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Self-driving vehicles as communal public transport

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Index

What do I want to know?	How do I get it?	
1. Mode shift	Transport model	
2.1. Socioeconomic return	NPV and BCR	CBA
2.2. Who perceives how much benefit/costs	Sub-balances	

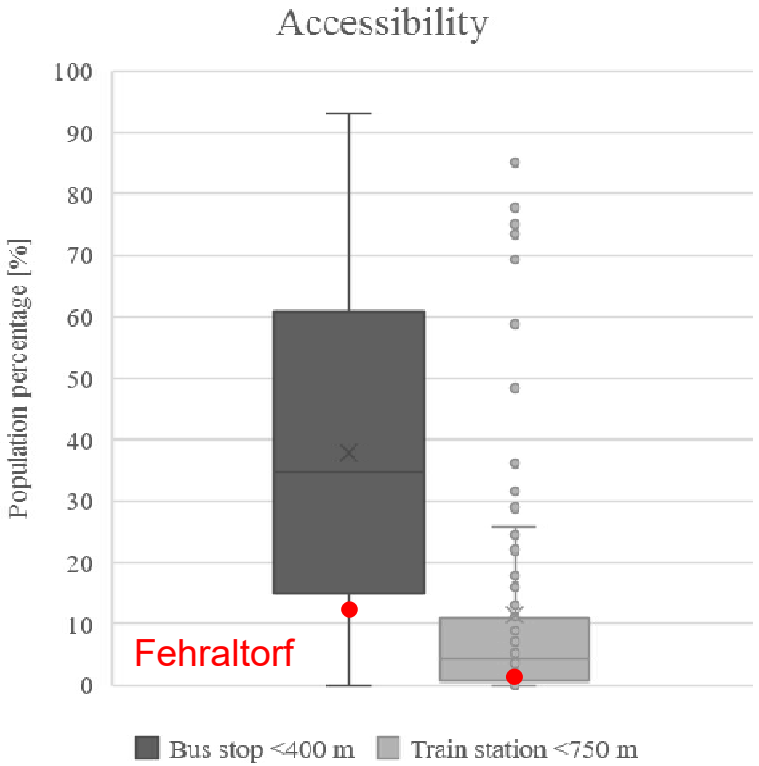
Service definition

Dimension	SERVICE 0 REFERENCE	SERVICE 1 AUTONOMOUS	SERVICE 2 DYNAMIC	SERVICE 3 LOW COST
Steering	Manual	Autonomous	Autonomous	Autonomous
Propulsion	Fossil fuel	Fossil fuel	Electric	Electric
Fleet structure	City bus	City bus	?	Midsize
Route and time	Fixed stops	Fixed stops	DRS	Predefined stops in a corridor
Booking	None	None	Direct booking + collecting request	Wide time window
Fleet ownership	Operator	Operator	Operator	Users
Integration	No FTS	No FTS	Independent	Independent

Location choice

Choice criteria:

- Geographical abstraction
- Low accessibility
- Centrality in the canton ZH



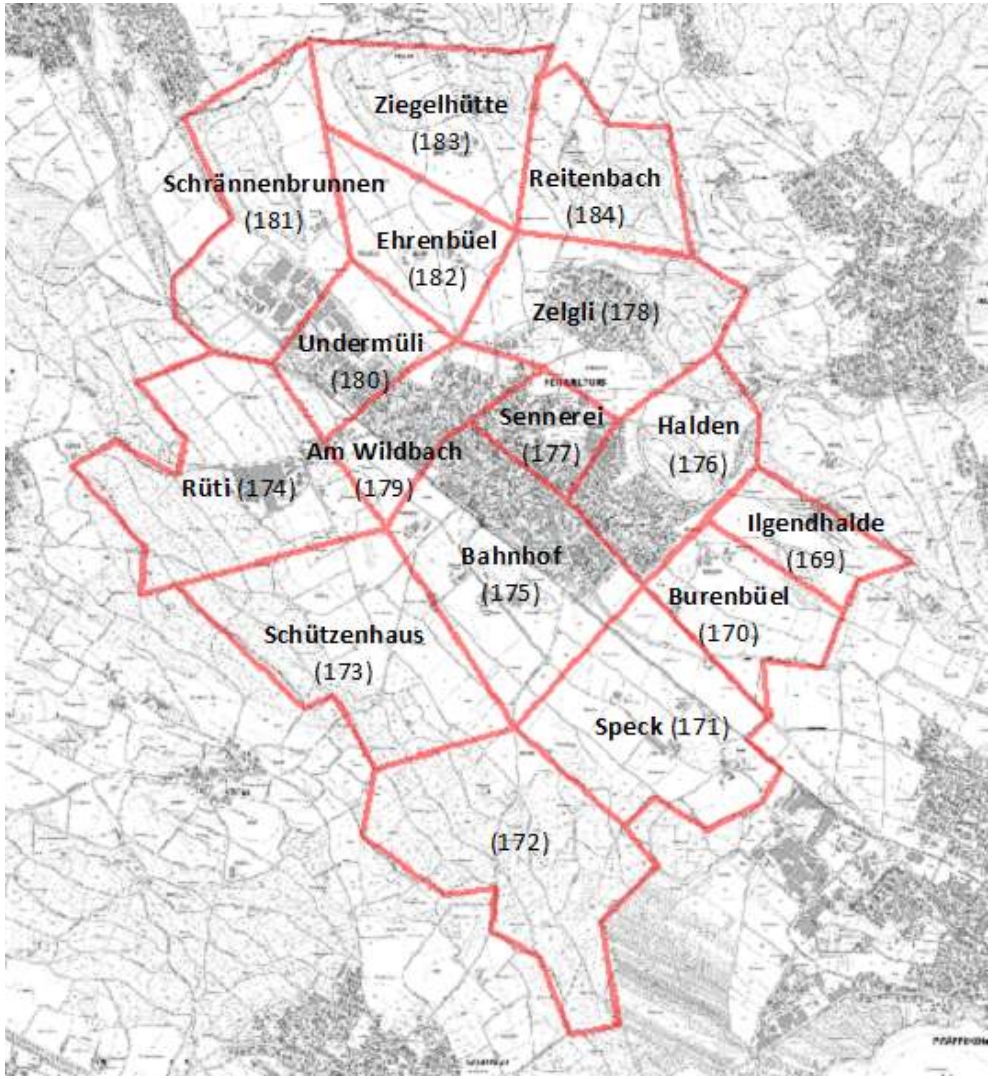
Source: ZVV, 2015

Transport model – Layout

- Zoning
- Trip generation
- Trip distribution
- Mode choice
- Route choice (AoN)

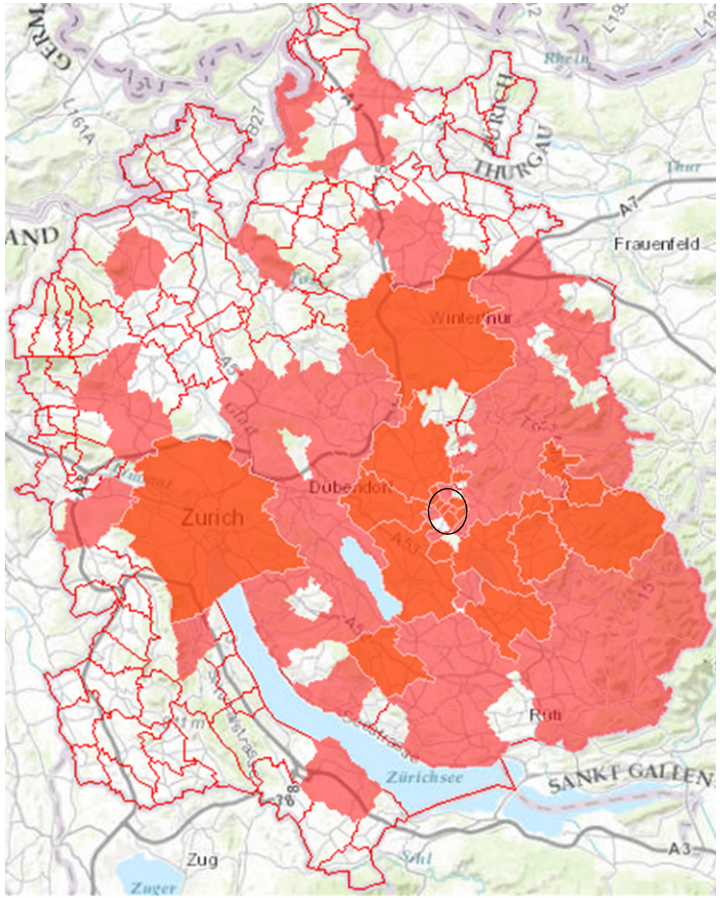
Transport model – Zoning (1)

