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

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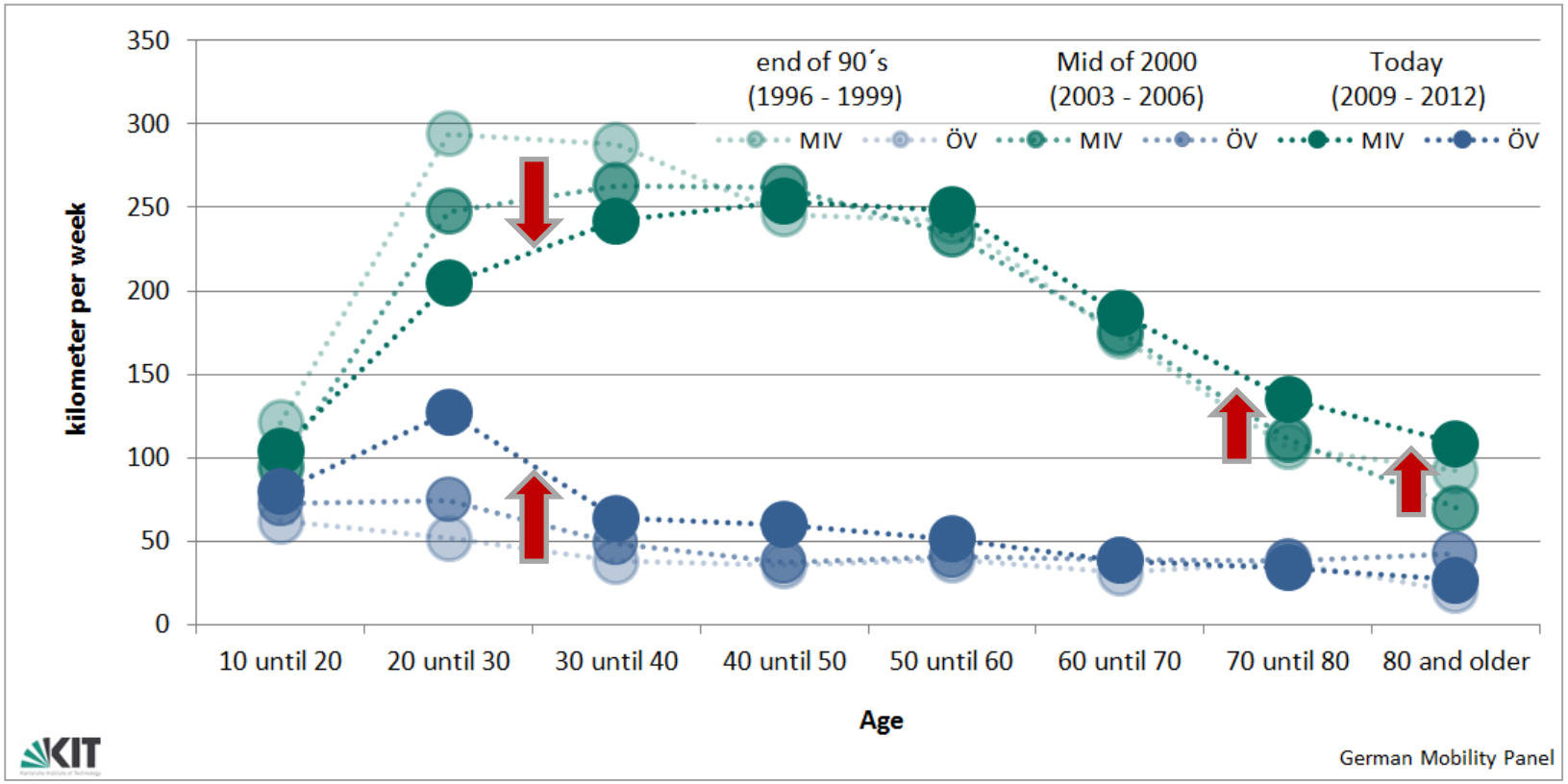
Outline

- Motivation and Description of the Project
- Basic Requirements of Intermodal E-Sharing Services
  - Supply Concepts
  - Vehicle Concepts
  - Intermodal Trip Information
- Evaluation by Transport Models
  - Microsocopic Demand Model
  - Macroscopic Assignment Model
- Summary

Motivation

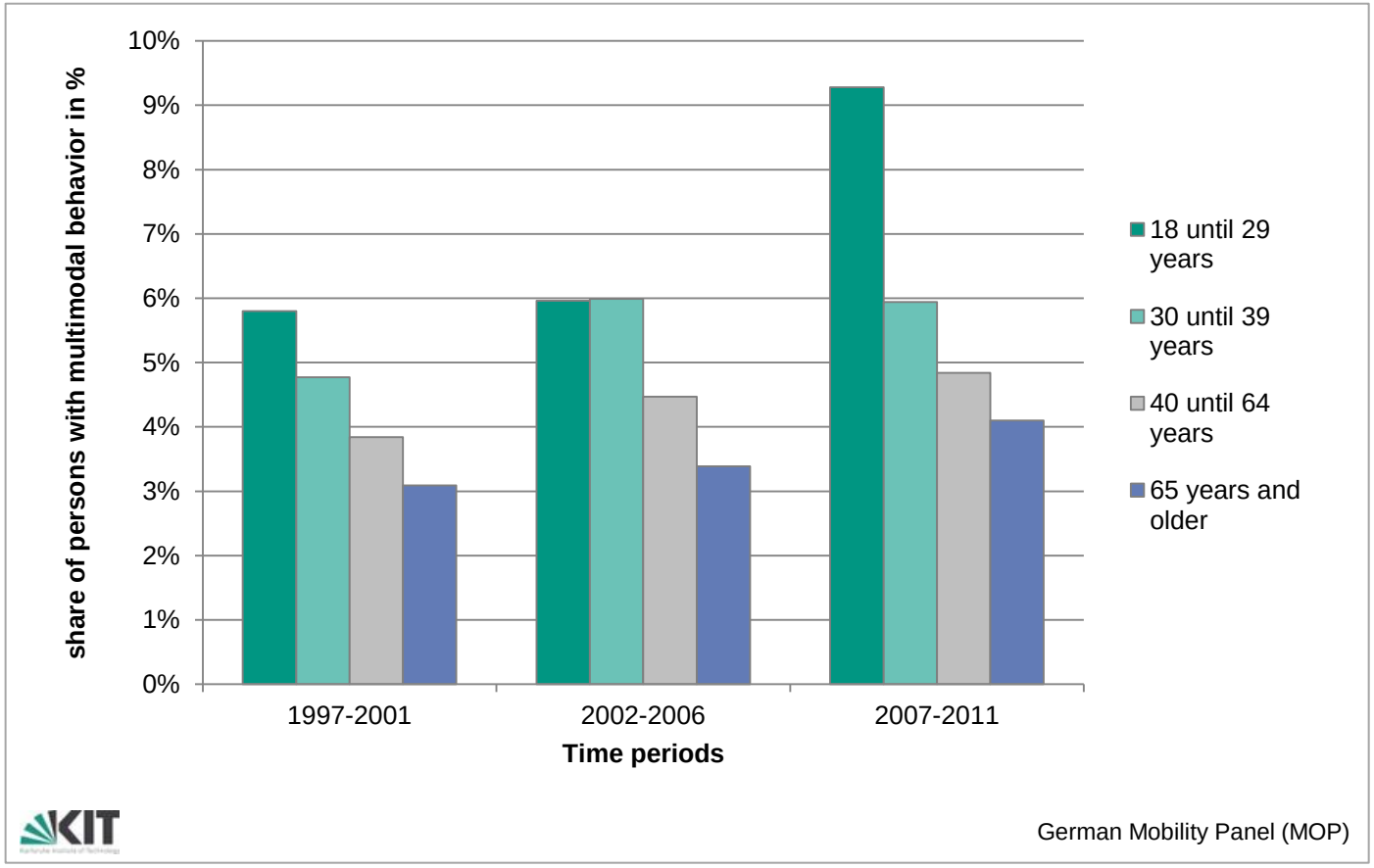
- Changing travel behaviour in different age classes



