Success Factors of Tramway Systems

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Background of this presentation

Image: Gil / IFS [1]

Basis of the data: Bachelor's thesis at RWTH Aachen (2019)

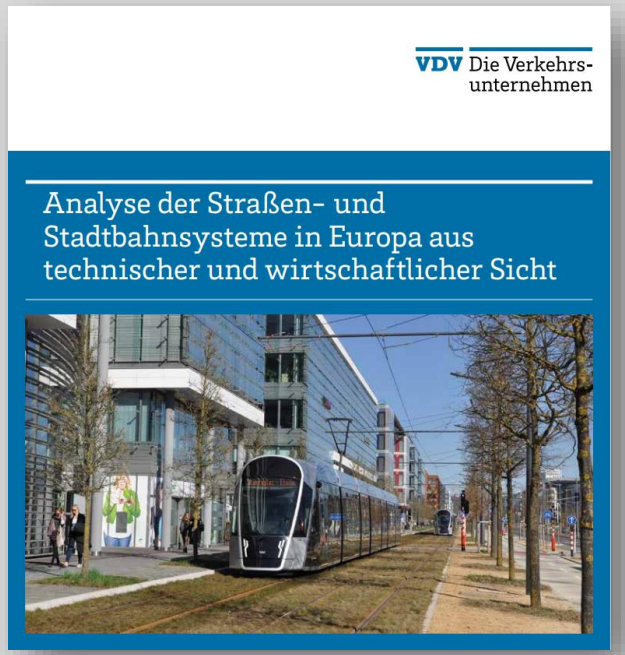
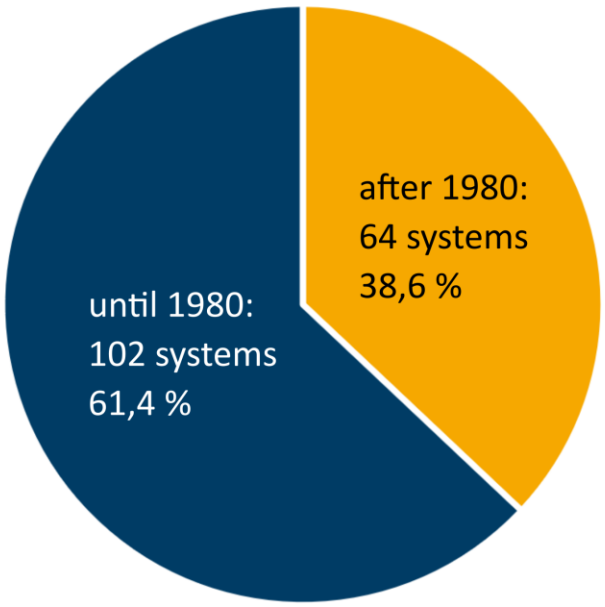
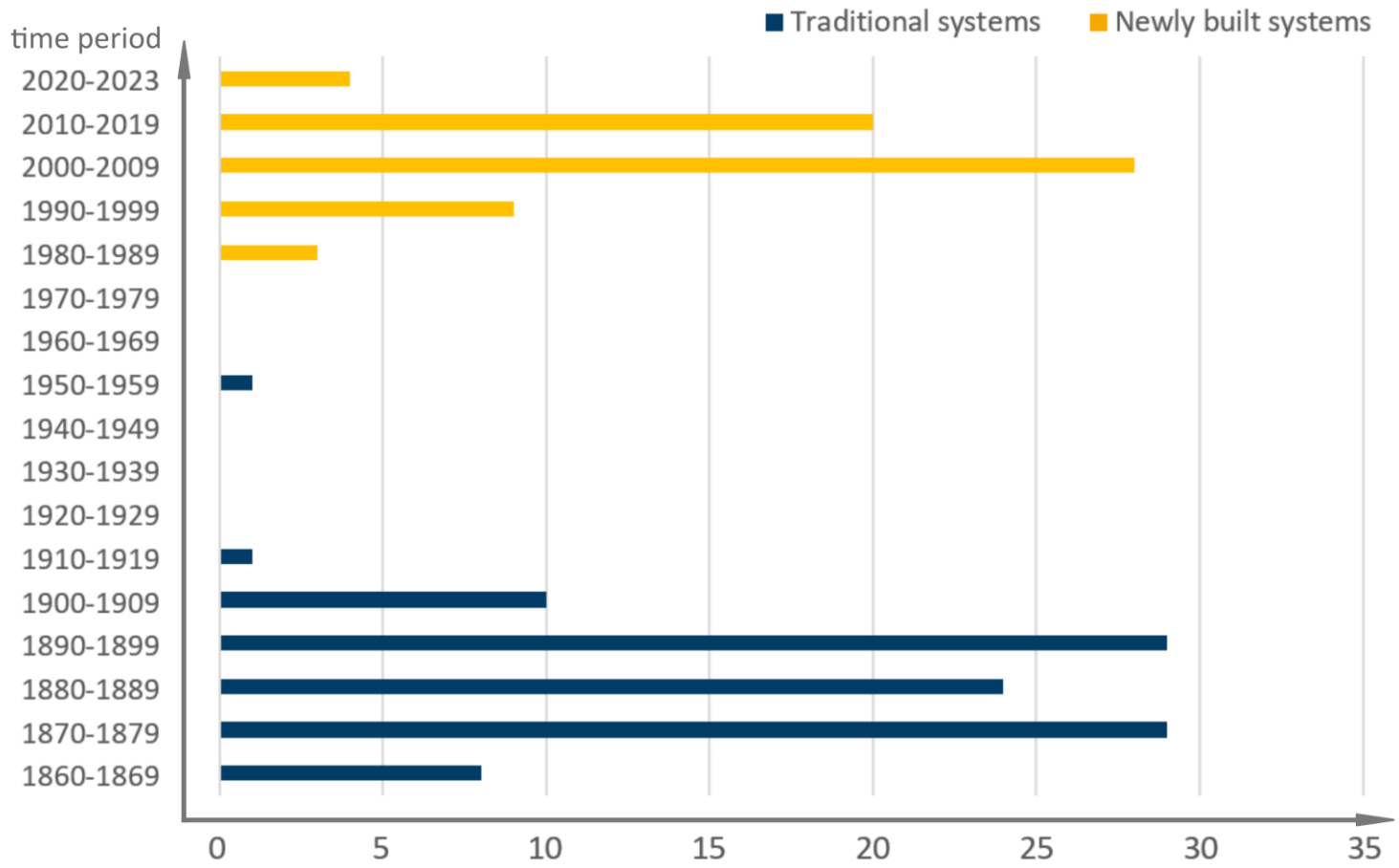


Image: beka Verlag [2]

Results published as VDV "Blue Book" (2020)

