Potentials for reducing greenhouse gas emissions by inducing modal shift in long-distance passenger travel

Kees van Goevearden, Bart van Arem, Rob van Nes

Delft University of Technology

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The scene

- Climate change is a threat for the quality of life; GHG emissions should be reduced.
- Long-distance travelling contributes considerably to the GHG emissions of person transport.
- There are large differences in energy efficiency of different travel modes.
- A target of the EU is >50% market share of the train in 2050 on medium distances (current share is 12-13%).
Research question

• Which reduction of GHG emissions by long distance transport can be achieved by modal shifts to the train?
• The analysis is limited to Europe.
• The question how considerable modal shifts can be achieved is no subject of the paper.
Simple calculation?

- Simple: multiply the mileage by train by 4, assume a proportional decrease of the mileage by the alternative modes, and calculate the corresponding emission changes.
- No, the shift process is more complex. The potential for shifted kilometres from a certain mode depends on the association between sensitivity to modal change and journey distance.
Potential for shifting kilometres

Journey distance

Journeys ranked by propensity for modal shift

Length

Expected shifted km
High potential when length and propensity are positively correlated

![Graph showing the relationship between journey distance and journeys ranked by propensity for modal shift. The graph has two lines: one for length and another for expected shifted km. The x-axis represents journeys ranked by propensity for modal shift, while the y-axis represents journey distance.]
Low potential when length and propensity are negatively correlated

![Graph showing journey distance and expected shifted km against journeys ranked by propensity for modal shift](image-url)
Segments with comparable expected modal shifts

Mileage

Segments ranked by propensity for modal shift

Mileage

Expected shifted km
Method

• Breakdown long-distance travel market into segments with comparable sensitisiveness to modal shift.
• Assessing volumes of mileage (by mode) and emissions per segment.
• Predicting volumes and emissions in 2025 according to different scenarios that differ regarding assumed shifts to the train.
Defining segments

Basic assumption: the propensity/sensitivity to modal shift to the train correlates to the relative appropriateness of the train.

- Define the general appropriateness of the train compared to the most important alternative long-distance modes.
- Identify the variables that affect the appropriateness significantly and define the most discriminating categories.
- Cross the variables, estimate the appropriateness for each cell and cluster cells with comparable appropriateness.
## Relative appropriateness of the train

<table>
<thead>
<tr>
<th>Variable</th>
<th>Component</th>
<th>Airplane</th>
<th>Bus public</th>
<th>Bus private</th>
<th>Car</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time</td>
<td>Normal speed</td>
<td>++</td>
<td>0/-</td>
<td>0/-</td>
<td>0/-</td>
</tr>
<tr>
<td></td>
<td>Leaving/approaching</td>
<td>--</td>
<td>0/-</td>
<td>0/-</td>
<td>0/-</td>
</tr>
<tr>
<td>Space accessibility</td>
<td>-</td>
<td>+/-</td>
<td>+</td>
<td>++</td>
<td></td>
</tr>
<tr>
<td>Time availability</td>
<td>+/-</td>
<td>+/-</td>
<td>+</td>
<td>++/--</td>
<td></td>
</tr>
<tr>
<td>Alternative time use</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>--</td>
</tr>
<tr>
<td>Time/comfort</td>
<td>Transfer</td>
<td>0</td>
<td>0</td>
<td>+</td>
<td>++</td>
</tr>
<tr>
<td>Comfort</td>
<td>Space</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Price</td>
<td>+/-</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+/-</td>
</tr>
</tbody>
</table>
Variables with significant influence on the relative appropriateness

- Travel distance
- Car availability
- Number of travellers
- Crossing important sea barrier
- Location of origin or destination
- Other less important but still significant variables (transport of luggage; crossing national border; age, gender, employment, income of traveller; country of residence)
# Variables, categories, and segments