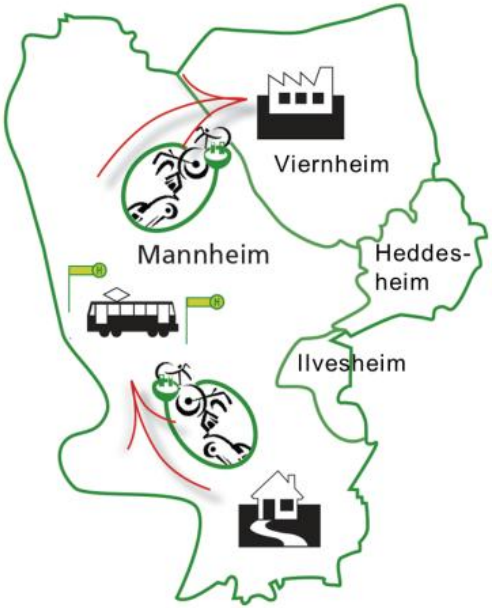
Institute for Transport Studies.
Karlsruhe Institute of Technology (KIT)

Motivation

- Multimodal and intermodal behaviour is getting more and more important



The Project „IeMM“



- 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.

partner

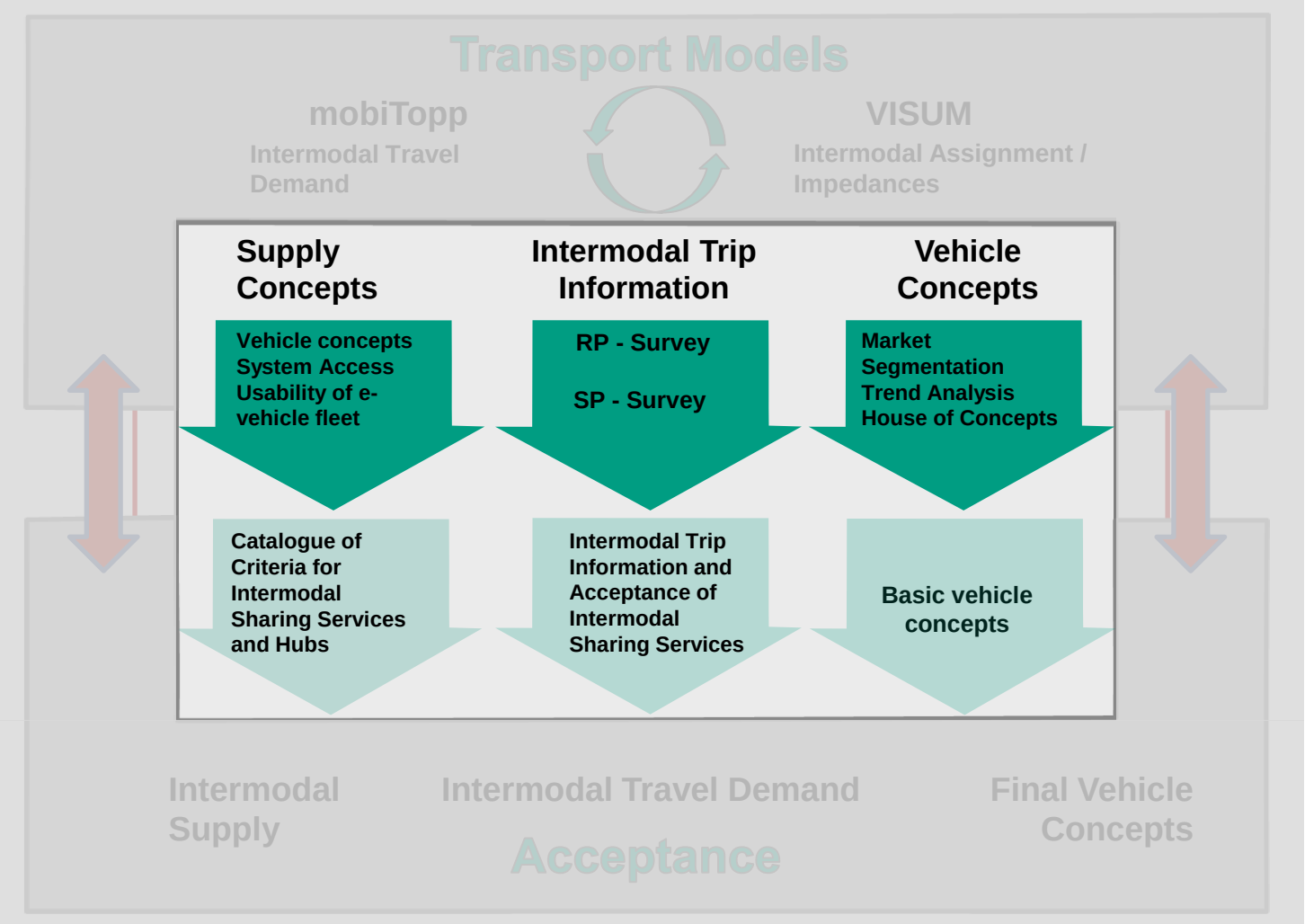
PTV GROUP stadtmobil carsharing KIT Karlsruhe Institute of Technology raumobil RA CONSULTING FZI rnv

