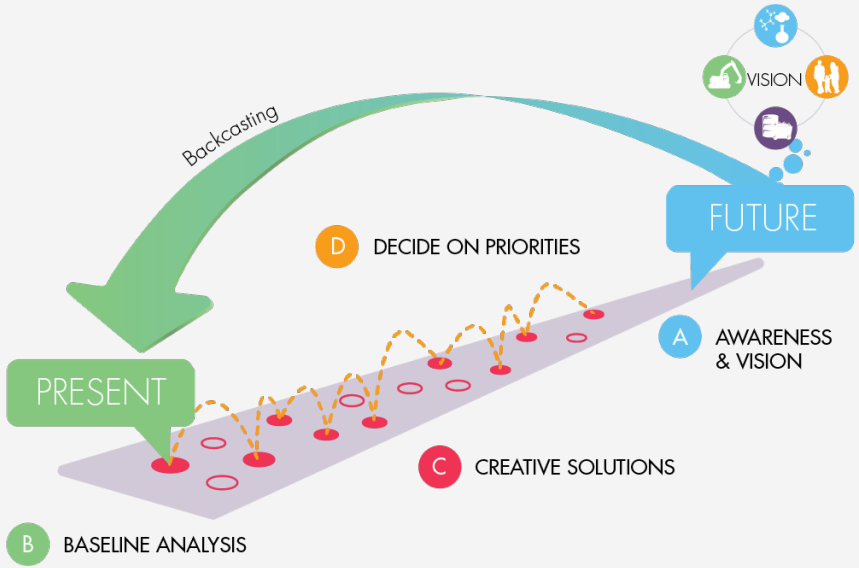
Fachhochschule Nordwestschweiz
Hochschule für Architektur, Bau und Geomatik

Using backcasting to support corporate mobility management

STRC September 2021



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CORPORATE MOBILITY MANAGEMENT (1)

Relevance of commuting for transport planning

Worldwide, time spent on commuting varies between 39 and 97 minutes, with an average of 69 minutes (Lam, 2019).

In Switzerland, 32% of the weekday distance results from commuting trips (20% of daily duration). Distance, one-way, is 12.4 kilometers and takes 24 minutes (one-way).

60% of the daily commuting distance is covered by car; 32% by public transport.

Changes in commuting patterns and mobility behaviour will impact the space required for transport and limit negative externalities.

From a corporate perspective

New developments and redevelopments require careful consideration:

(1) To reduce negative externalities of new developments or densification, authorities set stringent permit requirements, limits are set on the number of parking lots that can be built. Externalities include emissions, traffic jams, crowding, less parking for residents available, etc. (Kanton Zürich, 2017)

(2) Companies have an intrinsic motivation to reduce emissions to meet corporate sustainability guidelines. While commuting can be perceived as external, many companies include commuting in their sustainability assessment.

(3) Not only that, the construction of parking is prohibitively expensive and is usually not out against market-conform rates.

CORPORATE MOBILITY MANAGEMENT: INSTRUMENTS

Sharing:

Organisation.

Regulate:

To be updated

STARTING POINT

Parking eligibility: Employees who have to travel more than 45 minutes by public transport (one-way) are not eligible for parking on-site. There are several exceptions to this policy.

Mobility bonus: Employees who refrain from a parking permit or are not eligible receive a mobility bonus of 40 CHF per day.

Shuttle busses: Shuttle busses are available between different sites during the entire day. Also, shuttle busses are available during commuting hours from Basel to sites located outside Basel.

Digitalisation leads to a transformation of mobility offerings and results in opportunities for mobility management.

The developments in the mobility market are dynamic. New offerings are launched almost every month.

Operating principles are required to cope with these dynamics

Project goals

- Recognize and prioritize different mobility management policies based on
  - Technological developments
  - Policy
  - Behaviour

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PLANNING FOR THE FUTURE: SCENARIO THINKING, BACKCASTING AND FORECASTING

Scenario thinking

- Has its origins in the Cold War and was used by Royal Dutch Sheel as a tool for long-term planning.
- Scenarios make a differentian between:
  - **Certain** elements
  - **Uncertain** elements
- **Certain elements** are assumed to hold for all scenarios (for example company Y will have N employees at Site A)
- **Uncertain elements** are based on assumptions on future developments. These developments are defined during in the process accompanying scenario thinking. Uncertain elements are incoporated in difference scenarios

Forecasting

- With forecasting, the future is **projected**
- The starting point is the current state is extrapolated based on (expected trends) and the desired state in the future.
- Typical methods include econometric models (regression), trend analysis, System Dynamics and sensitivity analyses.

Backcasting (Robinson 1990)

- Is a **prospective** scenario technique
- The starting point is a desired and/or possible future.
- The goals and indicators for a desired future are described and possible routes to this future are decribed.
- Typical methods include: Design Thinking, interdisciplenary discussions, associative thinking, systems theory, Typische Methoden bei der Erarbeitung: Design Thinking, assoziatives Denken, Systemtheorie, interdisziplinärer Diskurs, technology assessment