- Municipalities connected to Fehraltorf by bus are zonified according to bus stop areas of influence
- The rest in the canton, according to administrative boundaries
- Outside areas, integrated in a single zone



Transport model – Zoning (and 2)

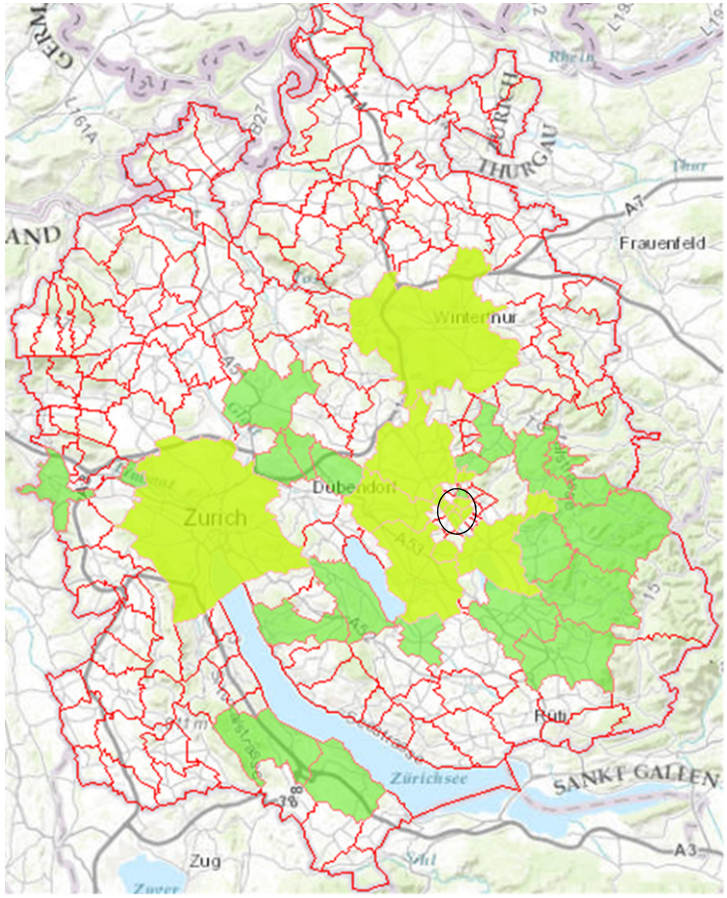
Car trips distribution



>300 trips

>0 trips

PT trips distribution



>40 trips

>0 trips

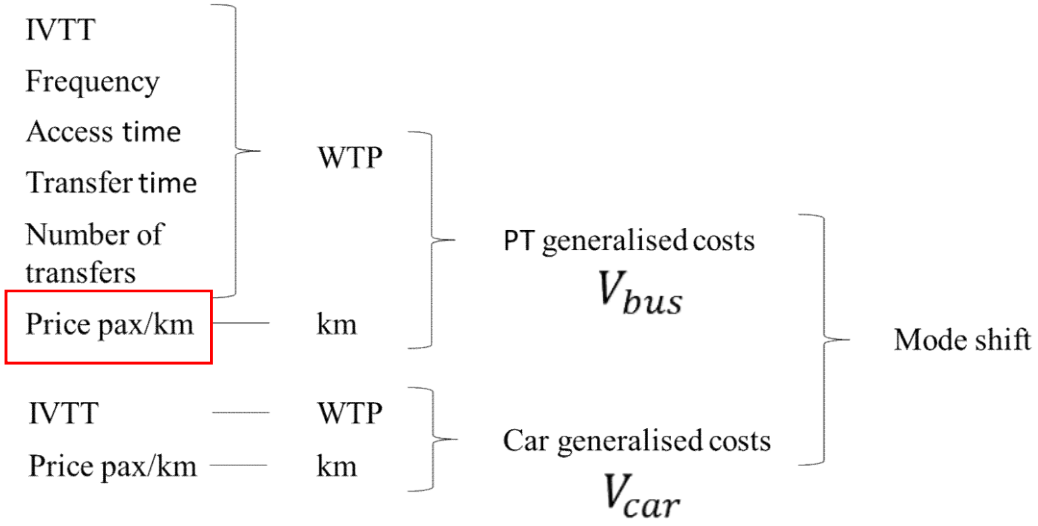
Transport model – Mode choice