elektromobilität süd-west

INVENTED IN GERMANY

GEFÖRDERT VOM Bundesministerium für Bildung und Forschung

Multi Method Approach - Overview



Vehicle Concepts

Customer

Market Segmentation

Trend Analysis

Vehicle requirements of customers

House of Quality

Vehicle Concept

Technical Product Characteristics

basic vehicle concepts as input for survey and modelling

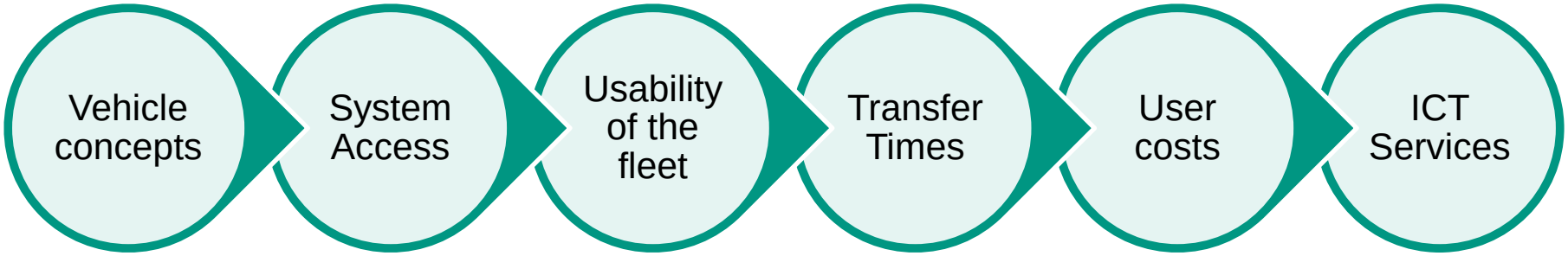
„medium“

„light“

„premium“

Supply Concepts – Intermodal Services

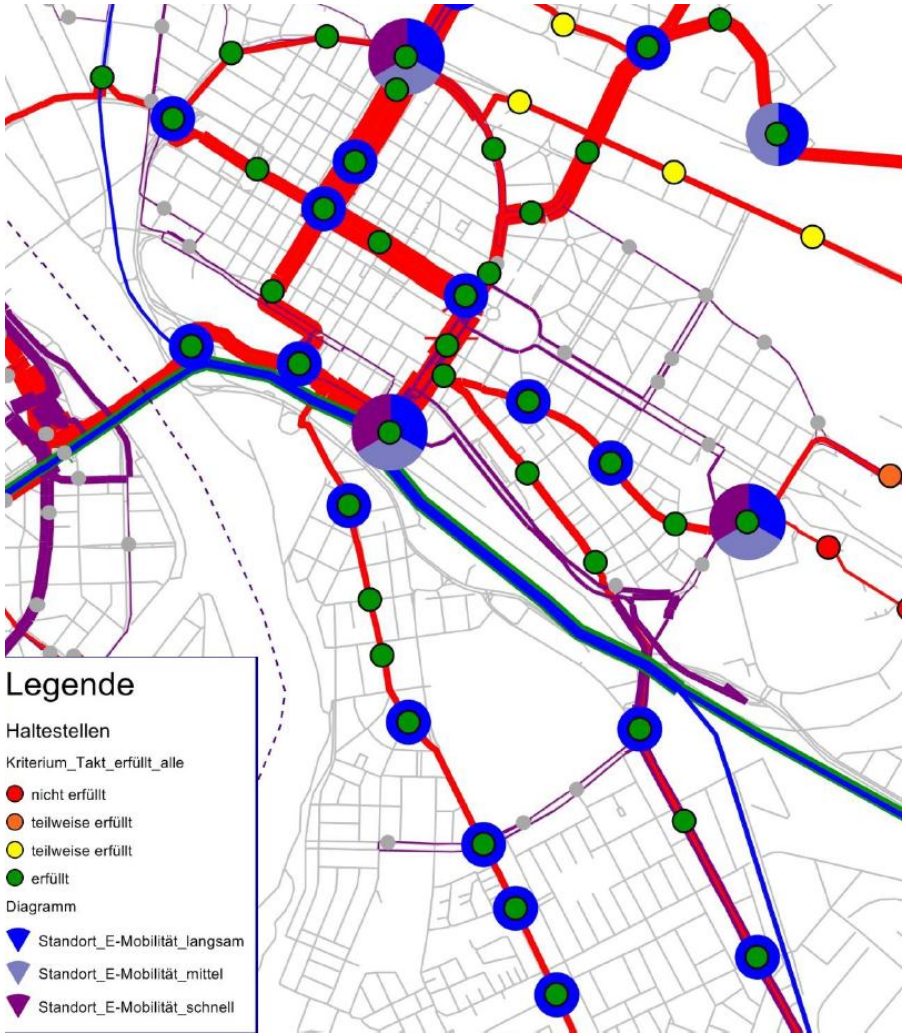
1. Identification of potential components of e-mobility services to design service concepts.



→ 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

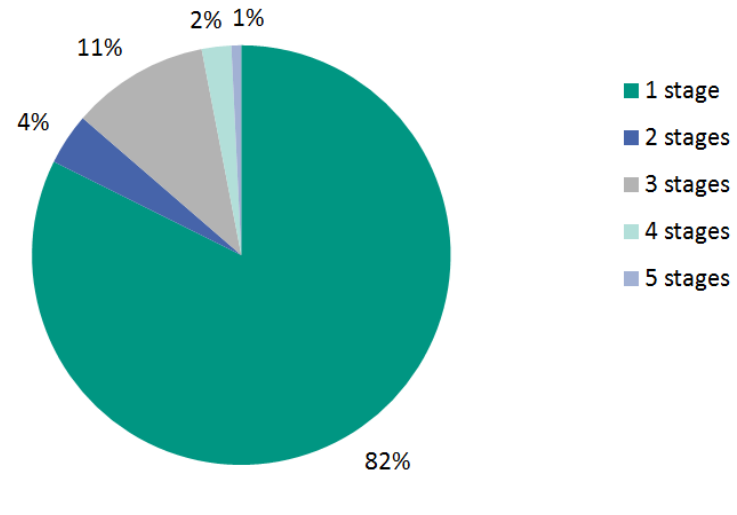
Revealed Preference	Stated Preference
(Intermodal Trip Information)	(Acceptance of E-Sharing Services on trips and stages)