Opening dates of tramway systems in Western and Central Europe



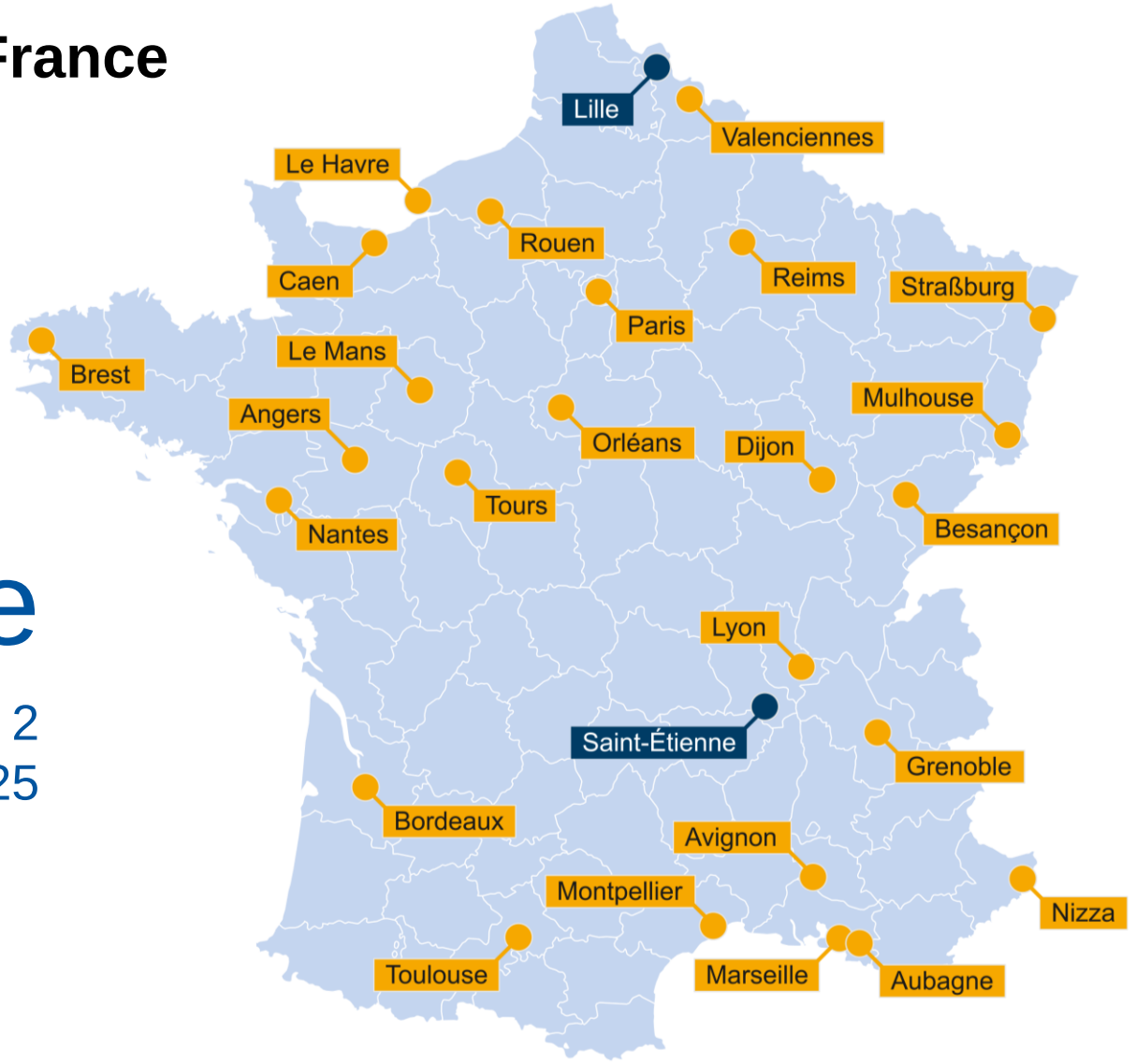


Tramway systems in Germany

Germany

Traditional systems: 50
Newly built systems: 1

Tramway systems in France



France

Traditional systems: 2
Newly built systems: 25

Traditional system

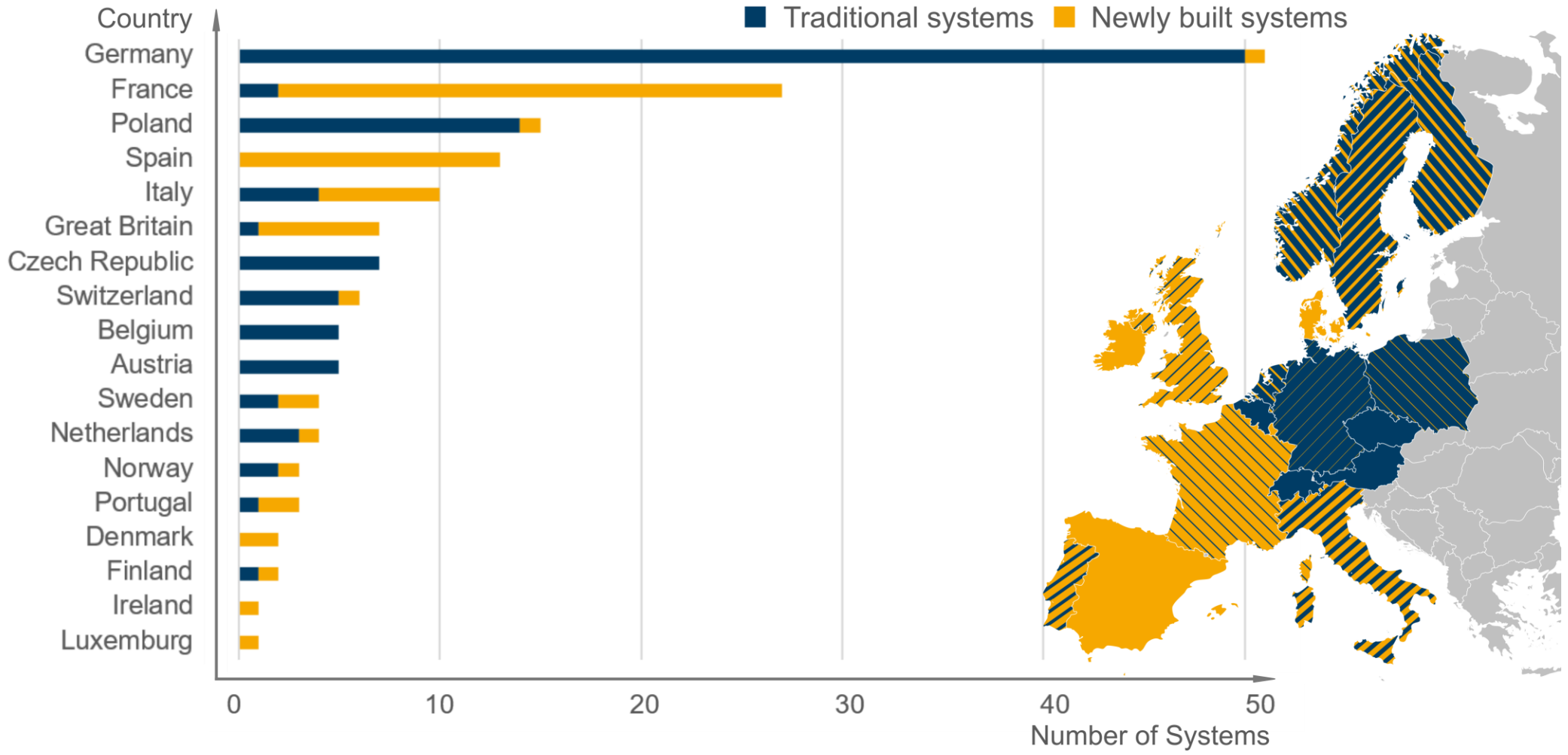
Newly built system

Tramway systems in the Scandinavian countries

Scandinavia

Traditional systems: 5
Newly built systems: 6

Tramway systems in Western and Central Europe



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Transport capacity

- Usually, if a tramway system is being discussed, a bus system is already present

