MCDA for transport project appraisal.

• AHP is the dominant MCDA method for transport projects.

• The kind of decision subjects handled by MCDA the most are infrastructure choices.

• Often many stakeholders are involved and therefore the use of a method capable of group decisions is important.

• MAMCA as an approach to deal with complex problems with multiple actors.

References

Bristow and Nellthorp (2000), Transport Project appraisal in the European Union, in Transport Policy, 7, 51-60


Grand-Muller et al. (2001), Economic appraisal of the European transport projects: the state-of-the-art revisited, in Transport Reviews, 21, 2, 237-261


Morisugi (2000), Evaluation methodologies of transportation projects in Japan, in Transport policy, 7, 35-40

Springael J. and W. De Keyser (2004), A new generation of multi-criteria based group decision support methods. MCDM 2004, August 6-11, Whistler, B.C. Canada