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

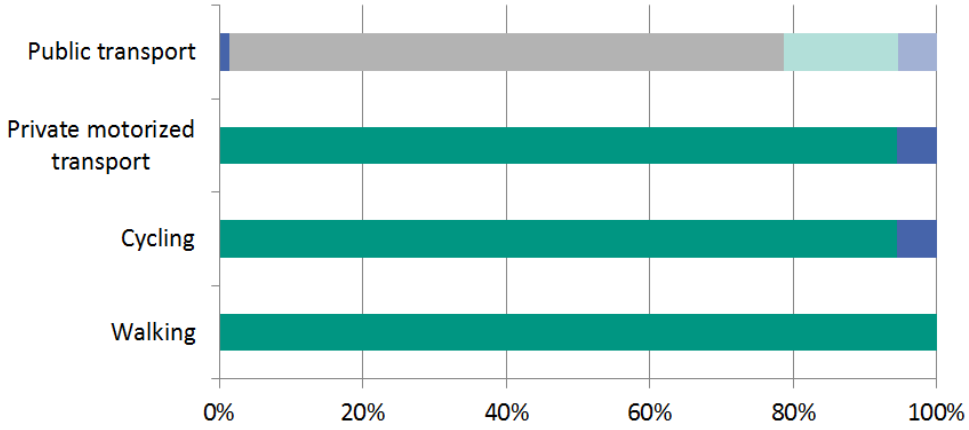
Intermodal Trip Information

Results: Intermodal Trips

Number of stages on trips



Number of stages with main modes



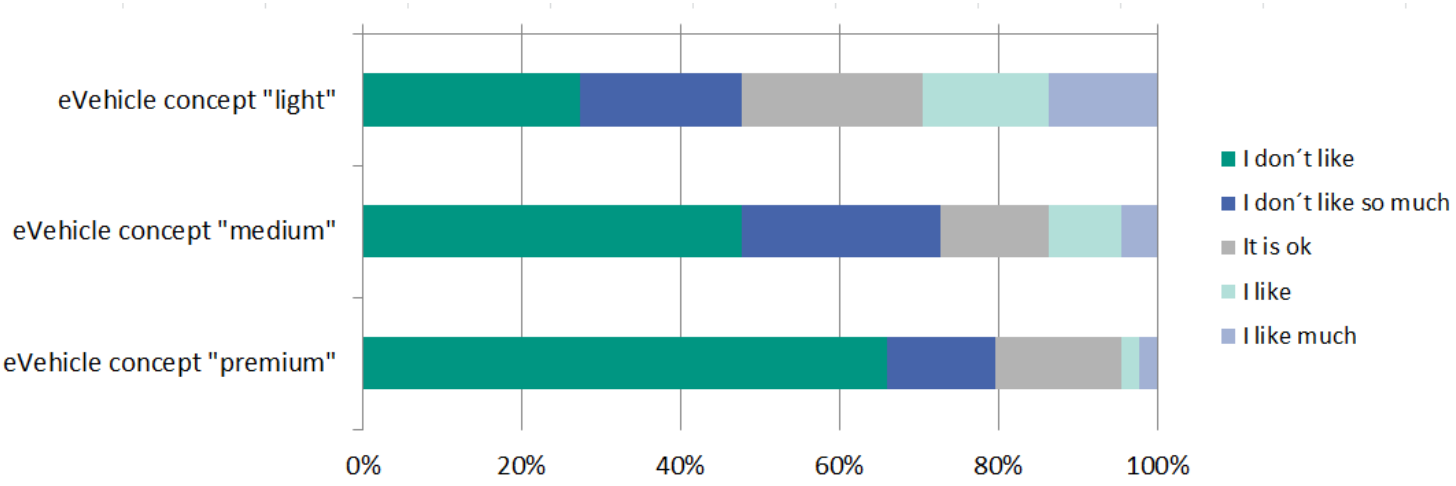
Definition Hauptverkehrsmittel: Das Hauptverkehrsmittel eines Weges ist das ranghöchste benutzte Verkehrsmittel in allen Etappen des Weges (ÖV>MIV>Rad>Fuß)