- Comparison of tramway system and bus system:
  - Bus: 1200 – 1680 pphpd*
  - Tram: 2800 – 7200 pphpd*

Transport capacity of tram system exceeds transport capacity of bus system

*pphpd = persons per hour per direction, source: Foljanty et. al 2009

Image: Christo, CC-BY-SA-4.0, Wikimedia Commons [3]

Average speed

- Trams are able to run on tracks separated from individual traffic
- Due to interior layout: Trams have shorter passenger boarding and alighting times
- Average Speed:
  - Bus: 10 – 15 km/h
  - Tram: 15 – 30 km/h

Trams have a higher average speed than buses

Image: Arild Vågen, CC-BY-SA-4.0, Wikimedia Commons [4]

Urban development

- Use of green track has a positive effect on the cityscape
- Catenary-free operation at sensitive places
- Individual design of vehicles and tram stops

Trams can lead to an upgrade of the urban space

Image: Florian Fèvre, CC-BY-SA-4.0, Wikimedia Commons [5]

Customer experience

- Direction of the tramway immediately recognisable due to visible tracks
- Tram stops separated from road traffic
- Rail vehicles are perceived to be safer and more comfortable than buses

Trams offer a better customer experience compared to buses

Image: Neimedia_, CC-BY-SA-4.0, Wikimedia Commons [6]

What about costs?

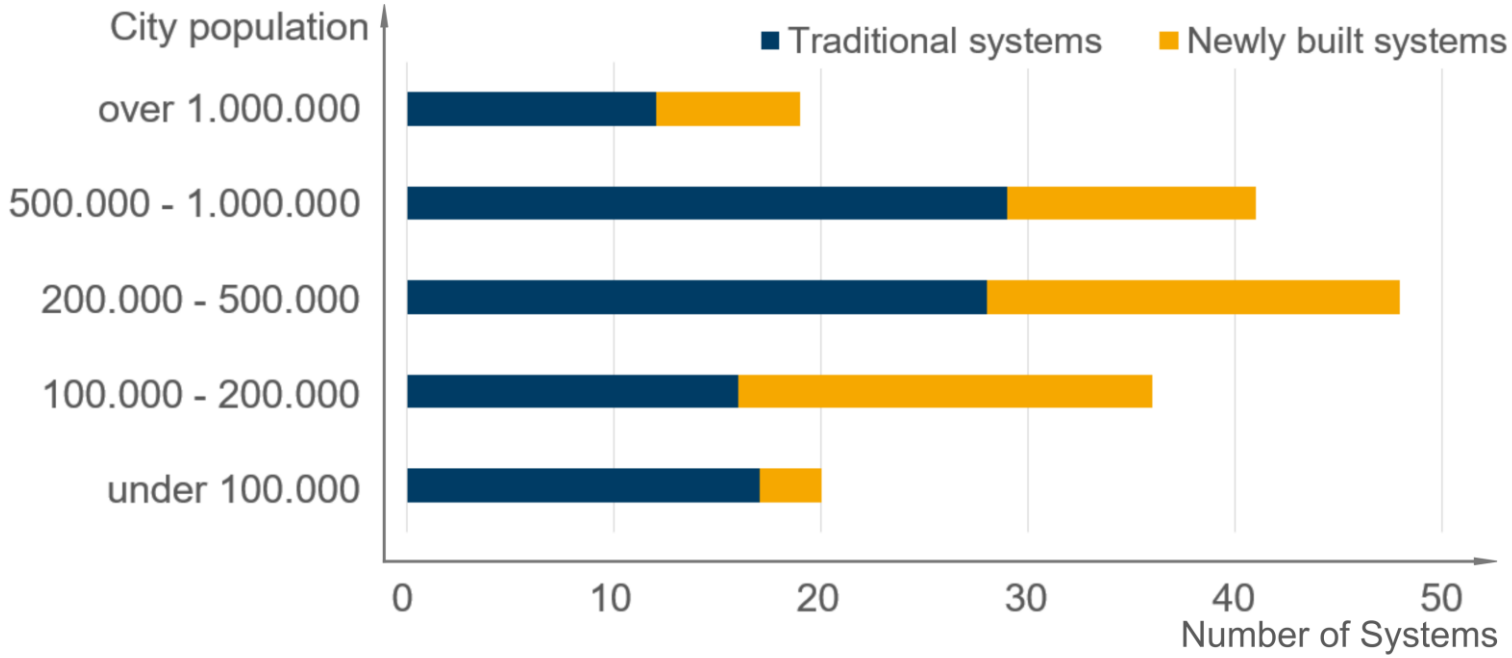
- High cost of tramway infrastructure, while buses can use present road infrastructure
- Vehicle costs for trams higher than for buses, however: Trams have 3-4 times higher lifespan
- Energy costs and personnel costs are similar for both tram and bus systems

→ Overall costs for tram systems exceed the costs for bus systems

Image: Avij, Public Domain, Wikimedia Commons [7]

Affordability

- Opponents of tramway projects often claim that their city is not big enough for a tram
- Overview of the population of cities with tramway systems: Many of these cities are comparatively small



Although costs are higher, affordability can be assumed for many cities with more than 100,000 inhabitants

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What does modal split mean?

- Modal split: Method to describe the behaviour of citizens in terms of mobility

- Percentage of the conducted journeys with the following means of transport:
  - Car
  - Bicycle
  - Public transport
  - Pedestrian traffic

