# CoEXist

# Final Conference

## Enabling "*Automation-Ready*" Transport Planning

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**This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 723201-2**

# The webinar team

*Moderator:*
**Siegfried Rupprecht**

*Project Coordinator:*
**Wolfgang Backhaus**

*Poll manager:*
**Marie Rupprecht**

*Question manager:*
**Daniel Franco**

*Technology manager:*
**Wolfram Buchta**



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# CoEXist Virtual Final Conference - Part 1:
## Automation-ready tools and impact assessment findings

### Wednesday 25 March 2020

*CET (UTC+01:00)* — ***Moderator:*** *Siegfried Rupprecht, Rupprecht Consult*

13:45 Registration and technical support

**14:00** **Welcome**, Siegfried Rupprecht, *Rupprecht Consult* & INEA (tbc)

**Introduction to CoEXist**, *Daniel Franco, Rupprecht Consult*

**CoEXist tools**

Automation-ready transport modelling and infrastructure assessment

**14:10** **Overview of the CoEXist impact assessment approach and automation-ready transport (infrastructure) assessment tool**, *Johan Olstam, VTI*

14:25 Polls - Q&A

**14:30** **Automation-ready modelling tools: microscopic traffic flow simulation**, *Charlotte Fléchon, PTV Group*

14:45 Polls - Q&A

**14:50** **Automation-ready modelling tools: macroscopic travel demand simulation**, *Markus Friedrich, University of Stuttgart*

15:05 Polls - Q&A

**15.10** **Toward the Development of Analysis, Modelling, and Simulation (AMS) Tools for Connected and Automated Vehicles (CAVs),**
Rachel James, USDOT Federal Highway Administration (FHWA)

15:25 Polls - Q&A

15:30 *Break*

**CoEXist impact assessment findings**

Potential impact of vehicle automation in four cities, across eight scenarios:

**15:45** **Helmond (NL): (i) multimodal signalised intersection and (ii) highway-urban road transition**, *Frank van den Bosch, city of Helmond*

16:00 Polls - Q&A

**16:05** **Gothenburg (SE): (i) shared space; (ii) accessibility during long-term roadworks**, *Iman Pereira & Chengxi Liu, VTI*

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**16:45** **Stuttgart (DE): (i) network level travel time & mode choice; (ii) ridesharing**, *Jörg Sonnleitner, University of Stuttgart*

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**17:05** **Lessons learnt & conclusions,** *Wolfgang Backhaus, Rupprecht Consult*



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# Potential impacts of vehicle automation

## Eight use cases in four cities

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## Poll question

**What do you think are the primary reasons for developing CAD (select all that apply)?**

- Improving safety
- Improving productivity
- Reducing congestion
- Increasing mobility options
- None of the above / other (specify in question box)

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# Helmond: Use case 3 & 4

Frank van den Bosch, city of Helmond

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# Use case 3: Signalised Intersection with Cyclist and Pedestrians

- Signalised intersection on main road in the city of Helmond
  - Large volumes of car traffic
  - Crossing of cyclists and pedestrians

- Research questions
  - Is the performance of the intersection getting better because of a more efficient flow?
  - Is the impact dependent on the penetration rate of CAVs?
  - Is it dependent on the kind of CAVs?
  - Is automation enough to produce benefits, or is there also a need to be connected to the infrastructure (V2I)


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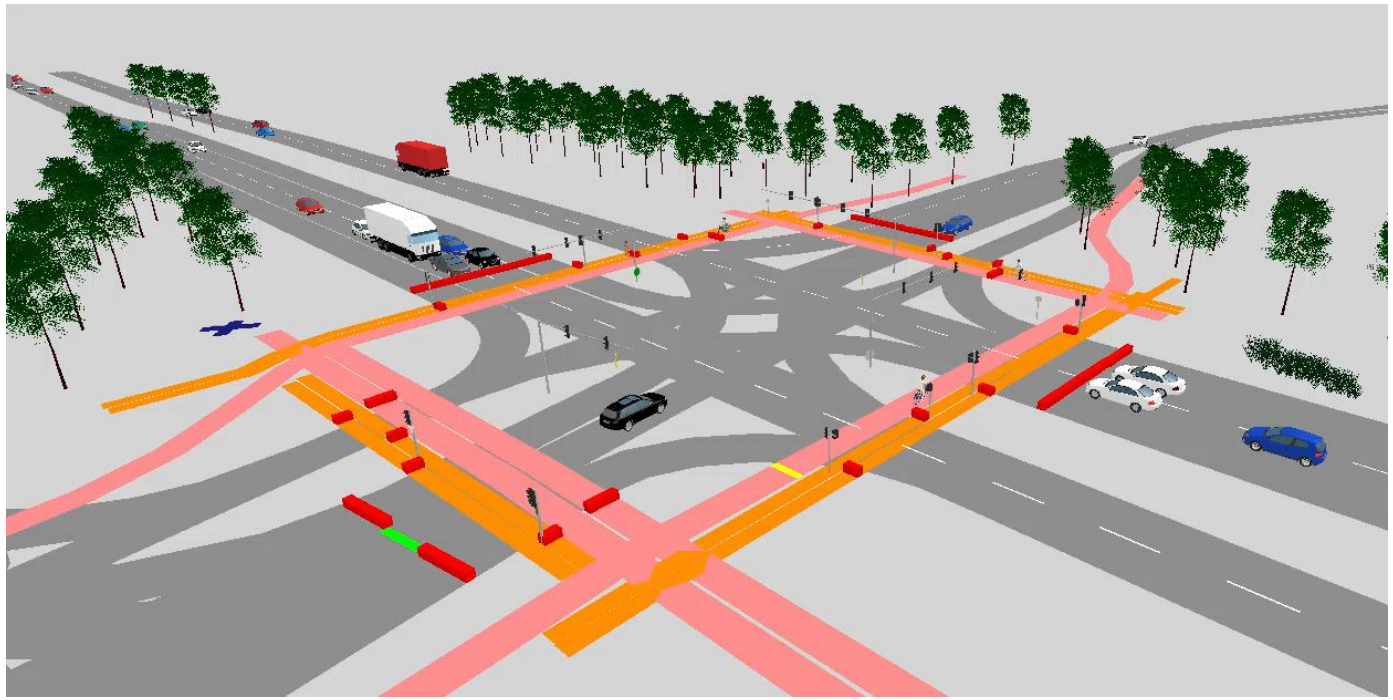
# The model

- Microscopic model including cars, trucks, cyclists and pedestrians.
- Connection with Imflow-simulator so real implementation of the adaptive traffic light regulation.





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# Scenario specification

| Stages | Vehicle type | AV penetration | AV class mix | | |
|---|---|---|---|---|---|
| | | | Basic AV share | Intermediate AV share | Advanced AV share |
| Today (no AV) | Cars, Trucks | 0 | 0 | 0 | 0 |
| Introductory 1 | Cars, Trucks | 25 % | 80 % | 20% | 0 |
| Introductory 2 | | | 20 % | 80 % | 0 |
| Established 1 | Cars, Trucks | 50 % | 20 % | 80 % | 0 |
| Established 2 | | | 0 | 50 % | 50 % |
| Prevalent 1 | Cars, Trucks | 75 % | 0 | 50 % | 50 % |
| Prevalent 2 | | | 0 | 0 | 100 % |



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# The impacts of AVs on traffic performance (Time)


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# The impacts of AVs on traffic performance (Delay)




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# Measure: Priority for AV's on Intersections

- Unable to simulate because of technical problems but in Maven (another Horizon 2020 project) was this effect simulated and :

- *Looking at the integrated MAVEN system based on negotiation-drive adaptive traffic light control, a large reduction of delay time for all traffic participants in the network was observed.*

- So there is space to reallocate greentime (in advance of pedestrians and cyclists)




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# Safety assessment results

| | Type of accident | Arterial Pilot | | | |
|---|---|---|---|---|---|
| | | ☹ | 😐 | 🙂 | 😀 |
| 1 | Driving accident | | | | 4 |
| 2 | Turning off accident | | | 5 | 2 |
| 3 | Turning-in / Crossing accident | | 1 | 4 | |
| 4 | Pedestrian accident | | | | 4 |
| 5 | Accident with parking vehicles | | | | |
| 6 | Accident in lateral traffic | | | | 6 |
| 7 | Other accident type | | | | |



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# Conclusions

- In the early stages with very cautious AV's the travel performance first will get worse.
- In the prevalent stage the traffic performance will improve which is mainly the result of the advanced AV's with connectivity.
- When AV's become more and more sophisticated in prevalent stages and with connectivity there would be space to reallocate greentime in favour of pedestrians and cyclists.



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# Use case 4: Transition from interurban highway to arterial (Helmond, NL)

- Study area
  - Road between Eindhoven and Helmond, which changes from an interurban motorway to an urban road, with having very different speed limits and traffic conditions (4 signalised intersections)
- Research questions
  - Can CAV deployment improve traffic conditions in transitions from highway to arterial roads?
  - Will the speed become more homogenous due to the presence of CAVs, and will it lead to a more efficient flow?
  - Do the results depend on the penetration rate or kind of CAVs?


