Green Logistics and Traffic Management in Europe

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Istanbul Technical University (ITU)
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1. Introduction

2. Sustainable Logistics Concept

3. Transport Volume and Transport Modes

4. E-Mobility in Logistics

5. Green Logistics Education

6. Conclusion
Sustainability approaches for global supply and transport chains are an **intensively discussed and necessary topic**.

New topics emerge therein, some examples are:

- What is a *sustainable* supply chain (greener versus green logistics)? Zero emission or zero balance of GHG for example?
- How can an overall *sustainability measurement* be developed and standardized? How can CO$_2$ measurements be *standardized* globally?
- Which *action fields* can be identified and are important for future sustainable supply chains?
- How can effective *management methods* be applied globally to tackle greener logistics, combined with transport management?
At the same time: The economic crisis 2008/2009 has shown …

- the potential weakness of financial and industry sector,
- the **high volatility of logistics** demand and transport volume
- with specific areas of logistics losses up to 11.2%.
1. Introduction

- Mobility and functioning traffic are vital for the economy – this is particularly true for Germany and also Turkey as large exporting economies.
- In the past (until 2008) steadily increasing transport volumes and performance were assumed, but negated in the economic crisis 2008/2009 (e.g. rail transport performance decrease).

<table>
<thead>
<tr>
<th>Year</th>
<th>Railway TonKilometer</th>
<th>Inland Ship</th>
<th>Pipeline</th>
<th>Road</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>115,652</td>
<td>-20%</td>
<td>15,670</td>
<td>460,100</td>
<td>655,479</td>
</tr>
<tr>
<td>2009</td>
<td>95,834</td>
<td>55,497</td>
<td>15,950</td>
<td>414,600</td>
<td>581,881</td>
</tr>
<tr>
<td>2010</td>
<td>107,317</td>
<td>62,278</td>
<td>16,259</td>
<td>434,000</td>
<td>619,854</td>
</tr>
<tr>
<td>2011</td>
<td>113,160</td>
<td>55,027</td>
<td>15,623</td>
<td>460,000</td>
<td>643,810</td>
</tr>
</tbody>
</table>
Research Question:

How can sustainable and also flexible management concepts be implemented to safeguard European transport management in a long-term perspective (e.g. until 2025)?
2. SL Concept

1 Definition & Measurement
- e.g. greener and green logistics, CO₂ measurement standards

2 Reduction
- e.g. transport volume reduction, political low carbon regimes

3 Compensation
- e.g. carbon offsetting, climate change damage reduction (fonds)

4 Global Reach Transport Modes
- e.g. intermodal transport concepts, global energy concepts

Total Sustainability Management (TSM)
Areas of an integrated sustainability concept:

1. The basis is provided by **definitions and measurement** standards e.g. regarding global CO\(_2\) measurement.

2. Green logistics management concepts have to include **reduction instruments** regarding energy consumption and emissions for example by avoiding transport or using new motor and energy concepts (hybrid drives, sky sails etc.).

3. Future sustainable concepts have to include **compensation concepts** regarding e.g. carbon offsetting and even possible damage control funds in order to support areas and countries which undergo severe problems due to climate change.

4. Concepts and measures have to be implemented on a **global scale** in order to be suitable for global supply chains. This may require new global standards or even institutions.
Scientists identify six main Greenhouse Gases:

- Carbon Dioxide ($\text{CO}_2$)
- Methane ($\text{CH}_4$)
- Nitrous Oxide ($\text{N}_2\text{O}$)
- Sulphur
- Hexafluoride ($\text{SF}_6$)
- Perfluorocarbons (PFCs)
- Hydrofluorocarbons (HFCs)

**SCOPE 1:** Greenhouse gas emissions from sources that are owned or controlled by a Federal agency.

**SCOPE 2:** Greenhouse gas emissions resulting from the generation of electricity, heat, or steam purchased by a Federal agency.