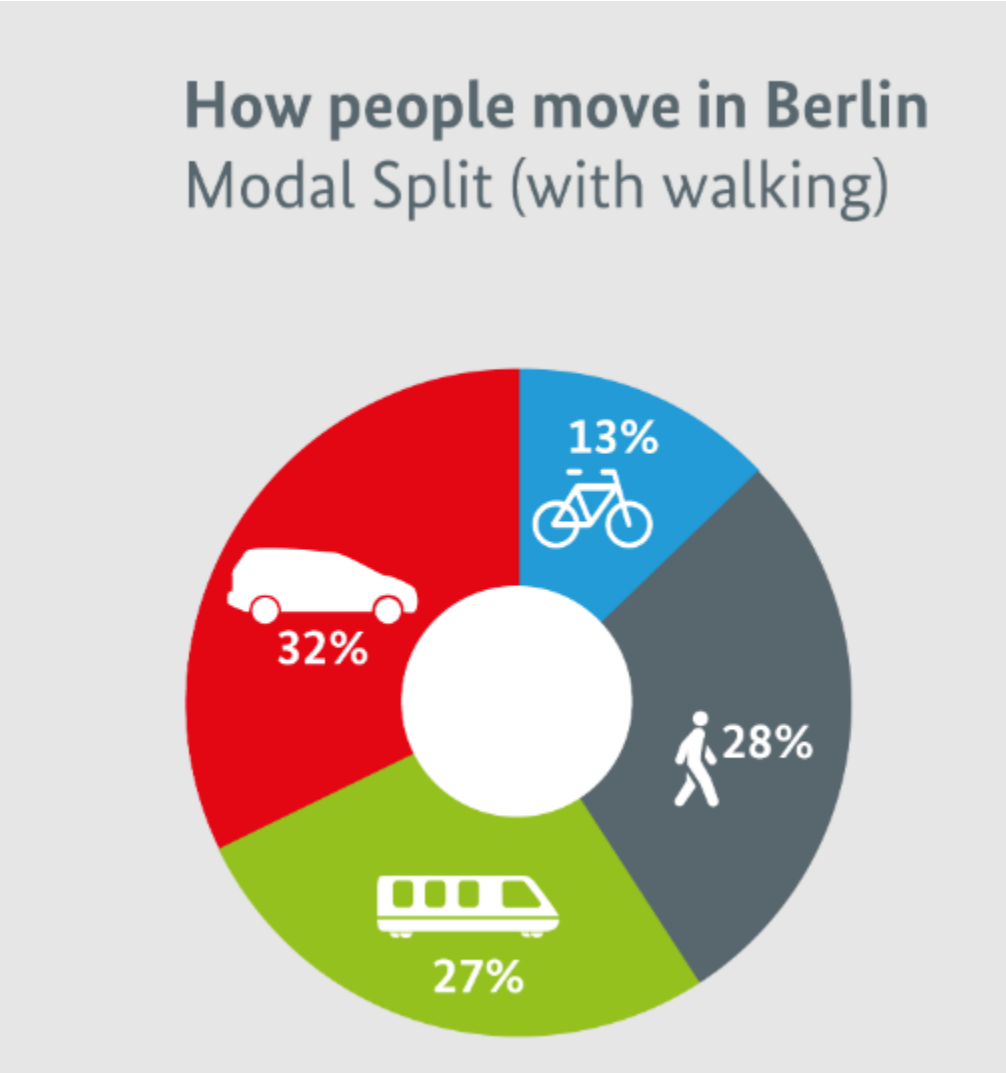


Image: Transformative Urban Mobility Initiative, CC-BY-SA-4.0, Wikimedia Commons [8]

How can the modal split be determined?

Images: [9] Pasquale Paolo Cardo, CC-BY-SA-2.0, Wikimedia Commons
[10] Public Domain, Wikimedia Commons
[11] Pixabay, CC0, Wikimedia Commons

- Traffic Count

[9]

→ Location of the traffic counter has very high influence on the result

- GPS Tracking

[10]

→ Promising method, but data privacy concerns are present

- Survey

[11]

→ Today (still) the most common method to determine the modal split

Data collection approach

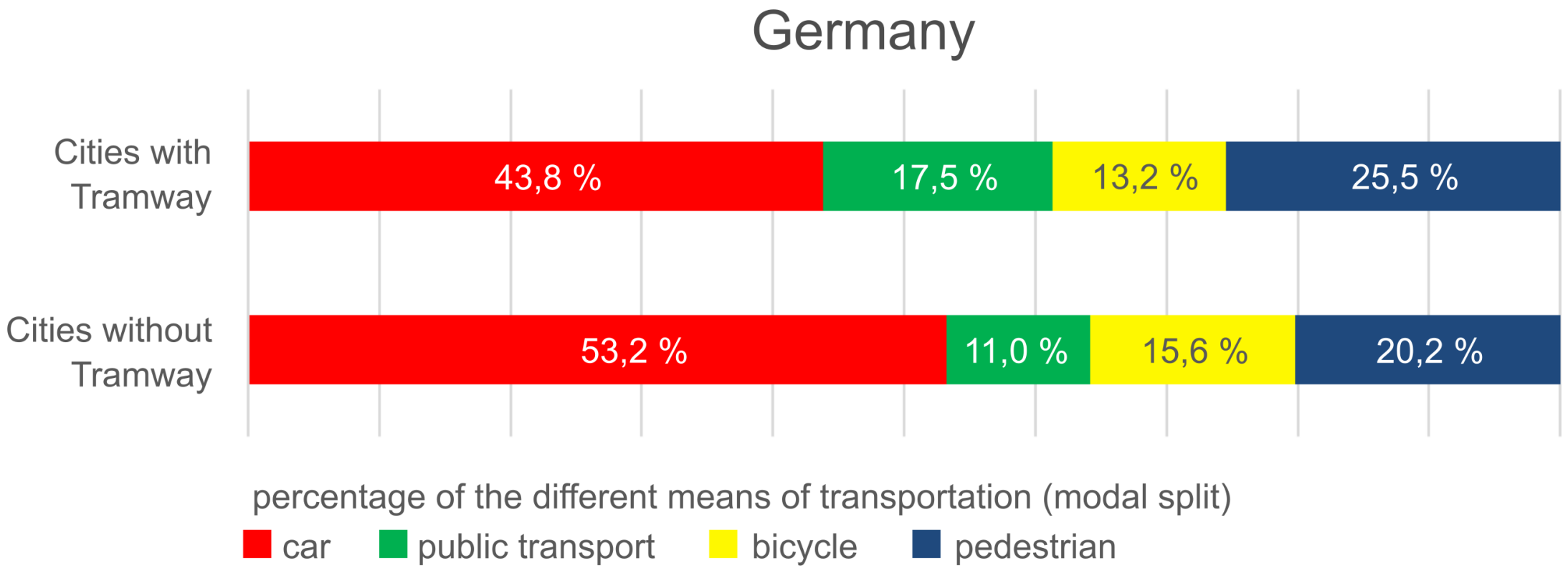
- Germany: „System of representative traffic surveys“ (SrV)
- Conducted each 5 years in multiple cities
- For this study: Usage of data from **71 cities** (40 cities with trams, 31 cities without trams)

Image: Stadt Halle [12]

