

The impact of vehicle automation on public transport

Future of public transport in the era of emerging modes

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Outline



- Vehicle automation: cars and public transport
- Impact on public transport usage
- Mobility system design
- From pilots to implementation
- Conclusions

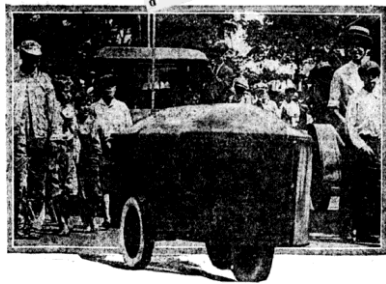


Vehicle automation: cars and public transport



Automated vehicles: New concept?

Private transport



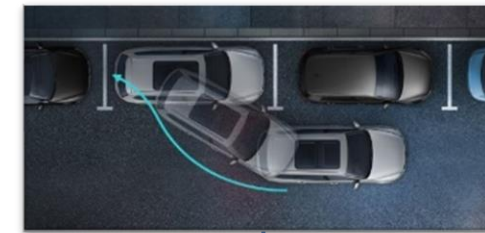
1925



1970s



1983



1999

2000s



2014

2016

2019

Public transport



Automation levels

SAE L0



NO AUTOMATION

SAE L1



**DRIVING
ASSISTANCE**

SAE L2



**PARTIAL
AUTOMATION**

SAE L3



**CONDITIONAL
AUTOMATION**

SAE L4



**HIGH
AUTOMATION**

SAE L5



FULL AUTOMATION

Automation technologies	NO	SOME	YES	YES	YES	YES
Driving tasks	DRIVER	DRIVER	DRIVER/VEHICLE	DRIVER / VEHICLE	VEHICLE	VEHICLE
Driver's attention	YES	YES	YES	YES	NO	NO
ODD	/	/	/	LIMITED	LIMITED	COMPLETE

Driverless shuttles

Low operating speed

- 15 – 25 km/h

Small passenger capacity

- Between 6 and 12 pax

SAE automation level 4+

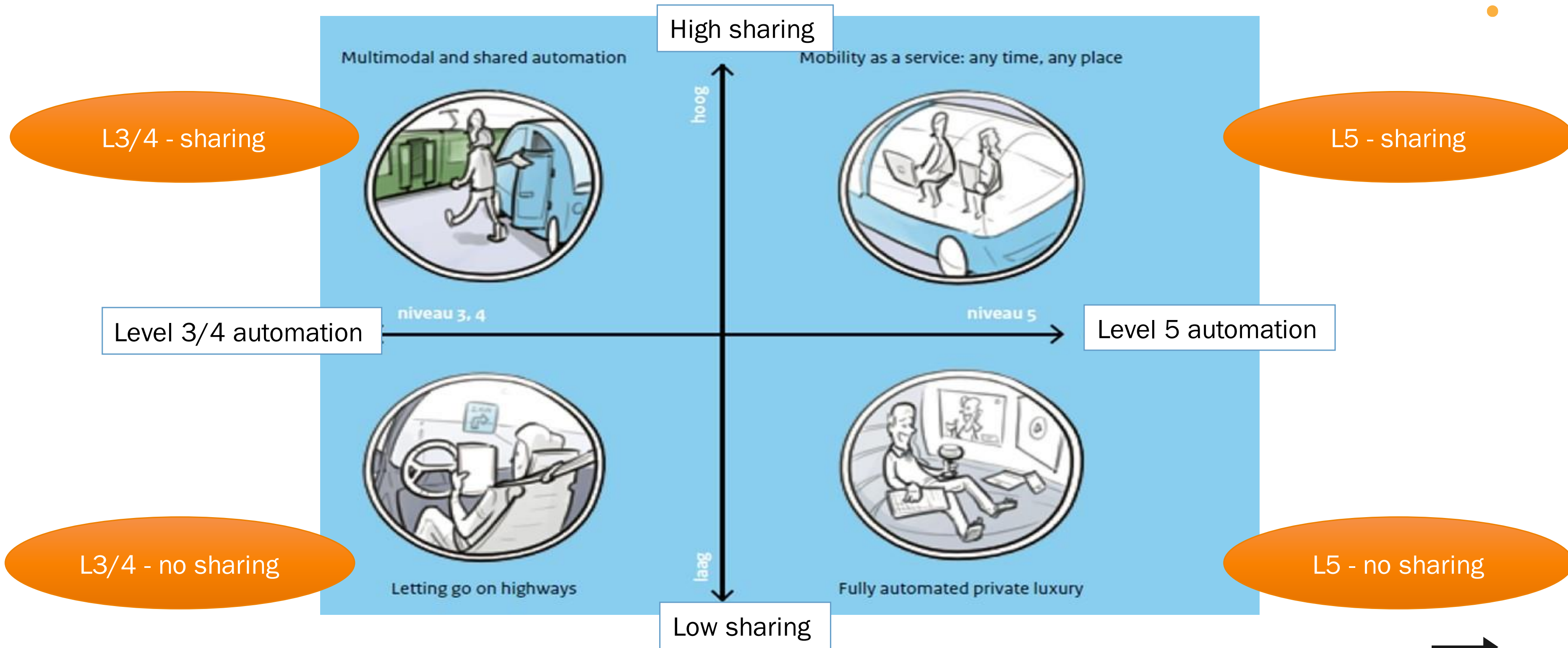
- Driver-less operations
- No user interfaces
- No driver engagement
- Limited ODD