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

Intermodal Trip Information

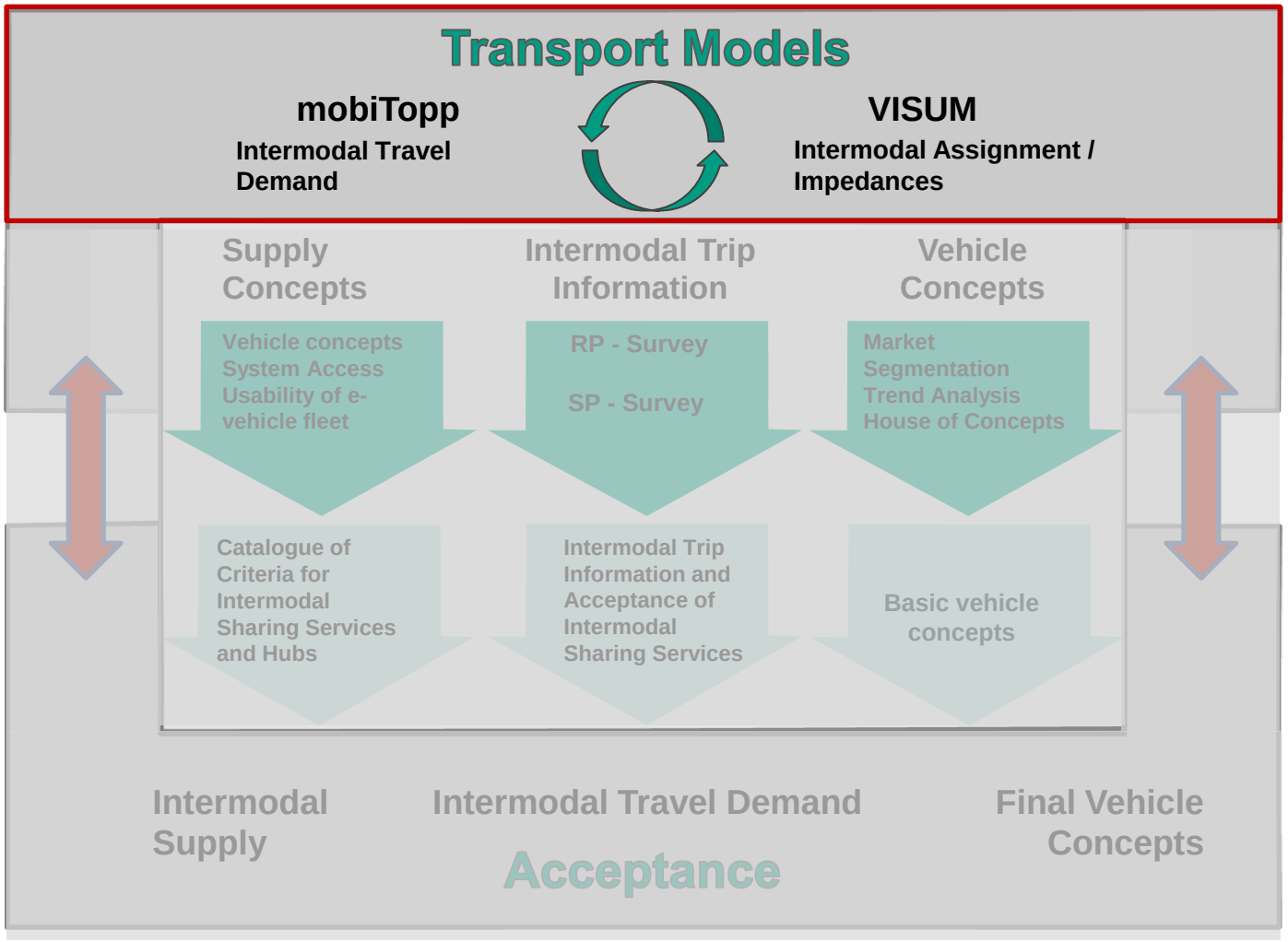
Results: Acceptance

Example: Access stage to public transport



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

Transport Models



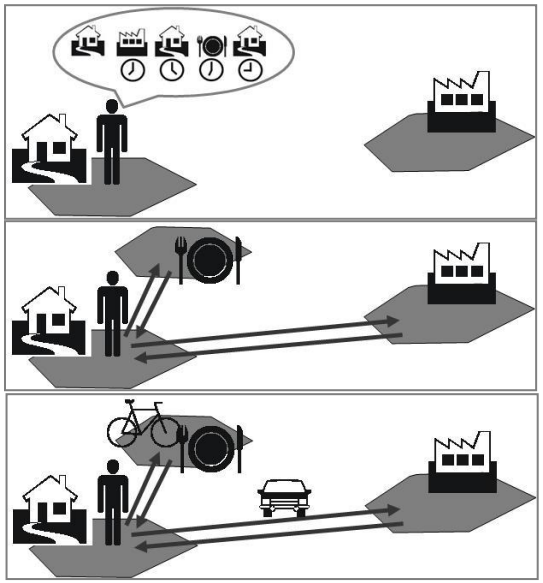
Agent-based transport demand model

mobilopp represents each person and household with their individual travel behaviour

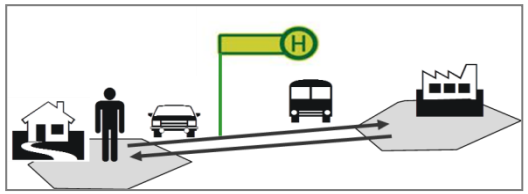
Trip Generation

Destination Choice

Mode Choice



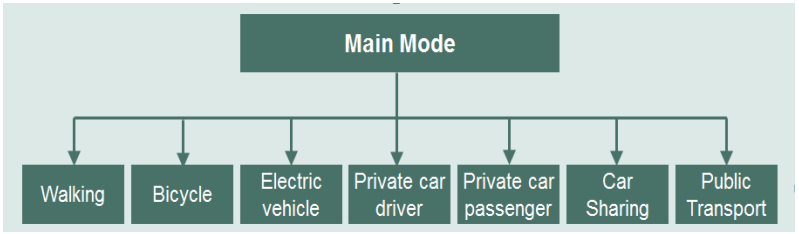
Intermodal Mode Choice

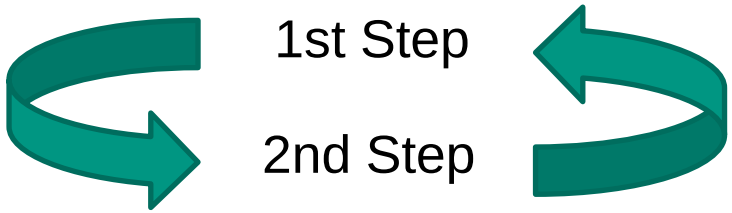


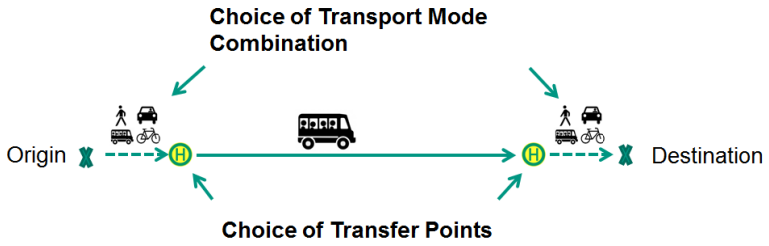
Result: Simulated travel behaviour of every person in a study area
(= complete household travel survey)

Agent-based transport demand model

Intermodal Mode Choice







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 $i \in M = \{Fuß, Rad, MIV, ÖV\}$

X_{itk} = Zahlenwert des Attribut k bei Alternative i für Individuum t

Used attributes: time, cost, mode availability

b) Choice probabilities (LOGIT)

$$p_t(i) = \frac{e^{U_{it}}}{\sum_{j=1}^{I} e^{U_{jt}}} \text{ für } i \in M$$

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 $a \in V = \{ mögliche\ VM - Kombinationen\}$

und $r \in E = \{mögliche\ Etappen - Kombinationen\}$

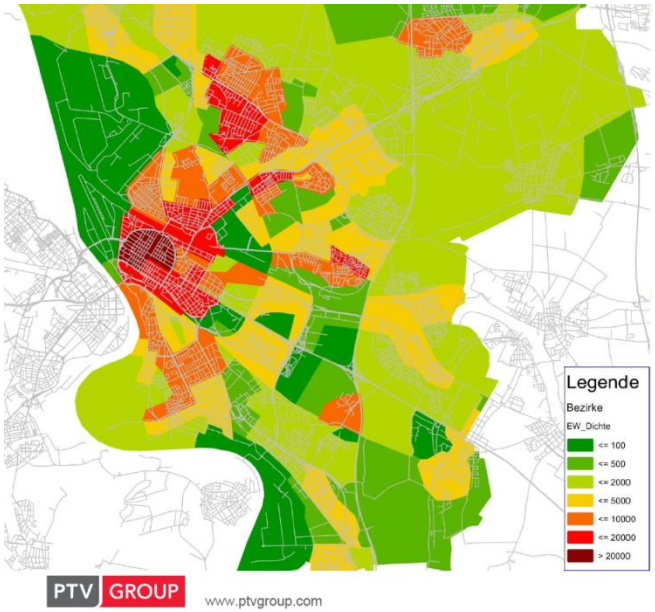
b) Choice probabilities (LOGIT)

$$p_t(a) = \frac{e^{U_{art}}}{\sum_{j=1}^{I} e^{U_{jrt}}} \text{ für } a \in V \text{ und } r \in E$$