**SCOPE 3:** Greenhouse gas emissions from sources not owned or directly controlled by a Federal agency but related to agency activities.
2. Detail: (b) Reduction

Material acquisition

- Supplier selection
- Setting incentives
- Reducing volume
- Ensuring high quality

Inbound logistics

- Freight consolidation
- Packaging
- Transportation modes
- Carrier selection

Transformation

- Inventories vs. JIT
- Packaging
- Integrating logistics in product-design
- Network re-design

Outbound logistics

- Freight consolidation
- Packaging
- Transportation modes
- Carrier selection

Marketing

- Distribution channels
- e-Commerce
- Demand forecasts
- Alignment of infrastructure

After sales

- Service logistics
- Reverse logistics
- Remanufacturing
- Alignment of infrastructure

Waste

- Recycling/Re-using
- Reverse logistics
- Network re-design
- Carrier selection
2. Detail: (b) Reduction
2. Detail: (b) Reduction

[Map showing standard regions and tours A and B with extension]

Nov-12  Klumpp: Green Logistics and Traffic Management in Europe  12
2. Detail: (c) Compensation

The CarbonFree® Partner program is an innovative and flexible way to help your business reduce its carbon footprint to zero through carbon offsets and reductions.

Let Carbonfund.org help you meet your environmental goals today.

Example

Select an Emission Source

Office Emissions
Fleet
Business Travel
Employee Commute
Events
Paper
Shipping

Calculate

First, let's take a look at your building and office space. Just fill in the boxes below. You may skip any stage.

Office Emissions Calculator

Business Name
State (abbr) or Zip (5 digit)

How would you like to calculate?
- Utility bills
- # of employees
- Office Space (Sq Ft)

--- Do you have servers? ---
- Yes we do
- No we don't

Your Office Footprint (in tons CO2):
Cost to Offset:

Offset your Footprint now!

Offset your Footprint at least your Office, Fleet and Travel.
Min. $350 donation.

Copyright 2003-2011 — All Rights Reserved
2. Detail: (d) Global Reach

- **Example ESPRIT** (Ratingen/Germany & Hong Kong/China)
- Traditional sourcing in Asia (China)
- Sourcing shift to Mediterranean and India
  > Greener supply chain
2. Comprehensive Simulation

- **Basis:** Given calculation definition (carbon) e.g. by ISO DIN EN 16258:2011 is used as common ground.
- The three other perspectives “reduction”, “compensation” and “global reach” are multiplied as an index value.
- If a company/SC would reach 100 points this would indicate that
  - first of all the technically possible reduction of environmental impact has been reached (technological production frontier, total resource efficiency per output parameter as e.g. ton-kilometre),
  - second, the environmentally negative influences left are compensated by matching measures to a full extend and
  - third, this is reached on a fully global scale for the whole company or supply chain (ubiquitous approach).
- Therefore this **total greener logistics (TGL)** index value could enable logistics companies to measure & compare their efforts.
2. Comprehensive Simulation

Total Greener Logistics Index Value \( T \) = Reduction Index Points \( R \) \( \times \) Compensation Index Points \( C \) \( \times \) Global Reach Index Points \( G \)

\[ T = R \cdot C \cdot G \]
3. Freight Transport Development

- WTO World Trade Report 2008 lists the following aspects:
  - Because of the economic opening of the former Soviet Union, China and India the number of participants in the world economy rises from about 1.5 billion to 3 billion workers.
  - With the introduction of freedom to provide services in freight transport in combination with newly found information and communication technologies new opportunities for cross site production were created.
  - In addition: transaction and trading costs were reduced.
  - The development of transport infrastructure and the containerization of international goods flows enable cost reduction and productivity increase.
  - Altogether: Increase in trade and transport to be expected.
3. Economic Interdependency

- German logistics development indicator

Based on qualitative interviews with executives from 100 German companies.

- Upturns as well as downturns indicated by economic development.