BACKCASTING METHOD

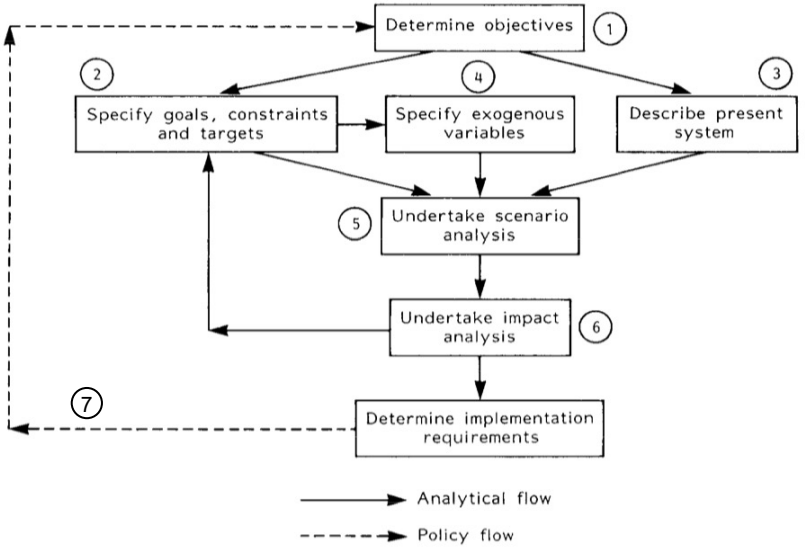
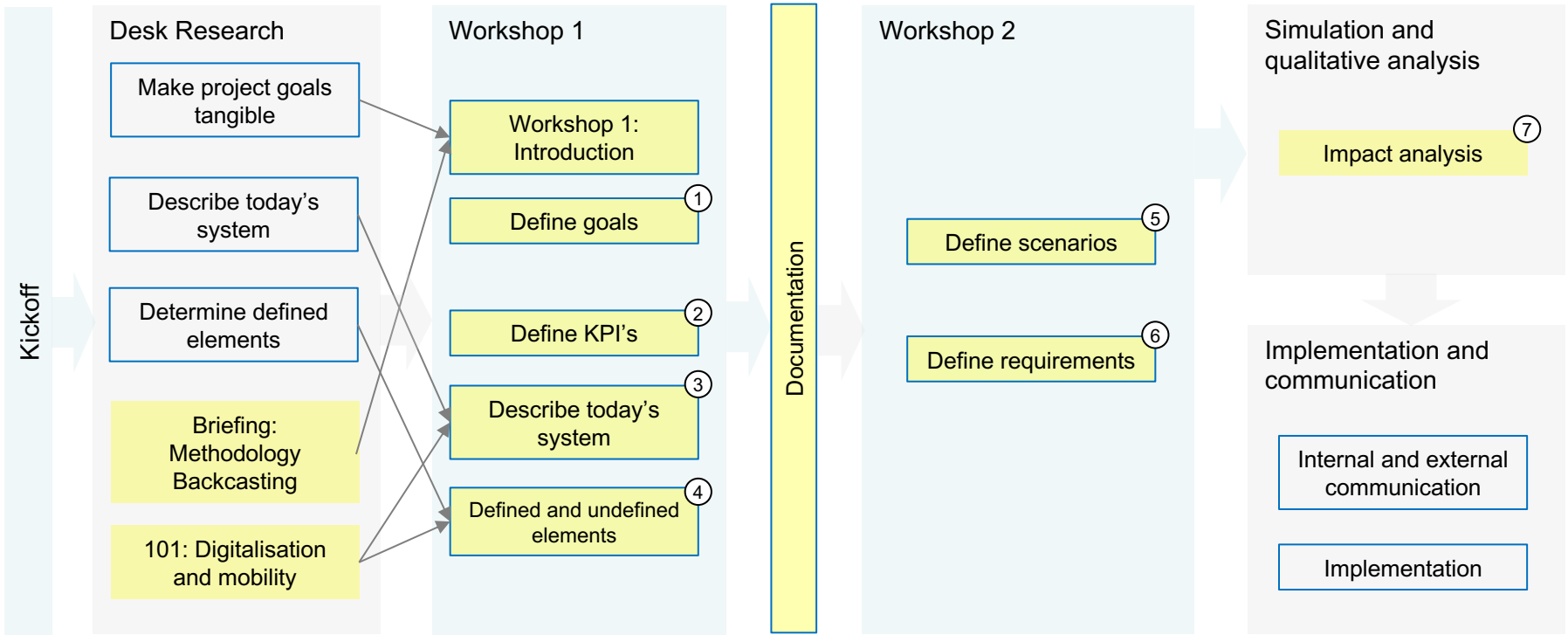


Figure 1. Outline of generic backcasting method.

Quelle: (Robinson 1990)

PROJECT OVERVIEW



CERTAIN ELEMENTS

Public transport

1. S-Bahn station Solitude
2. Pharma Express

Private transport

1. Planned motorway extensions (Rhine tunnel)
2. Mobility Pricing
3. Autonomous vehicles

Bicycling infrastructure

1. Bicycling highways in Basel-Land, (Switzerland) und Germany

bz

Mehr bezahlen zu Stosszeiten: Wessels erwägt Pilotprojekt

von Leif Simonsen · Schweiz am Wochenende · 21.2.2020 um 19:00 Uhr

Feierabendverkehr (Symbolbild)
© Kenneth Nars

Das Konzept des Mobility Pricing sieht vor, dass Autofahrer und ÖV-Benutzer, die zu Stosszeiten unterwegs sind, mehr bezahlen müssen. Dies könnte die Verkehrsprobleme in der Schweiz entschärfen.

Artikel zum Thema

CORONAVIRUS
British Airways erwägt Beurlaubung von 36'000 Mitarbeitern 2.4.2020

PANDEMIE
Wegen Coronavirus: Zürcher Wirte sollen per April keine Miete mehr bezahlen 30.3.2020

NHL
NHL erwägt Playoffs im August 28.3.2020

ENGLAND
Harry Kane erwägt Abschied von Tottenham 29.3.2020

UNCERTAIN ELEMENTS

Public transport:

1. Partnering with Mobility-as-a-Service providers *

Private transport:

1. More charging stations
2. Parking costs
3. Parking eligibility

Organisation

1. Relaxation of home office policies
2. Childcare at work*

Bicycling:

1. Subsidies for bicycle ownership
2. Bike sharing*
3. Corporation with bicycle share programs *

Living in proximity to work

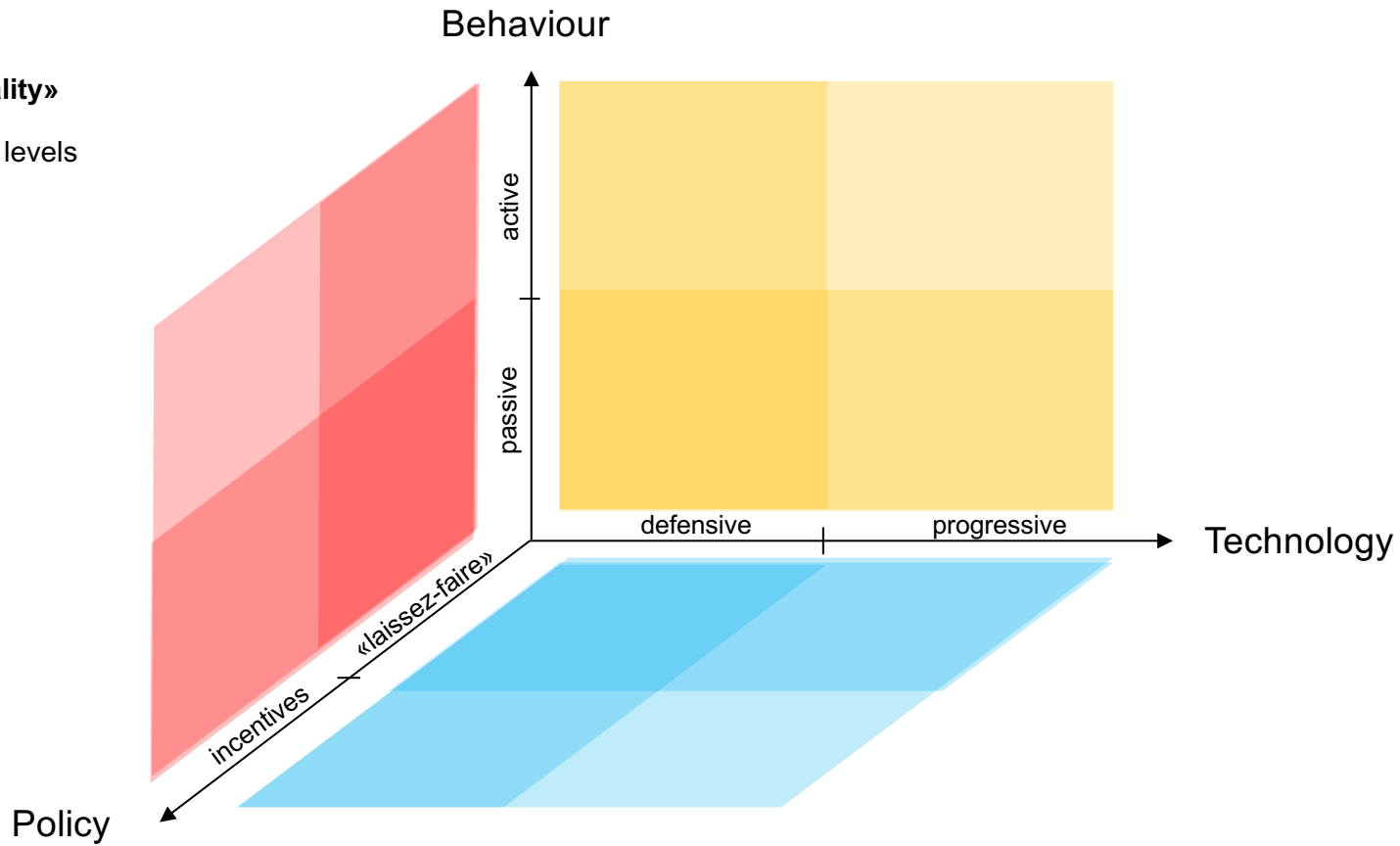
1. Subsidies for home ownership close to work
2. Cooperative flats

* Not quantified

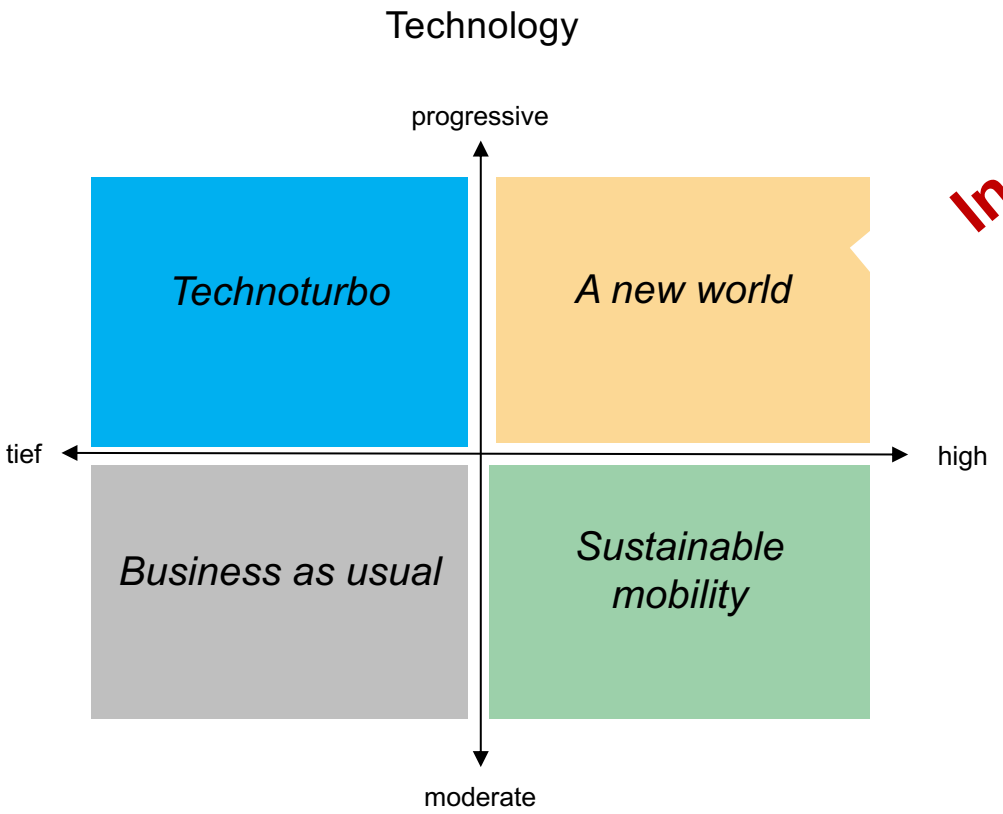
POSSIBLE SCENARIO DIMENSIONS

«The curse of dimensionality»

- 3 dimensions with only 2 levels
- 2^3 = 8 scenarios



POSSIBLE SCENARIOS



Include some examples

CALCULATION OF KPI'S:

CO^2 emissions per day have been calculated by taking the emissions multiplied by the distance traveled of the chosen mode of traveled.