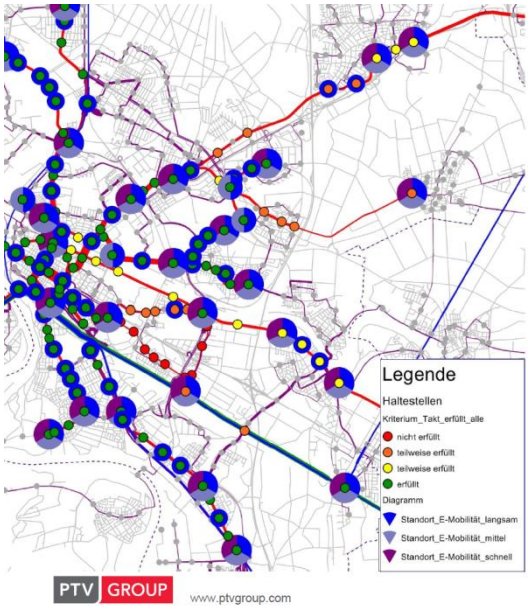
Result: Simulated travel behaviour of every person in a study area including intermodal trips

Macroscopic Assignment Model - VISUM

Common Database



Public Transport Network

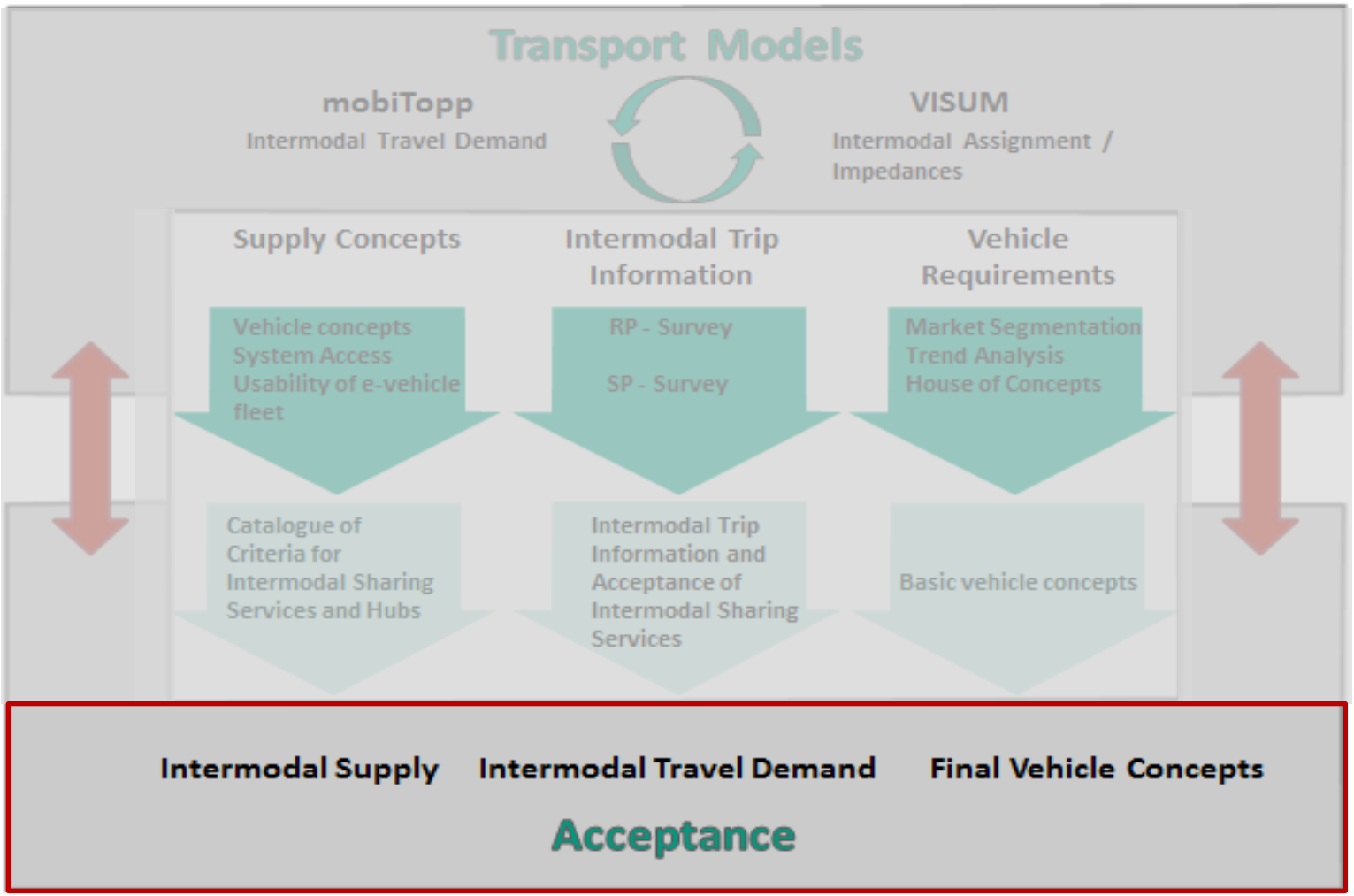


- eVehicle Concepts
- Stations
- Lines
- Schedules and cycle times
- Fare system

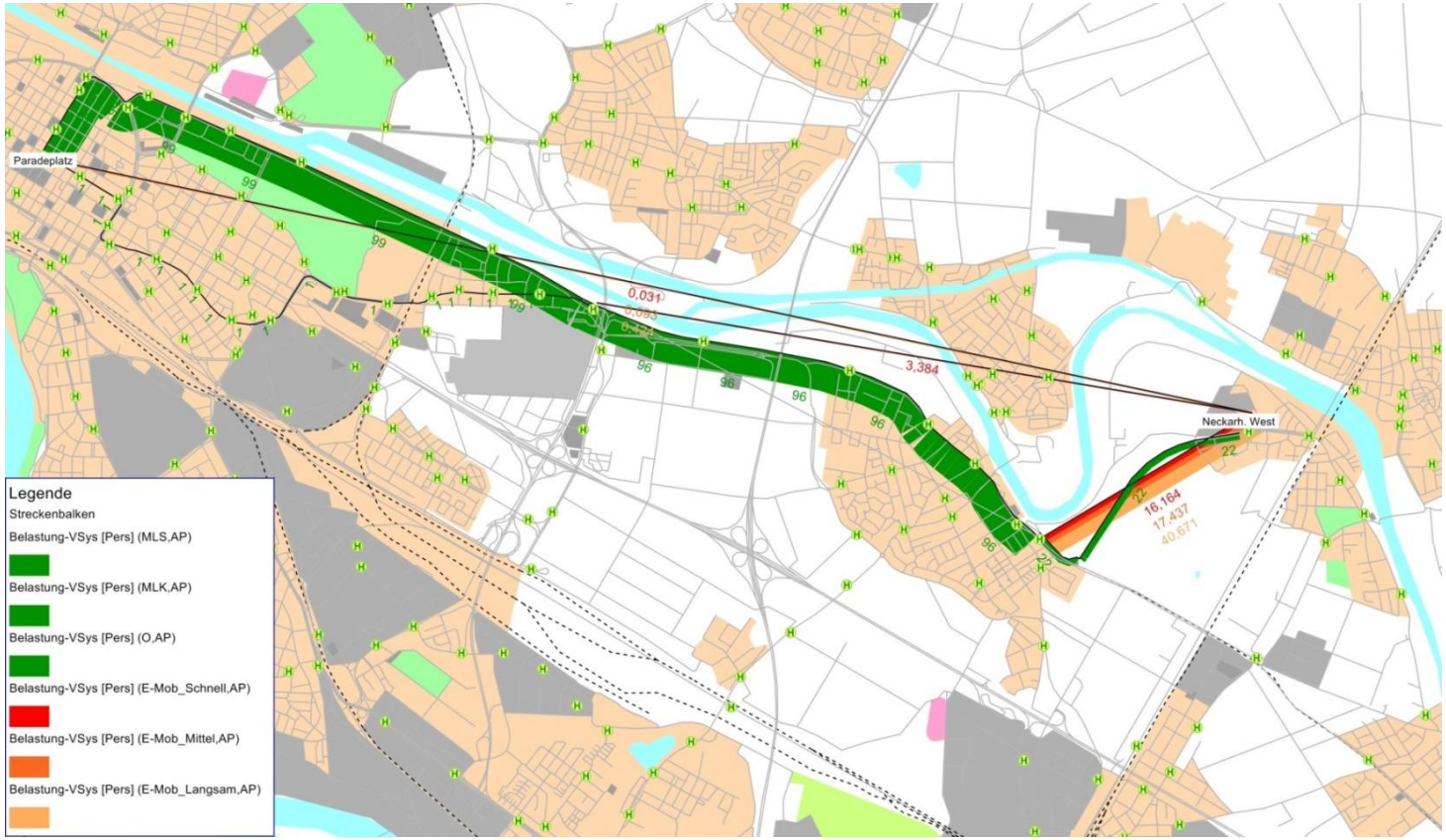
→ Impedances between zones

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

Results


Transport Models
mobiTopp
Intermodal Travel Demand
VISUM
Intermodal Assignment / Impedances
Supply Concepts
Intermodal Trip Information
Vehicle Requirements
Vehicle concepts