Graph showing:
- Normal level
- Climate
- Actual situation
- Expectation for the near future

Data points from 2007-Q2 to 2012-Q2.
3. Green Transport Prognosis

- Model simulation for transport and sustainable development:
  - According to EU specifications GHG emissions have to be **reduced in 2025 by 60%** cp. to 2004 (EU White Book 2011).
  - But: The transport volume will **increase by 80%** to 914 billion tkm (prognosis of the German federal government, 2004 to 2025).

Is that realistic?
3. Prognosis with GAMS

- What opportunities of reducing CO\(_2\) are conceivable?
  - Technological progress (efficiency increase is not feasible endlessly)
  - Restriction of mobility (not desired)
  - Shift away from fossil fuels (only possible in long-term perspective)
  - Switching to eco-efficient transport modes/technologies (e-mobility)

- The modal split is subject to certain restrictions, too:
  - Capacity of rail freight is limited and not unlimited scalable (network)
  - Inland shipping is upgradeable but not available everywhere

- Therefore assumptions have to be taken to deal with this facts.
3. Prognosis with GAMS

DE transport capacity: waterway (left) and rail transport (right)
A first calculation has shown that even at 100% utilization of the CO₂-poorest transport carrier ship in a best case scenario, the reduction targets cannot be reached.

- What can be done?
- With GAMS, a model with a limitation of CO₂ emissions above the guidelines can be calculated.
- The difference must then be borne by other industry sectors (for example, in electricity generation: renewable energy).
3. Prognosis with GAMS

Required information:

- CO\textsubscript{2} emissions per tkm
  - today and '2025'
- For today it can not be determined, depending on several factors
  - Utilization (all transport modes)
  - Mix (train)
  - For inland waterway vessels, according to experts no simple answer possible

CO\textsubscript{2}-emissions per tkm depending on the average load factor

- Area average load factors (truck: 21t, vessel: 625 t, rail: 500t)
Positive: technological progress

Raising efficiency (commercial vehicles)

CO₂-emissions from road transport per tonne-kilometer (1991 = 100%)
3. Prognosis with GAMS

<table>
<thead>
<tr>
<th>mode of transport</th>
<th>2004</th>
<th>2025</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mio. tkm(^1)</td>
<td>g/CO(_2) per tkm(^2)</td>
</tr>
<tr>
<td>---------------------------------</td>
<td>-----------------------</td>
<td>-----------------------</td>
</tr>
<tr>
<td>Road transport</td>
<td>392.600</td>
<td>77,5</td>
</tr>
<tr>
<td>Railway</td>
<td>91.921</td>
<td>68,5</td>
</tr>
<tr>
<td>IWT (Inland waterways)</td>
<td>63.667</td>
<td>40,5</td>
</tr>
<tr>
<td><strong>Sum</strong></td>
<td>548.188</td>
<td>39.302</td>
</tr>
</tbody>
</table>

\(^1\) source: Federal Statistical Office  
\(^2\) average to the VDA  
\(^3\) own estimate  
\(^4\) +80% base year 2003, projection: BMVBS and ifmo  
\(^5\) The VDA assumes a CO\(_2\) reduction of almost 30% per tkm for road transport, this value was transferred to the other modes  
\(^6\) Adopted from 2004. Due to the scarcity of fossil fuels is expected by 2025, an increase that has to be included, adjusted for inflation. In addition, OPEC expects in their study, Oil outlook to 2025 'With a constantly rising world oil demand by nearly 50%, which would have combined with the finiteness of a still incalculable price explosion that follows
sets
i Verkehrsträger / Strasse, Schiene, Schiff / ;
parameters
a(i) Kapazität der VT i im Jahr 2025 in Mio. tkm
/ Strasse 999999, Schiene 229802.5, Schiff 191001 /
b(i) Gramm CO2-Emission je tkm
/ Strasse 55, Schiene 48.6, Schiff 28.8 /
c(i) Kosten je tkm in €
/ Strasse 0.05, Schiene 0.055, Schiff 0.035 /;
variables
X            tkm je VT
Y            CO2-Ausstoss
Z            Gesamtkosten ;
positive variable x ;
equations
Costs       Gesamtkosten
Co2emi      CO2-Emission ermitteln
Co2lim      CO2-Limit
Demand      Bedarf an Transportleistung
Demmax      Bedarfsobergrenze ;
costs ..  z =e= sum((i), x*c(i)) ;
co2emi ..  y =e= sum((i), x*b(i)) ;
co2lim ..  y =l= 23581 ;
demand ..  x =e= sum((i), a(i)) ;
demmax ..  x =e= 986738 ;
model transport /all/ ;
solve transport using lp minimizing z ;
display x.l, x.m ;
3. Prognosis with GAMS