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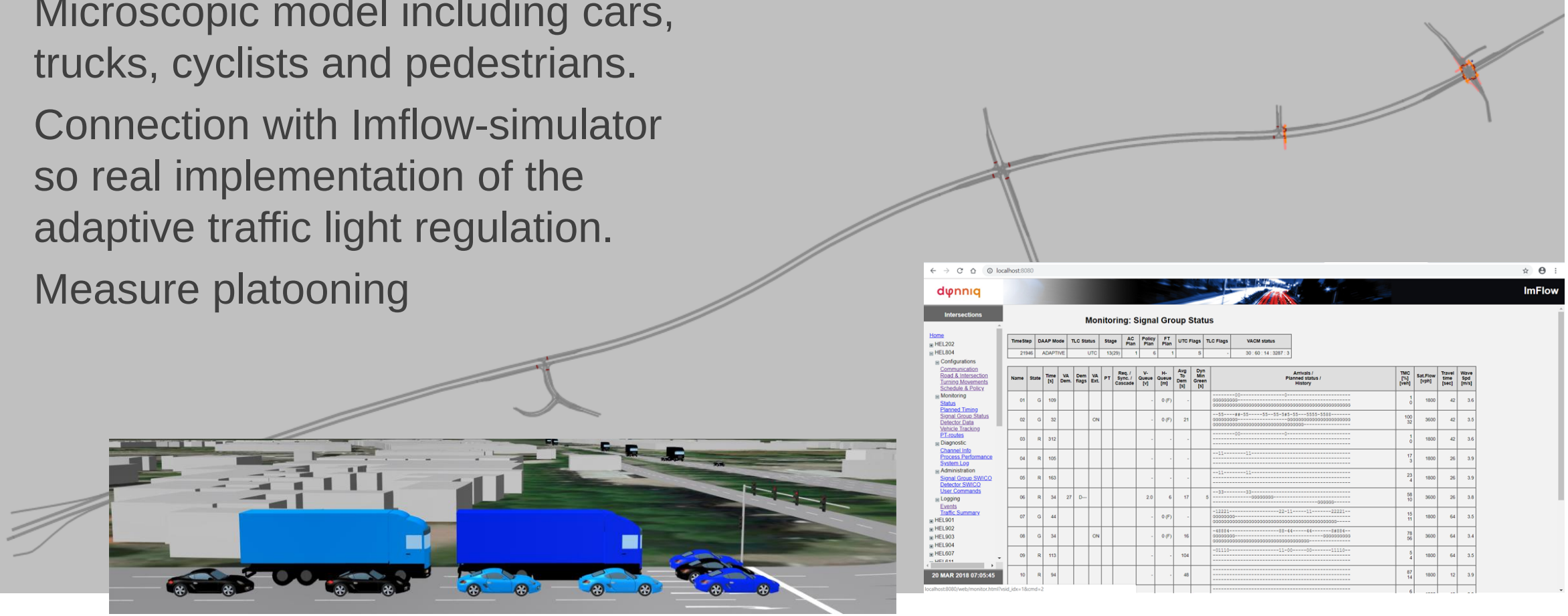
# Baseline model specification

- Microscopic model including cars, trucks, cyclists and pedestrians.
- Connection with Imflow-simulator so real implementation of the adaptive traffic light regulation.
- Measure platooning

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# Scenario design

| Stages | Vehicle type | AV penetration | AV class mix | | |
|---|---|---|---|---|---|
| | | | Basic AV share | Intermediate AV share | Advanced AV share |
| **Today (no AV)** | Cars, Trucks | 0 | 0 | 0 | 0 |
| **Introductory 1** | Cars, Trucks | 25 % | 80 % | 20% | 0 |
| **Introductory 2** | | | 20 % | 80 % | 0 |
| **Established 1** | Cars, Trucks | 50 % | 20 % | 80 % | 0 |
| **Established 2** | | | 0 | 50 % | 50 % |
| **Prevalent 1** | Cars, Trucks | 75 % | 0 | 50 % | 50 % |
| **Prevalent 2** | | | 0 | 0 | 100 % |



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# Scenario design

| Stage | AV penetration |
|---|---|
| Today (No AV) | 0% |
| Introductory | 25% |
| Established | 50% |
| Prevalent | 75% |

| Demand |
|---|
| 100% |
| 110% Traffic |
| 200% VRU |

| Measure |
|---|
| no |
| platooning |
| right lane platooning |



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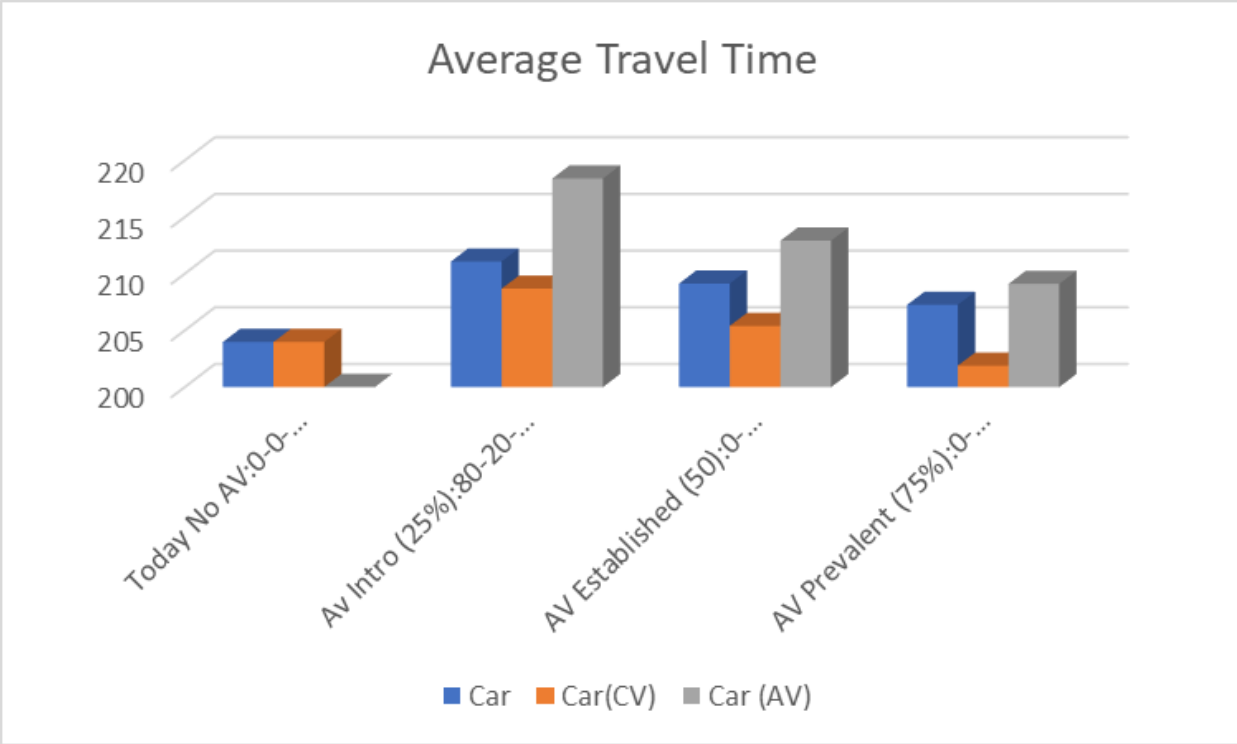
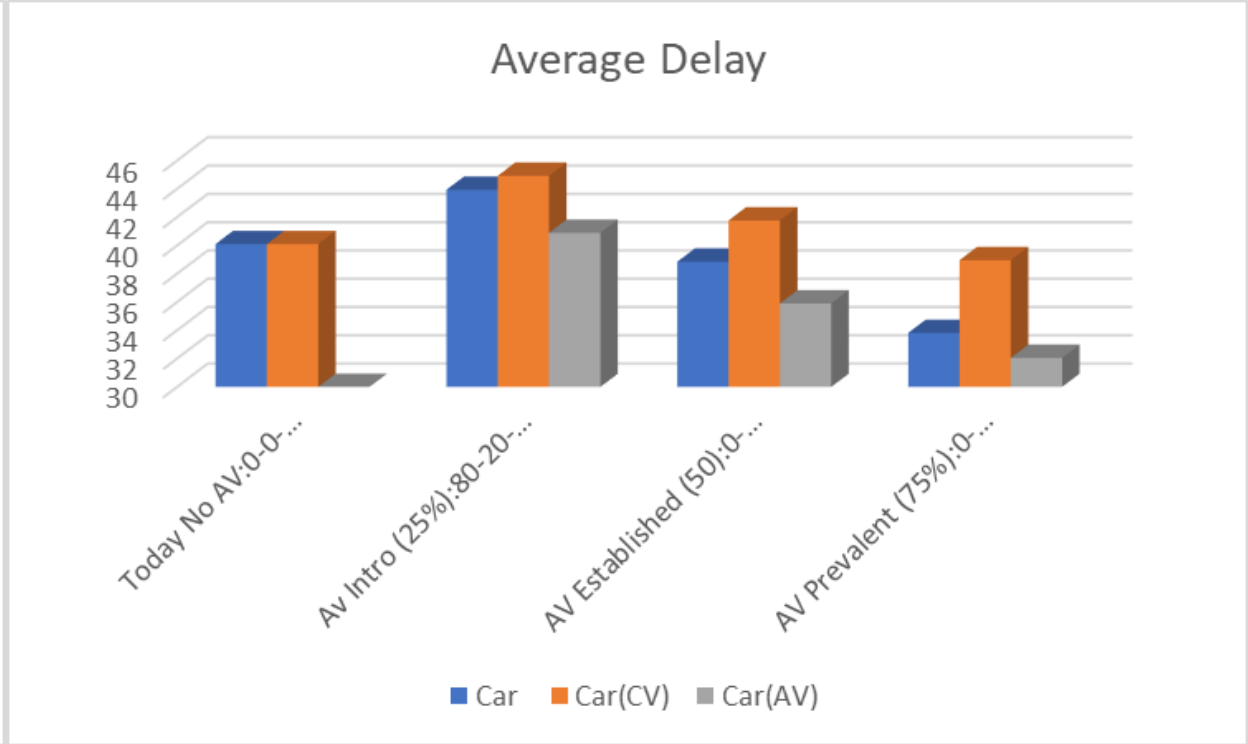
# The impacts of AVs on traffic performance



