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Sustainable mobility: A public transport perspective

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Sustainable mobility

A public transport perspective

23-9-2020



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Smart Public Transport
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smartPTlab.tudelft.nl

What are sustainable modes?



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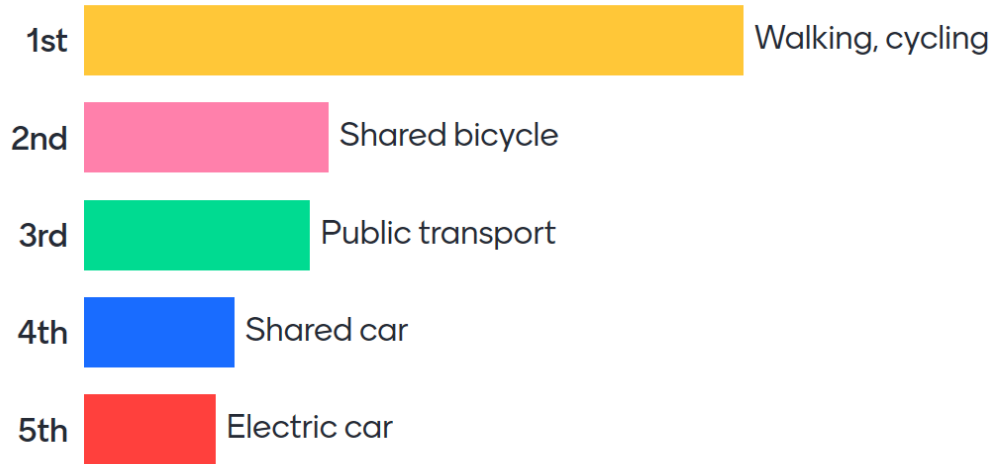
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Mentimeter

What is the most sustainable mode?



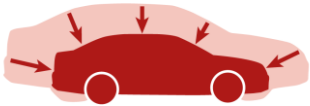
Opportunities and discussions on sustainable mobility



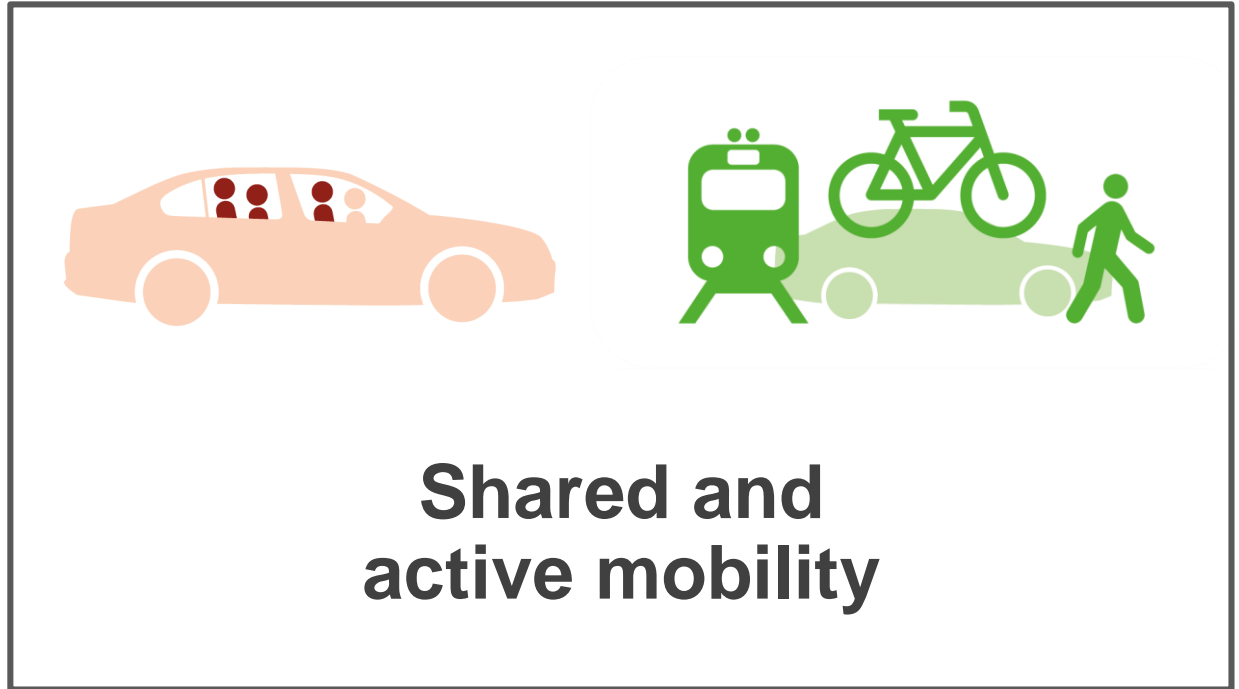
Electric cars



Cleaner PT



Smaller cars



Shared and active mobility

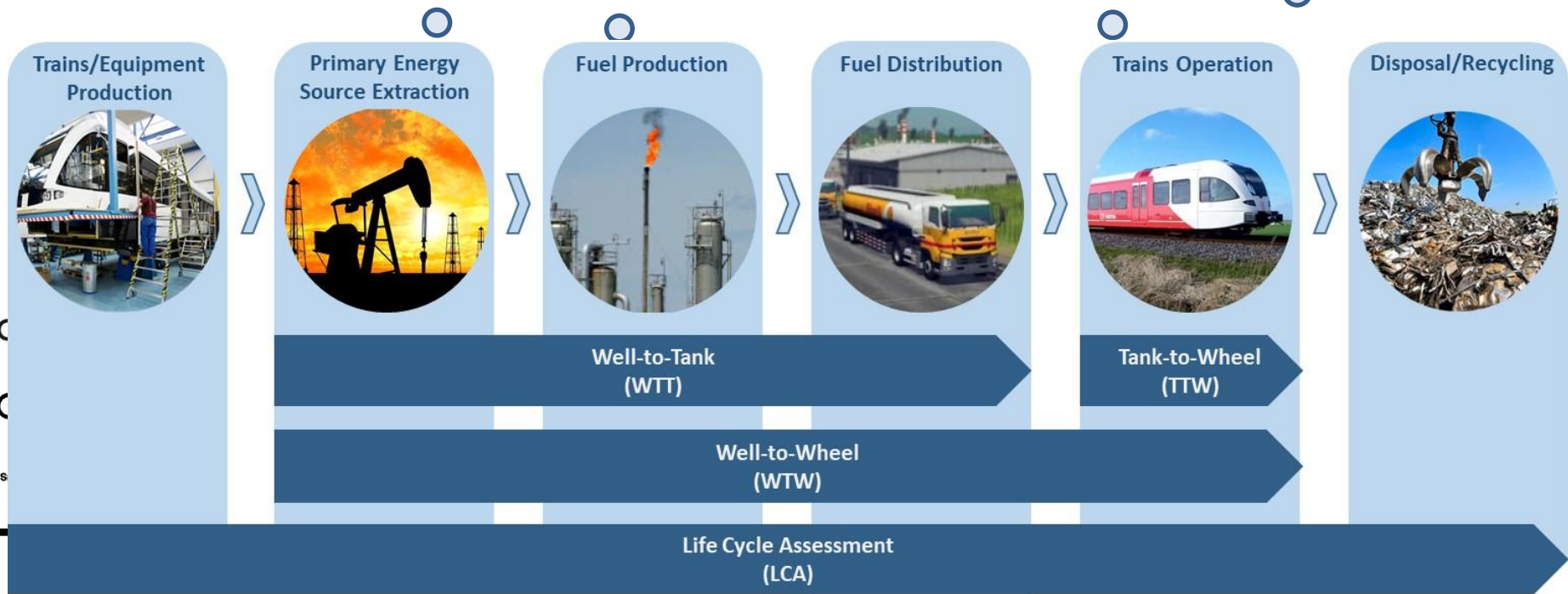
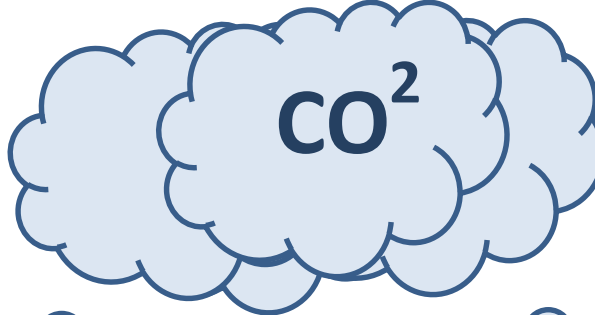
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Cleaner PT

<https://vimeo.com/391940694>



Zero emission buses

'Twéé pauzes! Dat is me in een dieselbus nog nooit overkomen'

Two mealbreaks in one shift! Never happend to me in a diesel bus!



Introductie van grootste elektrische vloot
Met dit nieuwe contract introduceert Keolis Nederland de grootste vloot van elektrische voertuigen in Nederland. In samenwerking met de opdrachtgevers wordt een deel van de laadinfrastructuur gerealiseerd voor deze meer dan 300 elektrische voertuigen. Daarnaast zorgt Keolis voor capaciteit op de eigen stallingslocaties waarmee wordt bijgedragen aan een duurzamere samenleving in de drie provincies. Deze e-vloot is tevens voor Keolis Group de grootste in zijn soort wereldwijd.



Introduction of largest e-fleet: over 300 buses

Wouter Hylkema • Nieuws 29 dec 17
'Elektrische bussen over tien jaar de standaard'

In ten years time, electric buses run by default



De e-bus rijdt schoon. Maar waar laad je op?

E-buses are clean. But where do you charge batteries?



■ Shift to shared and active mobility?



Agenda today

- Example cities (benchmarks and details)
- What are the impacts of emerging modes/technologies?
 - MaaS -> On demand transport
 - (Shared) bicycle+ transport

“

We should not only be good at what we do,
but what we do should be good for something.