- Equations:
  - co2total co2 emission over all
  - coststot costs in total
  - supply(i) obtain limit per mode
  - demand(j)
    - sum(i, x(i,j)) =g= b(j) ;
  - coststot
    - z =e= sum((i,j), f(i,j)*x(i,j)) ;

- Result:
  - road 682857.143; train 106142.857, ship 191000.000

That means for the German transport sector: savings of about 750,000 tons CO$_2$ = cost about half a billion Euro.
Due to different infrastructure conditions (Europe-wide view)
- different circumstances need to be considered,
- for example, the current allocation on various modes of transport,
- capacity restrictions or
- national regulations and infrastructure.

Advantages of this approach are that overall costs regarding specific carbon reduction targets can be determined and alternatives can be discussed.

In the future, other factors have to be included (e.g. demographic change) and cost assumptions have to be verified (decreasing returns to scale and cost).
4. E-Mobility

- Car traffic: outstanding importance for our mobility
- Undeniable: global dependence on oil as an energy source
- Oil Shortages:
  - Resource is finite
  - Security problems, political unrest - 62% of reserves in the middle east
  - Constant increasing demand - BRICS countries *
  - More speculative markets
- Statistical range: about 40 years

*) Brazil, Russia, India, China, Southafrica (since 12/2010)
### 4. E-Mobility

**Trace Gas**

|---------------------------------|--------------------------------------------------------------------------------------|---------------------------------|---------------------------------|
| Carbon Dioxide (CO₂)            | • use of fossil energy  
• deforestation                                           | 280 ppm ➔ 370 ppm               | 61 %                            |
| Methane (CH₄)                   | • use of fossil energy  
• animal breeding, rice cultivation                                        | 0,28 ppm ➔ 0,31 ppm             | 15 %                            |
| Nitrous Oxide (N₂O)             | • especially field work (fertilizer)                                                 | k.A.                             | 4 %                             |
| CFC-gases                       | • man-made blowing gas (aerosol can)  
• cooling liquid                                                            | 0 ppb ➔ 0,5 ppb                 | 11 %                            |
| Sulfur Hexafluoride (SF₆)       | • e.g. cover gas at the technical production of magnesium                           | 0 ppb ➔ 40 ppb                  | 4 %                             |

*estimation

ppm ≡ parts per million (10⁻⁶)  
ppb ≡ parts per billion (10⁻⁹)
Combustion of fossil fuels → $\text{CO}_2$ emissions

Goal of many nations: reducing emitted GHG quantities
- see Kyoto Protocol - 11 December 1997, Kyoto (Japan)
- Canada: “dropped out” on 13th December 2011
- U.S. & China: never participated
- Russia and Japan will not extend after 2012

Raw oil shortage + climatic goals = Search for alternatives

Solution: electric mobility (e-mobility)?