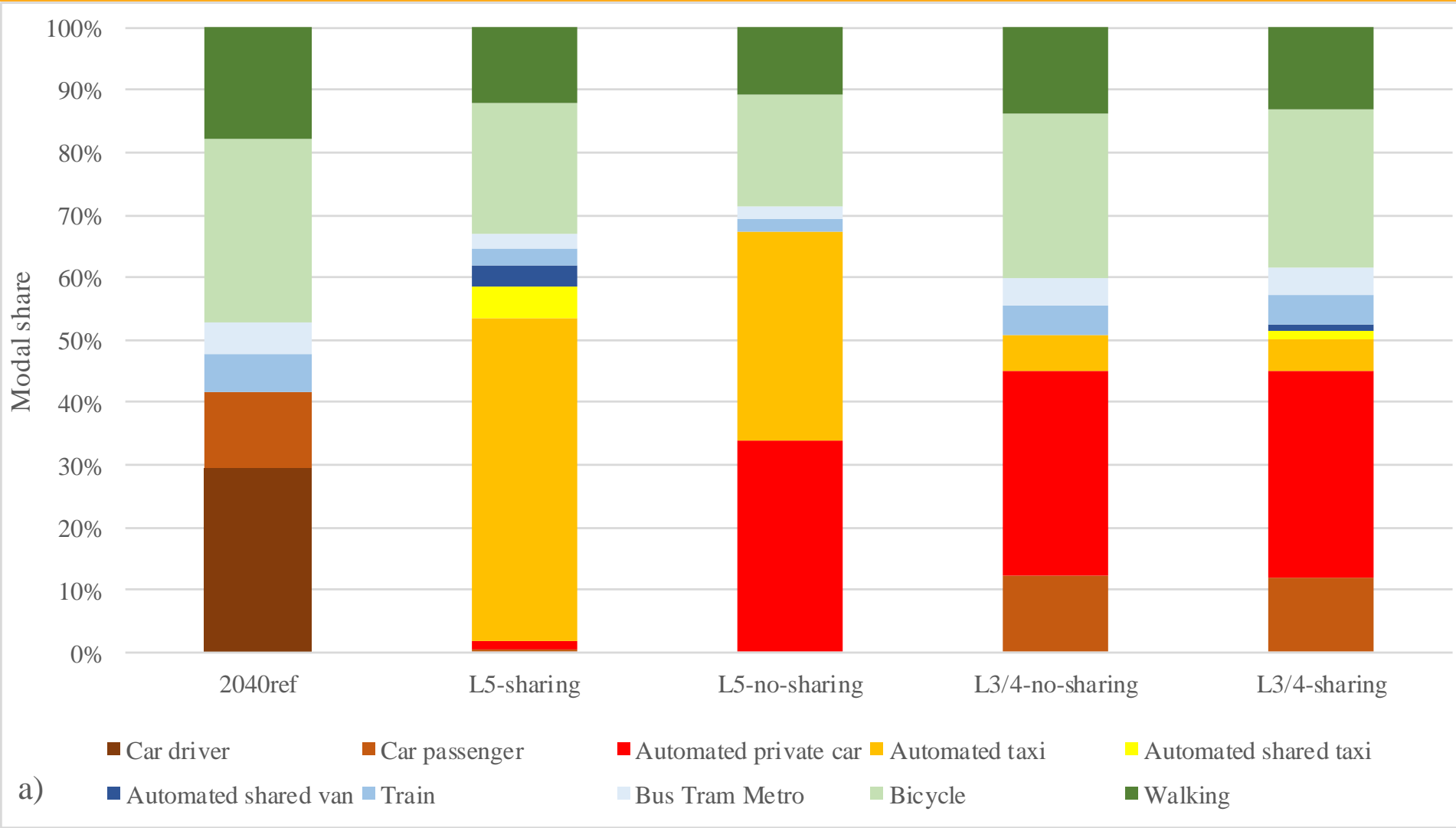