System Access
Usability of e-vehicle fleet
RP - Survey
SP - Survey
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

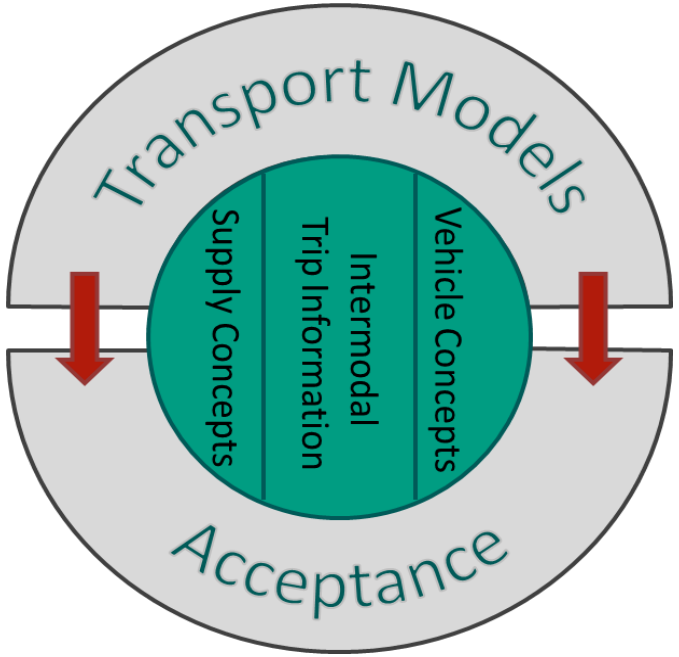
Evaluation / Acceptance



➡ 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

Karlsruher Institut für Technologie

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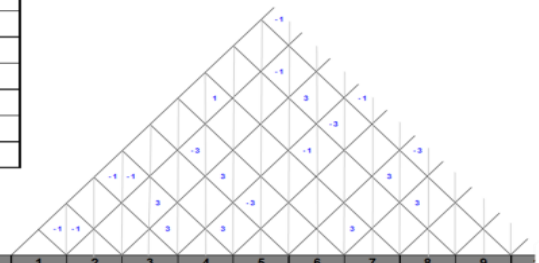
INSTITUT FÜR VERKEHRSWESEN

BACKUP

Vehicle concepts

- Example House of Quality

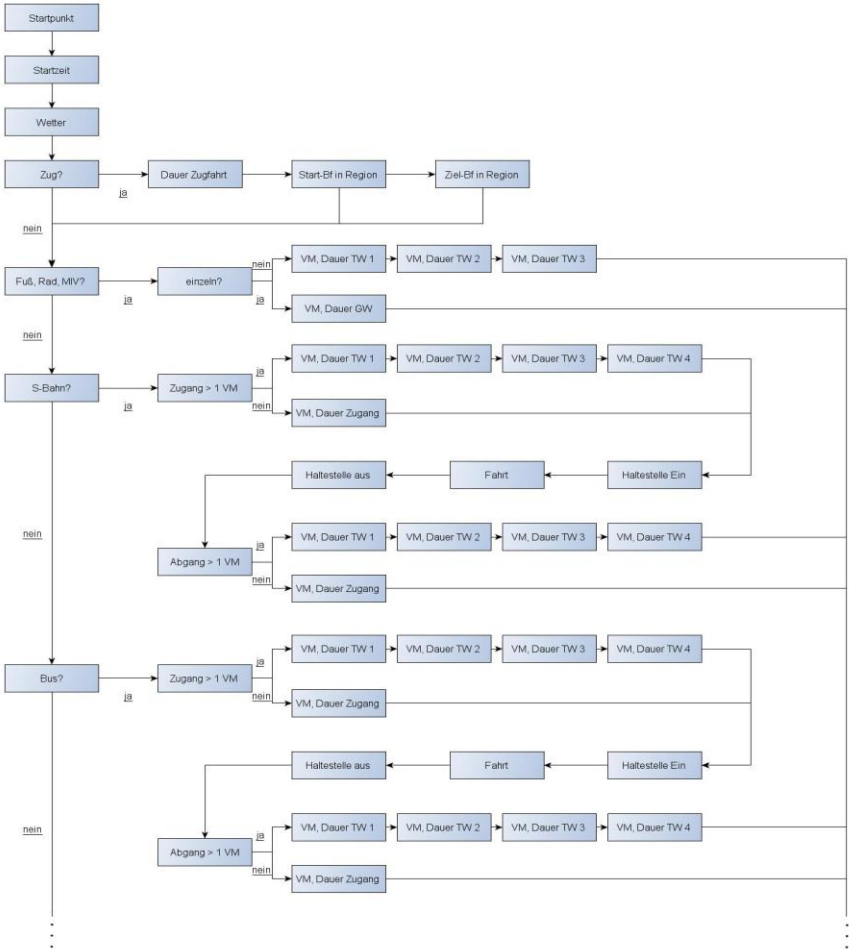
Legend	
3	strong positive correlation
1	positive correlation
-1	negative correlation
-3	strong negative correlation
▼	minimise
▲	maximise
x	fixed requirement