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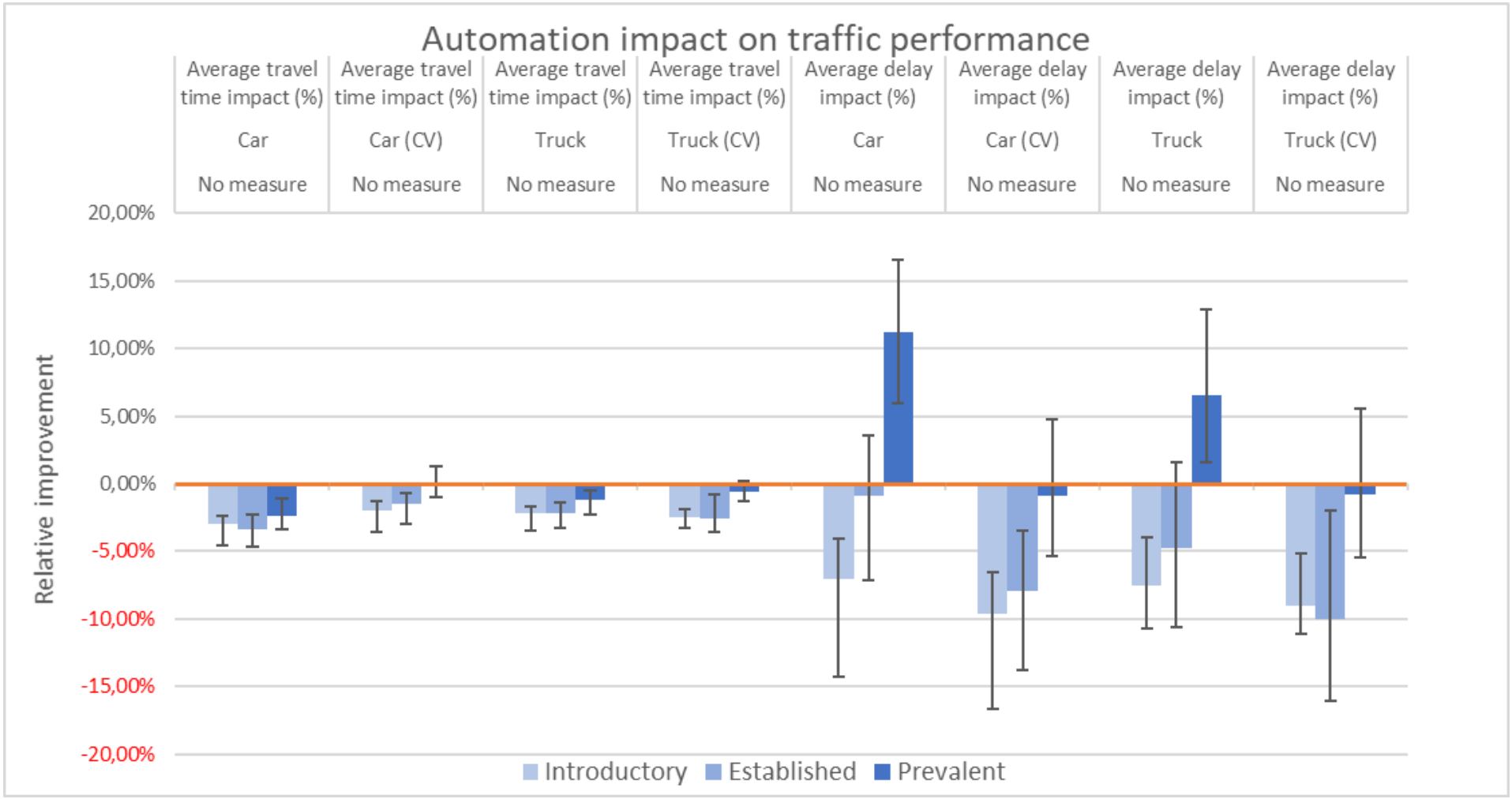




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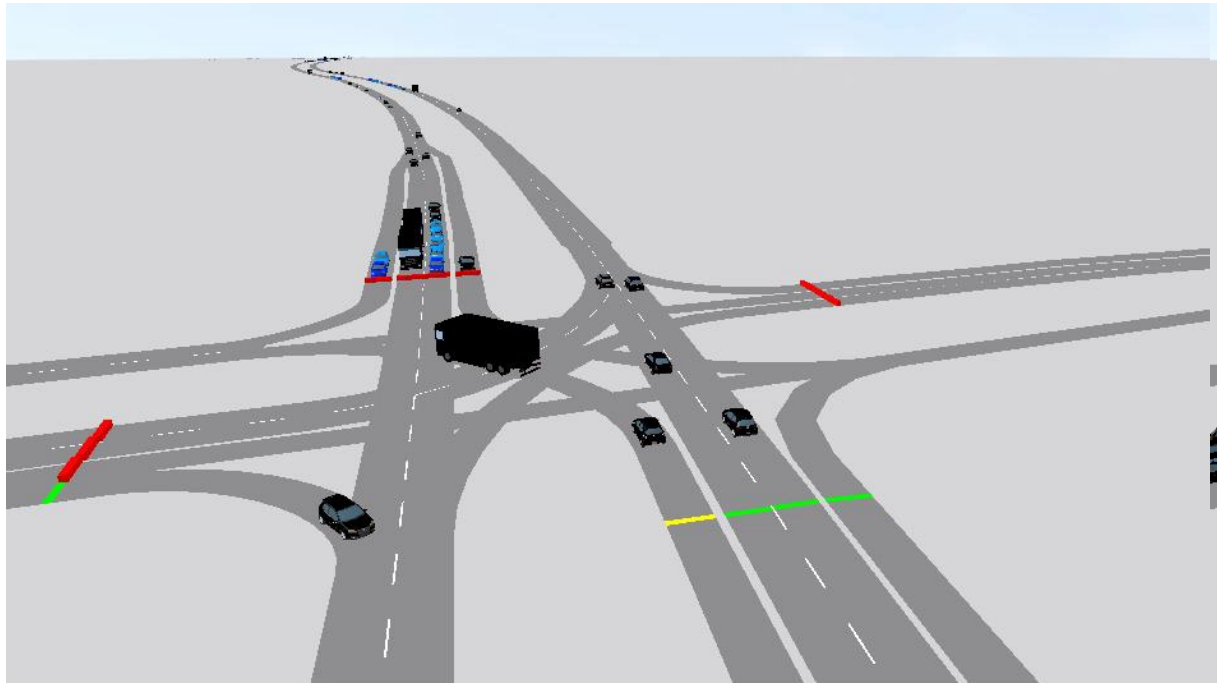
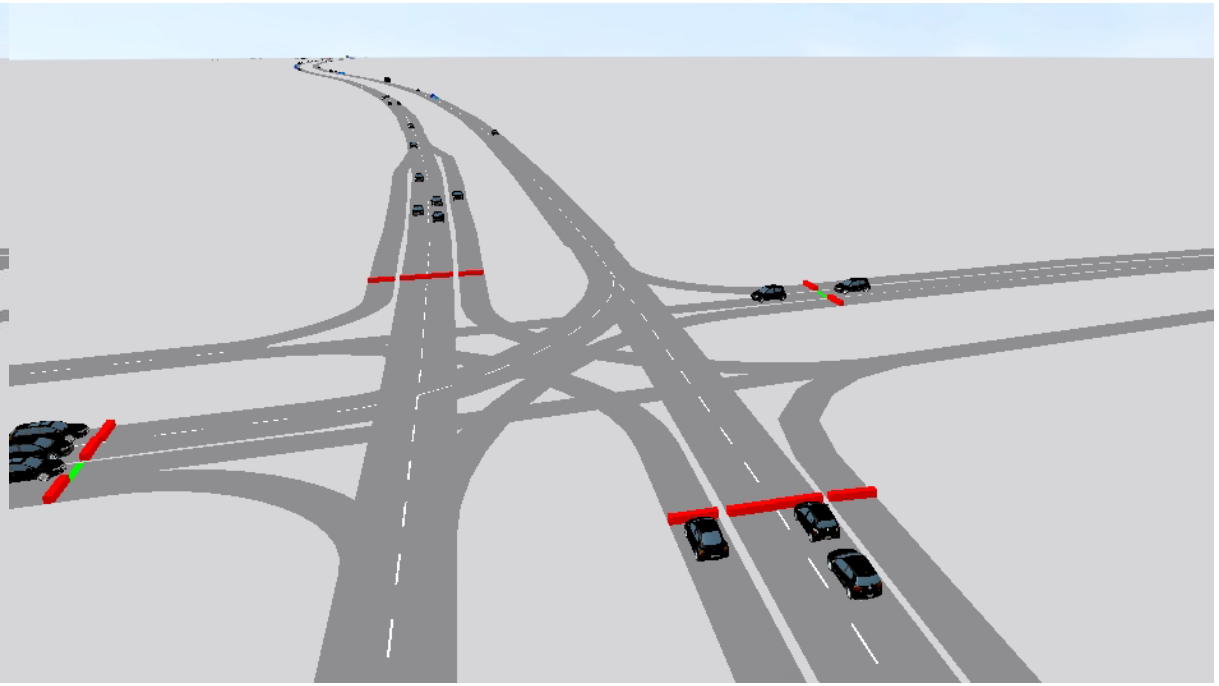
# Measure 1 Platooning