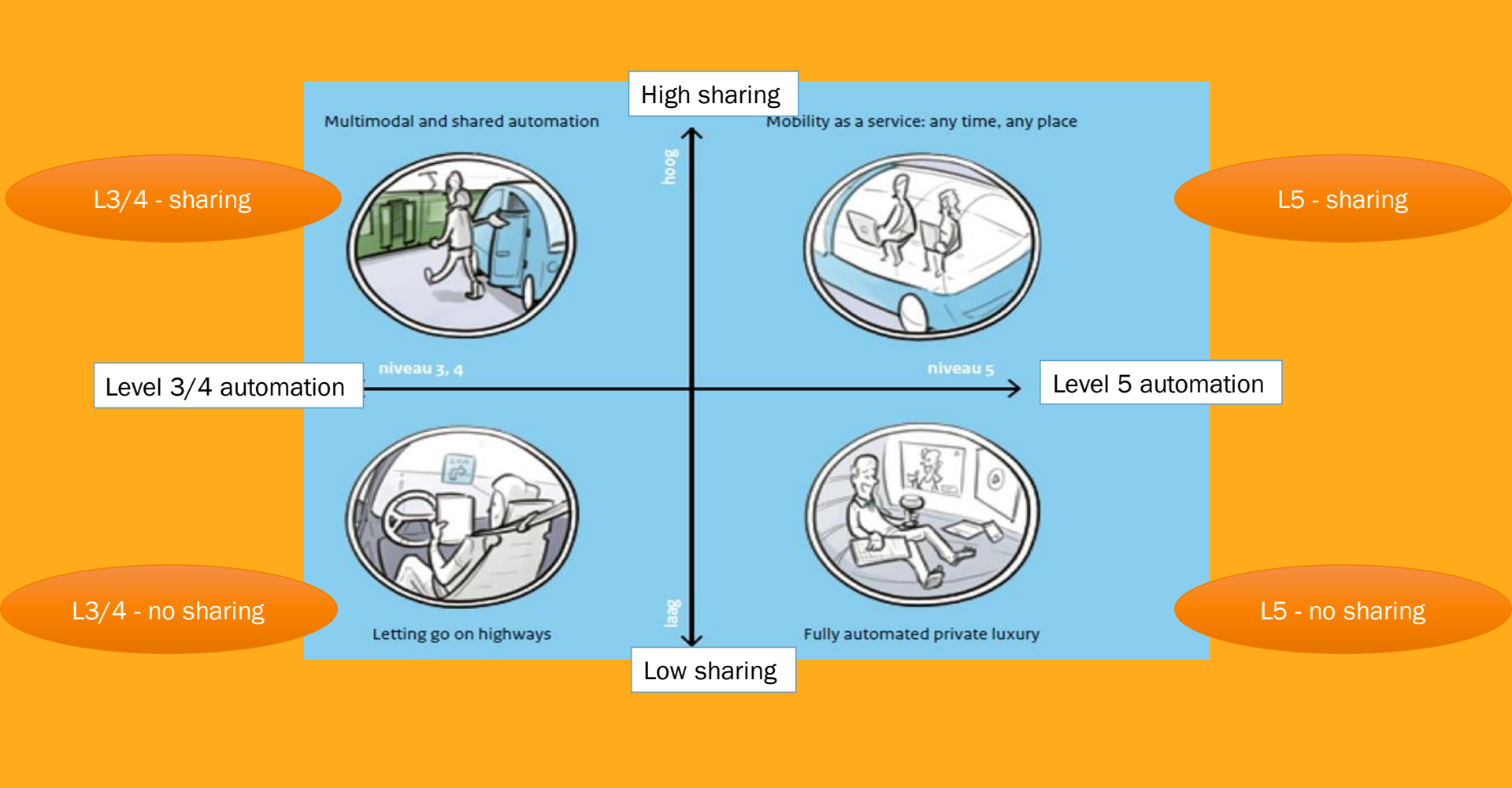
Impact on public transport usage



