Simulation in Logistics Tour and Location Planning –
Two German Business Applications

Christina Westphal
Victor Kuchshaus
Philipp Düppe
Matthias Klumpp
Hella Abidi, FOM ild Essen

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1. Introduction and Research Interest

2. Case 1: Green Transport Decisions (DEA)

3. Case 2: Production Location Decision (GAMS)

4. Conclusion
1. Introduction

- Logistics service providers as well as industry companies in Europe face strong influences from globalization as well as technology developments:
  - Successful research in information and communication technologies ICT;
  - increased competition within the market;
  - environmental awareness of loaders and customers (restriction);
  - rapid growth of transport volume in the future (restriction).
- Logistics has to be flexible and dynamic because of speed and shipment volume volatility demands - but often business strategies are based on human knowledge instead of ICT.
- Increasing interest towards simulation and modelling tools in order to enhance logistics decisions e.g. tour planning and routing, location, scheduling.
2. CASE 1

- European shipments from Germany (Ruhr area) to Italy (northern region) for a German chemical company.
- **Comparative Analysis** with real data sets using **DEA** in order to compare transport prices and carbon footprint as outputs of transport performance for truck & combined truck-rail transports.

<table>
<thead>
<tr>
<th>Data (Example)</th>
<th>Destination</th>
<th>Weight</th>
<th>Distance</th>
<th>Distance Milano-Dest</th>
<th>CO₂ Emiss. kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>L-Bosco Marengo</td>
<td>Bosco Marengo</td>
<td>19,237</td>
<td>1,006</td>
<td>101</td>
<td>1,117.57</td>
</tr>
<tr>
<td>L-Brendola</td>
<td>Brendola</td>
<td>20,220</td>
<td>975</td>
<td>275</td>
<td>1,083.13</td>
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<tr>
<td>L-Arcole</td>
<td>Arcole</td>
<td>18,540</td>
<td>1,065</td>
<td>195</td>
<td>1,183.11</td>
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<tr>
<td>L-Bareggio</td>
<td>Bareggio</td>
<td>23,180</td>
<td>912</td>
<td>21</td>
<td>1,013.14</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>
2. CASE 1

Transport Map Germany-Italy
2. CASE 1
### Main result:
Due to *detour length* (Terminal Milano) in most cases no productivity improvement with combined truck-rail transport alternatives.
3. Case 2

- **Automotive industry** in Europe with highly competitive and cost-sensitive supply chains.

- Transport costs usually determine production location close to OEM plants (Europe). Location costs decide about plant.

- Location question of cost-minimal location within Europe, application of a GAMS model (start draft for extension).

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### Energy Cost Data

<table>
<thead>
<tr>
<th></th>
<th>Electricity prices (per kWh)</th>
<th>Gas prices (per kWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Households (1)</td>
<td>Industry (2)</td>
</tr>
<tr>
<td>EU-27</td>
<td>s2</td>
<td>s2</td>
</tr>
<tr>
<td>Euro area</td>
<td>0.164</td>
<td>0.173</td>
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<tr>
<td>Belgium</td>
<td>0.173</td>
<td>0.182</td>
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<tr>
<td>Bulgaria</td>
<td>0.186</td>
<td>0.197</td>
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<tr>
<td>Czech Republic</td>
<td>0.082</td>
<td>0.083</td>
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<tr>
<td>Denmark</td>
<td>0.139</td>
<td>0.139</td>
</tr>
<tr>
<td>Germany</td>
<td>0.255</td>
<td>0.271</td>
</tr>
</tbody>
</table>

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### GAMS

```plaintext
EQUATIONS
TeamMaKostenJahr(I)
TeamEnKostenJahr(I)
GesamtMaKostenJahr(I)
GesamtEnKostenJahr(I)
GesamtKostenJahr(I);

TeamMaKostenJahr(I) .. W2 =I= KgMaYear(I);
TeamEnKostenJahr(I) .. X2 =I= KgENYear(I);
GesamtMaKostenJahr(I) .. Y2 =I= KgMGYear(I);
GesamtEnKostenJahr(I) .. Z2 =I= KgEGYear(I);
GesamtKostenJahr(I) .. Z3 =I= KgMGYear(I) + KgEGYear(I);

MODEL
TRANSPORT /ALL/ ;
SOLVE
TRANSPORT USING lp maximizing Z3;
```
3. Case 2

- Wage and energy costs determine **Bulgaria** as favorite location in the European Union (exemplary data).
4. Conclusion

- For both cases the quantitative methods have provided first draft **decision support** (not always the obvious ones).
- Simulation **assumptions** have to be checked and adjusted in order to provide for more realistic results (e.g. 10% cost increase for combined truck-rail transport in Case 1).
- Nevertheless modelling and simulation is increasingly needed for complex daily logistics decisions – software as well as human competence **requirements** in business practice.
- Methods have to be **implemented in daily logistics practice** in order to gain experience and context data for supporting optimal decisions in modern transport settings.
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Thank you for your attention.

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