CO^2 emissions per year have been calculated by multiplying the CO^2 emissions per day with the number of days per year on-site.

Distance traveled per year has been calculated by multiplying the distance per day (home-bound and work-bound) with the number of days on-site.

The **perceived travel time per day** has been calculated by multiplying the travel time of the chosen alternative with the aforementioned perception factor.

A variant of the **logsum** has been calculated by multiplying the choice probability of each alternative with the travel time.

CALCULATION OF KPI'S: ASSUMPTIONS

Emissions

CO^2 emissions have been calculated using the figures available from the website Mobitool. The emissions per mode are:

- Public transport: 16 g/km
- Private vehicle (non-electric): 198 g/km
- Electric vehicle: 82 g/km
- Autonomous vehicle (AV): 1.5 times the emissions from an electric vehicle to account for empty rides.

Perception of travel time

- Bicycle/by foot is assumed to be more 40\% more relaxing than traveling by private vehicle
- Public transport and AV trips longer than 20 minutes are assumed to be more 20\% more relaxing than traveling by private vehicle as other activities can be conducted.
- Public transport and AV trips shorter than 20 minutes are assumed to be more 10\% more relaxing than traveling by private vehicle as other activities can be conducted.

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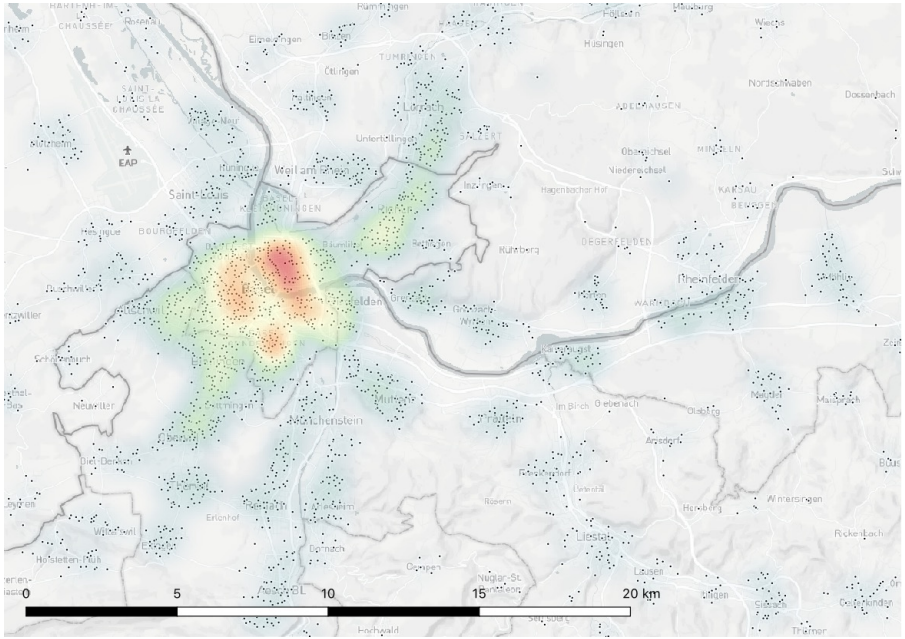
RESIDENTATION LOCATIONS



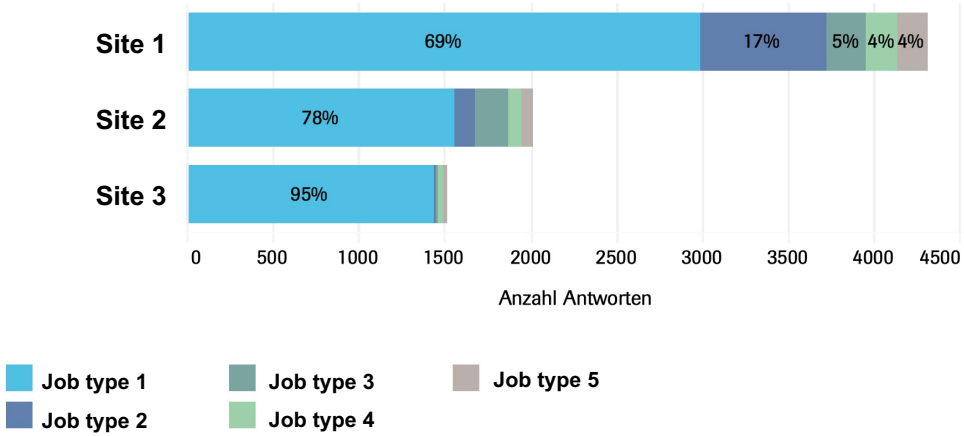
Residential locations are used to calculate **travel times** for different modes (public transport, private transport, bicycle, foot).

Travel times for **private transport, bicycle** and **foot** are calculated using the Google Travel Time API using expected travel times for peak hour.

Travel times for **public transport** for France and Germany are not covered (well) in the Google Travel Time API. GTFS feeds for the areas surrounding Basel were obtained, transposed to the same year / date and used for routing.

Assuming that commuters are aware of the most convenient connections, the connection with the lowest travel time in a 2 hour interval was selected between 6am and 8am.