# Measure 2 Platooning







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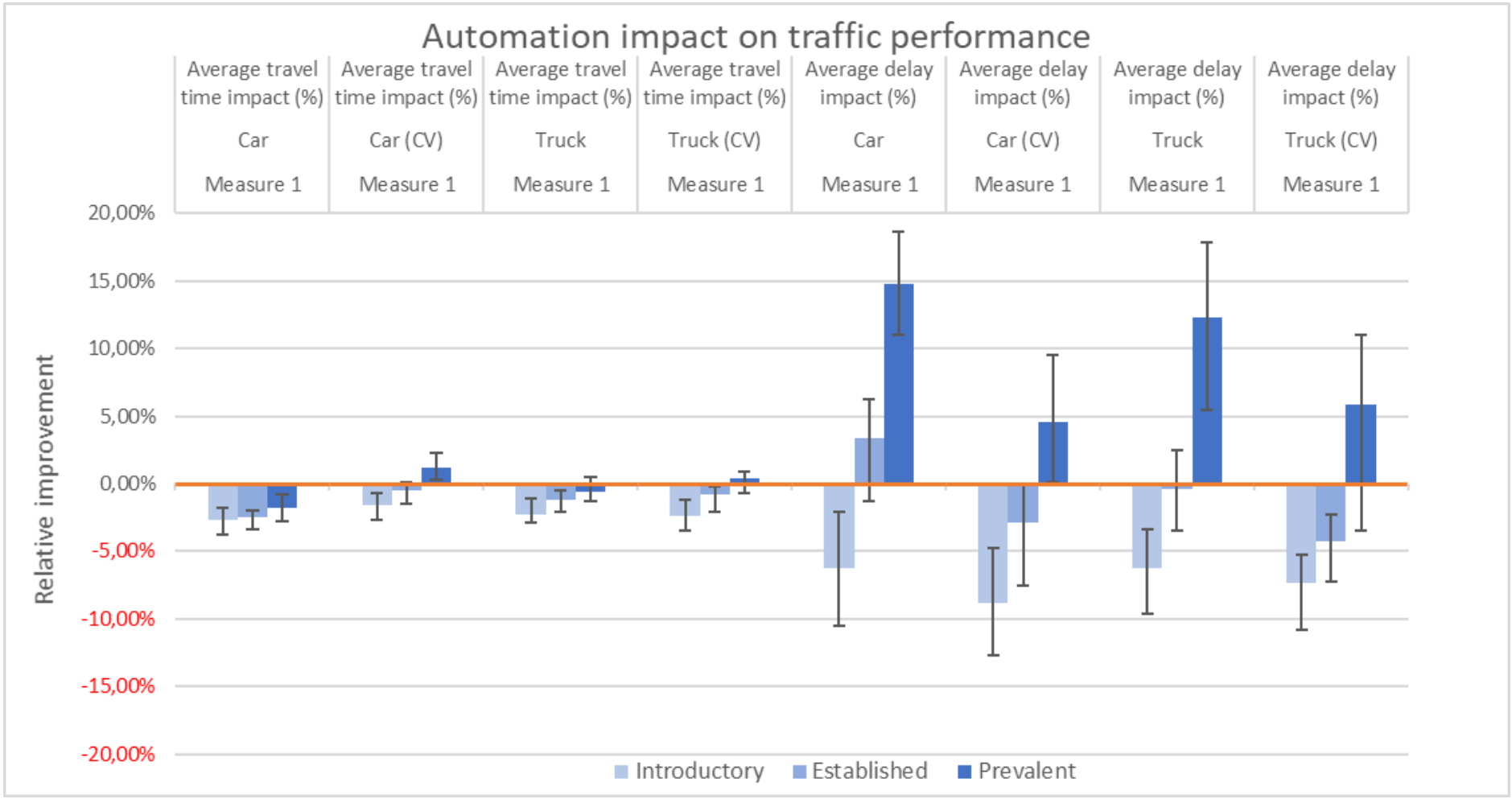
# Measure 1: Platooning on highway and arterial



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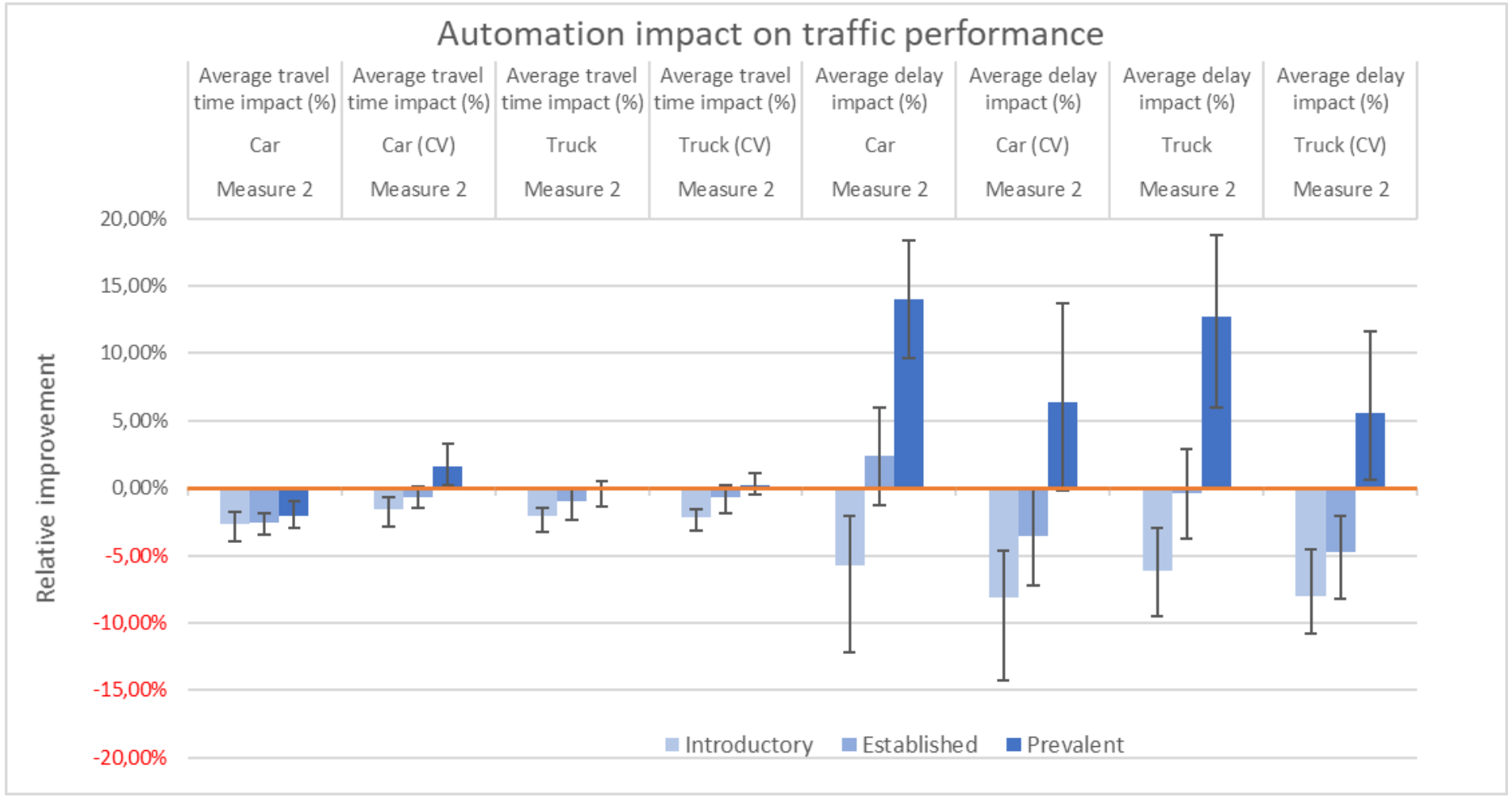
# Measure 2: Platooning only on right lane