- Rector Magnificus **Tim van der Hagen**

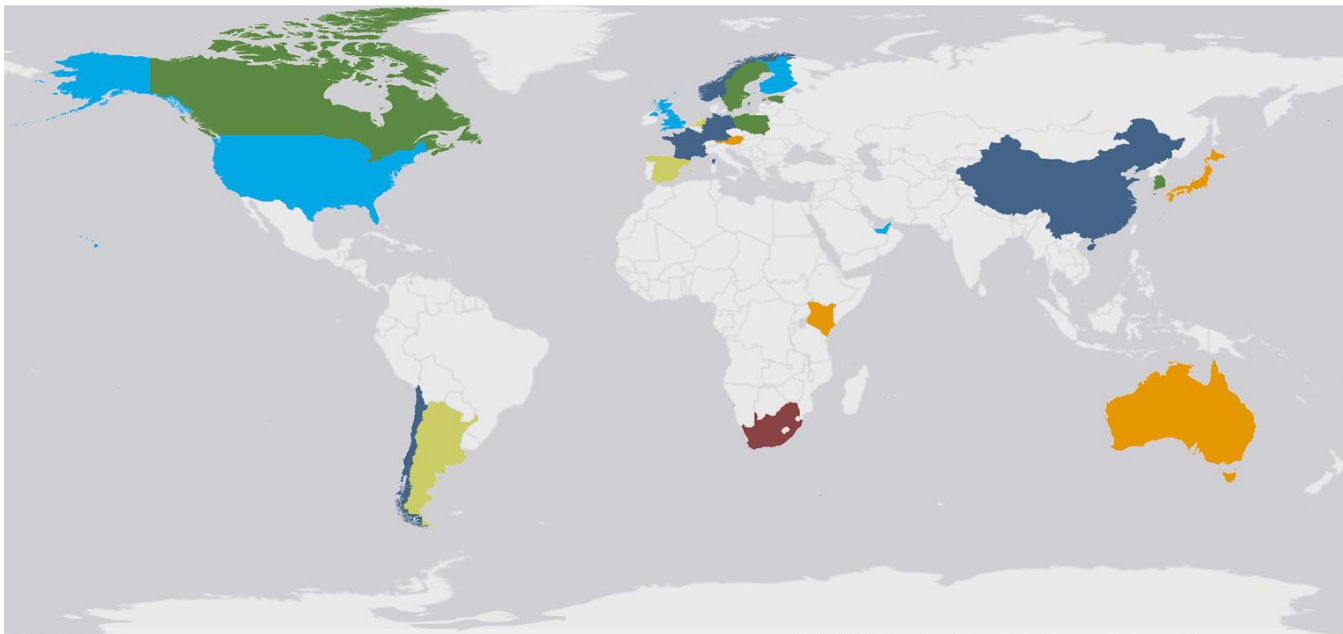


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Research project sustainability worldwide



Esri, HERE, Garmin, (c)

Legend

- | | |
|---|--|
|  Social |  Active Modes |
|  Environmental |  Digitization, Data, & Innovation |
|  Operations & Service |  Finances, Funding, & Governance |

2017 Arcadis Sustainable Mobility Index

- Tracked the performance of 100 cities on three main indices - **People**, **Planet**, and **Profit** - which are composed of 23 total indices.
- Evaluated the effectiveness of a city's mobility system to reach social, financial, and environmental goals.

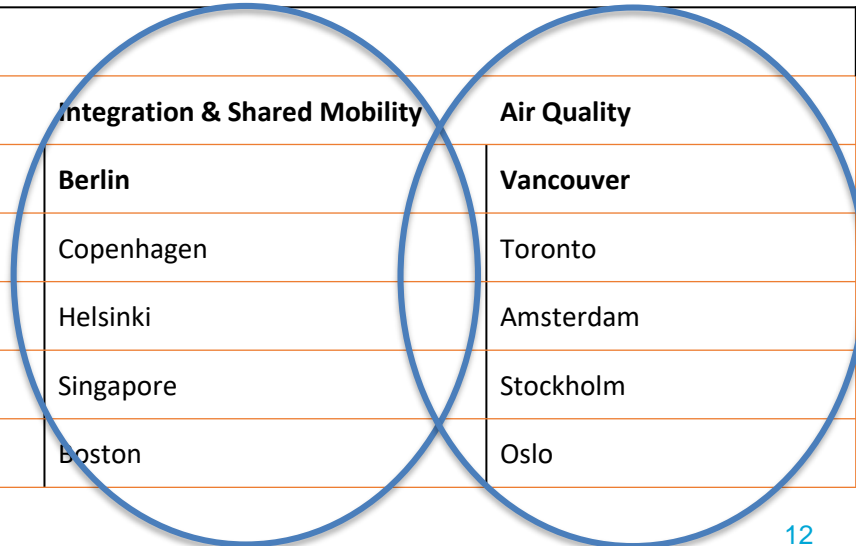
People	Planet	Profit	Overall
Hong Kong	Frankfurt	Zurich	Hong Kong
New York	Munich	Prague	Zurich
Tokyo	Berlin	Warsaw	Paris
Seoul	Stockholm	-	Seoul
Beijing	Amsterdam	Paris	Prague
Barcelona	Vienna	Hong Kong	Vienna
Madrid	Zurich	Athens	London
Paris	London	Vancouver	Singapore
Singapore	Copenhagen	Vienna	Stockholm
London	Antwerp	Lyon	Frankfurt

2019 Deloitte City Mobility Index

- Evaluated the state of urban mobility in 50+ cities based on “integrated and shared mobility, vision and strategy, innovation, regulatory readiness for the future of mobility, and ease of use.”
- The Index is centered around three Themes - **Performance & Resilience, Vision & Leadership, and Service & Inclusion** - each with 5 more specific metrics.

2019 Deloitte City Mobility Index: Performance and Resilience Top Five

Congestion	Public Transport Reliability	Transport Safety	Integration & Shared Mobility	Air Quality
Amsterdam	Shanghai	Hong Kong	Berlin	Vancouver
Helsinki	Tokyo	Tokyo	Copenhagen	Toronto
Columbus	Columbus	Boston	Helsinki	Amsterdam
Copenhagen	Toronto	Toronto	Singapore	Stockholm
Rotterdam-Hague	Vancouver	Amsterdam	Boston	Oslo

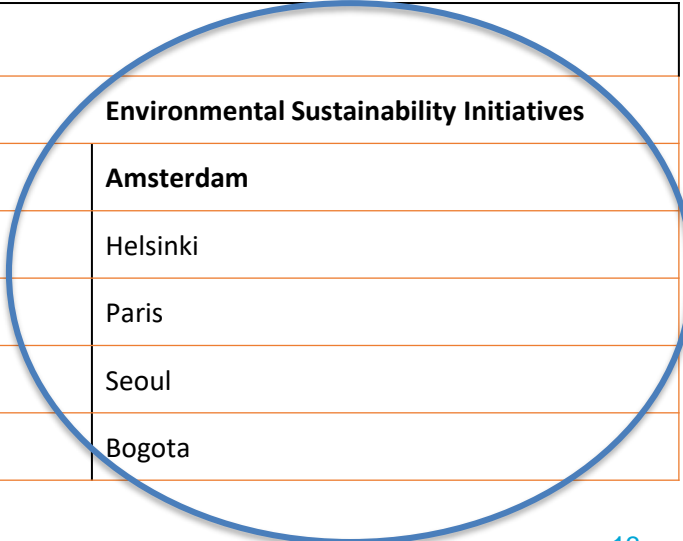


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2019 Deloitte City Mobility Index: Vision and Leadership Top Five

Vision & Strategy	Investment	Innovation	Regulatory Environment	Environmental Sustainability Initiatives
Columbus	Berlin	Berlin	Boston	Amsterdam
Los Angeles	London	Helsinki	Helsinki	Helsinki
Barcelona	Oslo	London	Singapore	Paris
London	Shenzhen	Stockholm	Chicago	Seoul
Oslo	Singapore	Dubai	Columbus	Bogota

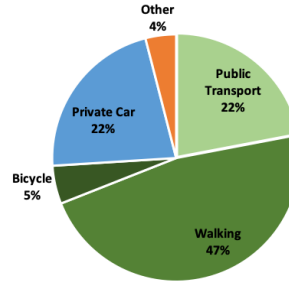


Findings

- Many cities, especially in China, Singapore, and Japan, are leading sustainable mobility efforts due to:
- Modern and efficient transit systems;
- Incentives for using transit;
- Willingness to try new technologies in payment systems, vehicles, and traffic management.
- Extensive PT systems and good walking infrastructure.
- Pollution from private vehicles and industrial sources still pose a problem for active transportation.

Modal Splits

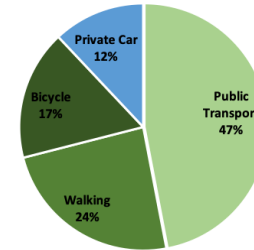
SHENZHEN MODAL SPLIT



Sustainable Mobility: 74%

Source: Deloitte City Mobility Index, data as of 2019

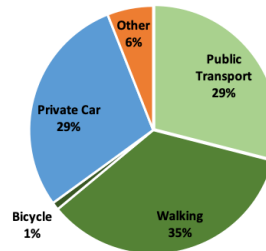
TOKYO MODAL SPLIT



Sustainable Mobility: 88%

Source: Deloitte City Mobility Index, data as of 2020

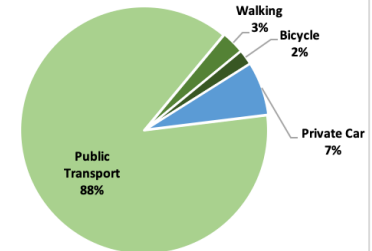
SEOUL MODAL SPLIT



Sustainable Mobility: 65%

Source: Deloitte City Mobility Index, data as of 2019

HONG KONG MODAL SPLIT



Sustainable Mobility: 93%

Source: Deloitte City Mobility Index, data as of 2019

Mass, density and centrality



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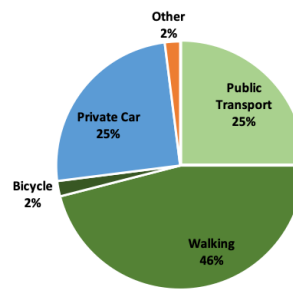
By David290 - Own work, CC BY-SA 4.0,
<https://commons.wikimedia.org/w/index.php?curid=79272711> 15

Findings

- European cities are consistently high ranking due to:
- Established infrastructure,
- Efficient underground systems
- Strides to adopt progressive, **low-carbon technologies**
- Many cities are piloting **innovative mobility technologies**, such as Vienna and Berlin. This includes shared mobility, autonomous technology, and electric vehicles.
- Public transportation is often high-quality and well used. However, many cities still struggle with **congestion** from private vehicles.
- While countries such as the Netherlands, Denmark, and Germany **see increasing cycle use**, there is potential in other regions for more active mode usage.

