Developing and Evaluating Intermodal E-Sharing Services – a Multi-Method Approach

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Outline

- Motivation and Description of the Project

- Basic Requirements of Intermodal E-Sharing Services
  - Supply Concepts
  - Vehicle Concepts
  - Intermodal Trip Information

- Evaluation by Transport Models
  - Microscopic Demand Model
  - Macroscopic Assignment Model

- Summary
Motivation

- Changing travel behaviour in different age classes

![Chart showing travel behaviour by age and time period](chart.png)
Motivation

- Multimodal and intermodal behaviour is getting more and more important

![Graph showing the share of persons with multimodal behavior in different time periods and age groups. The graph indicates an increase in multimodal behavior over time, particularly in the 18-29 age group.](image)

German Mobility Panel (MOP)
The Project „leMM“

- Intermodal electric Mobility Management

Work-Hypothesis:
Electric mobility is successful when
- changing travel behaviour is reflected and
- a suitable supply performance is provided.

Goal:
Developing and evaluating suitable electric supply services to cover egress and access to public transport considering the travel behaviour in the planning area.
Multi Method Approach - Overview

Transport Models

mobiTopp
Intermodal Travel Demand

VISUM
Intermodal Assignment / Impedances

Supply Concepts
Vehicle concepts
System Access
Usability of e-vehicle fleet

Intermodal Trip Information
RP - Survey
SP - Survey

Vehicle Concepts
Market Segmentation
Trend Analysis
House of Concepts

Catalogue of Criteria for Intermodal Sharing Services and Hubs

Intermodal Trip Information and Acceptance of Intermodal Sharing Services

Basic vehicle concepts

Intermodal Supply
Intermodal Travel Demand
Final Vehicle Concepts

Acceptance
Vehicle Concepts

Customer

Market Segmentation
Trend Analysis

Vehicle requirements of customers

House of Quality

Technical Product Characteristics

Vehicle Concept

basic vehicle concepts as input for survey and modelling

„medium“
Motorcycle-similar vehicles

„light“
Two-wheelers

„premium“
Battery electric cars
Supply Concepts – Intermodal Services

1. Identification of potential components of e-mobility services to design service concepts.

- Vehicle concepts
- System Access
- Usability of the fleet
- Transfer Times
- User costs
- ICT Services

Evaluation by SP-survey data

2. Improvement of basic concepts
   a) Most promising e-mobility service concepts are further improved and specified in detail.
   b) Detailed transport model based evaluation process.
Supply Concepts – Intermodal Hubs

Multi Criteria Catalogue:

- Rail based PT-station

- Demand potential of at least 1000 residents or workplaces in catchment area

- Minimum service (20 minutes)

- Reachability and space for e-vehicle classes and their loading infrastructure
### Intermodal Trip Information

#### Survey

<table>
<thead>
<tr>
<th>Revealed Preference</th>
<th>Stated Preference</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Intermodal Trip Information)</td>
<td>(Acceptance of E-Sharing Services on trips and stages)</td>
</tr>
</tbody>
</table>

- **Recruitment:** National register sample + random route
- **Method:** CAWI and CATI
- **Sample size:** 164 persons in 145 households
- **Responses rate:** around 7 %
Intermodal Trip Information

Results: Intermodal Trips

- 18% of all trips are intermodal trips
- Intermodal trips are mainly covered by public transport
Intermodal Trip Information

Results: Acceptance

Example: Access stage to public transport

- eVehicle concept „light“ is preferred
- eVehicle concept „medium“ is rejected
- Most people prefer their used transport mode
Agent-based transport demand model

mobilopp represents each person and household with their individual travel behaviour

Trip Generation

Destination Choice

Mode Choice

Intermodal Mode Choice

Result: Simulated travel behaviour of every person in a study area (= complete household travel survey)
Agent-based transport demand model

Intermodal Mode Choice

1st Step
- Result: Simulated travel behaviour of every person in a study area including intermodal trips

2nd Step

- a) Utility-Function of main transport modes i for an individual t
  \[ U_{it} = \beta_0 + \sum_{k=1}^{K} X_{ itk} \cdot \beta_k \]
  für i ∈ M = {Fuß, Rad, MIV, ÖV}
  \[ X_{ itk} \] Zahlenwert des Attribut k bei Alternative i für Individuum t
  Used attributes: time, cost, mode availability

- b) Choice probabilities (LOGIT)
  \[ p_t(i) = \frac{e^{U_{it}}}{\sum_{j=1}^{l} e^{U_{jt}}} \] für i ∈ M