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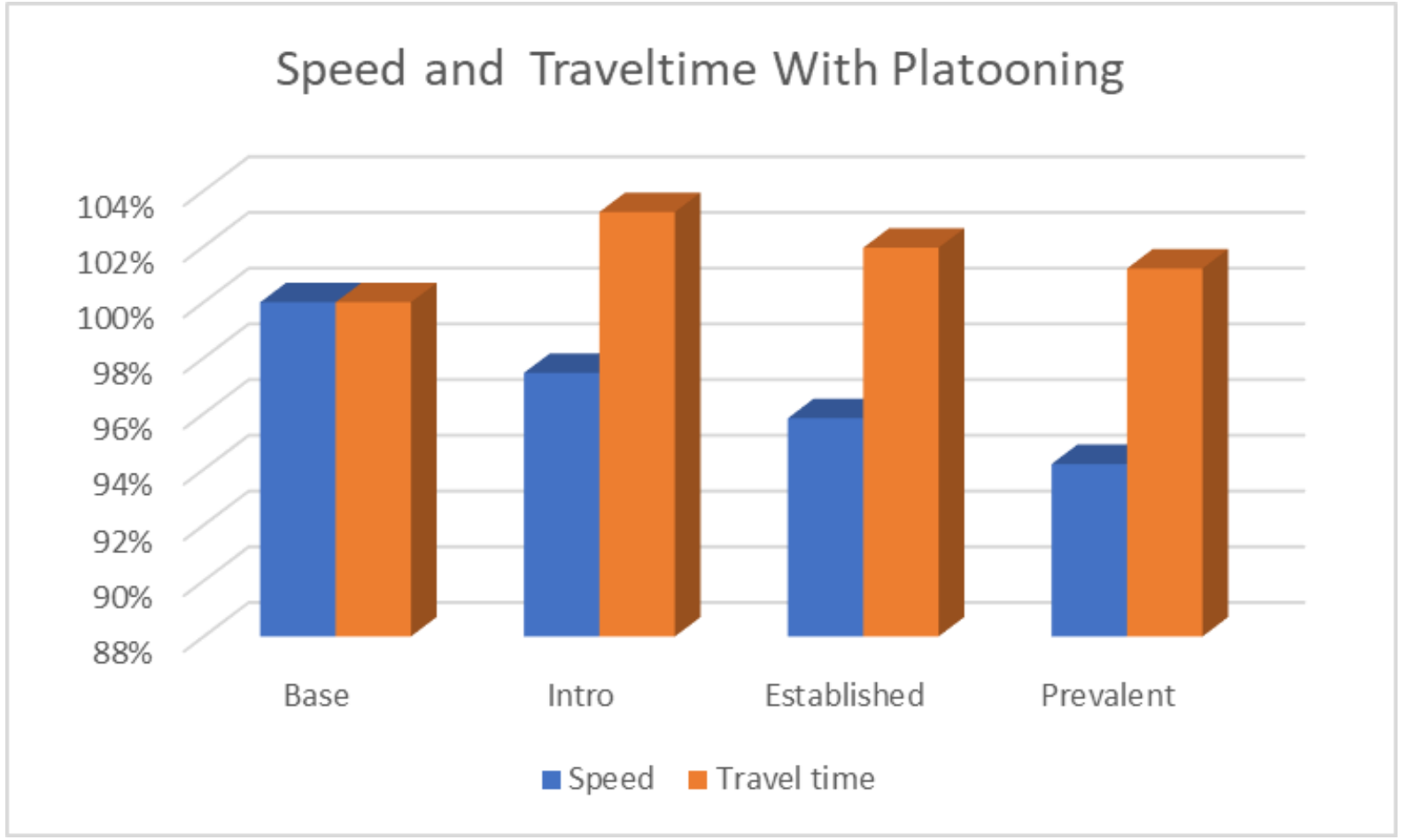




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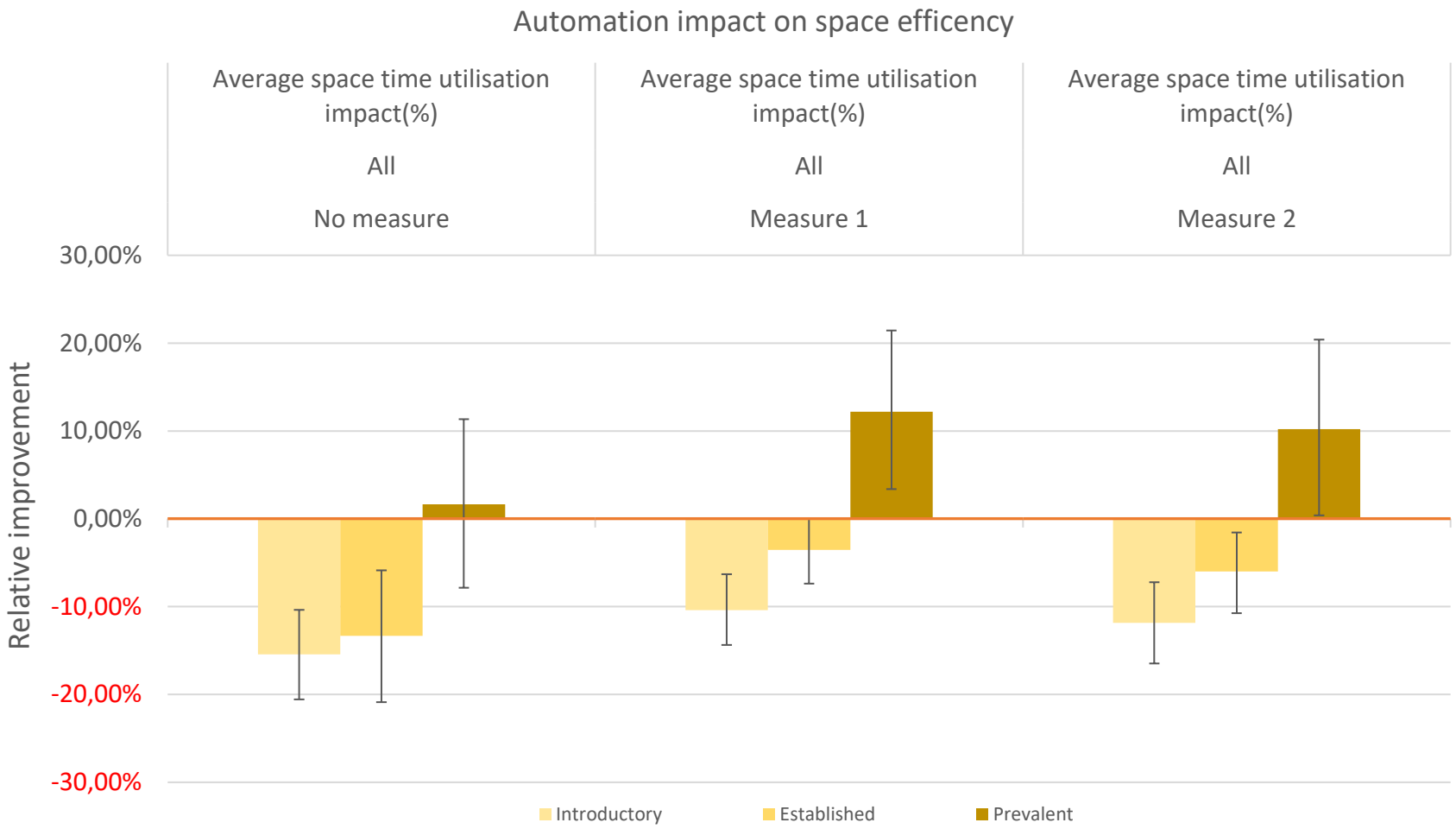
# The impacts of AVs on Space Efficiency

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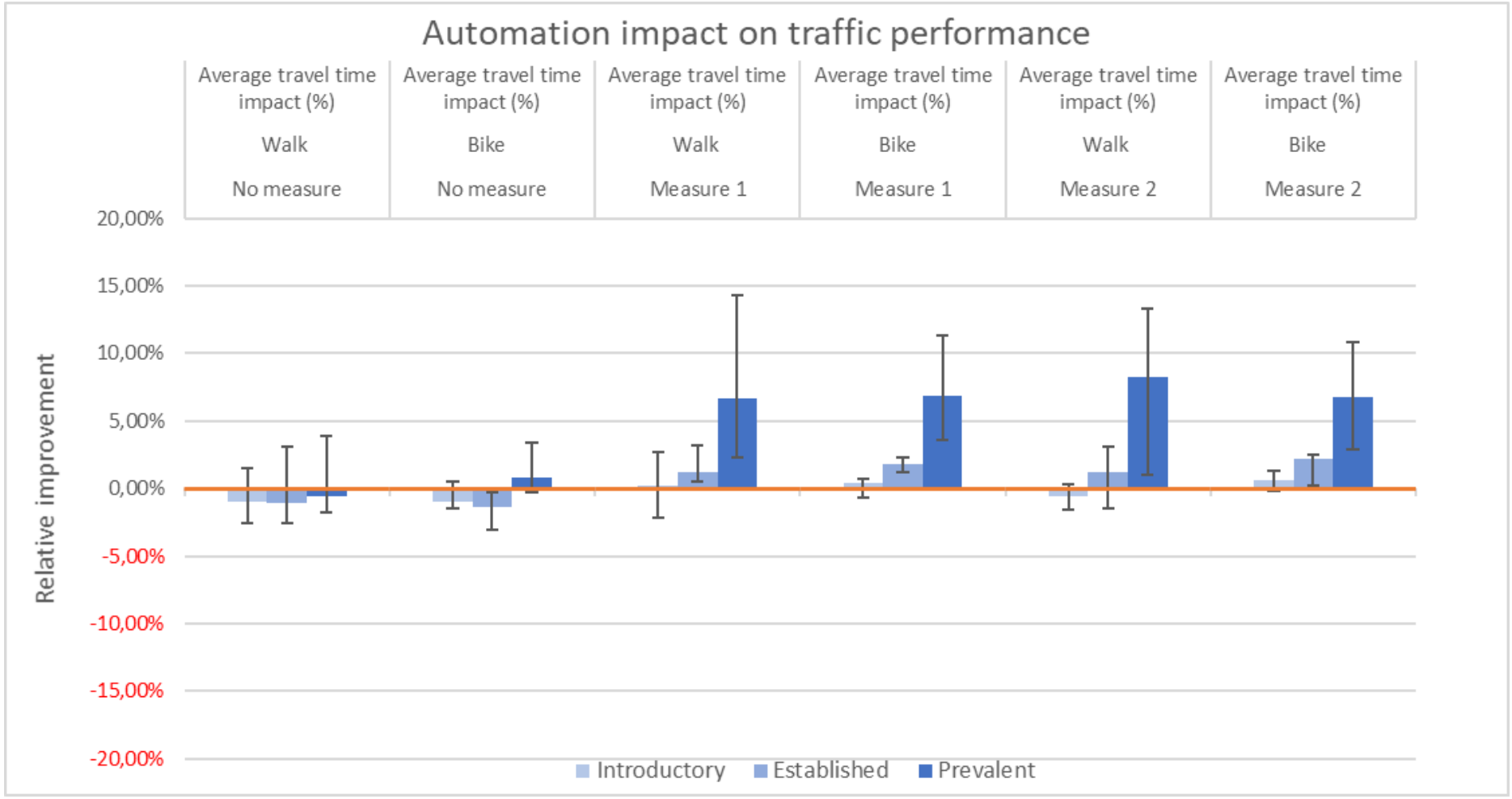
# Traffic Performance Cyclists and Pedestrians