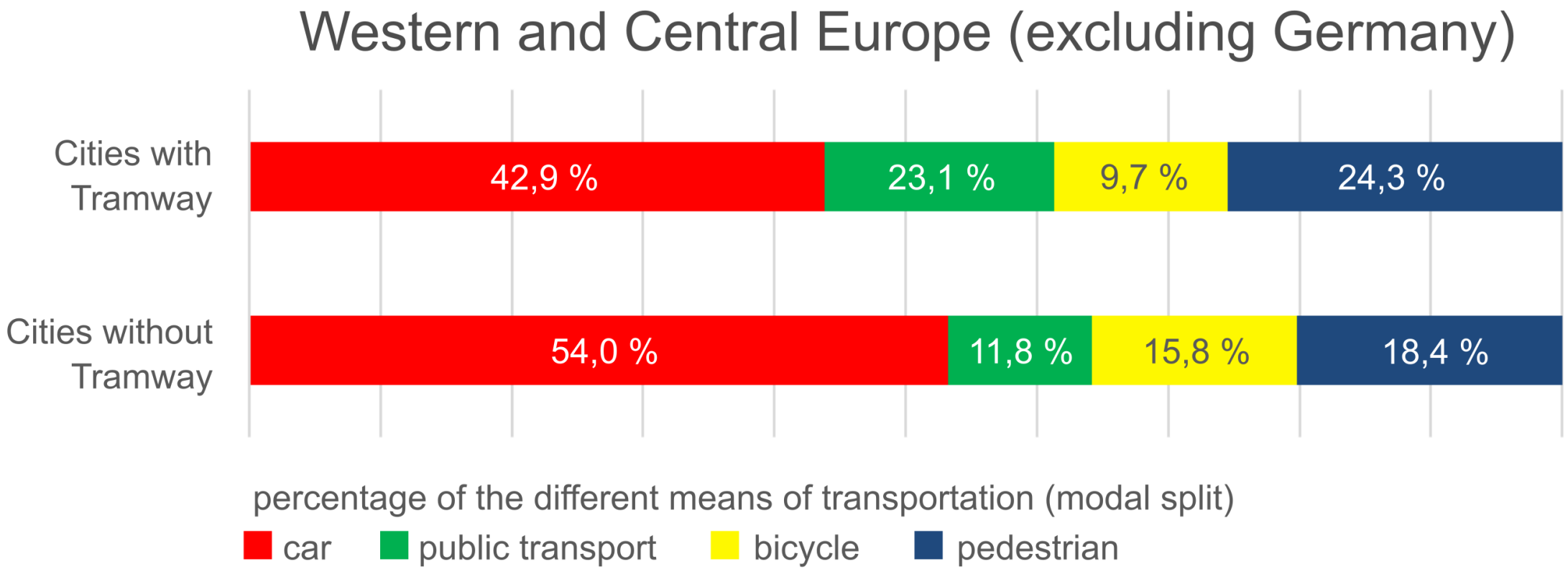
- Europe: „European Platform on Mobility Management“ (EPOMM)
- Large database of modal split values from different European countries
- For this study: Usage of data from **91 cities** (36 cities with trams, 55 cities without trams)

Image: EPOMM [13]

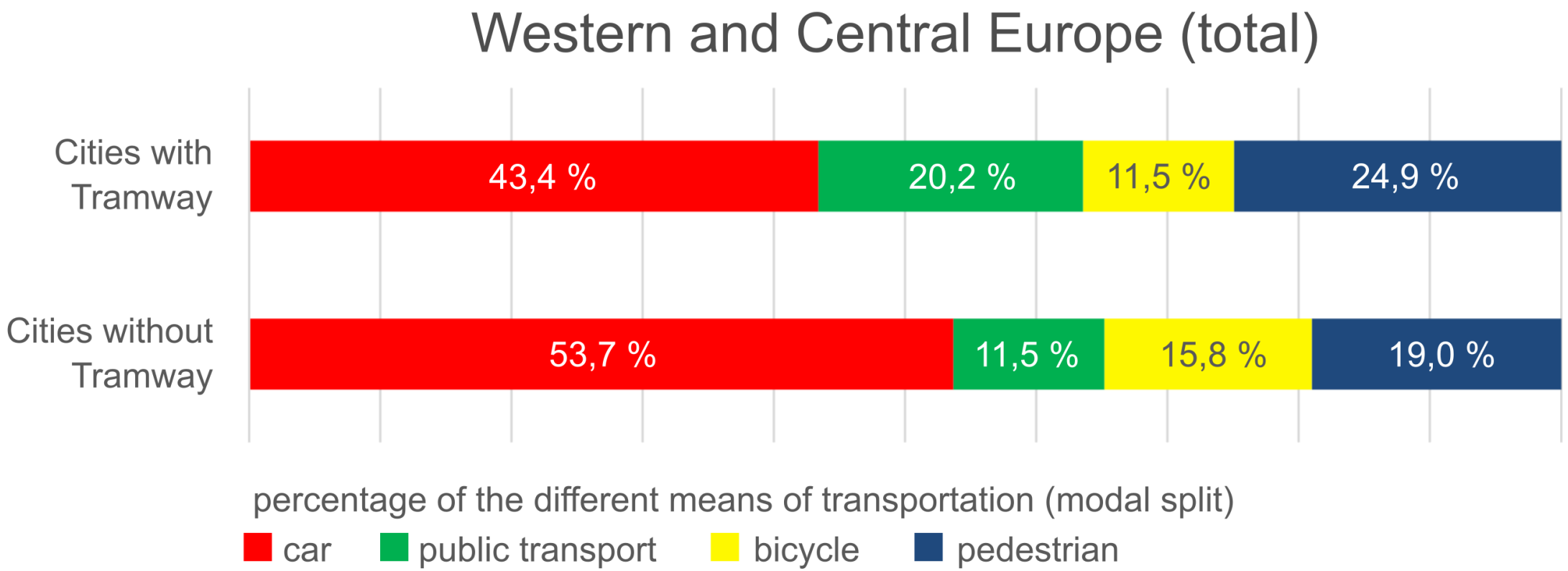
Modal split distribution with German SrV data



Modal split distribution with EPOMM data



Modal Split



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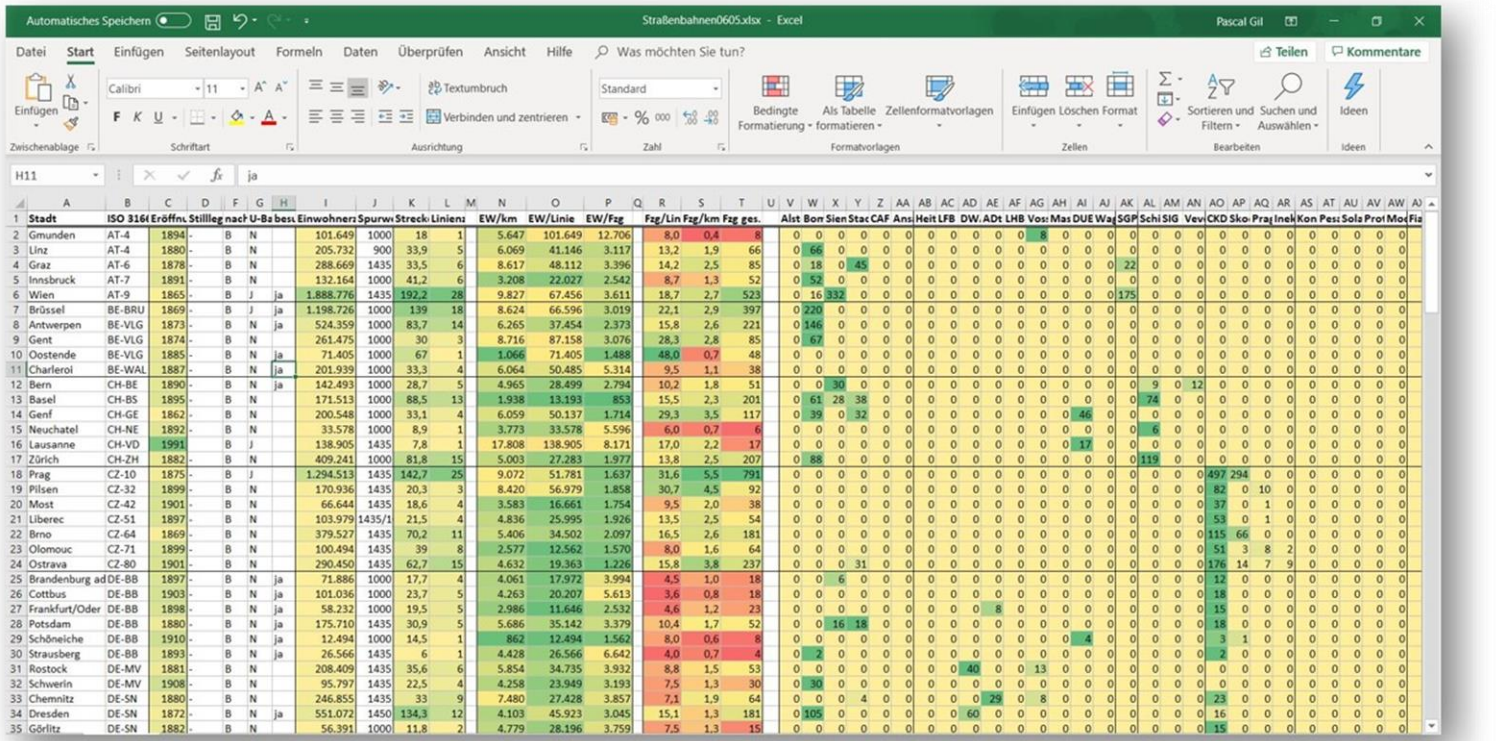
How to find Good Practices?