Modal Splits

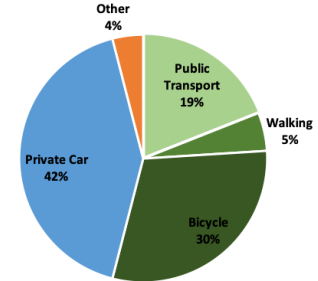
PARIS MODAL SPLIT



Sustainable Mobility: 73%

Source: Deloitte City Mobility Index, data as of 2019

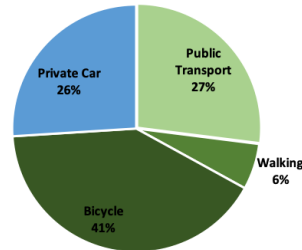
AMSTERDAM MODAL SPLIT



Sustainable Mobility: 54%

Source: Deloitte City Mobility Index, data as of 2019

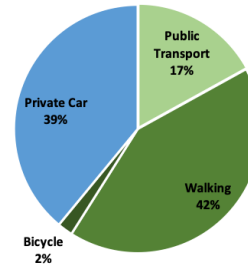
COPENHAGEN MODAL SPLIT



Sustainable Mobility: 74%

Source: Deloitte City Mobility Index, data as of 2019

BARCELONA MODAL SPLIT



Sustainable Mobility: 61%

Source: Deloitte City Mobility Index, data as of 2019



Emissions: Paris, France / Population: 2.1 million



Description

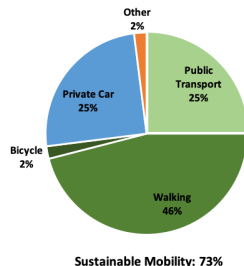
- **Public Rail Network:** Paris has 16 metro lines, 6 RER (suburban rail) lines, 8 tramway lines, and over 400 stations. In addition, high frequencies (as short as 2 min intervals) & long service hours (up to 2:15 AM) provide fast & comprehensive coverage of the city, reducing the need for private vehicles.¹ The city has a goal of low-carbon public transport by 2025, and has rolled out a variety of low-energy solutions, including quiet, ultra-low emission trams; power-recycling train brakes; low-energy stations; and electric shuttles.²
- **Buses:** The city's bus network of 64 lines serves the city & inner suburbs, and has some dedicated bus lanes. A 47-line night service runs from 12:30h to 5:30h. A network of electric minibuses runs on 5 lines. The Bus 2025 project will convert the fleet to 100% clean energy - 80% electrical & 20% biogas.^{1,3}
- **Low Emission Zones:** In January 2017, the city of Paris established the first low-emission zone (LEZ), and in July 2019, the city established the first metropolitan LEZ.

• Vehicle Restrictions

- Car Free Days:
- Seine Car Ban:
- Local Government Fleet

- **Infrastructure Investment:** Along with its already robust PT and pedestrian network, Paris is investing significant dollars to make sustainable modes more attractive. At the same time, it has passed measures that make travelling by private vehicle more difficult. These measures include:⁴
 - The construction of more cycling lanes throughout the city;
 - The transformation of central squares (such as Bastille and Madeleine) to more pedestrian and cyclist friendly spaces;
 - The construction of the Grand Paris Express, a rail connection worth 41.5 billion euros.
- **Logistics:** Paris is also making strides to reduce emissions from commercial travel. Measures include:
 - Urban Logistics System: The city is establishing a coordinated urban logistics system to spur a modal shift from on-road vehicles to low-carbon electric vehicles and delivery tricycles. It aims to optimize transport flows in coordination with the Ile-de-France region and seven other departments.⁶
 - Chapelle International Hub: This logistics hub will accommodate the daily capacity of two trains and help build efficient distribution of goods throughout Paris. The yearly environmental benefits are equivalent to 13,700 fewer lorries entering the city, or 560 tons of CO₂. It will also reduce noise and atmospheric pollution. The city aims to build five other hubs like Chapelle by 2030. These hubs will use the urban logistics system to accommodate mass arrival of goods by train and their subsequent distribution by electric and low-carbon vehicles.⁶
 - Pricing Scheme: Paris and the Ile-de-France region will implement a kilometer-based price scale for heavy goods vehicles travelling in the city.⁴
 - Water Transport: Paris is encouraging inland water freight on the Seine and canals. Inland waterway transport consumes five times less fuel and 2.5 times less CO₂ per ton transported than road transport.⁶ There is capacity in the waterways to remove up to 2 million lorries off the road. The French grocery store Franprix will supply 135 stores using the Seine, removing up to 2,600 lorries off of Paris's roads a year.⁴
 - Bercy Charenton Designated Development Zone: This 7,500 m² site, a former train station, will feature a logistics center to handle goods prior to delivery to other locations in Paris. It has good access to the A4 motorway, ring road, and rail stations. By prioritizing rail transfers and developing a possible tramway connection, the sight aims to accelerate low-carbon freight transport.⁶

PARIS MODAL SPLIT



Source: Deloitte City Mobility Index, data as of 2019

Sources

¹<https://en.parisinfo.com/discovering-paris/sustainable-tourism-in-paris/getting-to-and-around-in-paris-without-polluting-the-environment/public-transport-eco-transport/public-transport-eco-transport>

²<https://www.ratpdev.com/en/commitments/sustainable-mobility>

³<https://en.parisinfo.com/practical-paris/how-to-get-to-and-around-paris/public-transport>

⁴<https://ecomobility.org/paris-leads-the-way-for-sustainable-urban-mobility/>

⁵<https://www.lez-france.fr/en/general-information/future-environmental-zones.html#119277>

⁶<https://www.r.ac.co.uk/drive/news/motoring-news/law-change-for-uk-drivers-in-french-cities/>

⁷<https://cdn.paris.fr/paris/2019/07/24/1a706797eac9982aec6b767c56449240.pdf>

⁸https://www.eltis.org/sites/default/files/sump_conference_2017_op_s2_1_n9dovskl.pdf

⁹<https://www.curbast.com/2016/02/1308078/paris-bans-cars-against-air-pollution-mayor-anne-hidalgo>

¹⁰<https://www.tipsavvy.com/velib-bike-rentals-in-paris-1618445>

¹¹<https://thinksustainableblog.com/2018/02/07/sustainable-cities-france/>

¹²https://www.c40.org/press_releases/city-of-paris-passes-its-new-air-quality-energy-climate-action-plan



Emissions: Paris, France / Population: 2.1 million

Description

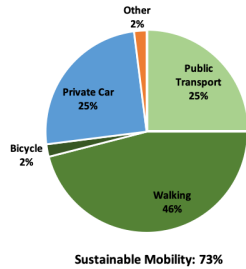
- **Active Transportation:** Paris has an ambitious plan to increase cycling as a transport mode. It aims to have a 15% modal share of cycling. Measures include:⁷
 - Cycle Network: Doubled the length of bicycle lanes from 700 km to 1400 km.
 - Express Bike Network: Created a cycling express network for easy crossing from North to South and East to West.
 - Suburbs: Expanding the cycling continuity between Paris and close suburbs.
 - Cycle Parking: Paris will add 10,000 parking spaces in the city, improve parking security with secured boxes (Velobox), & is expanding parking in railway stations (Véloje).

• Active Transportation:

Paris has an ambitious plan to increase cycling as a transport mode. It aims to have a 15% modal share of cycling. Measures include:⁷

- Cycle Network:
- Express Bike Network:
- Cycle Parking:
- Slow Zones:
- Cycle Culture:

PARIS MODAL SPLIT



Source: Deloitte City Mobility Index, data as of 2019

Sources

- ¹<https://en.parisinfo.com/discovering-paris/sustainable-tourism-in-paris/getting-to-and-around-in-paris-without-polluting-the-environment/public-transport-eco-transport/public-transport-eco-transport>
 - ²<https://www.ratpdev.com/en/commitments/sustainable-mobility>
 - ³<https://en.parisinfo.com/practical-paris/how-to-get-to-and-around-paris/public-transport>
 - ⁴<https://ecomobility.org/paris-leads-the-way-for-sustainable-urban-mobility/>
 - ⁵<https://www.lez-france.fr/nc/en/general-information/future-environmental-zones.html#119277>
 - ⁶<https://www.rac.co.uk/drive/news/motoring-news/law-change-for-uk-drivers-in-french-cities/>
 - ⁷<https://cdn.paris.fr/paris/2019/07/24/1a706797eac9982aec6b767c56449240.pdf>
 - ⁸https://www.eltis.org/sites/default/files/sump_conference_2017_op_s2_1_n9dovskI.pdf
 - ⁹<https://www.curbcast.com/2016/9/27/13080078/paris-bans-cars-seine-right-bank-air-pollution-mayor-anne-hidalgo>
 - ¹⁰<https://www.tripsavvy.com/velib-bike-rentals-in-paris-1618445>
 - ¹¹<https://thinksustainabilityblog.com/2018/02/07/sustainable-cities-paris-france/>
- ¹https://www.c40.org/press_releases/city-of-paris-passes-its-new-air-quality-energy-climate-action-plan

temporary program, which aims to increase safety of cyclists and pedestrians as well as encourage local placemaking, green streets and quiet streets are being introduced in all districts.⁶

- **Other City Actions:** Along with strides in sustainable mobility, Paris and France have endeavored to reduce emissions throughout the whole economy by:¹⁰
 - Shutting down all coal power stations in France by 2021;
 - Limiting the energy consumption of new buildings to 50 kWh/m²/year and existing buildings to 80 kWh/m²/year;
 - Promoting renewable energy sources on building rooftops and adding green spaces around buildings.