SURVEY: RESPONSES



Approximately **7000 employees** participated in survey on mobility behaviour.

The expected **survey duration** was 10 minutes.

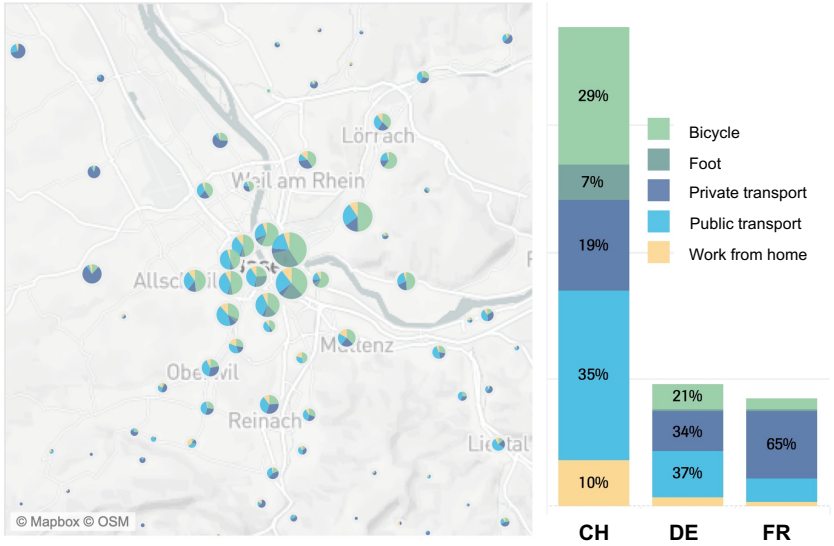
The **survey** covered the following topics:

- Mobility behaviour (one week of mode choice)
- Mobility tool ownership
- Satisfaction with mobility services
- Attitudes towards mobility

Respondent weights were derived from overall company figures to correct for under / overrepresentation of employees per site, job type and country of origin and were used in descriptive analysis and model application.

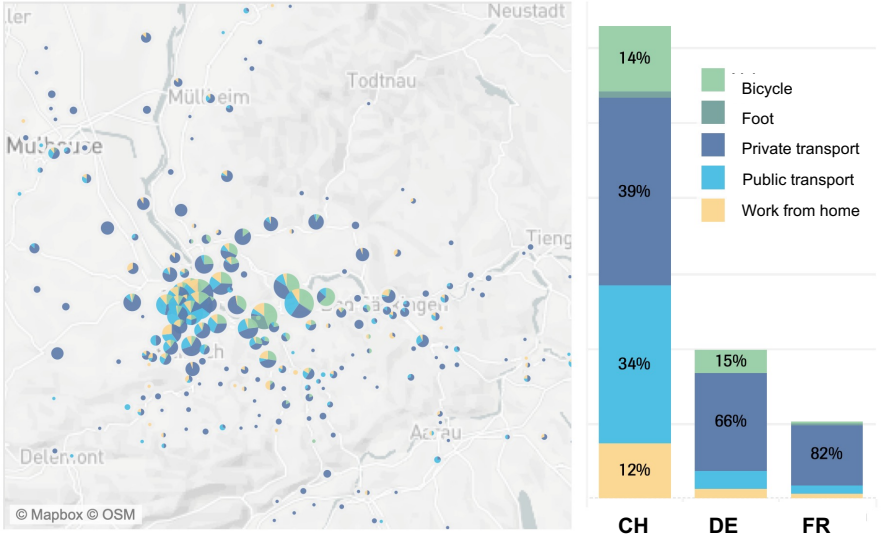
SURVEY: SOME INSIGHTS

Site 1: Urban



In the urban site, approximately 33% travels by bicycle or foot (main mode during the week). Around 40% travels by public transport. The remaining 30% travels by private transport.

Site 2: Suburban



In the suburban site, over 50% travels by private transport. Around 31% travels by public transport. The remaining 15% travels by private transport.

Clear differences between countries can be observed: employees from Germany and France are more inclined to travel by private transport.

STATISTISCHES MODELL: MNL MODELL

Jeder Person entscheidet sich für eine Alternative aus einer eingeschränkten Set von definierten Alternativen.

Wir gehen davon aus, dass ein Person die Alternative mit der höchsten Nutzen auswählt (*Homo Oeconomicus).*

Nutzen U_{jq} der Alternative j für Person q

$$U_{jq} = U(Xkjq) = \square V(Xkjq) + \square_{jq}$$

$V(Xkjq)$: Systematisch beschreibbarer Anteil

ε_{jq}: Nicht systematischer, d.h. persönlicher oder nicht beschriebener Anteil

η: Konstante, die von der Verteilung von ε_{jq} abhängt.

$$V(X_{kjq}) = \beta_j + \sum_m \beta_{k'} \cdot p_{k'q} + \sum_n \beta_{kj} \cdot x_{kjq}$$