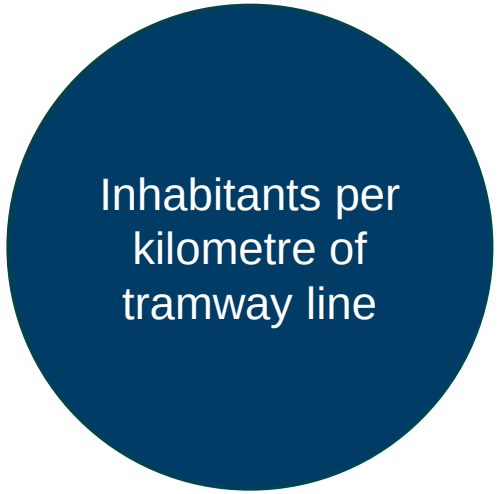
- Collection of data for all tramway systems in Western and Central Europe

- Included data:
  - Opening date
  - Number of inhabitants
  - Overall route length
  - Number of lines
  - Track gauge
  - Number of vehicles

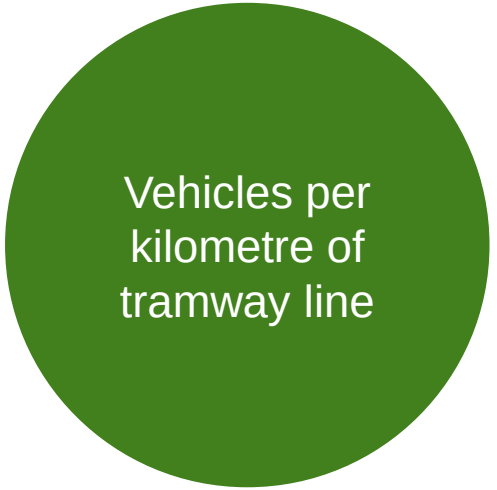


Stadt	ISO 3166	Eröffnu	Stilllegu	nach	U-Ba	best	Einwohner	Spurwe	Streck	Linien	EW/km	EW/Linie	EW/Fzg	Fzg/Lin	Fzg/km	Fzg ges.
Gmunden	AT-4	1894	-	B	N		101.649	1000	18	1	5.647	101.649	12.706	8,0	0,4	8
Linz	AT-4	1880	-	B	N		205.732	900	33,9	5	6.069	41.146	3.117	13,2	1,9	66
Graz	AT-6	1878	-	B	N		288.669	1435	33,5	6	8.617	48.112	3.396	14,2	2,5	85
Innsbruck	AT-7	1891	-	B	N		132.164	1000	41,2	6	3.208	22.027	2.542	8,7	1,3	52
Wien	AT-9	1865	-	B	J	ja	1.888.776	1435	192,2	28	9.827	67.456	3.611	18,7	2,7	523
Brüssel	BE-BRU	1869	-	B	J	ja	1.198.726	1000	139	18	8.624	66.596	3.019	22,1	2,9	397
Antwerpen	BE-VLG	1873	-	B	N	ja	524.359	1000	83,7	14	6.265	37.454	2.373	15,8	2,6	221
Gent	BE-VLG	1874	-	B	N		261.475	1000	30	3	8.716	87.158	3.076	28,3	2,8	85
Oostende	BE-VLG	1885	-	B	N	ja	71.405	1000	67	1	1.066	71.405	1.488	48,0	0,7	48
Charleroi	BE-WAL	1887	-	B	N	ja	201.939	1000	33,3	4	6.064	50.485	5.314	9,5	1,1	38
Bern	CH-BE	1890	-	B	N	ja	142.493	1000	28,7	5	4.965	28.499	2.794	10,2	1,8	51
Basel	CH-BS	1895	-	B	N		171.513	1000	88,5	13	1.938	13.193	853	15,5	2,3	201
Genf	CH-GE	1862	-	B	N		200.548	1000	33,1	4	6.059	50.137	1.714	29,3	3,5	117
Neuchatel	CH-NE	1892	-	B	N		33.578	1000	8,9	1	3.773	33.578	5.596	6,0	0,7	6
Lausanne	CH-VD	1991		B	J		138.905	1435	7,8	1	17.808	138.905	8.171	17,0	2,2	17
Zürich	CH-ZH	1882	-	B	N		409.241	1000	81,8	15	5.003	27.283	1.977	13,8	2,5	207
Prag	CZ-10	1875	-	B	J		1.294.513	1435	142,7	25	9.072	51.781	1.637	31,6	5,5	791
Pilsen	CZ-32	1899	-	B	N		170.936	1435	20,3	3	8.420	56.979	1.858	30,7	4,5	92
Most	CZ-42	1901	-	B	N		66.644	1435	18,6	4	3.583	16.661	1.754	9,5	2,0	38
Liberec	CZ-51	1897	-	B	N		103.979	1435/1	21,5	4	4.836	25.995	1.926	13,5	2,5	54
Brno	CZ-64	1869	-	B	N		379.527	1435	70,2	11	5.406	34.502	2.097	16,5	2,6	181
Olomouc	CZ-71	1899	-	B	N		100.494	1435	39	8	2.577	12.562	1.570	8,0	1,6	64
Ostrava	CZ-80	1901	-	B	N		290.450	1435	62,7	15	4.632	19.363	1.226	15,8	3,8	237
Brandenburg ad	DE-BB	1897	-	B	N	ja	71.886	1000	17,7	4	4.061	17.972	3.994	4,5	1,0	18
Cottbus	DE-BB	1903	-	B	N	ja	101.036	1000	23,7	5	4.263	20.207	5.613	3,6	0,8	18
Frankfurt/Oder	DE-BB	1898	-	B	N	ja	58.232	1000	19,5	5	2.986	11.646	2.532	4,6	1,2	23
Potsdam	DE-BB	1880	-	B	N	ja	175.710	1435	30,9	5	5.686	35.142	3.379	10,4	1,7	52
Schöneiche	DE-BB	1910	-	B	N	ja	12.494	1000	14,5	1	862	12.494	1.562	8,0	0,6	8
Strausberg	DE-BB	1893	-	B	N	ja	26.566	1435	6	1	4.428	26.566	6.642	4,0	0,7	4
Rostock	DE-MV	1881	-	B	N		208.409	1435	35,6	6	5.854	34.735	3.932	8,8	1,5	53
Schwerin	DE-MV	1908	-	B	N		95.797	1435	22,5	4	4.258	23.949	3.193	7,5	1,3	30
Chemnitz	DE-SN	1880	-	B	N		246.855	1435	33	9	7.480	27.428	3.857	7,1	1,9	64
Dresden	DE-SN	1872	-	B	N	ja	551.072	1450	134,3	12	4.103	45.923	3.045	15,1	1,3	181
Görlitz	DE-SN	1882	-	B	N		56.391	1000	11,8	2	4.779	28.196	3.759	7,5	1,3	15