<table>
<thead>
<tr>
<th>Distance</th>
<th>Destination location</th>
<th>Origin location</th>
<th>Car availability</th>
<th>No car availability</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Number of travellers</td>
<td></td>
<td>Number of travellers</td>
</tr>
<tr>
<td></td>
<td></td>
<td>One</td>
<td>Two</td>
<td>3-14</td>
</tr>
<tr>
<td>Short</td>
<td>Core city</td>
<td>Core city</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Suburb</td>
<td>4</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Rural</td>
<td>4</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Suburb</td>
<td>Core city</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Suburb</td>
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<td>3</td>
</tr>
<tr>
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<td>Rural</td>
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<td>3</td>
<td>2</td>
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<td>Core city</td>
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<td>Suburb</td>
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<td>2</td>
</tr>
<tr>
<td></td>
<td>Rural</td>
<td>3</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Sea barrier</td>
<td></td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Medium</td>
<td>Core city</td>
<td>Core city</td>
<td>3</td>
<td>3</td>
</tr>
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<td></td>
<td>Suburb</td>
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<td>Rural</td>
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<tr>
<td>Suburb</td>
<td>Core city</td>
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<td>Core city</td>
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</tr>
<tr>
<td></td>
<td>Rural</td>
<td>3</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Sea barrier</td>
<td></td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Long</td>
<td>All</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>
Five defined segments

1: Train is inferior (no propensity to modal shift).
2: Train quality is poor.
3: Train quality is common.
4: Train quality is good.
5: Train is superior.

The train is compared to the best performing alternative mode.
Current market share of the train by segment

- Superior: 45%
- Good: 30%
- Common: 15%
- Bad: 5%
- Inferior: 0%
Data

- Dateline survey: the only available European long-distance travel survey that covers all long-distance travelling; it was conducted in 2001/2002.
- Update to 2013 based on statistics on modal use and on tourism (mainly from Eurostat).
- Prediction for 2025 of autonomous changes by (mainly) extrapolating trends.
Volume by segment (journey numbers)

![Bar chart showing volume by segment (journey numbers)]
Volume by segment (mileage)

Journey kilometres pppy

- Inferior
- Bad
- Common
- Good
- Superior

- All modes
- Train
Volume by segment (GHG emissions)

GHG emissions (kg pppy)

- Inferior
- Bad
- Common
- Good
- Superior

All modes
Train
Three scenarios for 2025

• Trend: autonomous growth.
• Doubling train use: doubling market share of the train in each segment (except for the inferior segment).
• Major shift to the train:
  – Inferior: no shift
  – Poor: 25% of non-train journeys.
  – Common: 50%
  – Good: 75%
  – Superior: 100%

Overall result: 50% market share on distances 100-1000 km.
Impacts on mileage by mode

- Other
- Plane
- Train
- Bus
- Car

T | S1 | S2
---|----|----
Inferior | | |
Poor | | |
Common | | |
Good | | |
Superior | | |
Potentials for reduction: impacts on total GHG-emissions

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Compared to 2013</th>
<th>Compared to Trend scenario</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>With reference to all long-distance travelling</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trend scenario</td>
<td>+16%</td>
<td>-</td>
</tr>
<tr>
<td>Doubling train use</td>
<td>+10%</td>
<td>-5%</td>
</tr>
<tr>
<td>Major shift to the train</td>
<td>+0%</td>
<td>-13%</td>
</tr>
<tr>
<td><strong>With reference to the 4 train-sensitive segments</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trend scenario</td>
<td>-6%</td>
<td>-</td>
</tr>
<tr>
<td>Doubling train use</td>
<td>-10%</td>
<td>-11%</td>
</tr>
<tr>
<td>Major shift to the train</td>
<td>-31%</td>
<td>-32%</td>
</tr>
</tbody>
</table>
Conclusions

• Large modal shifts to the train in Europe have limited impacts on emissions of LD-travel and are expected even not to compensate for the predicted autonomous growth in travelling.

• The main reason is the dominance of the segment where the train is inferior, which is also the fastest growing segment.

• Most efficient policy for reducing GHG-emissions seems influencing destination choice by intercontinental travellers.
Questions?