Problem: range of electric vehicles

<table>
<thead>
<tr>
<th>Rechargeable</th>
<th>Energy density of in Wh/kg</th>
<th>Energy density of in Wh/kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>lead-acid</td>
<td>35</td>
<td>diesel</td>
</tr>
<tr>
<td>Ni-MH</td>
<td>90</td>
<td>benzine</td>
</tr>
<tr>
<td>Li-Ionen</td>
<td>130</td>
<td>methanol</td>
</tr>
</tbody>
</table>

For comparison:
- coal: 6.670 Wh/kg
- Uranium ($^{235}\text{U}$): 18.7 Mio. kWh/kg
  → 1 kg Uranium = 2.800 t coal
4. E-Vehicles

- Announcement by the Federal Government (03/05/2010): Till 2020 at least 1 million electric vehicles should be on Germany's streets – reduced in October 2012 to 750,000 vehicles in 2020.

- Today there are 42.3 Mio. cars in Germany (FMTA: 01.01.2011)

- Alternative technologies are considered only slightly (40,000 vehicles, mainly gas turbines/powered)

- Current infrastructure for loading stations is not sufficient
  - Option 1: Change batteries (China - standards?)
  - Option 2: Widespread deployment of loading stations
## 4. E-Vehicles

<table>
<thead>
<tr>
<th>Model</th>
<th>$V_{\text{Max}}$ (km/h)</th>
<th>Charging duration (hours with 230V)</th>
<th>Charging duration (hours with 400V) for 80% capacity</th>
<th>Seats (adults)</th>
<th>Battery capacity (kWh)</th>
<th>consumption (kWh/100km)</th>
<th>range (km)</th>
<th>Monthly procurement (state)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Citroën C-Zero</td>
<td>130</td>
<td>6</td>
<td>0,5</td>
<td>4</td>
<td>16</td>
<td>13,5</td>
<td>150</td>
<td>?</td>
</tr>
<tr>
<td>Mitsubishi i-MiEV</td>
<td>130</td>
<td>6</td>
<td>0,5</td>
<td>4</td>
<td>16</td>
<td>13,5</td>
<td>150</td>
<td>2.100 (2011)</td>
</tr>
<tr>
<td>Nissan Leaf</td>
<td>150</td>
<td>7</td>
<td>0,5</td>
<td>5</td>
<td>24</td>
<td>21</td>
<td>175</td>
<td>3.300 (2012)</td>
</tr>
<tr>
<td>Peugeot iOn</td>
<td>130</td>
<td>6</td>
<td>0,5</td>
<td>4</td>
<td>16</td>
<td>13,5</td>
<td>150</td>
<td>?</td>
</tr>
<tr>
<td>Renault Fluence Z.E.</td>
<td>135</td>
<td>7</td>
<td>0,5</td>
<td>5</td>
<td>22</td>
<td>?</td>
<td>185</td>
<td>?</td>
</tr>
<tr>
<td>Renault Kangoo Z.E.</td>
<td>130</td>
<td>7</td>
<td>0,5</td>
<td>2</td>
<td>22</td>
<td>?</td>
<td>170</td>
<td>?</td>
</tr>
</tbody>
</table>
4. Environmental Balance

- How many CO₂-Emissions are really caused by E-vehicles?
- 'Local': zero emission, indicating 0 gram CO₂ per km
- Next to the emissions in the production of the vehicles (scope three) the carbon dioxide from electricity generation is relevant.

<table>
<thead>
<tr>
<th>types of power plants in the CO₂ comparison</th>
<th>CO₂-emission [g/kWh]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wind energy Offshore</td>
<td>23</td>
</tr>
<tr>
<td>Wind energy Onshore</td>
<td>24</td>
</tr>
<tr>
<td>Solar power [Import from Spain]</td>
<td>27</td>
</tr>
<tr>
<td>Nuclear power station</td>
<td>32</td>
</tr>
<tr>
<td>Hydroelectric power station</td>
<td>40</td>
</tr>
<tr>
<td>Multicrystalline solar cell</td>
<td>101</td>
</tr>
<tr>
<td>Combined Cycle Power Plant (heating)</td>
<td>148</td>
</tr>
<tr>
<td>Combined Cycle Power Plant</td>
<td>428</td>
</tr>
<tr>
<td>Importing Coal-fired power plant</td>
<td>622</td>
</tr>
<tr>
<td>Brown coal heating plant</td>
<td>729</td>
</tr>
<tr>
<td>Importing blue coal power plant</td>
<td>949</td>
</tr>
<tr>
<td>Brown coal power plant</td>
<td>1,153</td>
</tr>
</tbody>
</table>