β_j

$p_{k'q}$ Konstante für Alternative j

x_{kjq} Eigenschaft k‘ = 1...m‘ der Person q

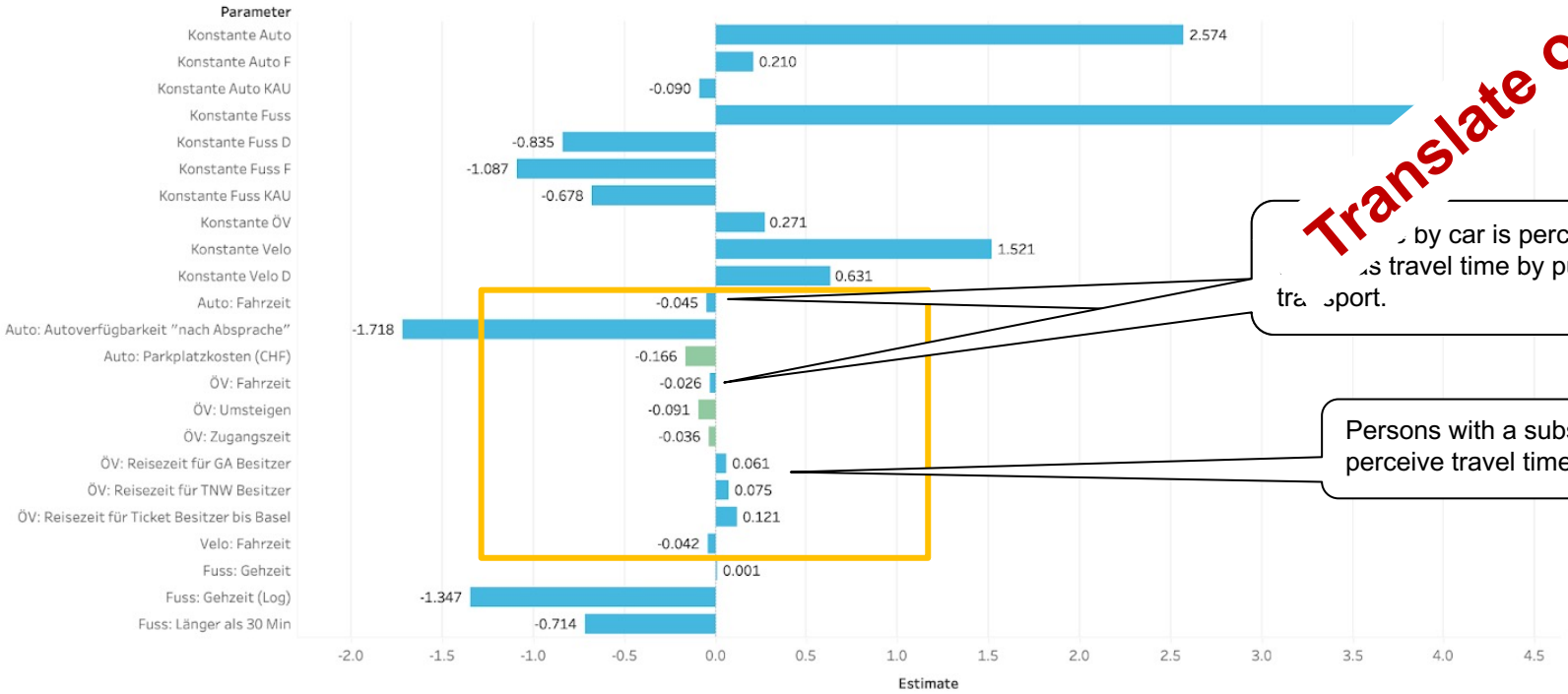
Eigenschaft k = 1...m der Alternative j für Person q

Auswahlwahrscheinlichkeit P_{kjq} der Alternative j mit Eigenschaften k für Person q

$$P_{kjq} =$$

Translate, maybe not necassry. Make link to application

MODEL ESTIMATION

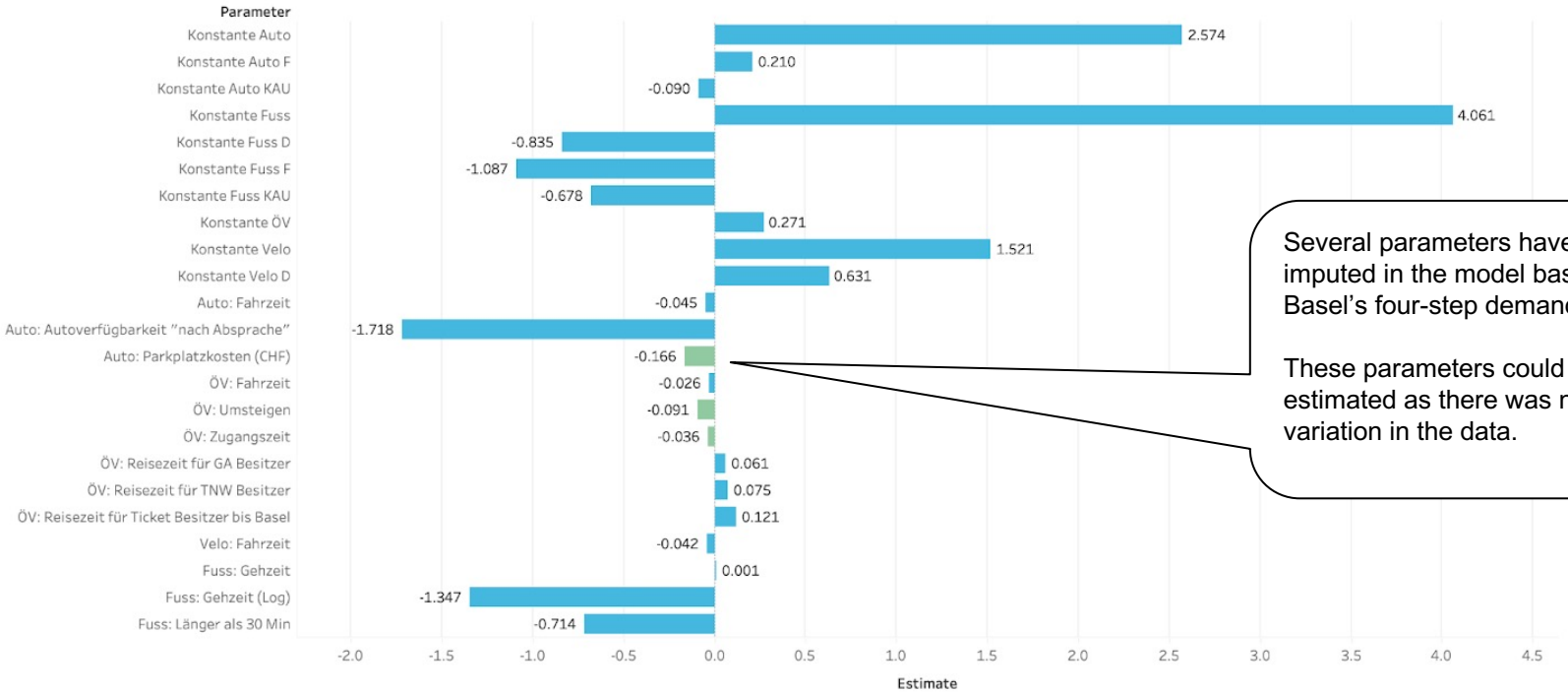


Translate or table

… by car is perceived … travel time by public transport.