Scenario's



Source: KIM, Chauffeur aan het stuur? Zelfrijdende voertuigen en het verk., 2015)



Impact

- Modal shift from walking, cycling and public transport to automated private cars, (shared) taxi's
- User acceptance has a large impact on results
- A strong mix of interventions is needed to keep areas accessible and liveable and to maintain a high share of 'traditional' public transport →

Mobility system design



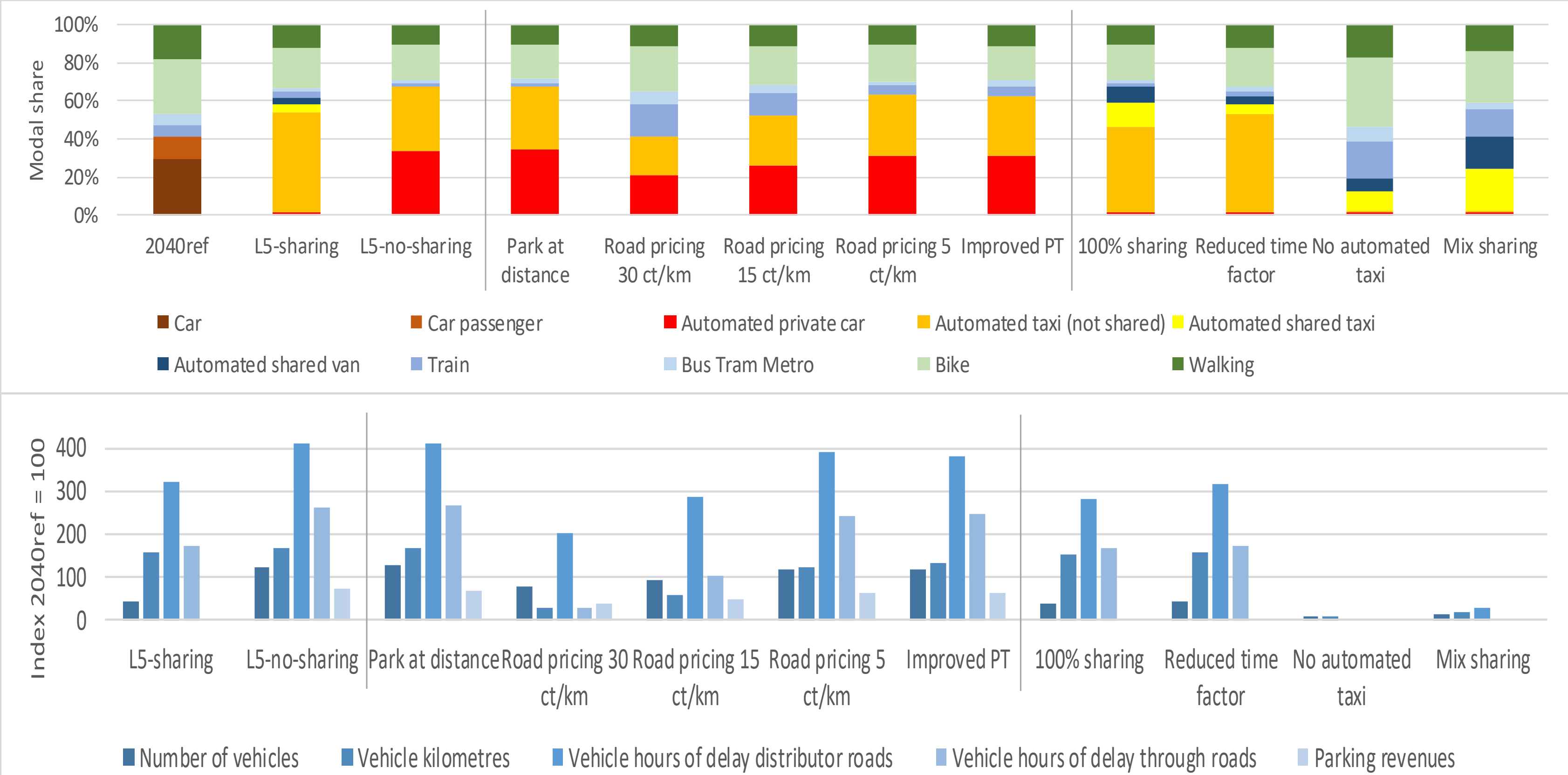
Interventions



- Car less attractive
 - Road pricing
 - Parking rates
 - Parking capacity → car free cities
 - Higher car ownership tax
- Public transport more attractive
 - Higher frequencies
 - Shared cars/bikes
 - Hubs
 - Shuttles