- Multinomial logit (MNL) model

$$P_{bus} = \frac{exp(V_{bus})}{exp(V_{bus}) + exp(V_{car})}$$

- Model calibration using alternative specific constants (ASC)
- Condition: overall real PT split = overall model PT split
- *Homo oeconomicus*

$$P_{bus} = \frac{exp(V_{bus})}{exp(V_{bus}) + exp(V_{car} + ASC)}$$

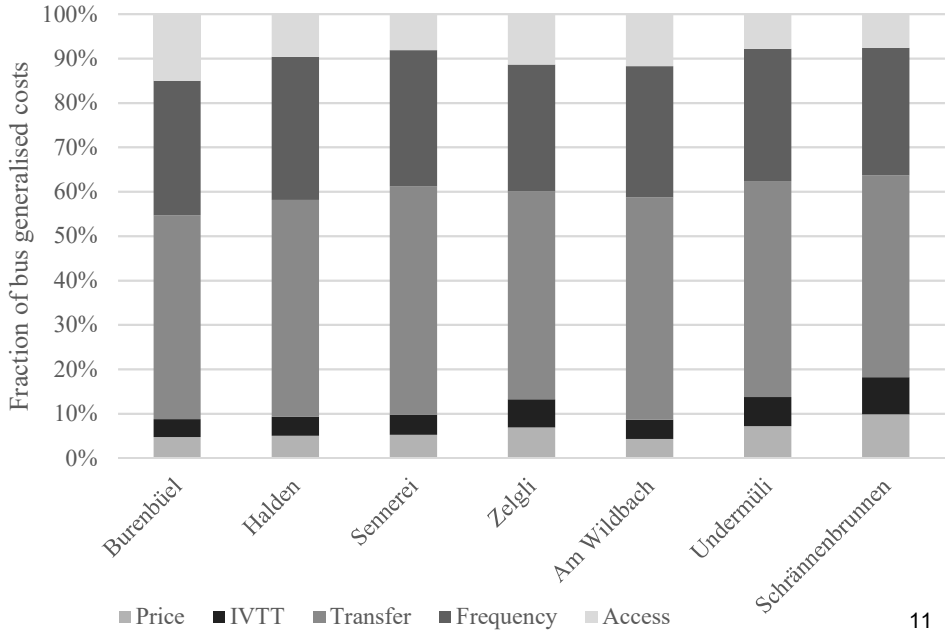


Mode	Cost pax/km [CHF]	Price pax/km [CHF]
Car	0.48	-
Bus	0.89	0.445
ABus	0.40	0.20
Train	0.47	0.235