Impact

- **Car Ownership:** Car ownership has dropped from 60% of households in 2001 to 35% of households in 2019.⁴ In addition, car traffic has been reduced by 30% since 2004.⁶
- **Emissions:** Paris has reduced its atmospheric pollution by over 50% since 2001, including fine particulate matter.⁶
- **Carbon:** Paris has been reducing its carbon emissions since 2004, with a 39% reduction between 2004 and 2014 in the transport sector. The reduction has been 10% for transit in France.⁶ Paris aims to reduce GHG emissions by 25% in 2020 and 50% in 2030, with plans to become a carbon neutral city by 2050, powered by 100% renewable energy.¹¹
- **Car-Free Days:** During the 2017 car-free day, there was a 25% reduction of nitrogen dioxide and a noise reduction of 2.7 decibels.⁶

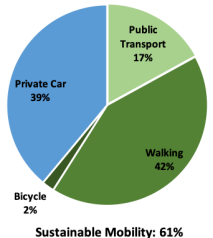


Bike Share: Barcelona, Spain / Population: 5.6 million

Description

- **Bicing:** Bicing is the bicycle sharing system in Barcelona introduced in 2007, with electric bikes added in 2016. It is available only to city residents, and is intended for short journeys around the city. It is one of Europe's first and most successful large-scale bike sharing systems. After launch, it was an immediate success; Bicing had over 100,000 subscribers at the end of its first year, six times more than expected.¹
- **Bicing Updates:** In 2019, Bicing unveiled a new and improved service. The update included:²
 - Operation of 24 hours a day, 365 days a year. A help line is also available at all hours;
 - Expansion of the fleet to 6000 mechanical bikes and 1000 electric bikes, as well as an increase to 425 stations;
 - A new service access system with three options: contactless smart card, mobile app, and smartphone with NRF technology;
 - Conversion to an all-electric bicycle regulation and distribution fleet;
 - New mechanical bicycles with improved frames & brakes, protected cables, LED lighting, RFID locking devices, durable wheels, reflectors, and 3-speed gears;
 - New electric bicycles with high-capacity batteries (up to 60 km), 4-hour full recharge rate, pedalling assistance, 250W motor, and sound-free propulsion.
- **Smou app:** The Smou app, used for Bicing, has a variety of capabilities including route planning, checking for bike availability, remote booking, QR code booking, request...

BARCELONA MODAL SPLIT



Source: Deloitte City Mobility Index, data as of 2019

Sources

- ¹<https://www.mdpi.com/2071-1050/11/3/728>
- ²<https://www.bicing.barcelona>
- ³https://www.barcelona.cat/en/tema/mobility-and-transport/the-new-bicing-is-here_756941.html
- ⁴<https://www.barcelonayellow.com/bcn-transport/79-bicing-city-bikes>
- ⁵<https://www.catalannews.com/society-science/item/barcelona-public-cycling-scheme-bicing-to-expand-to-11-neighborhoods>
- ⁶<https://copenhagenizeindex.eu/cities/barcelona>

Impact

- **Ridership**
- **Health**
- **Environmental: reduction in CO2 emissions from increased bicycle usage**

Impact

- **Bike Availability:** When launched, the service had 750 bikes available at 50 points.⁴ In 2019, this was extended to 7,000 bikes at 483 stations.² In early 2020, the city announced an increase to 519 stations, with some stations placed in new neighborhoods and some placed in highly used areas to manage demand.⁵
- **Ridership:** Today, there are over 123,000 subscribers and almost 2 million monthly users. In 2019, there were over 12.5 million rides, with an average travel time of 13 minutes. The top station sees 814 uses per day.²
- **Biking in the City:** After the first year of launch, cycling trips increased by 82%, largely attributed to Bicing and its role in normalizing cycling. In 2016, Bicing made up 16% of cycle trips. In addition, overall biking trips have grown in Barcelona - indicating that the acceptance of cycling as a transportation mode is increasing.¹
- **Health:** A study found that cyclists in Barcelona participate in up to two more hours of physical activity than other commuters. In addition, one study showed that Bicing and other bicycle users had less perceived stress than other commuters. In total, it is estimated that Bicing saves 12.3 lives per year due to health benefits.¹

- **Environmental:** One study estimated that the reduction in CO2 emissions from increased bicycle use represents 1% of transportation emissions in Barcelona.¹
- **Goals:** The introduction of the new service is expected to increase the use of Bicing by 10% in a decade, reaching 16 million rides per year.³ In addition, the

How to get there?

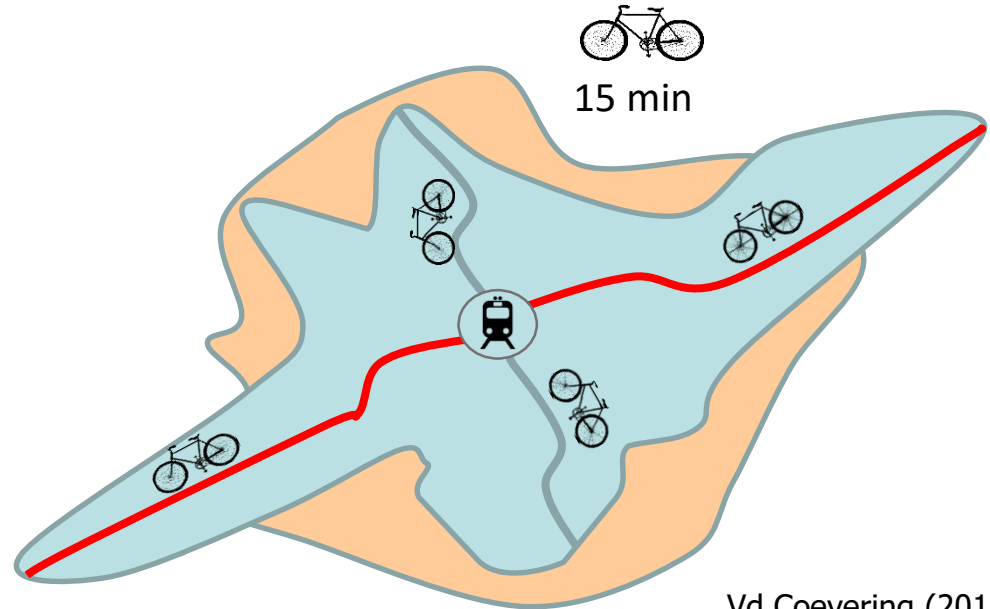
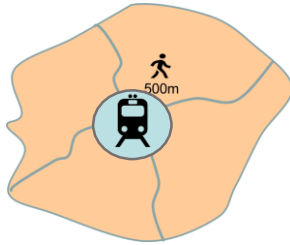


Multiple buttons; multiple scales



Transit oriented development

Bicycle oriented development



Vd Coevering (2019)

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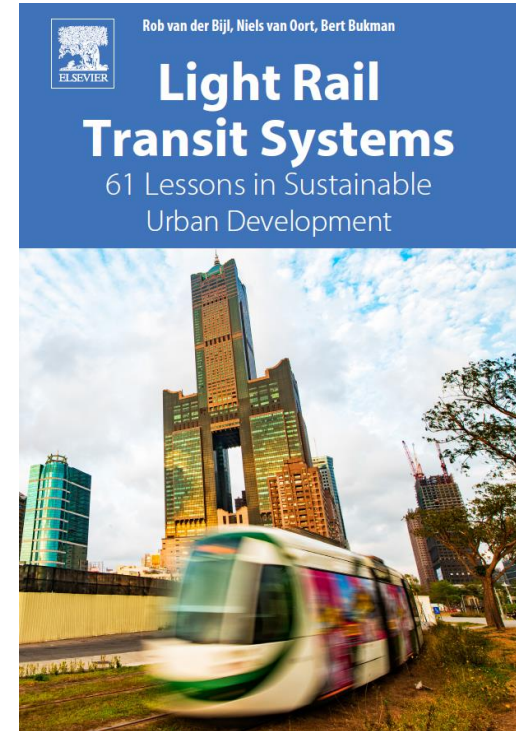
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Lessons learned: 61 cases of light rail projects

Project conception

- Focus on 'why' the project (short term and long term);
- ...
- Lessons applied to other modes as well



Van der Bijl et al. (2018)

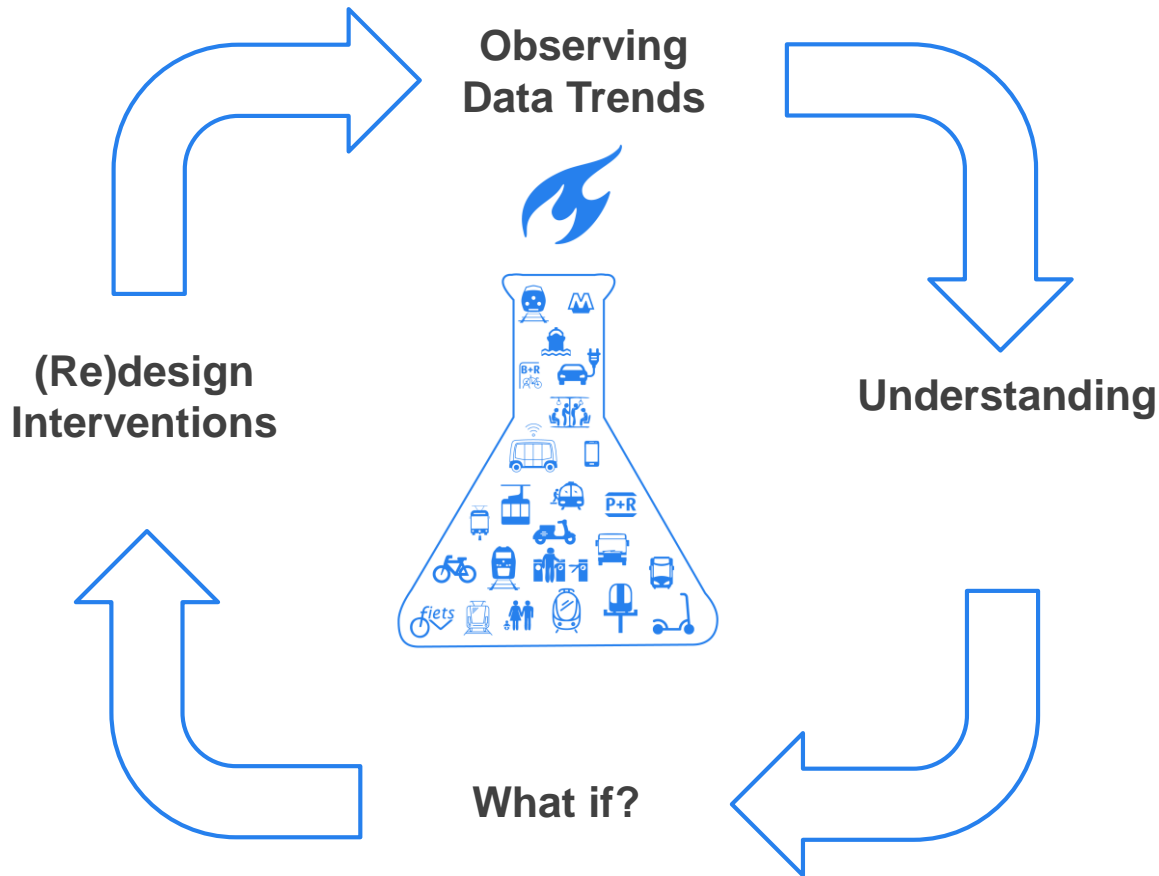
Elsevier

Objectives and impacts?