Interventions



Combined scenario



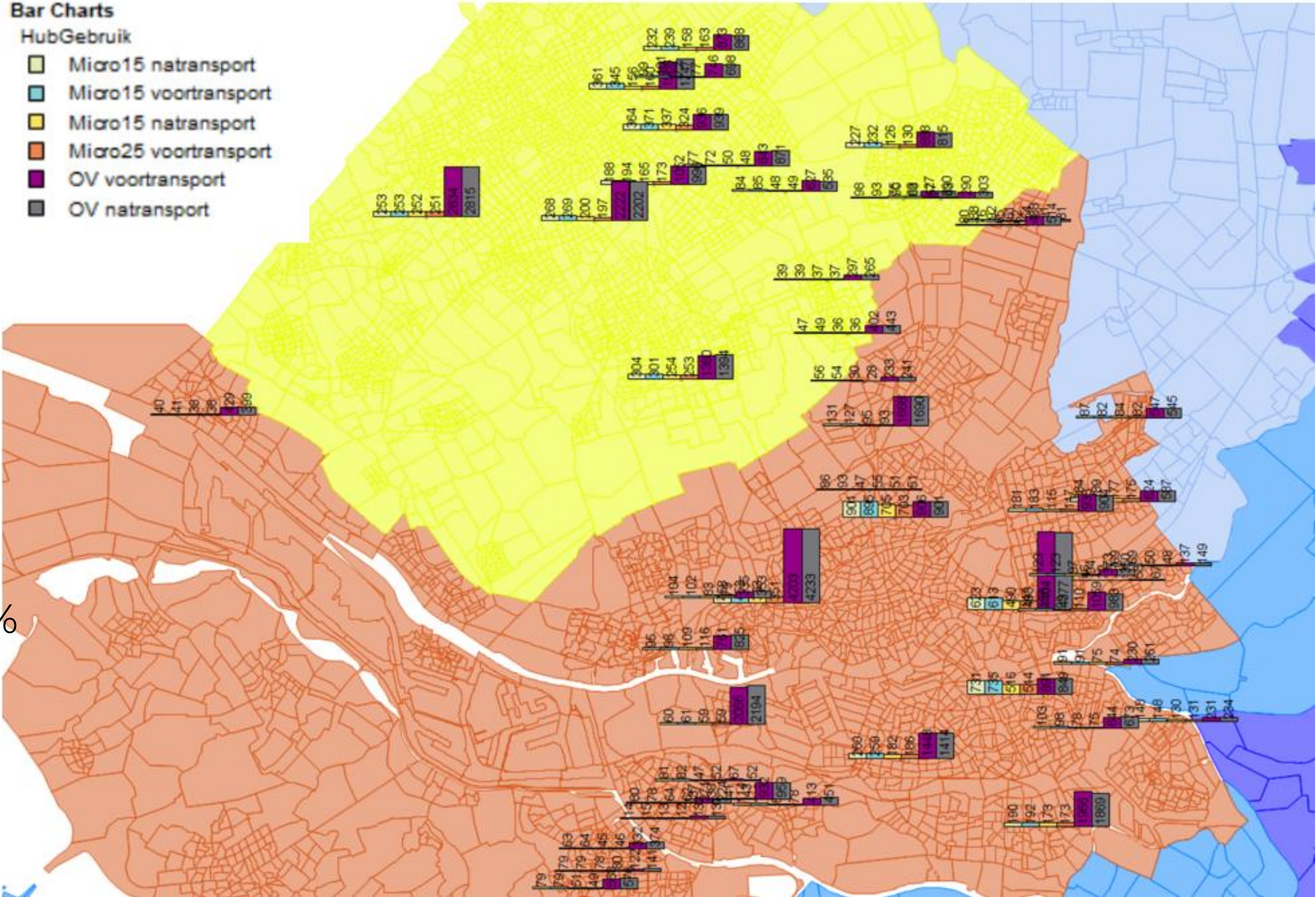
- Reduced parking capacity in the city centres of Rotterdam (-30%), The Hague (-30%) and Delft (all street parking locations)
- Extra hubs
 - Close to the centre + shared bikes
 - Further away from the centre + shared bikes

Modal split	Reference	Scenario
Car	55%	47%
Bike	36%	34%
E-Bike		9%
Traditional Public Transport	9%	10%



Hubs usage

- Egress modes
- Bike 11%
 - E-bike 8%
 - Traditional PT 82%



Source: TNO, Urban Tools Next, 2021)