Source: Bösch et al. (2017)

Transport model – Mode shift – Train market segment

- Temporal resolution
  - Morning peak
  - Off-peak
  - Evening peak
- Asymmetrical OD and generalised costs matrices
- Average access cost to train station (walk+bus)
- Price ≈ 7%
- Last-mile stage in Fehraltorf ≈ 28% of trip
- No mode shift

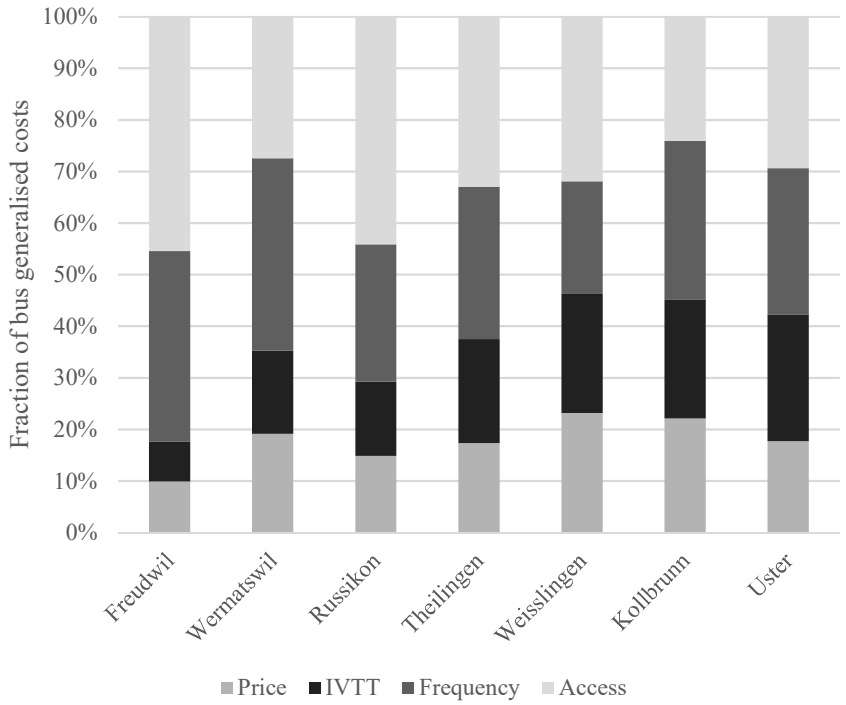


Transport model – Mode shift – Bus market segment

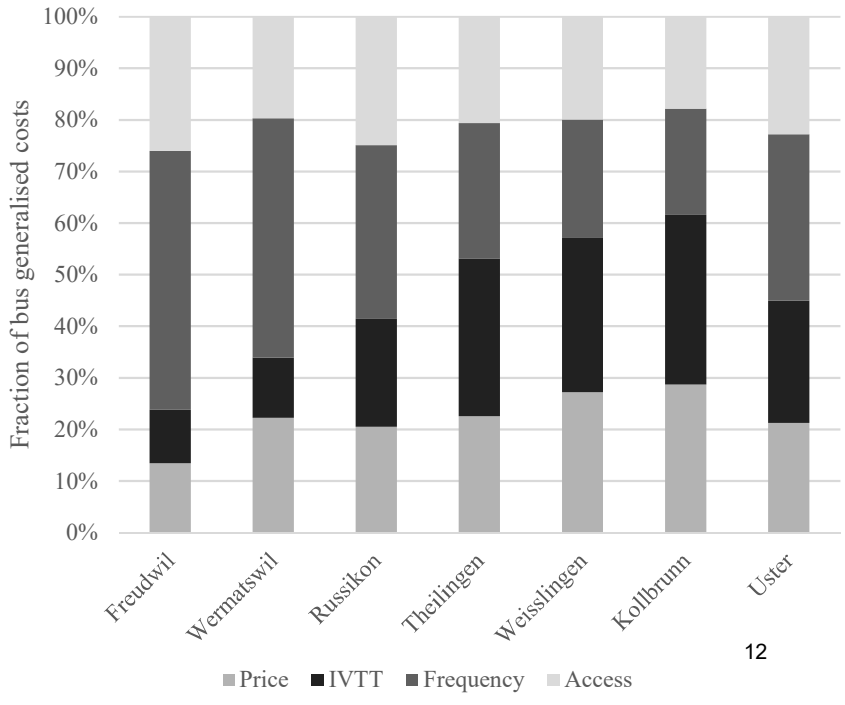
- Constant generalised costs along the day
- Symmetrical OD and generalised costs matrices