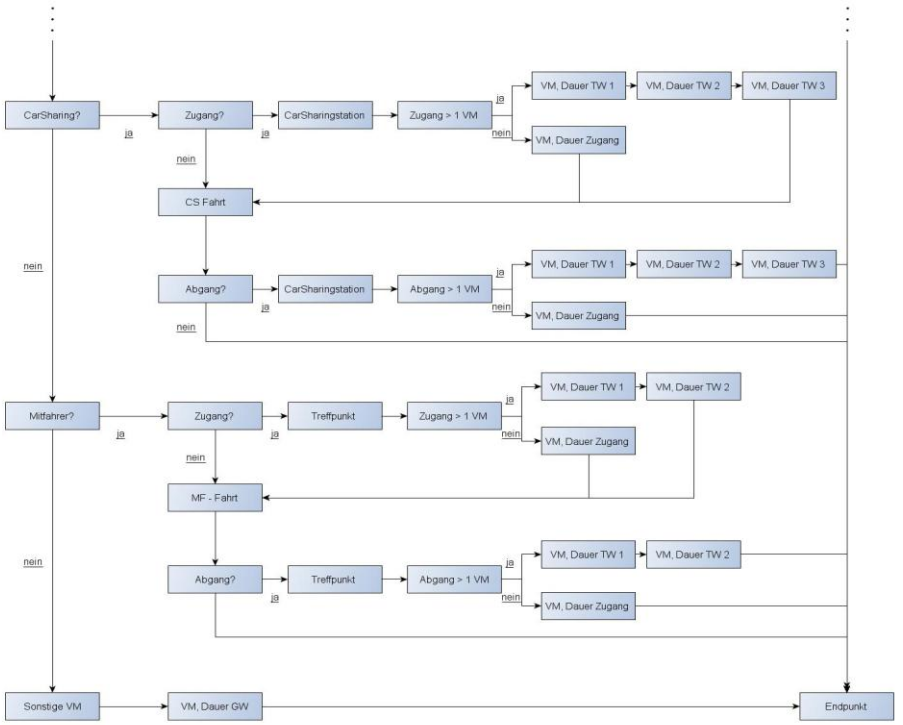


Number	Relative weighting of customer requirements	Significance	customer requirements \ quality characteristic	Noise	V_max	Efficiency	Performance	Acceleration	Range	Recuperation	Maintenance- /repair costst	consumption costs per km
			Number	1	2	3	4	5	6	7	8	9
			Direction of improvement	▼	▲	▲	▲	▼	▲	x	▼	▼
1	14,0%	8	Agility		3		3	3		1		
2	5,3%	3	Maneuverability									
3	14,0%	8	Suitability for every day use		1		1	1	3	1		3
4	1,8%	1	Lifestyle / attractiveness				1	3	1		1	1
5	3,5%	2	Comfort	3					1	1		
6	22,8%	13	Costs			1	1		1	1	3	3
7	17,5%	10	Safety	1								
8	21,1%	12	Environmental	3	1	1	1		1	1		
			Summ	52,0	44,0	25,0	58,0	35,0	52,0	43,0	40,0	64,0
			Percantage of total	30,4%	25,7%	14,6%	33,9%	20,5%	30,4%	25,1%	23,4%	37,4%
			Relative weighting of quality	6,7%	4,0%	7,5%	6,0%	6,0%	7,9%	11,3%	6,1%	9,4%

Intermodal Trip Information

- RP-Survey – Sample Description for one trip

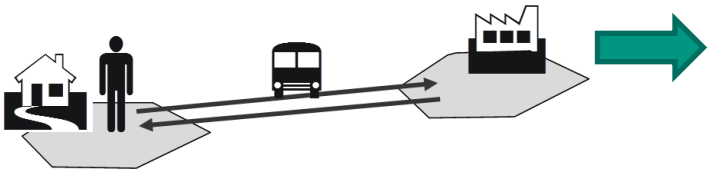




Agent-based transport demand model

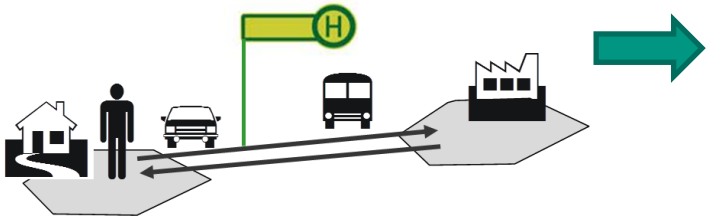
Intermodal mode choice

- Von Quelle-Ziel-Betrachtung



1.Stufe
Wahl des Hauptverkehrsmittels

- über Etappen



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

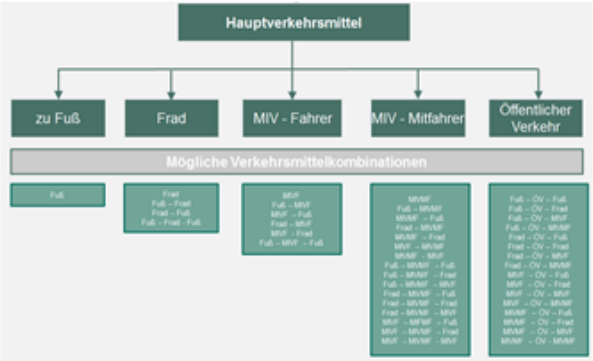
- Zunächst ohne E-Mobilität (Analyse)

- zu E-Mobilitätsangebote

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

Intermodal Mode Choice -

Festlegen der intermodalen Verkehrs-mittelkombinationen



Generieren von Zugangszeitmatrizen zu ÖV-Haltestellen

In jeder Zelle repräsentiert ein Knoten alle Umstiegspunkte. Die Umstiegspunkte sind von jeder Zelle aus erreichbar. Die Erreichbarkeit wird durch Zugangszeiten festgelegt.

Als Ergebnis erhalten wir Zugangszeiten von der Quelle einer Zelle zu jedem Umstiegspunkt 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 Etappen-kombinationen

Unrealistisch lange Etappenkombinationen (Gesamtwegdauer > 3 mal kürzeste Gesamtwegdauer) werden nicht als Auswahl-möglichkeit berücksichtigt.