- Fast, reliable, comfortable door-door
- Efficient land use
- Wealth and Wellbeing
- Sustainability and Health
- Social inclusion

How to get to the optimal mix?





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Technology trends

Automation



Elektrifikation



Information



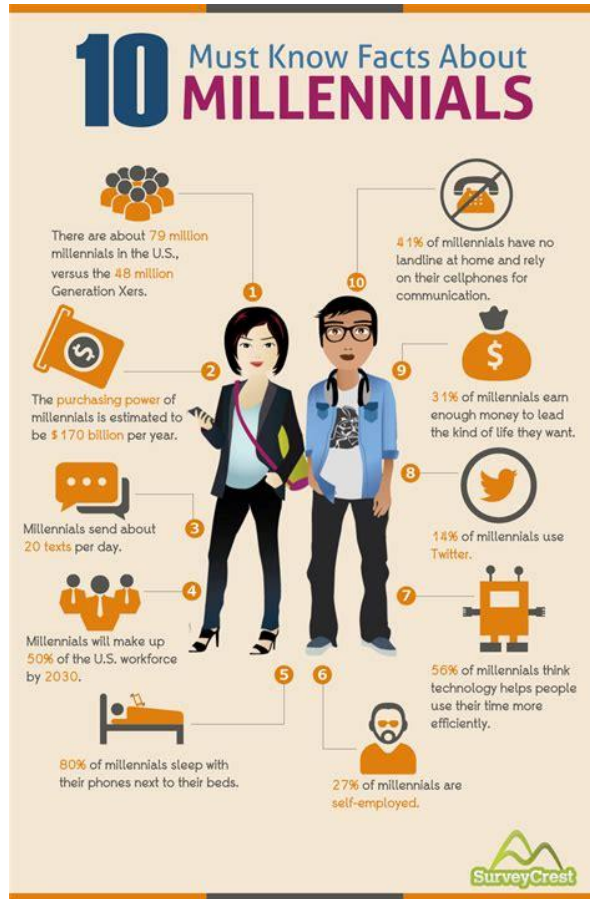
Sharification



Emerging Modes



Societal trends



Population ageing
Behavior and concerns of the *Millennials*

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Emerging modes and technologies

- MaaS and On demand PT
- (Shared) bicycle+ transport

What is MaaS?



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Mentimeter

What defines MaaS (keywords)?

available now
sustainability high quality
mobility as a service
less own car ownership
mobility solutions sharing
multi-operator
options
app
information
seamless

What is Mobility-as-a-Service (MaaS)?



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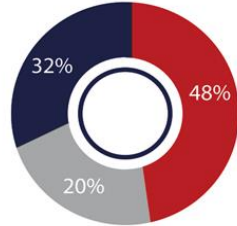
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End of car ownership?



"I would love to have access to a car without the hassle of owning one"

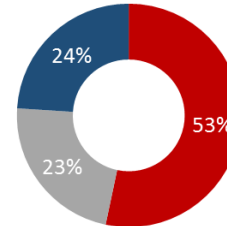


● Disagree ● Neutral ● Agree

Kamargianni et al. (2017)



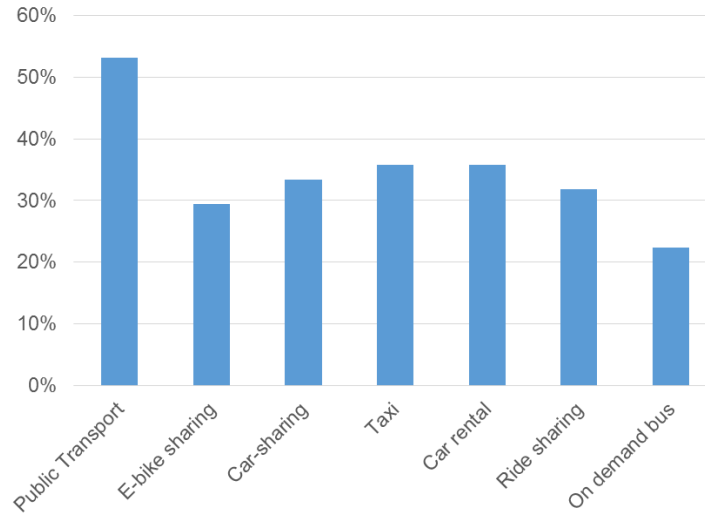
"I would like to have the convenience of a car without owning one"



■ Disagree ■ Neutral ■ Agree

Alonso-Gonzalez et al. (2018)

Transit is backbone of MaaS



Caiati, V. (2018)

Pilots sofar

	Level of integration	Bike sharing	Car sharing	Car renting	Taxi	Urban PT	Regional PT	International PT	Parking	Valet parking	Collective DRT	Tank filling	Electric car loading	Microbuses
moovel	2		x		x	x	x							
myCicero	2					x	x	x	x					
NaviGoGo	2		x		x	x	x							
iDPASS	2			x	x					x				
Tuup	2	x	x		x	x								
Hannovermobil	2		x		x	x	x							
EMMA (TaM)	2	x	x			x	x							
Business travellers cards	2	x	x	x	x	x	x		x		x	x		
Smile	2	x	x		x	x	x		x					
WienMobile Lab	2	x	x		x	x			x					
SHIFT	3	x	x		x					x			x	
UbiGo	3	x	x	x	x	x								
Whim	3	x	x	x	x	x	x							
Kutseplus	2													x

Pilots sofar

MODE CHANGES UBIGO PILOT

KARLSSON ET AL., 2016

Car

48% Less often
48% Same usage
4% More often



Shared Bicycle

16% Less often
61% Same usage
23% More often



Bus / Tram

4% Less often
46% Same usage
50% More often



Local Train

7% Less often
75% Same usage
18% More often



Shared car

6% Less often
37% Same usage
57% More often



Taxi

12% Less often
68% Same usage
20% More often



Walking

6% Less often
73% Same usage
21% More often



Expected modal shift?

Employees' interest in using MaaS for commuting trips



	Intention to use MaaS to commute in the:	
	Current situation (S0)	Scenario where the employer financing MaaS (S1)
Multi-modal travellers (42%)	27%	39%
Car-oriented travellers (39%)	9%	12%
Lease car users (19%)	31%	39%

Emerging modes: on demand transit



New?



2050
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Interreg Europe

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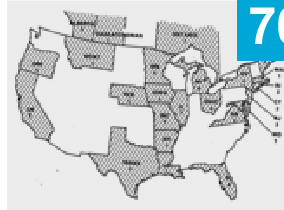
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Demand Responsive Transit (DRT)



10s

First DRT trials:
jitneys in the USA



70s

Spread of DRT in the
USA and Europe



90s

Enhanced data collection &
improved communication
solutions



60s

First dial-a-bus
experiences



80s

Development of GPS,
telephones and GIS



00s - 20s

Diffusion of internet
and smartphones

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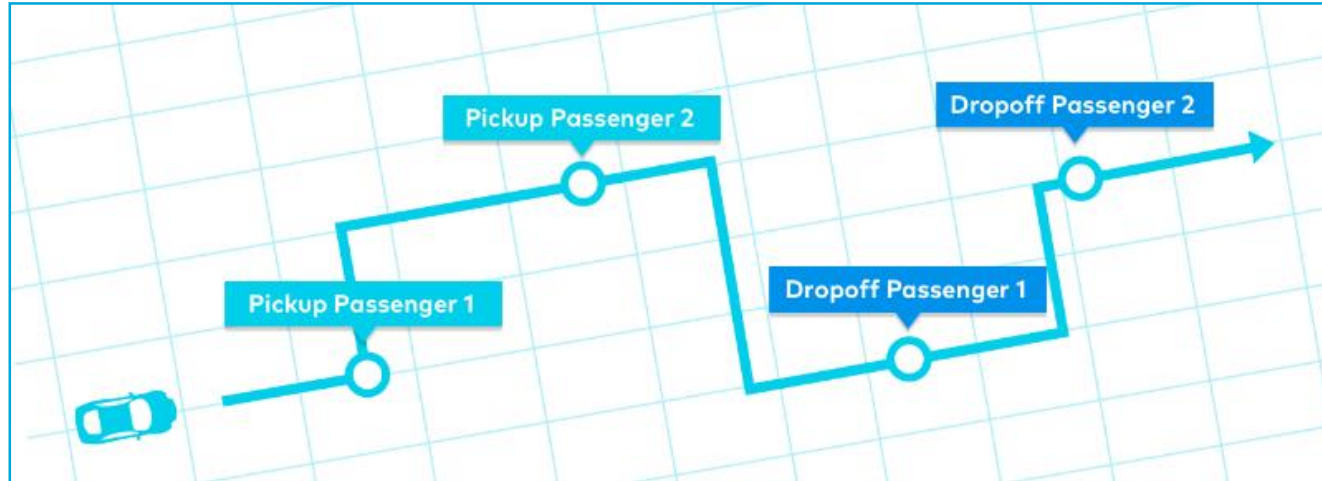
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Cities full with cheap taxis



Shareability of trips

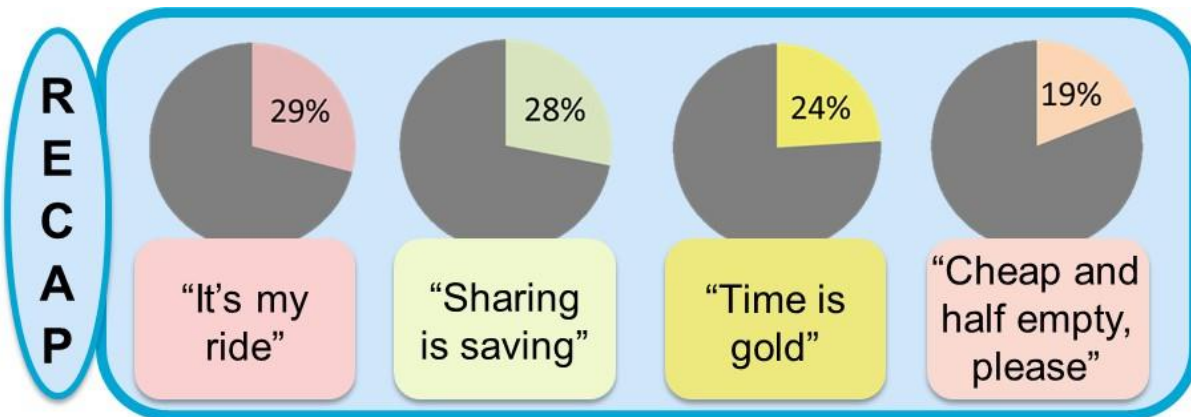


The share of taxi trips in New York City that can be shared is **above 95%** with **less than 5 minutes delay**.