DE: CO₂ emission factor of the electricity mix [g/kWh]
4. Environmental Balance

Energy mix in different states (Germany)

- government decision to phase out nuclear energy
  - No change in e.g. North Rhine-Westphalia
  - Strong change in e.g. Bavaria
- replaced nuclear energy by renewable forms of energy not possible
- Even more Emissions caused by more coal plants
4. International View

Global programs
- USA, Germany, China -
4. German Initiatives

- **8 model regions in Germany**
- **Budget of 130 million EUR**
- Cooperation of science, industry and the participating communes
- Different research and development projects to set up infrastructure
- **Aim:**
  - research and production site for e-mobility
  - location for electric vehicles
  - training capacity for e-mobility
4. E-Mobility in Logistics

- **Processes** have to be changed – with possible additional costs due to e.g. smaller routing areas in last mile distribution.

- Additional **infrastructure investments** by companies are necessary and have to be checked/calculated (e.g. plugs at parking slots).

- Preferred application areas will be **first and last mile transports** due to technical restrictions and missing efficiency on long haul lines for E-Vehicles compared to traditional diesel trucks.

- **Political frameworks** will be crucial to introduction and implementation share of E-Vehicles (e.g. road toll prices etc.).
Logistics service providers face strong influences from **industry** as well as **technology developments**:

- Successful research in information and communication technologies **ICT**;
- increased **competition** within the market;
- **environmental** awareness of loaders and customers;
- rapid **growth of transport volume** in the future.

LSP have to be flexible and dynamic because of service speed and strong deviations of incoming orders - but often business strategies are **based on human knowledge instead of ICT**.

Especially dynamic scheduling seems very useful - but the **major challenge** is to raise acceptance by employees & LSP through information and education.

→ Key for environmental & competitive success are competencies.
5. Example Dynamic Scheduling

**Quasi-continuous T&T**

- Shipment Barcode/RFID
- GPS-location
- Realtime communication
- Acknowledgement of receipt by the customer

**Holistic track & trace system in logistics networks**

- Assignment of shipments to receiving depot
- Assignment of shipments to liner traffic
- Clearing up of vehicle allocation
- Assignment of shipment to tour
“Two sides of the coin”: The personal acceptance of the employees who have to work with a scheduling system is limited because of skepticism. But most publications show theoretical benefits and cost reductions (Schorpp 2010).

Powell et al. (2000) and Powell et al. (2002) show problems for transferring dynamic planning algorithms into real-life:

- Many systems do not support daily operations within dispatching systems – employees would have to change their operations, which in fact is not easy during running production or plan execution.
- Background of this human interface challenge is a different solution approach - in dynamic real-life environments it is impossible to check suggested solution, dispatcher will go on with his solution.

Therefore the global result drops if the user is non-compliant with the software solution and vice versa.
Several examples for suggestions in dynamic scheduling, e.g. Slater 2002
5. Green Logistics Education

Learning circle

1. Learning orientation
2. Learning activities
3. Level/share of process relevant explicit knowledge in a company
4. Motivation & attractiveness of individual learning by accessible explicit knowledge
5. Positive motivation feedback and thereby increased individual learning motivation

Organisational-individual cycle of learning motivation
Supporting planning and scheduling