Persons with a subscription perceive travel time less.

MODEL



Several parameters have been imputed in the model based on Basel's four-step demand model.

These parameters could not be estimated as there was no variation in the data.

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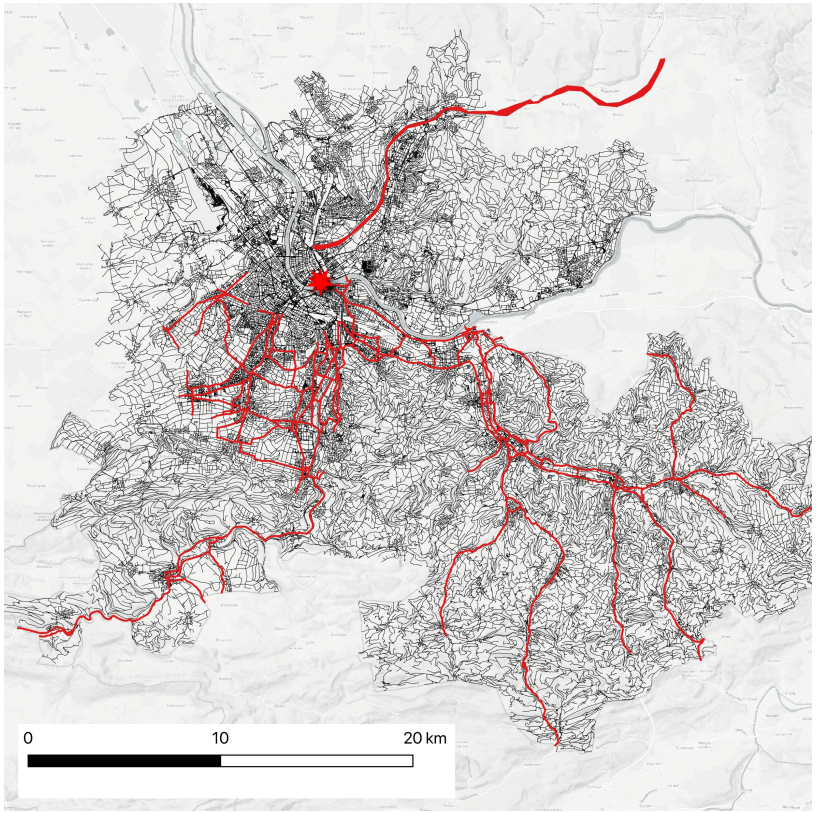
CASE STUDY: CYCLING INFRASTRUCTURE



Bicycle highways

Improved bicycling infrastructure will result in increased comfort and higher speeds.

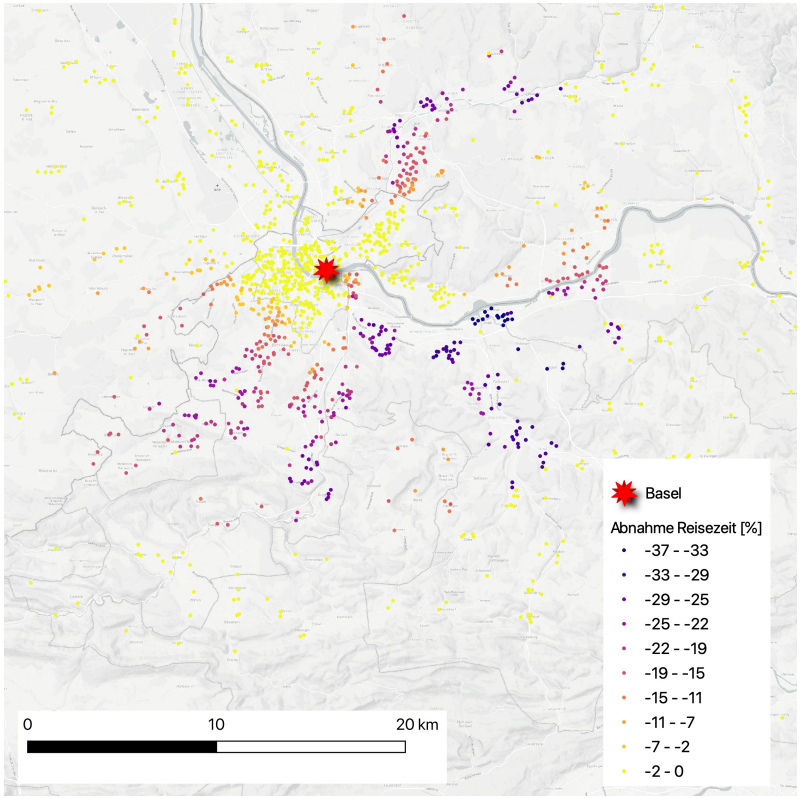
Implementation

Über Reisezeit für Velo

Method

- Bicycle highways are taken from Basel-Land's Geoportal and drawn for Germany
- Using buffer analysis, existing links are assumed to be part of the new cycling infrastructure
- On these links, speeds are updated to 30 km/h.

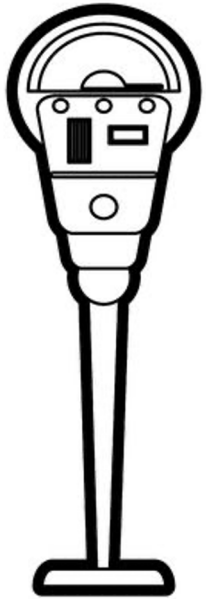
CASE STUDY: CYCLING INFRASTRUCTURE



Result

The map shows the decrease in travel time to a selection of network nodes.