In Amsterdam:
Replacement rate on demand: cars -> 1:9

(Narayan et al., 2019)
(Santi et al., 2014)
(Shareable Cities, MIT, 2017)

Willingness to share?





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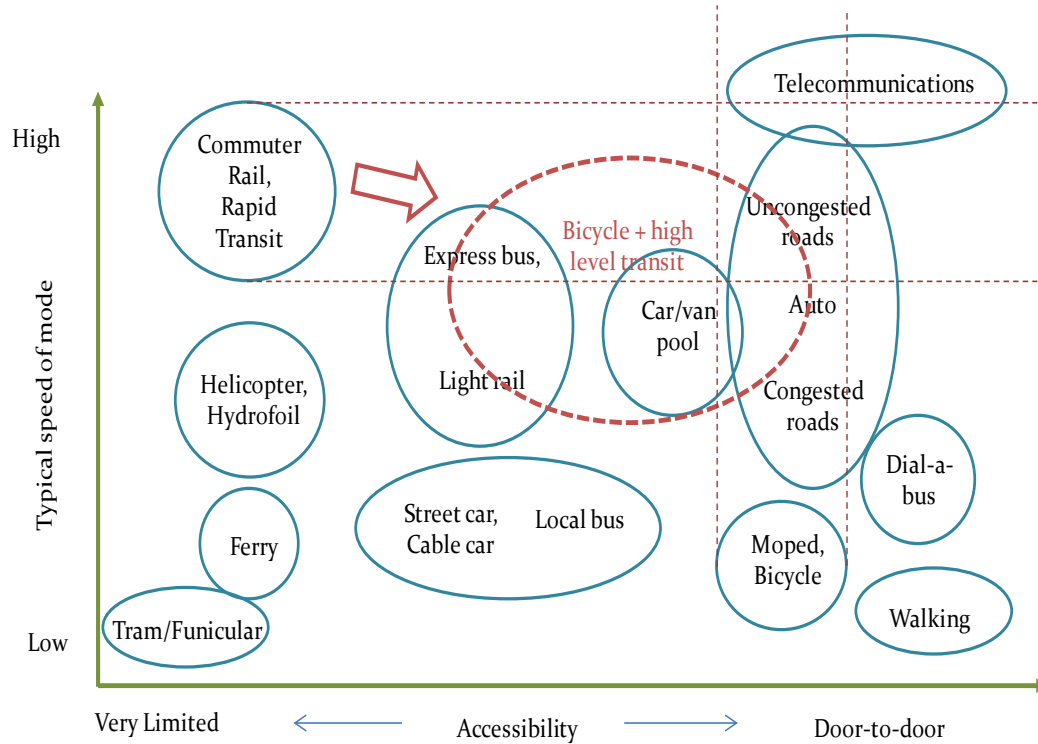
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Bicycle and transit





Bicycle + PT: Best of both worlds



[Kager et al. (2016), Shelat et al. (2017)]



Good news show?



CONGESTION



CLIMATE



AIR QUALITY



HEALTH



SAFETY



SUBSIDIES

Public transport design

<https://english.kimnet.nl/latest-news/feature/2016/07/07/the-choice-of-the-passenger>



Challenges



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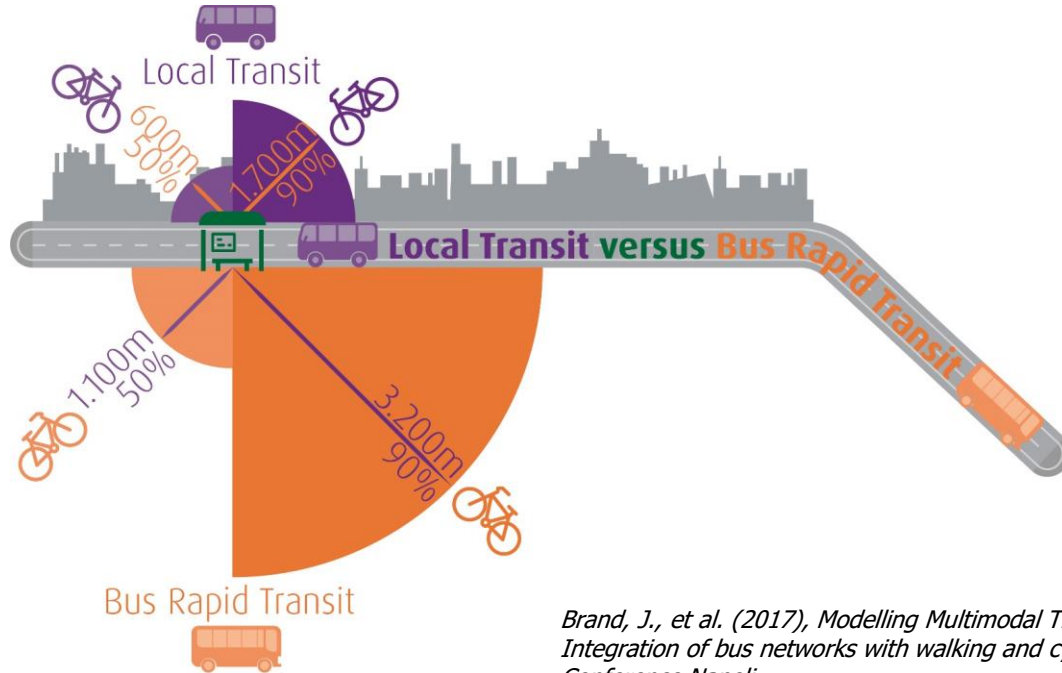
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39 FACTORS IN 8 GROUPS

1. Culture & attitudes towards cycling and rail
2. Characteristics cycle-rail users
3. Rail system
4. Train journey
5. Station typology
6. Region's bikeability
7. Bicycle journey
8. Competition other modes

Impact quality PT on catchment area



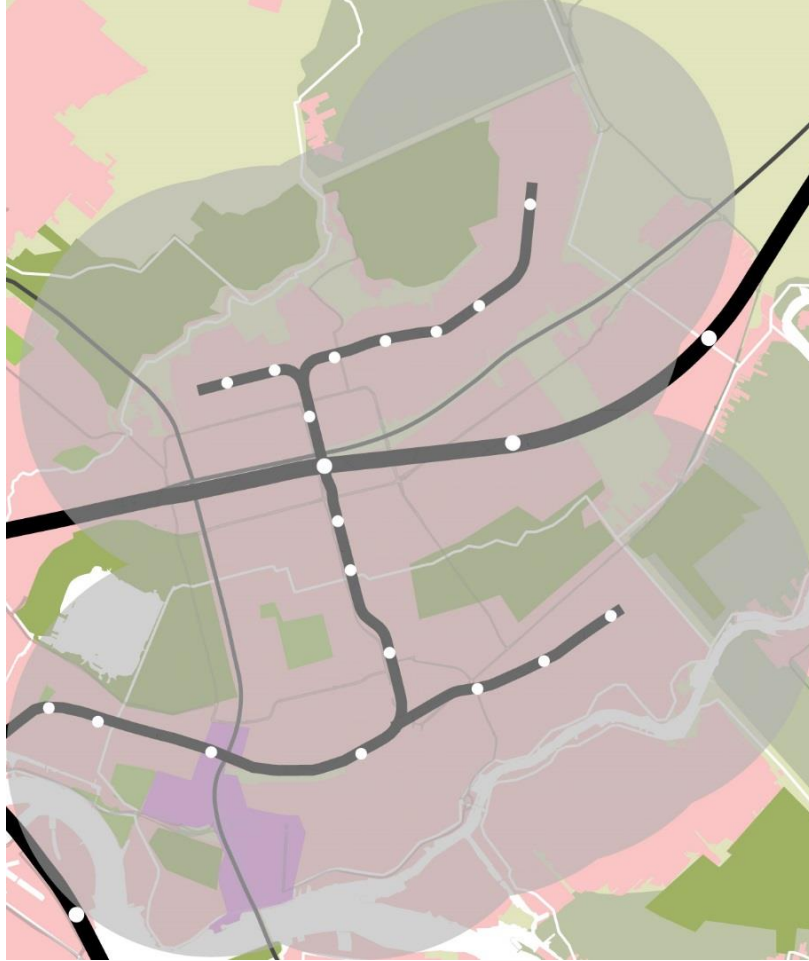
Brand, J., et al. (2017), *Modelling Multimodal Transit Networks; Integration of bus networks with walking and cycling*, MT-ITS Conference Napoli.