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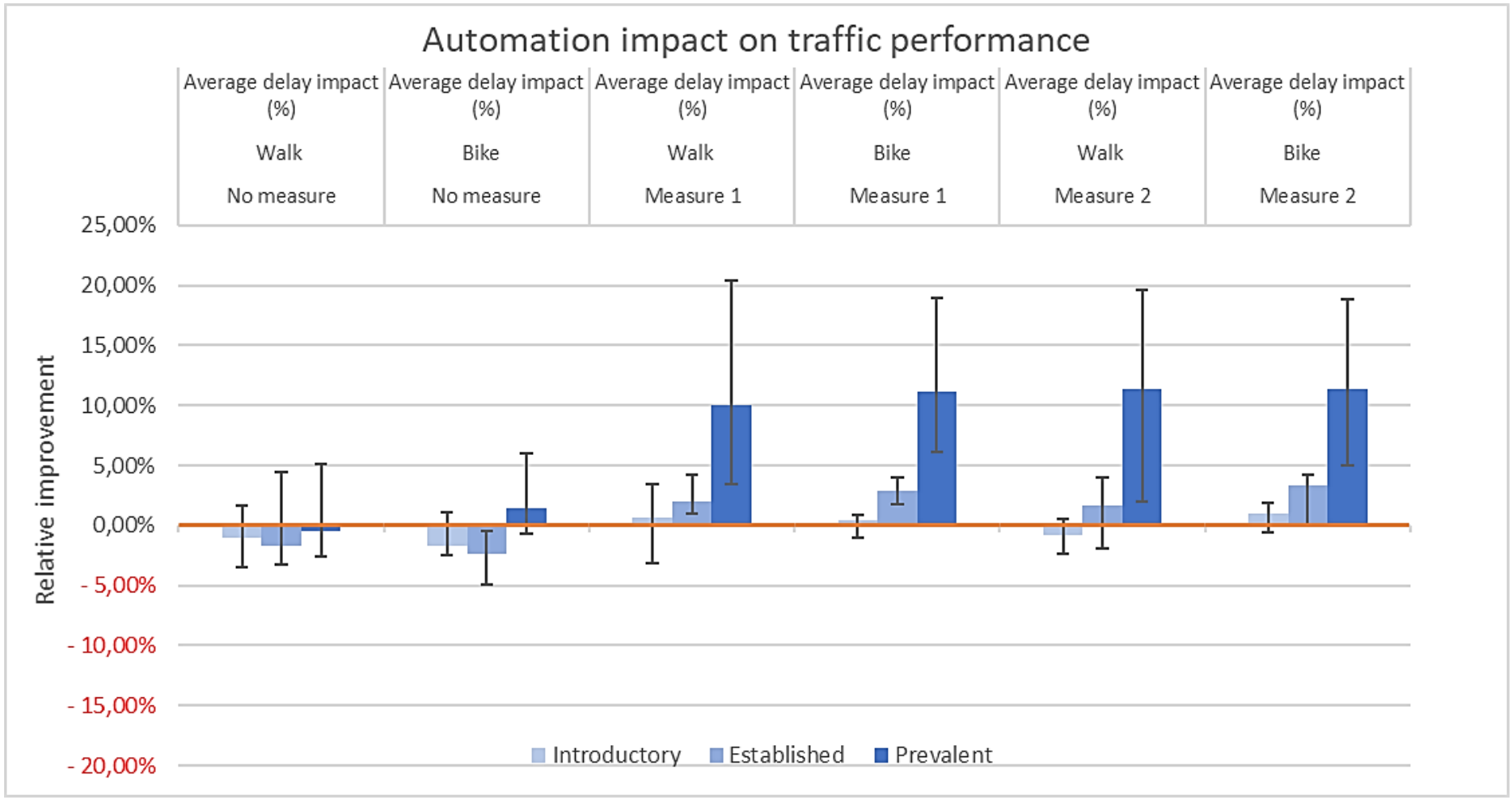




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# Conclusions

- Travel time increases for CAVs in comparison to conventional vehicles, given full speed-limit compliance.
- In the Introductory phase first also increased delay for vehicles due to ‘Cautious’ driving behaviour, and during the stages and AV’s becoming more sophisticated (like All-knowing behavior) there is a decrease for delay of all traffic.
- Enabling platooning, in both measures, resulted in consequently slightly shorter delays, but also similar increases in travel times (again, due to speed limit compliance).
- Because of less delay and better space efficiency there could be time to reallocate green at the intersections depending on city policy.



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## Poll question

**When do you expect a noticeable effect from AVs on the road (in your city)?**

- Before 2025
- Before 2035
- Before 2050
- After 2050

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# Gothenburg: Use case 1 & 2

Iman Pereira, VTI
Chengxi Liu, VTI
Fredrik Johansson, VTI
Johan Olstam, VTI

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# Use case 1: Shared space

- Shared space in Gothenburg city center
  - Large volumes of pedestrian traffic
  - Small volumes of car traffic

- Research questions
  - Effects of introducing an automated last mile service?
    - Is it feasible?
    - Negative effects on pedestrians and conventional traffic?
  - Can the area be re-designed to improve performance of (automated) car traffic without worsening it for pedestrians?


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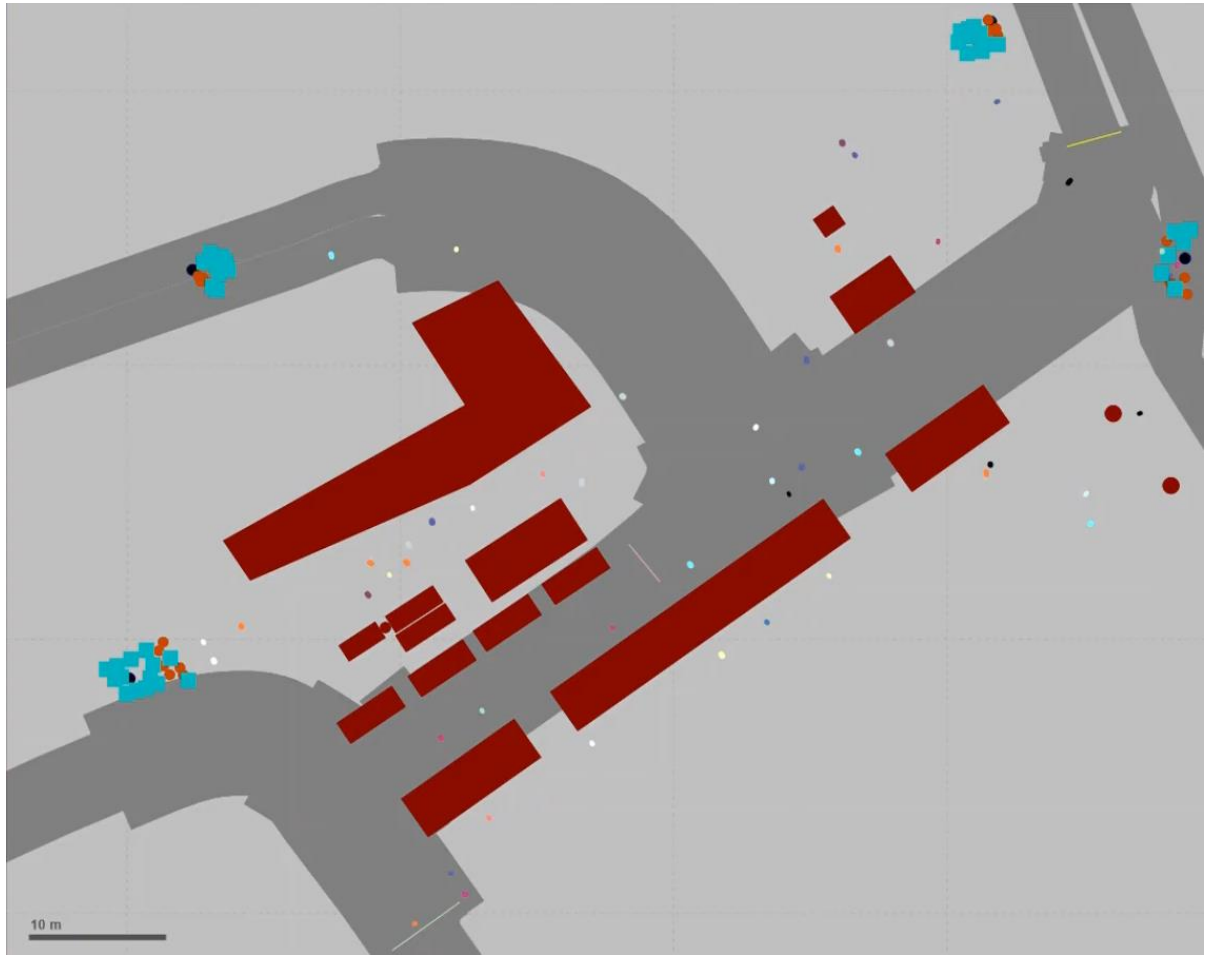
# The model