- Price ≈ 17%
- Mode shift: from 14% to 31%

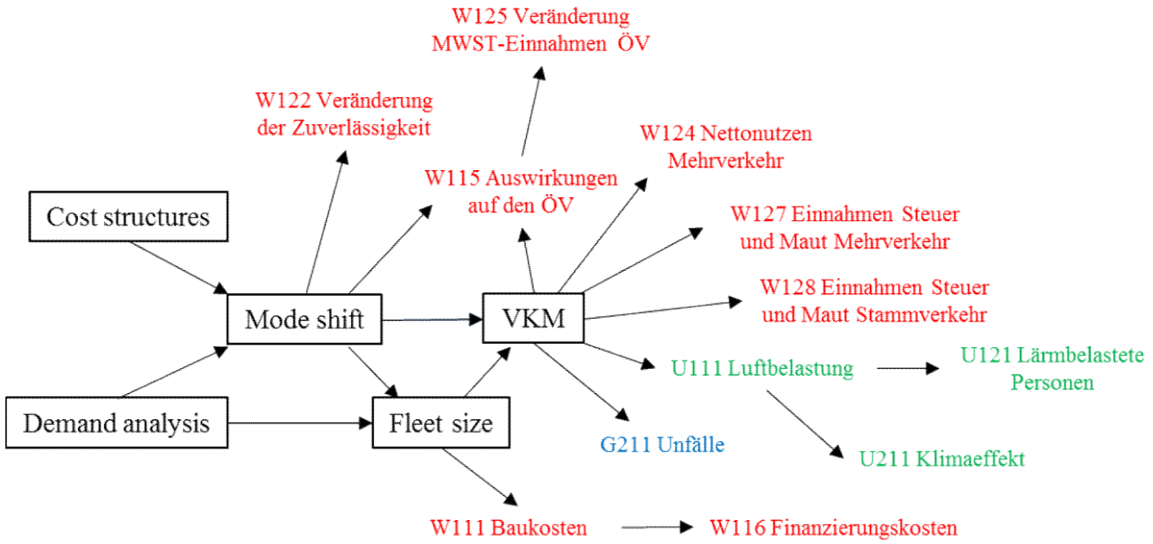
Generalised costs structures from all zones in Fehraltorf