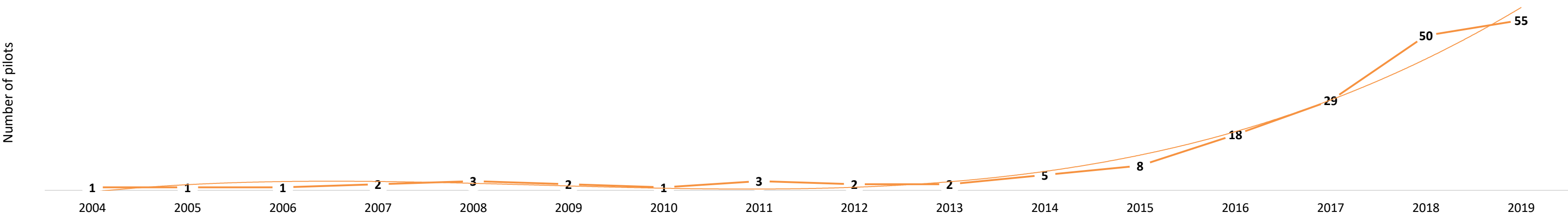


From pilots to implementation

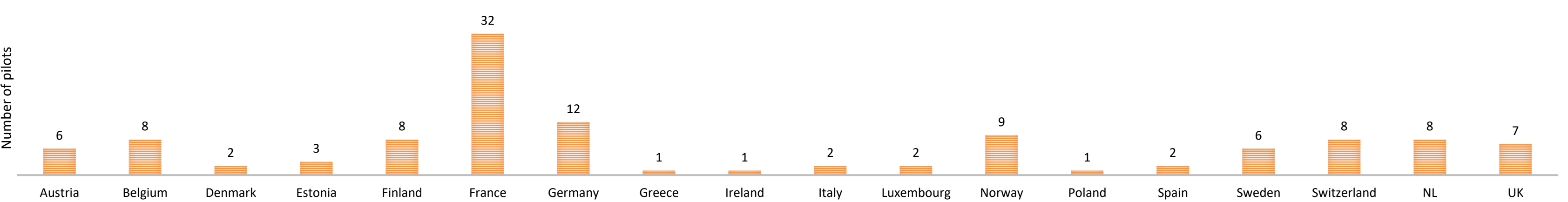


From pilots ...example shuttles

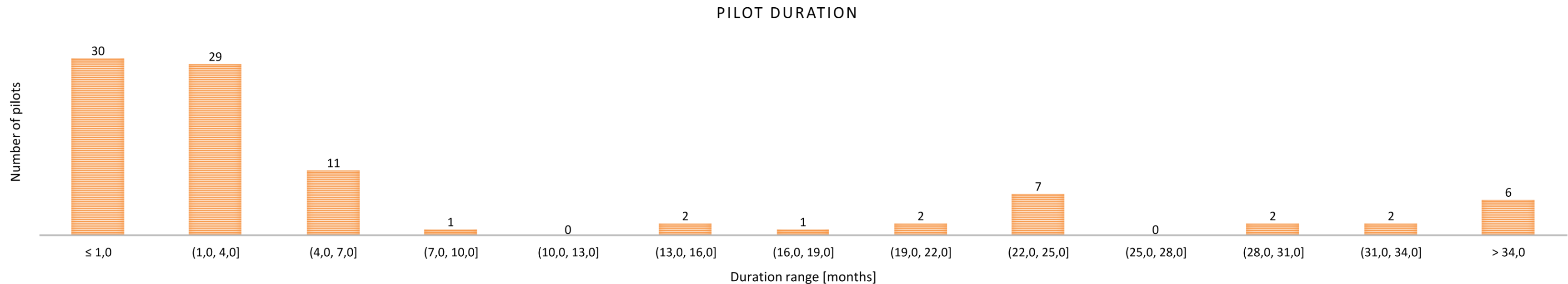
NUMBER OF ACTIVE PILOTS PER YEAR



NUMBER OF PILOTS PER COUNTRY



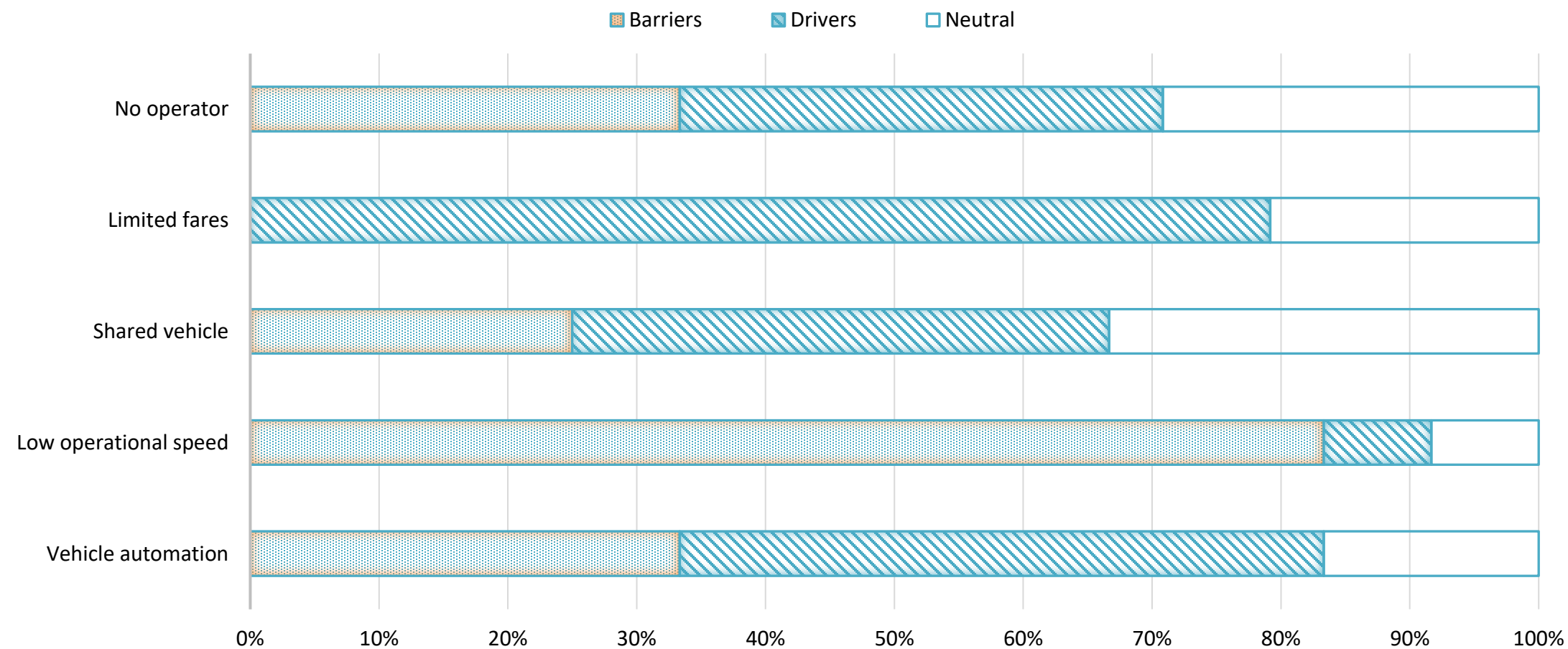
From pilots ... to implementation



- ❖ Short average duration
- ❖ Very few become actual operative systems
- ❖ Interest in bringing forward these pilots

Development directions: Experts opinion from stakeholder survey

❖ Drivers and barriers for driverless shuttle integration



Biggest drivers

- Limited fares
- Vehicle automation

Biggest barrier

- Low operational speed

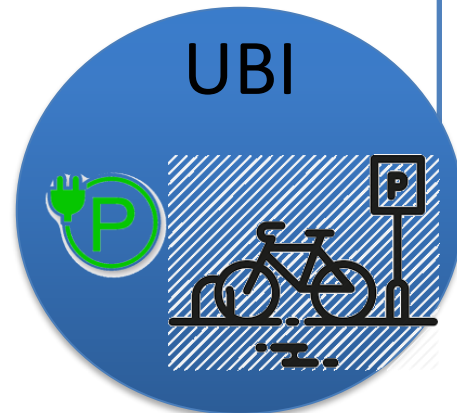
Not relevant

- No operator
- Shared vehicle

Deployment scenarios: Experts opinion from stakeholder survey

	Supervision	Area	Infrastructure	Operations
Scenario A	Remote control	Urban	Dedicated lanes	Schedule-based
Scenario B	Remote control	Urban	Dedicated lanes	On-demand
Scenario C	Remote control	Rural	Mixed infrastructure	On-demand
Scenario D	Remote control	Urban	Mixed infrastructure	On-demand
Scenario E	On-board steward	Urban	Mixed infrastructure	On-demand