- Microscopic model including pedestrians and cars
- Advanced modelling of interaction between pedestrians and vehicles
  - Not directly using the driving logics implemented in Vissim



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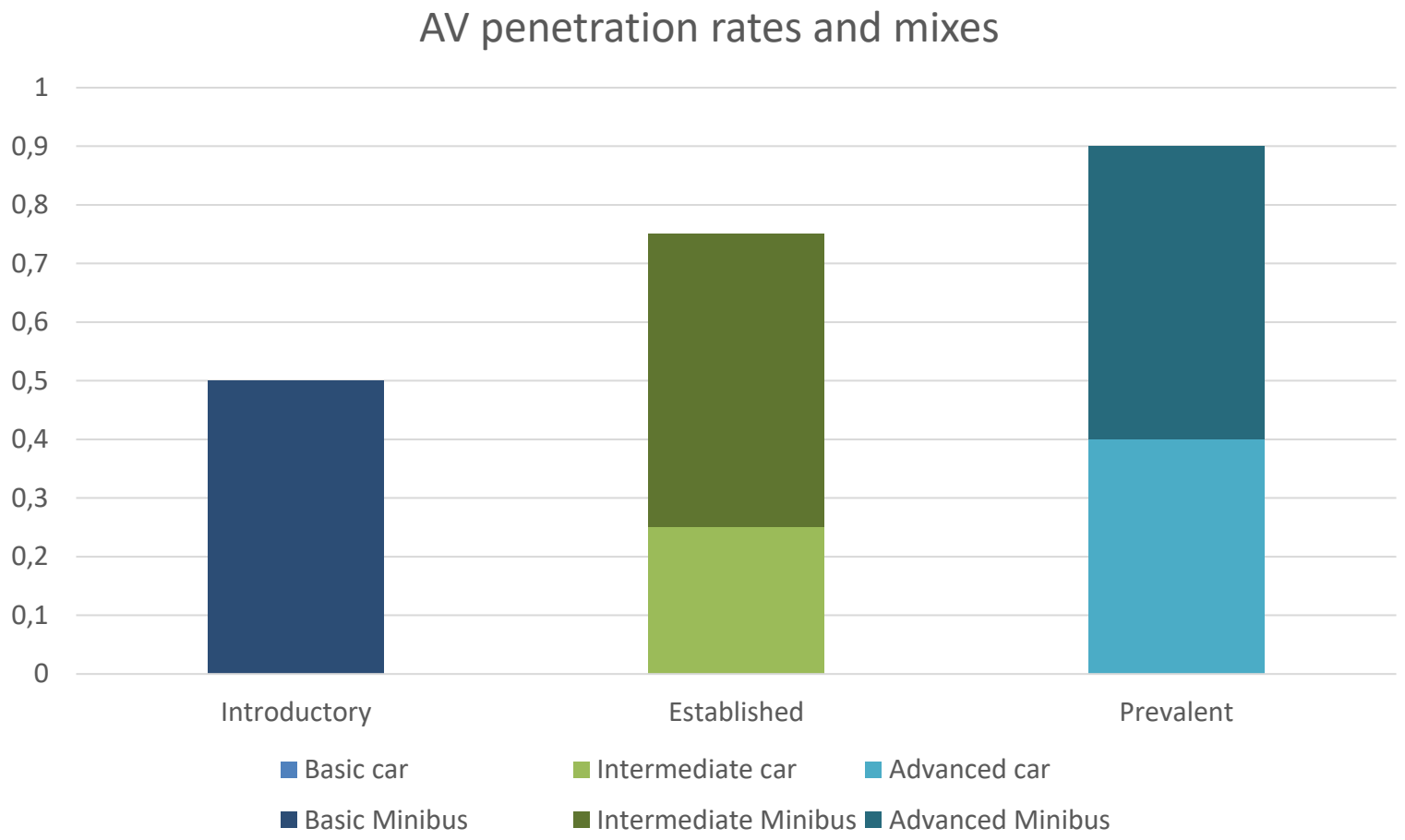
# Experimental design

- Uncertain factors
  - 3 demand configurations
  - 3 pedestrian populations
  - 1 Measure
  - 42 experiments



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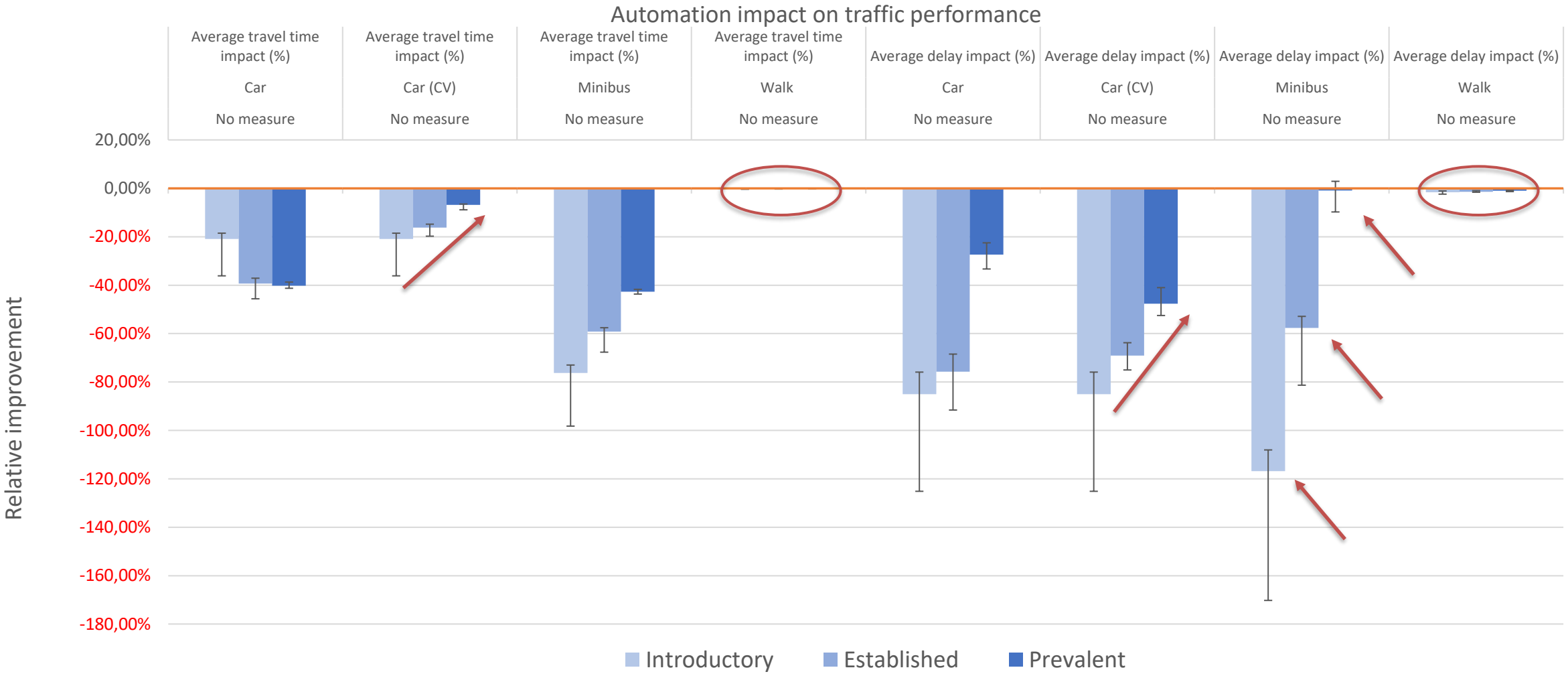
# The impacts of AVs on traffic performance