Key Figures for the comparison of tramway systems



Key figure for the density of the tramway network and the coverage of the city area



Key figure for the service frequency and transport capacity

Examples of tramway systems with high key figure values

Innsbruck

- “Good Practice” for small city
- East-West connection served by trolley bus system until 2006
- Inauguration of tram on former trolley bus routes 2019

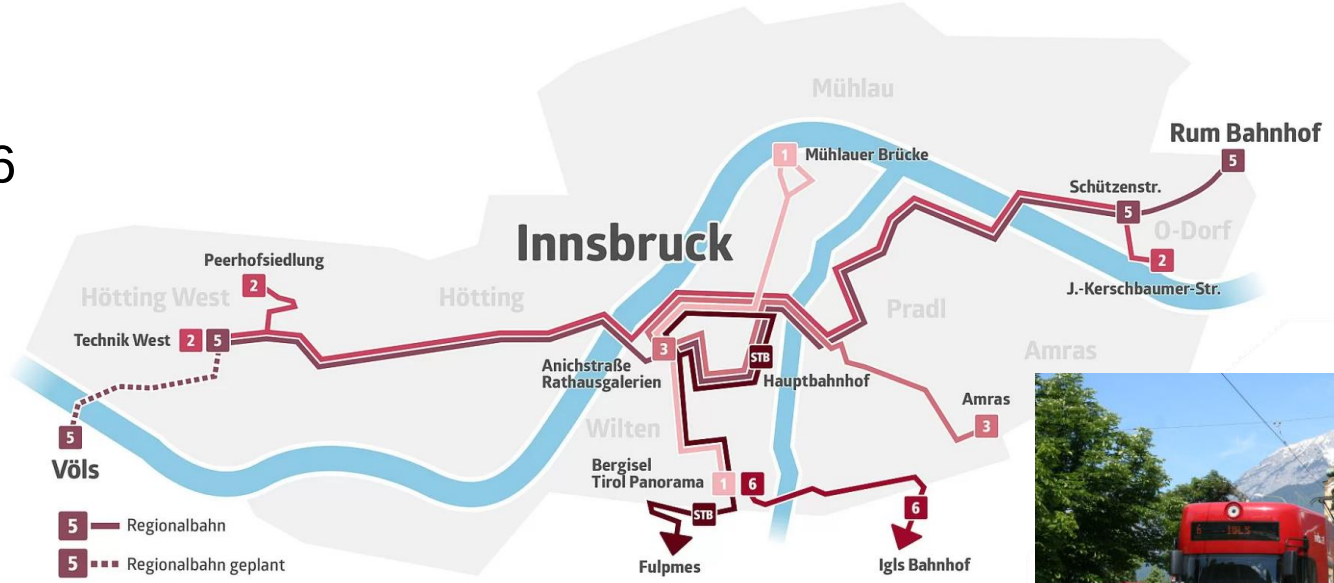


Image: IVB Innsbruck [14]

Image: Gustav Stehno, Public Domain, Wikimedia Commons [15]

- Lines: 6
- Network: 41.3 km
- Vehicles: 52
- Inhabitants: 158,550

Freiburg

- “Good practice” for medium-sized city
- In the 1980s: Restrictions for car traffic, fare reduction of public transportation
- Modal share of cars: ~20 percent

- Lines: 5
- Network: 36.4 km
- Vehicles: 69
- Inhabitants: 229,636

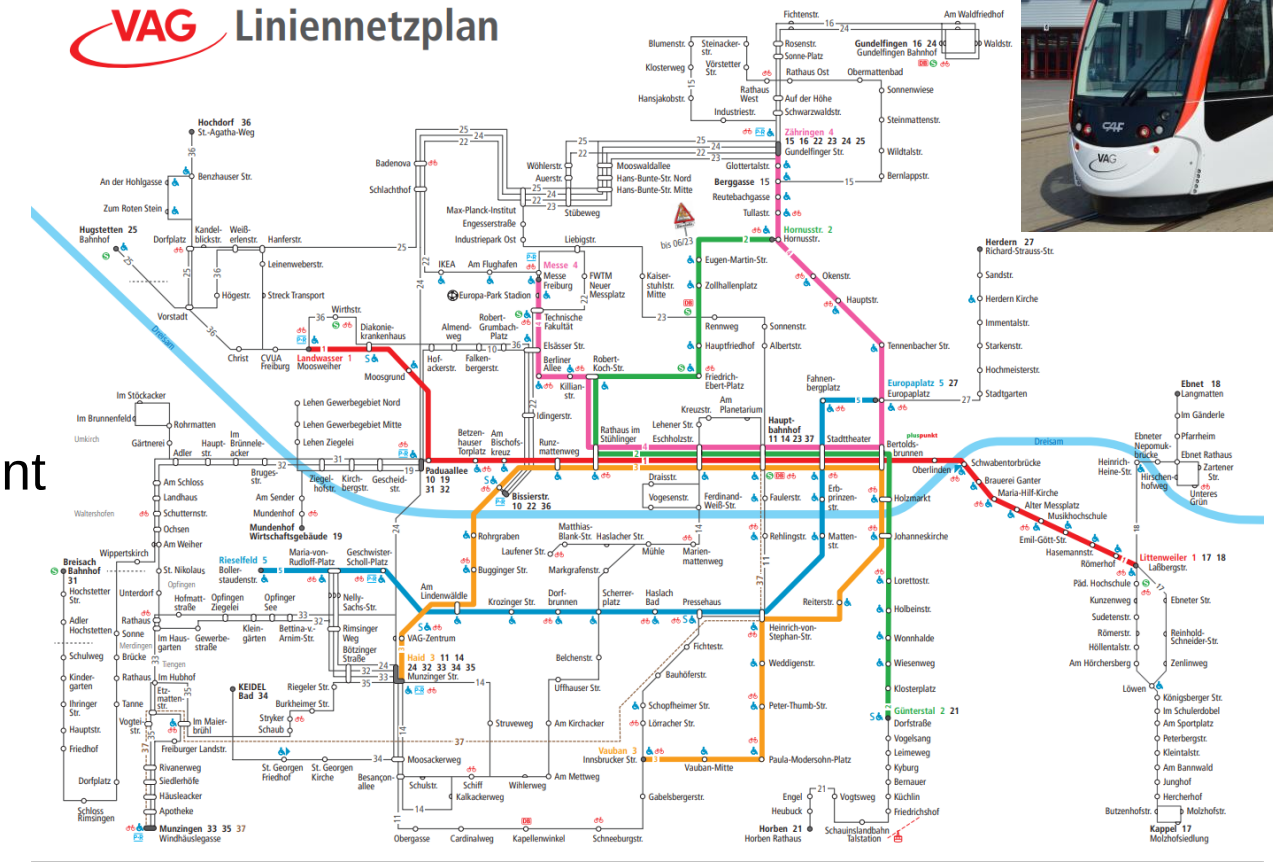


Image: VAG Freiburg [16]