CASE STUDY: PARKING COSTS



Assumption

Market conform pricing (approx. 140 CHF / Monat or 7 CHF per day)

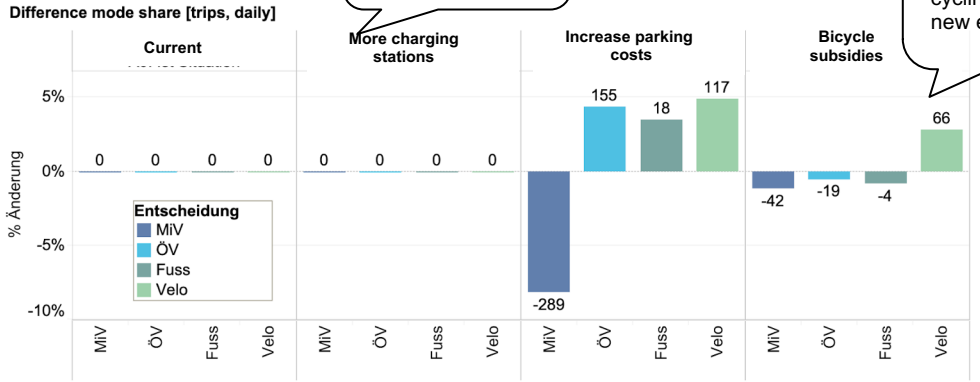
COMPARISON OF SCENARIOS

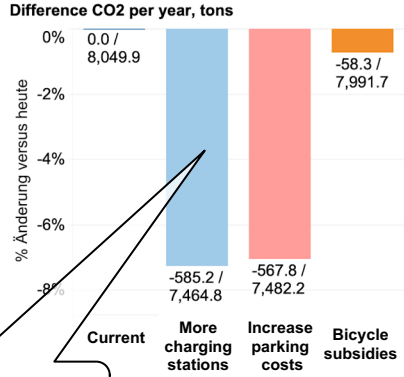
Scenario

- [x] A0: Ist Situation
- [ ] Business as Usual
- [x] E2: Mehr Ladestationen
- [ ] E3: Differenzierte Parkkosten
- [ ] Neue Mobilität
- [ ] O1: Vermehrte Nutzung Home-Office
- [ ] O3: Grenzgänger ohne Beschränkung
- [ ] ÖV3: Haltestelle Solitude
- [ ] S1: Geplante Netzausbauten
- [ ] S2: Road Pricing
- [ ] S3: Anpassung Parkplatzberechtigungen
- [x] S4: Anpassung Parkplatzgebühren
- [ ] Sanfte Mobilität
- [ ] Techno Turbo
- [x] V4: Vergünstige Velos

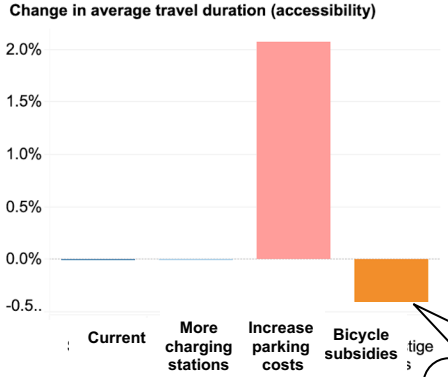
No change in mode choice because of electric vehicles

Bicycles are assigned to people currently cycling as well new employees.

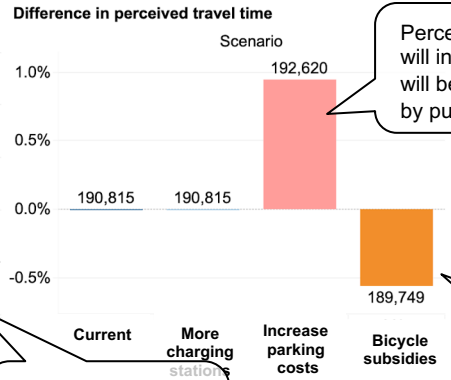




Similar results concerning CO2 emissions



Decrease in travel time as employees will cycle instead of taking public transport



Perceived travel time will increase as people will be traveling longer by public transport.

Travel time by by bicycle is perceived less

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CONCLUSION

Model estimation

We were presented with several challenges when estimating a choice model:

(1) Given that mobility policies are similar for all respondents, there is no variety in certain attributes (e.g. parking costs), making workarounds necessary.

(2) Mobility policies result in a ‘distorted’ market: public transport travel time parameters required interactions with other attributes (e.g. mobility tool ownership). Still, the sensitivity for public transport travel time is low. The revealed preference data basis makes it difficult to account for travel time, distance and costs.

Model estimation went hand-in-hand with model application: socio-demographic variables were not included, as were attitudes, as these were not available for the entire population.

Scenario analysis

Model application

Applying the choice model on the population resulted in insights on the potential of exogenous and endogenous measures and took into account the spatial distribution of employees and the spatial structure of the tri-regional area surrounding Basel.

Carrot or stick

Increase of parking costs or limiting parking eligibility has a larger influence than improvements in travel time.

Only when assumptions on season tickets and parking eligibility are made, scenarios including public transport travel times lead to minor changes.

OUTLOOK

Reflection

- Did we eventually apply backcasting?

Implementation

- The project has helped to define the potential and order of magnitude of certain and uncertain elements.

Next steps – practical

- We will monitor the effect of different measures biyearly
- KPI's will be measured using a variety of data sources:
  - Survey (small sample)
  - Counts (bicycle usage)
  - Analysis of passively collected data (charges, parking occupancy, transaction data)

Next steps – methodological

- In several scenarios, we assigned mobility tool ownership with sampling. Using simulation can further help to quantify confidence intervals.
- Models with socio-demographics and attitudes