Focus: accessible, sustainable, safe and livable urban areas



Business models

Technical feasibility

Impact assessment

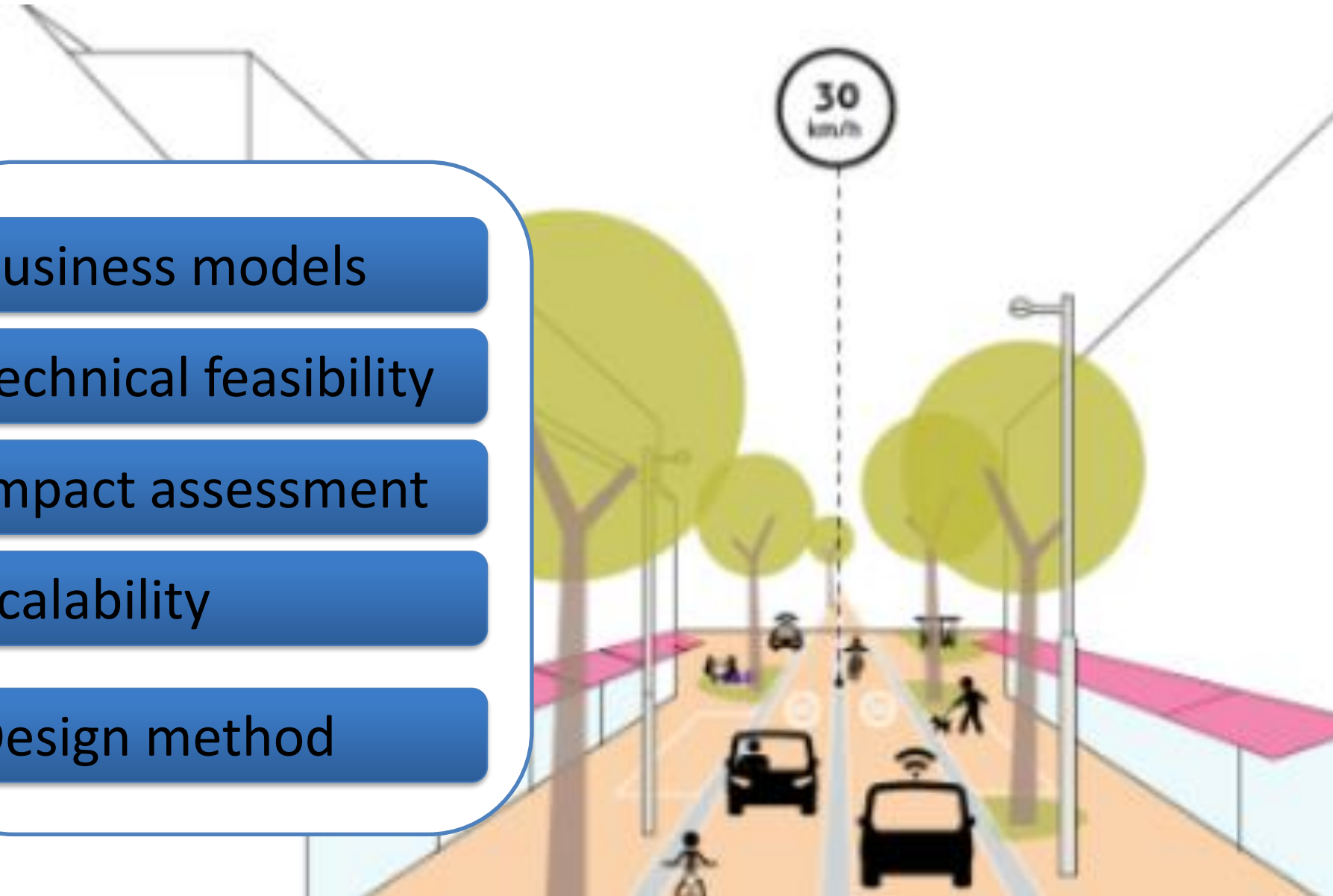
Scalability

Design method

Small scale pilots in
protected environments

1

Full-fledged implementations
in competitive settings.





Take aways

- Clear multimodal vision needed including emerging modes
- Important to steer towards societal goals
- From pilots to implementation
 - Business/value case
 - Technical feasibility and monitoring
 - Mobility and environmental impacts

More information



- Snelder, M., Wilmink, Isabel, van der Gun, J., Bergveld, H.J., Hoseini, P., van Arem, B. (2019) Mobility impacts of automated driving and shared mobility – explorative model and case study of the province of north-holland, *European Journal of Transport and Infrastructure Research*, vol. 19, n. 4 Doi: <https://doi.org/10.18757/ejtir.2019.19.4.4282>.
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Thank you!

Do you have any question?

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