Image: Grauer Elefant, CC-BY-SA-3.0, Wikimedia Commons [17]

Hannover

- “Good practice” for big city
- “Stadtbahn” approach: Underground tracks in city centre, tram tracks in suburban area

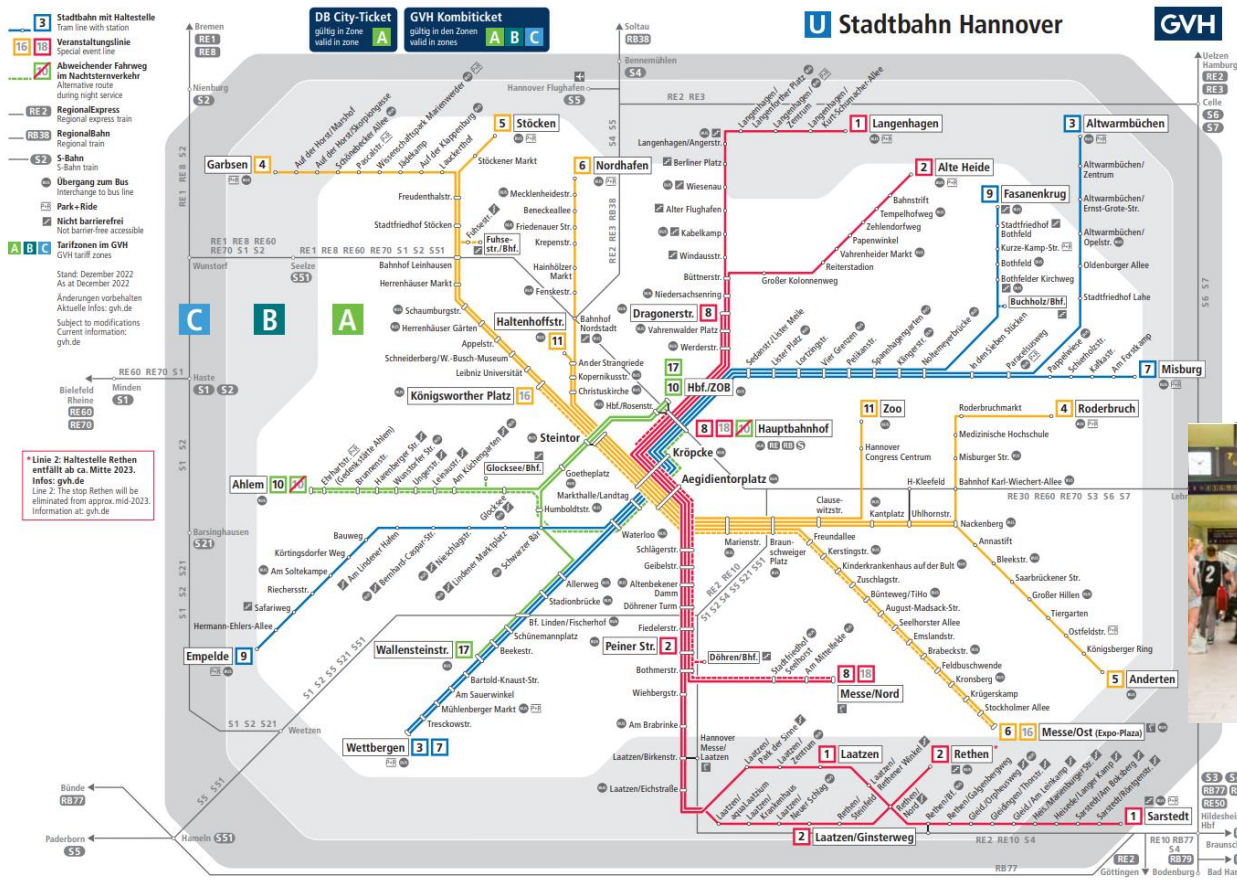


Image: üstra [18]

Image: üstra [19]

- Lines: 12
- Network: 122.7 km
- Vehicles: 341
- Inhabitants: 734,079

Strasbourg

- “Good practice” for city with newly built tram system
- Tram system dismantled in 1960, inauguration of new system in 1994
- Continous development

Lines:	6
Network:	46,5 km
Vehicles:	105
Inhabitants:	412,234

Image: Gil / IFS [21]

Image: Maximilian Dörrbecker, CC-BY-SA-2.5, Wikimedia Commons [20]

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Conclusions

- High number of traditional tramway systems, rising number of newly built systems
- Percentage of newly built systems varies in different counties
- Success factors for the tramway compared with bus systems:
  Transport capacity, average speed, urban development, customer experience
- Higher costs than bus systems, but affordability is usually given for cities > 100,000 inhabitants
- Trams increase modal share of public transport and reduce modal share of cars
- “Good practices”: Dense networks served with high frequency

Thank you for your attention!

[1] https://www.ifs.rwth-aachen.de/startseite/
[2] https://www.beka-verlag.info/
[3] https://upload.wikimedia.org/wikipedia/commons/5/5f/Budapest%2C_V%C3%B6r%C3%B6sv%C3%A1ri_%C3%BAt%2C_2.jpg
[4] https://commons.wikimedia.org/wiki/File:Liding%C3%B6bron_October_2015_03.jpg?fastcci_from=986270&c1=986270&d1=15&s=200&a=fqv
[5] https://commons.wikimedia.org/wiki/File:Alstom_Citadis_302_n%C2%B02012_SOLEA_Coteaux.jpg
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[9] https://upload.wikimedia.org/wikipedia/commons/b/bd/%E4%BA%A4%E9%80%9A%E9%87%8F%E8%AA%BF%E6%9F%BB_%E3%83%91%E3%82%A4%E3%83%97%E6%A4%85%E5%AD%902%E3%81%A4_%2822624395159%29.jpg
[10] https://commons.wikimedia.org/wiki/File:USMC-12263.jpg
[11] https://commons.wikimedia.org/wiki/File:Questionnaire-checklist-completed.png
[12] https://m.halle.de/de/Verwaltung/Stadtentwicklung/Verkehr-allgemein/Planung/SrV/
[13] https://epomm.eu/
[14] https://www.ivb.at/
[15] https://commons.wikimedia.org/wiki/File:6_309_Bergisel_2013-06-13.jpg
[16] https://www.vag-freiburg.de/
[17] https://upload.wikimedia.org/wikipedia/commons/b/b8/Urbos_Freiburg.jpg
[18] https://www.uestra.de/#/
[19] https://www.uestra.de/#/
[20] https://upload.wikimedia.org/wikipedia/commons/b/b4/Strasbourg_-_Stra%C3%9Fenbahn_-_Netzplan.png
[21] https://www.ifs.rwth-aachen.de/startseite/

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