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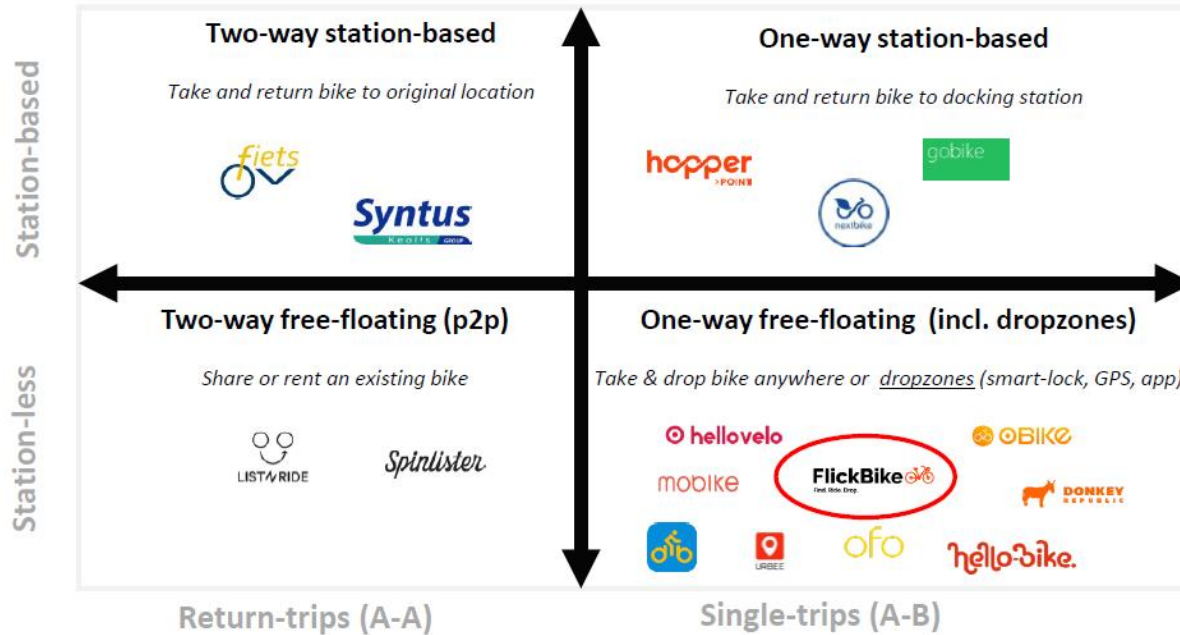
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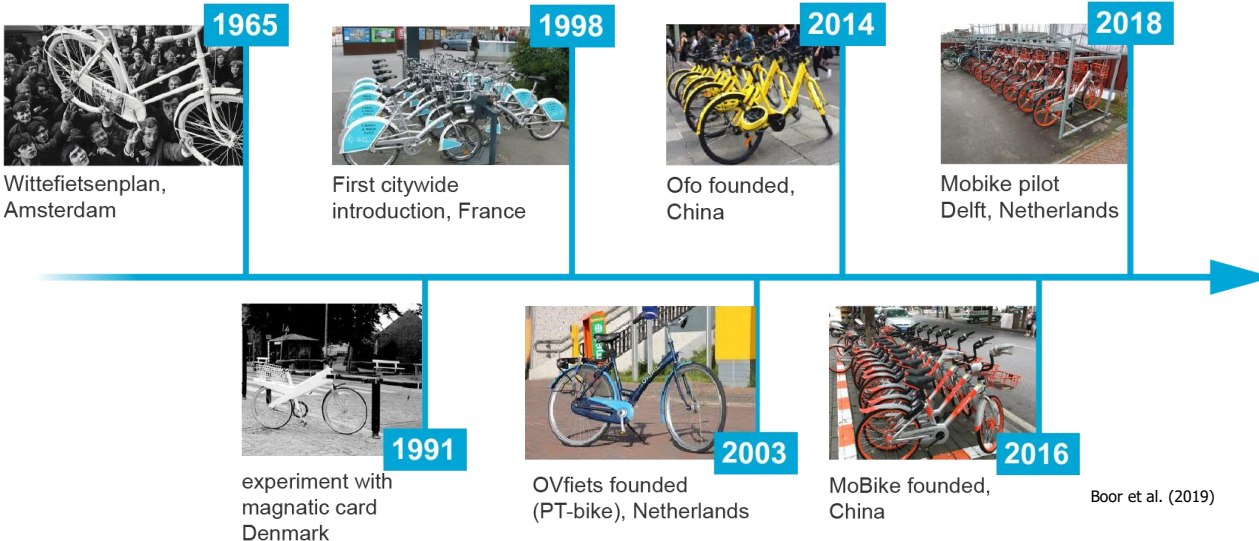
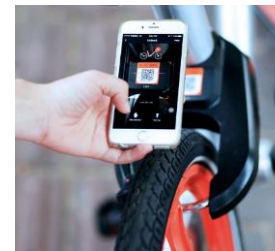
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> 1600 schemes operating
 391 others are under construction in more than 50 countries

Van Waes et al. 2018

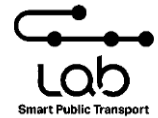
Dockless shared bikes



Boor et al. (2019)

Boor et al. (2019)

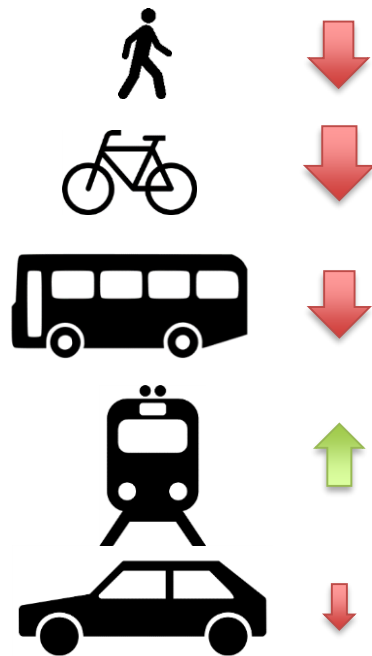
Lessons from Delft



Average daily trips/ bicycle:	1.6.
Avg daily trips/ active bicycle:	2.5-3.8
Avg trip length:	1.7- 2.3 km
Link to stations	~20%

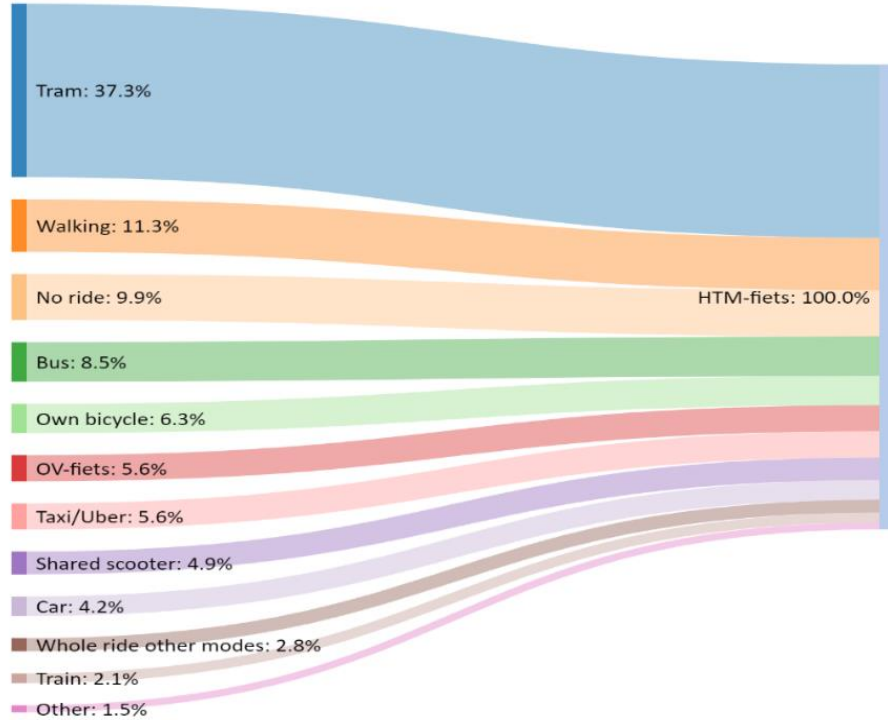
Boor et al.
(2019)

Modal shift?



Ma et al. (2020)