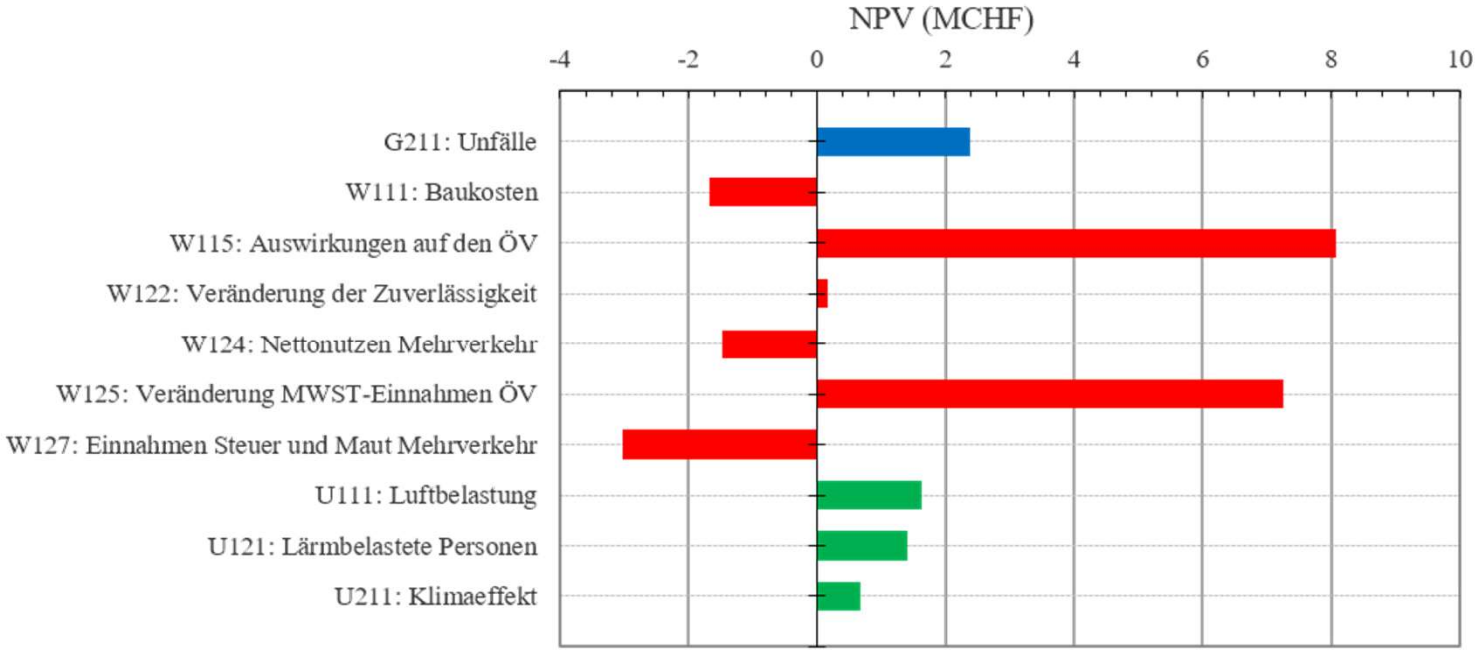


Generalised costs structures from train station zone



CBA – Indicators





CBA – Sub-balances

Sub-balances CBA	Costs	NPV [MCHF] Balance	Benefits
Sub-balance state			
Sub-sub-balance operator			
W111 Investment costs	1.68		
W115 Impacts on PT			8.07
W116 Financial costs			0.03
Accounting balance operator		6.43	
Sub-sub-balance rest state			
W125 Change in PT VAT revenue			7.25
W127 Induced traffic tax and charge revenue	3.02		
Accounting balance rest state		4.22	
Accounting balance state		**10.65**	
Sub-balance users			
W122 Change in reliability			0.16
W124 Induced traffic net benefits	1.47		
G211 Accidents (users share)			1.99
Accounting balance users		**0.69**	
Sub-balance community			
G211 Accidents (community share = external costs)			0.39
U111 Air pollution			1.62
U121 Noise affected people			1.41
U211 Climate effect			0.68
Interim balance traffic external costs		**4.11**	
W116 Financial costs	0.03		
Accounting balance state (carried over)			*10.65*
Accounting balance community		**14.73**	

Dynamic Service

Sub-balance	Autonomous Service	Dynamic Service
Operator 1	1	-1
Operator 2	-	?
State	1	-1
Users	1	2
Community	1	1

Literature

ZVV (2015) S-Bahnen, Busse und Schiffe. Retrieved from https://www.zvv.ch/zvv-assets/fahrplan/pdf/s-bahn_dez_2015.pdf

Bösch, P. M. F. Becker H. Becker and K. W. Axhausen (2017) *Cost-based Analysis of Autonomous Mobility Services*. Zurich.