- a) Utility-Function of mode combinations a for an individual t
  \[ U_{art} = \beta_0 + \sum_{k=1}^{K} X_{ artk} \cdot \beta_k \]
  für a ∈ V = {mögliche VM – Kombinationen}
  und r ∈ E = {mögliche Etappen – Kombinationen}

- b) Choice probabilities (LOGIT)
  \[ p_t(a) = \frac{e^{U_{art}}}{\sum_{j=1}^{l} e^{U_{jrt}}} \] für a ∈ V und r ∈ E
Macroscopic Assignment Model - VISUM

Common Database

Public Transport
Network

- eVehicle Concepts
- Stations
- Lines
- Schedules and cycle times
- Fare system

Impedances between zones

Amount of all origin destination (OD) relations of person groups
Results

Intermodal Supply  Intermodal Travel Demand  Final Vehicle Concepts

Acceptance
Evaluation / Acceptance

Evaluation of intermodal supply concepts and hubs
Summary

- Multi Method Approach
- Planning Tool for Intermodal E-Sharing Concepts in a particular area
  - Taken into account:
    - Supply Side
    - Demand Side
    - Vehicle Requirements
- Outlook:
  To implement such concepts in practice further components are required:
  - New business models
  - Mobility Apps for intermodal trips
  - Standardised information out of the eVehicles
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BACKUP
Vehicle concepts

- Example House of Quality

<table>
<thead>
<tr>
<th>Number</th>
<th>Relative weighting of customer requirements</th>
<th>Significance</th>
<th>Customer requirements</th>
<th>Quality characteristic</th>
<th>Noise</th>
<th>V_max</th>
<th>Efficiency</th>
<th>Performance</th>
<th>Acceleration</th>
<th>Range</th>
<th>Recuperation</th>
<th>Maintenance-repair</th>
<th>Cost</th>
<th>Fuel consumption costs per km</th>
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<td>Agility</td>
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<td>3</td>
<td>3</td>
<td>3</td>
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<td></td>
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<td>2</td>
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<tr>
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<td>8</td>
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<td>3</td>
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<td>22.8%</td>
<td>13</td>
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<td>7</td>
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<td>10</td>
<td>Safety</td>
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<td>8</td>
<td>21.1%</td>
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Legend:
- 3: strong positive correlation
- 1: positive correlation
- 0: weak positive correlation
- -1: negative correlation
- -3: strong negative correlation
- ▼: minimise
- ▲: maximise
- x: fixed requirement

Summ: 52.0 | 44.0 | 25.0 | 58.0 | 35.0 | 52.0 | 43.0 | 40.0 | 64.0 | 64.0

Percentage of total: 35.4% | 25.7% | 14.6% | 33.9% | 20.5% | 36.4% | 25.1% | 23.4% | 37.4% | 33.8%

Relative weighting of quality: 6.7% | 4.0% | 7.5% | 6.0% | 6.0% | 7.9% | 11.3% | 6.1% | 9.4% | 10.0%
Intermodal Trip Information

- RP-Survey – Sample Description for one trip
Agent-based transport demand model

Intermodal mode choice

- Von Quelle-Ziel-Betrachtung

1. Stufe
Wahl des Hauptverkehrsmittels

- über Etappen

2. Stufe
Bestimmung der Etappen und der auf den Etappen genutzten Verkehrsmitteln

- Zunächst ohne E-Mobilität (Analyse)

- Nach SP-Befragung mit E-Mobilität (Potenzialabschätzung)

zu E-Mobilitätsangebote
Intermodal Mode Choice -

Festlegen der intermodalen Verkehrsmittelkombinationen

Generieren von Zugangszeitmatrizen zu ÖV-Haltestellen


Als Ergebnis erhalten wir Zugangszeiten von der Quelle einer Zelle zu jedem Umsteigepunkt einer anderen Zelle (Zugangszeitmatrix).

Die Zugangszeitmatrizen werden für jedes Zugangsverkehrsmittel (Fuß, Fahrrad, MIV-Fahrer) getrennt berechnet.

Berechnung der Widerstandsmatrizen

Die Berechnung der Widerstandsmatrizen (Zeit & Kosten) erfolgt über eine Umlegung in PTV VISUM.

Einschränkung möglicher Etappenkombinationen

Unrealistisch lange Etappenkombinationen (Gesamtwegdauer > 3 mal kürzeste Gesamtwegdauer) werden nicht als Auswahlmöglichkeit berücksichtigt.