HTM Fiets

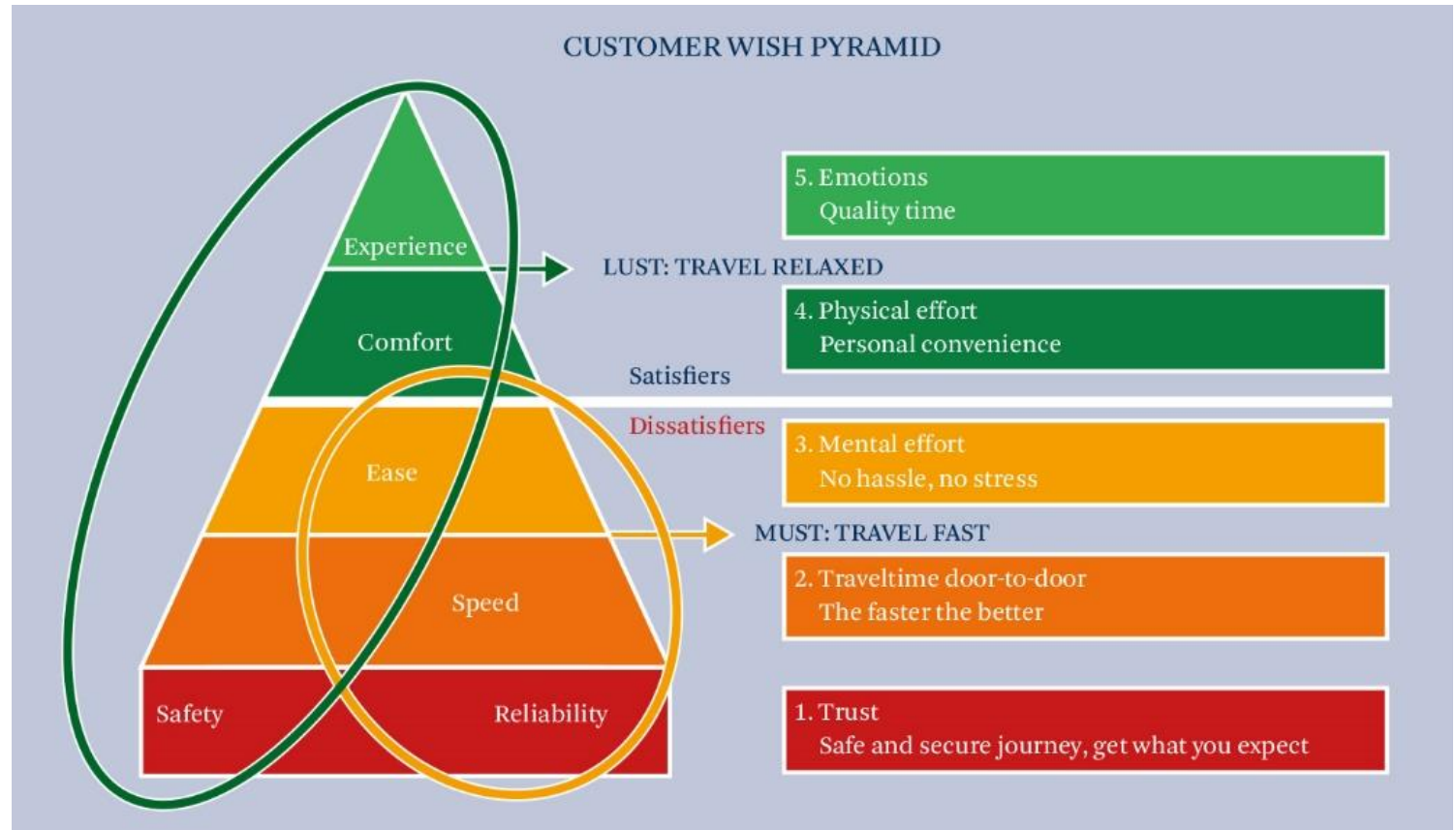


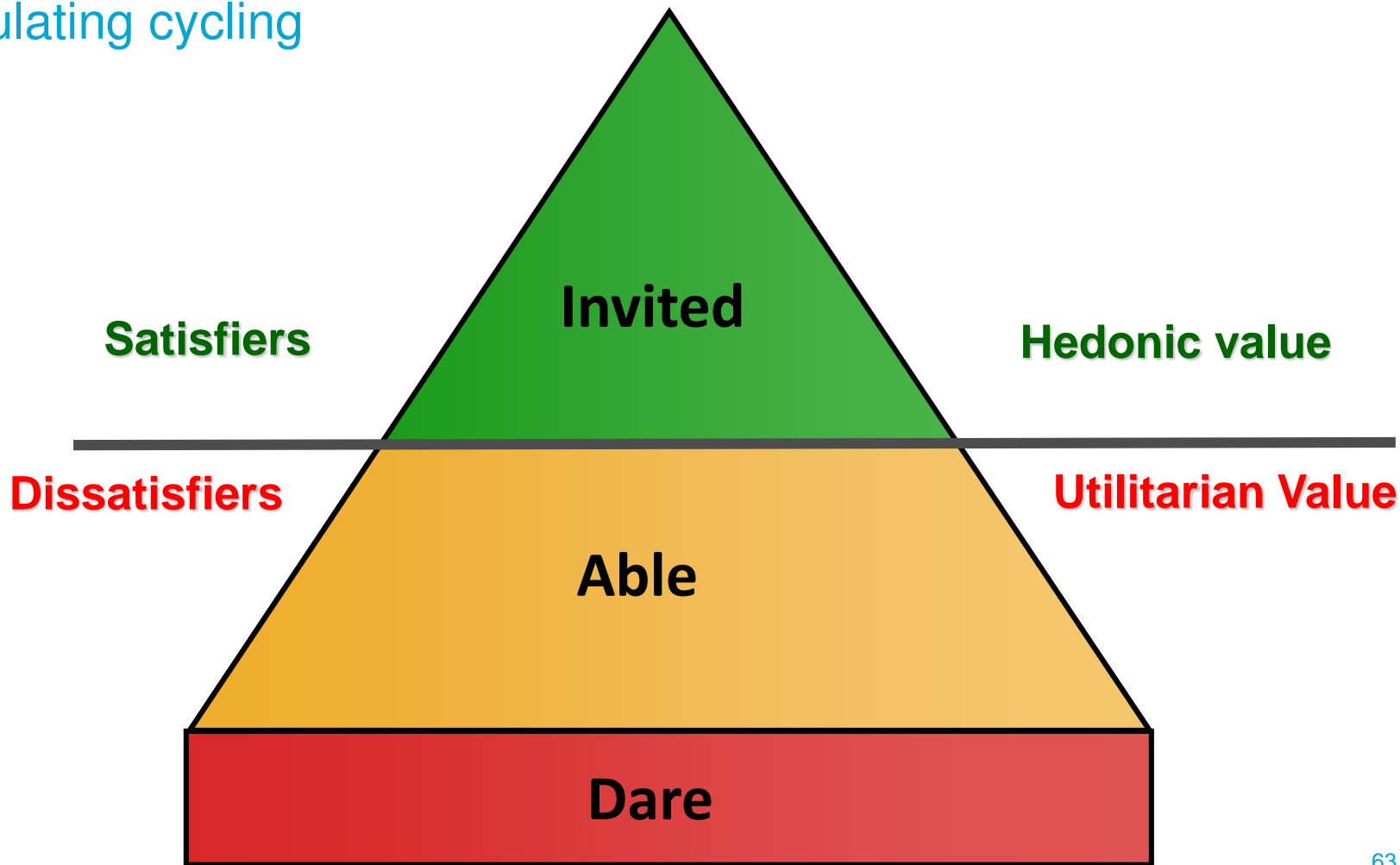
Van Marsbergen et al.
(2020)

Wrap up

- Mobility is both problem and solution of sustainable cities
- Shared and active modes are important part of the optimal mix
- Technology enablers
 - On demand transport
 - Shared bicycles
- Passenger preferences and behaviour are key!

Improving public transport





What is the most promising new mode/technology?



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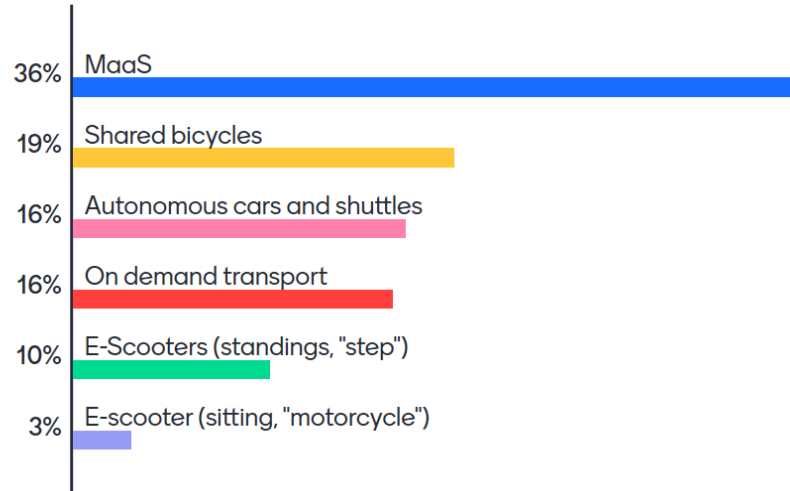
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Mentimeter

What is the most promising emerging mode/technology (divide 100 points)



Reading material: <http://nielsvanoort.weblog.tudelft.nl/>

Alonso-González, M. J., Liu, T., Cats, O., Van Oort, N., & Hoogendoorn, S. (2018). The Potential of Demand-Responsive Transport as a Complement to Public Transport: An Assessment Framework and an Empirical Evaluation. *Transportation Research Record*, 2672 (8), 879–889.

Alonso Gonzalez M.J., Hoogendoorn-Lanser S., van Oort N., Cats O., and Hoogendoorn S. (2019) "Drivers and barriers in adopting Mobility as a Service – A Latent Class Cluster Analysis of attitudes". *Transportation Research Part A: Policy and Practice* (in publication).

Boor, S., R. Haverman, N. van Oort, S. Hoogendoorn (2019), Ridership impacts of the introduction of a dockless bike-sharing scheme, a data-driven case study, CRB annual meeting

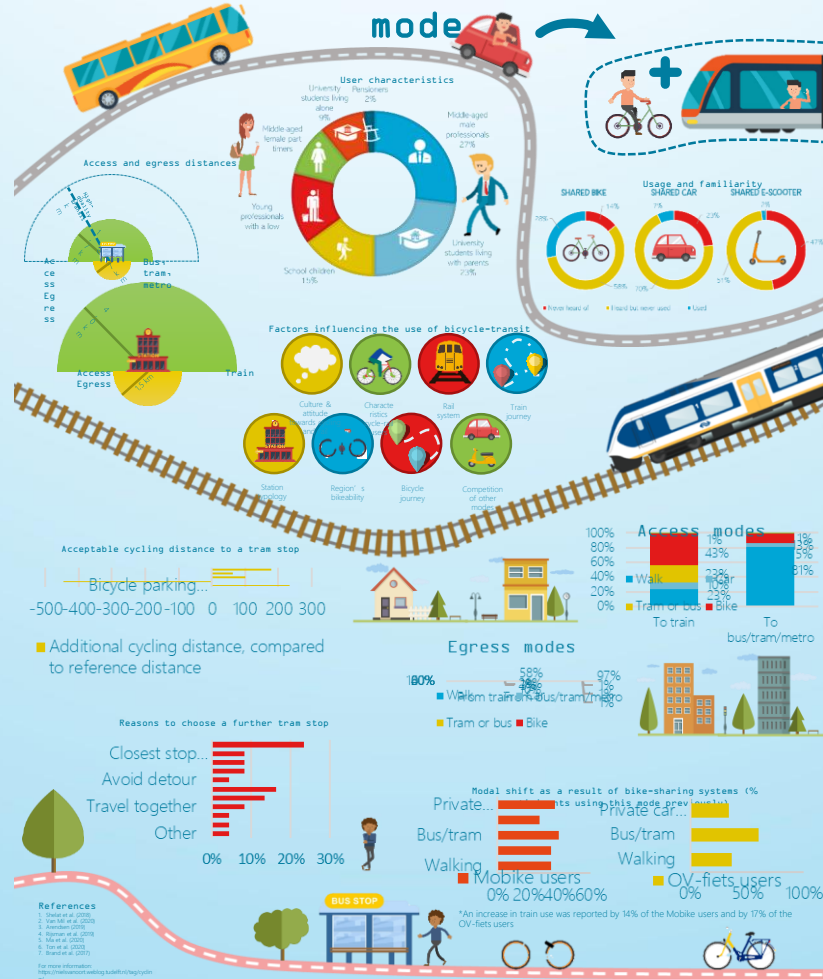
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Shelat, S., R. Huisman, N. van Oort (2018), [Analysing the trip and user characteristics of the combined bicycle and transit mode](#), *Research in Transportation Economics*, Vol. 69, pp. 68-76

van Mil, J.F.P., Leferink, T.S., Annema, J.A. & Van Oort, N.,(2020).Insights into factors affecting the combined bicycle-transit mode. *Public Transport*

Van Oort, N., R.A.J. vd Bijl, F.C.A. Verhoof (2017), The wider benefits of high quality public transport for cities, European Transport Conference, Barcelona.



See:

<https://nielsvanoort.weblog.tudelft.nl/overview-bicycletransit-research/>

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