- Supply Chain Scheduling with a holistic logistics view

GPS tracking system

Dynamic tour and route planning

Supplier  Manufacturer  Retailer

LSP  LSP

GPS/GALILEO
5. Green Logistics Education

**ild GPS.LAB**

- **GPS Satellite**
- **GPRS Tower**
- **Shipment Unit**

**AIS**

**Server**

**User**

**map&guide**
5. Case Study

Main Haul System / National Direct Line and Hub-Spoke Network
## Empirical GPS Measurement of Delays in Main Haul Network: 16.03.2012

### Main Haul Network

<table>
<thead>
<tr>
<th>Main Haul</th>
<th>Street</th>
<th>Zip</th>
<th>City</th>
<th>Qty</th>
<th>Weight</th>
<th>Delay</th>
</tr>
</thead>
<tbody>
<tr>
<td>München</td>
<td>VICTORIAPLATZ 2</td>
<td>40198</td>
<td>DUESSELDORF</td>
<td>1</td>
<td>503</td>
<td>30</td>
</tr>
<tr>
<td>Hannover</td>
<td>GRUENSTRASSE 15</td>
<td>40212</td>
<td>DUESSELDORF</td>
<td>1</td>
<td>151</td>
<td>110</td>
</tr>
<tr>
<td>Hannover</td>
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<td>40212</td>
<td>DUESSELDORF</td>
<td>1</td>
<td>96</td>
<td>110</td>
</tr>
<tr>
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<td>DUESSELDORF</td>
<td>1</td>
<td>90</td>
<td>110</td>
</tr>
<tr>
<td>Hannover</td>
<td>WAGNERSTR. 26</td>
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<td>110</td>
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<tr>
<td>Nürnberg</td>
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<td>0</td>
</tr>
<tr>
<td>Hannover</td>
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<td>DUESSELDORF</td>
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<td>53</td>
<td>110</td>
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<tr>
<td>Hannover</td>
<td>CUXHAVENER STR. 6</td>
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<td>DUESSELDORF</td>
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Example for Dynamic Last-Mile-Scheduling at SCHENKER (16.03.12)

Area of tour 406: Mettmann with extensions (2, 13, 8)

Area of Tour 402: Dusseldorf

Truck 402 Düsseldorf waits for delayed shipments
(achieving same-day delivery)
5. Case Study

Example for Dynamic Last-Mile-Scheduling at SCHENKER (16.03.12)

Shipments 2, 8, 13 on tour 406 from tour 402.

Truck 406 Mettmann delivers 3 shipments from tour 402 and has only 4 kilometers more to drive.
5. Green Logistics Education

Vehicle \textit{waits}, switching shipments in time onto other vehicle(s)

Cancellation of vehicle, assignment of remaining shipments onto other vehicle(s)

Vehicle \textit{waits} untill all shipments arrive

Vehicle \textit{starts},
(a) switching of delayed shipments on other vehicle(s); 
(b) onto new vehicle(s) with delayed shipments 
(depending on existing timetable for departure of last mile vehicles)

Decision algorithm draft

Duration of delay

Quantity of shipments delayed

q

0

p

\[ q \]

\[ p \]
Research paper has shown the **state-of-the-art** as well as **problems** in business practice regarding dynamic scheduling for e.g. **last mile tour planning** for LSP companies.

**Case study** showed possible mechanisms and business values for an automated dynamic scheduling process.

Shown draft **decision algorithm** may be the research basis for further development of such systems.

This could prove to be an important field for generating **business value** in saving costs as well as improving the ecological performance, latest research shows savings of about 11.500 Euro per month per terminal.

**Further research**: Test applications, piloting and implementation; sustainability impact calculation; **education and qualification requirements**.
Balancing sustainability and transport growth and flexibility requirements is a complex and nearly impossible task.

A special need for a comprehensive concept as well as education efforts and political frameworks has been identified.

Also this is an important area for research and has to be improved with further interaction areas such as transport and personnel costs (sensitivity analysis), product cost or social responsibility.
Green Logistics and Traffic Management in Europe

Thank you for your attention.

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