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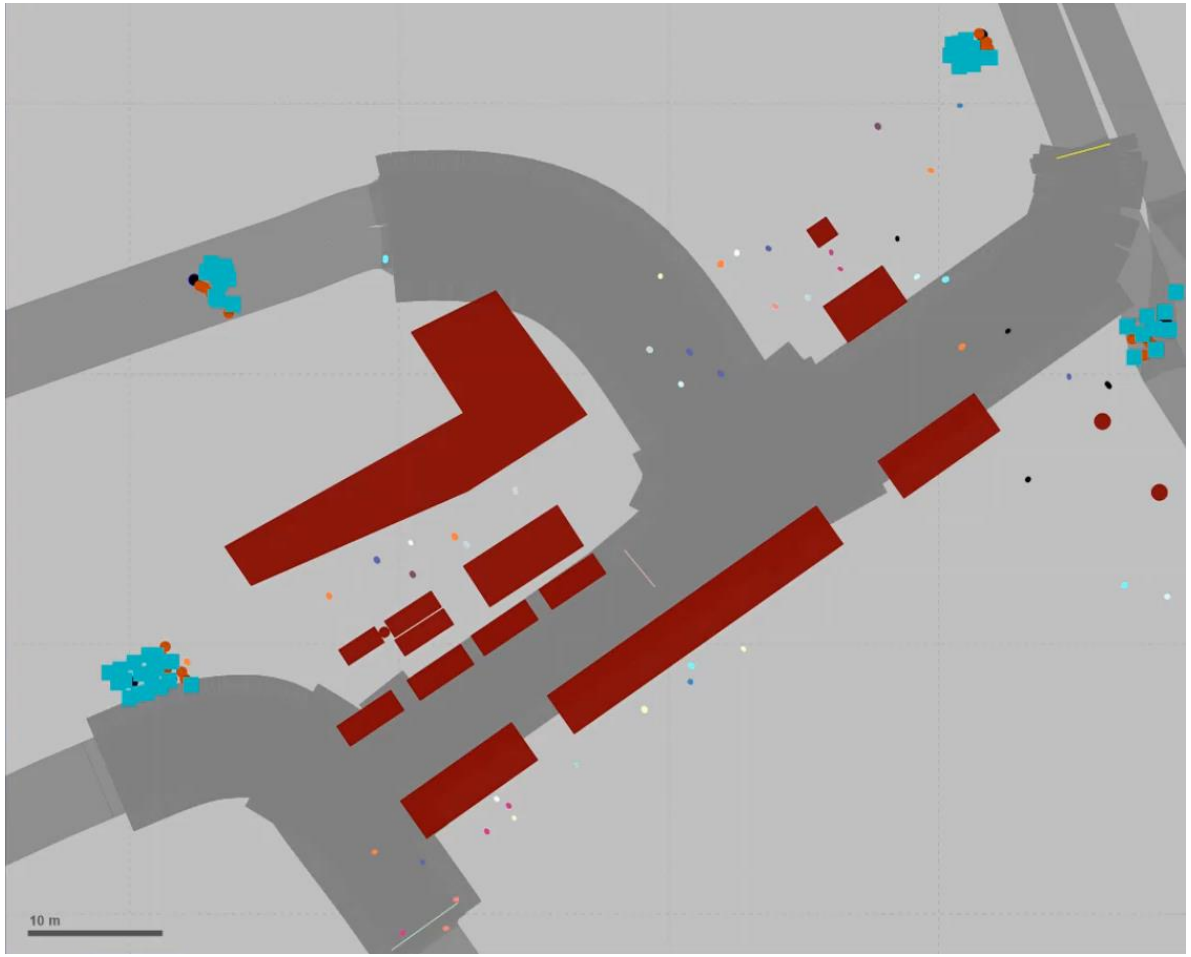
# Measure: Channelling of pedestrian flows

- Would a more traditional design with pedestrian crossings instead of shared space reduce the delay for AVs?

- Breakdown
  - Cueing out of the network
  - Traffic demand is not met



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# Safety assessment results

- Urban pilot
  - 24/79 accident types relevant for urban pilot and use case 1
  - Expected to increase safety substantially in 16/24 accident types
  - Expected to increase safety moderately in 8/24 accident types

| | Type of accident | Urban Pilot | | | |
|---|---|---|---|---|---|
| | | ☹ | 😐 | 🙂 | 😀 |
| 1 | Driving accident | | | | 2 |
| 2 | Turning off accident | | | | 1 |
| 3 | Turning-in / Crossing accident | | | | 1 |
| 4 | Pedestrian accident | | | 7 | 2 |
| 5 | Accident with parking vehicles | | | 1 | 6 |
| 6 | Accident in lateral traffic | | | | 3 |
| 7 | Other accident type | | | | 1 |



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# Conclusions

- Pedestrians are not affected by AVs
- AVs will be severely delayed by pedestrians until they become so advanced that they are as cautious as human drivers
- Channeling pedestrian flows to pedestrian crossings will cause a breakdown
- Automation can increase safety of pedestrians



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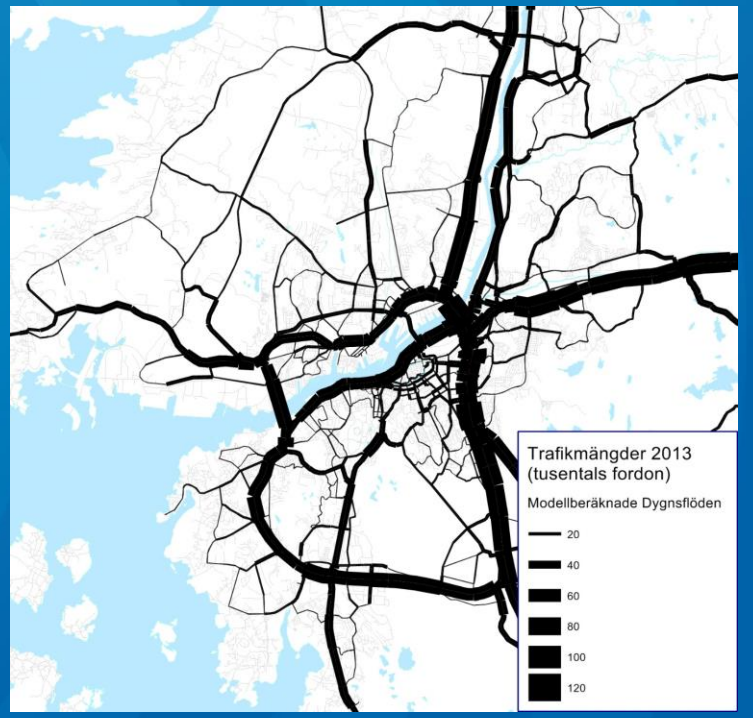
# Use case 2: Accessibility during long-term construction works, Gothenburg

- Study area
  - Gothenburg region: metropolitan + suburban/rural areas.
  - Severe congestions especially on motorways on peak hour.

- Research questions
  - How does the introduction of AVs affect the followings under the intensive construction period?
    - Route choice
    - Travel time saving and delay
  - At what penetration rates and which combinations of AV types can the following measures improve traffic performance?
    - Redesign of a one-directional tunnel tube to bi-directional AV only: Göta Tunnel.
    - Reserving a dedicated “Bus + AV” lane on the major motorways.



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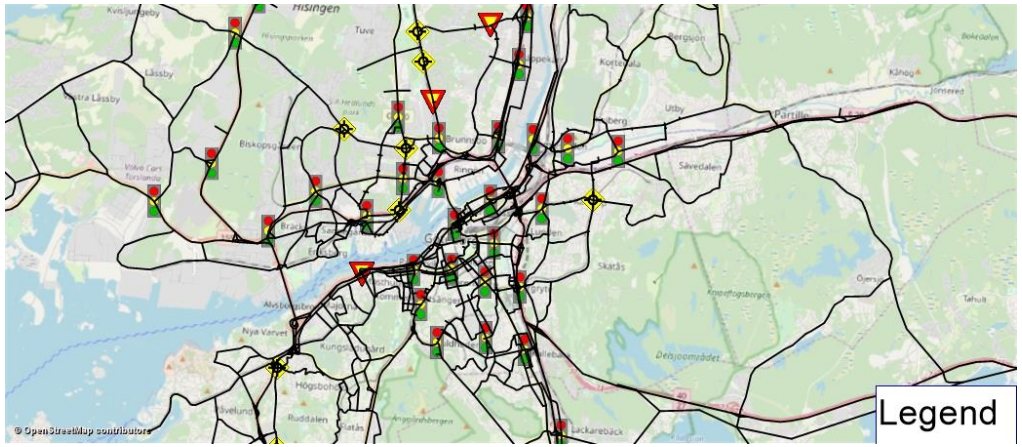
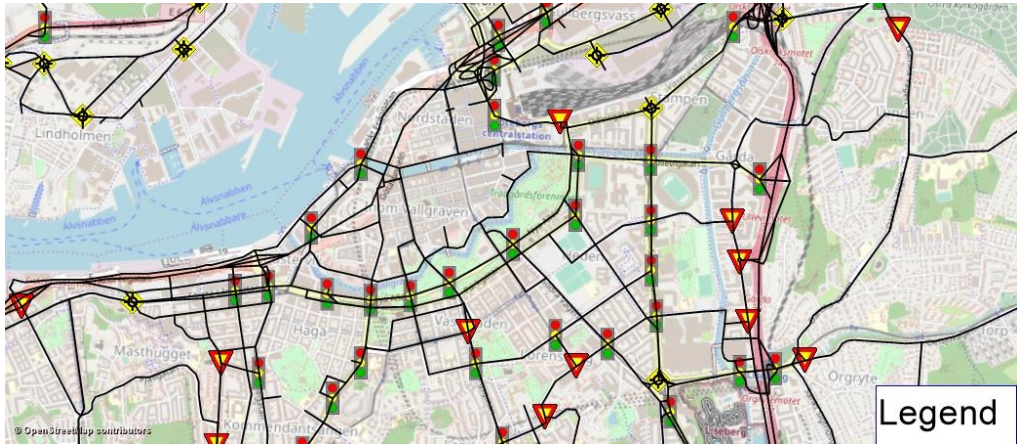
# Baseline model specification

- Route assignment model with detailed coding of intersection
- No consideration of modal shift
- Calibrated and validated against traffic in 2013/2014
- Used (other projects) to evaluate impacts of construction works.



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# Modelling of AVs

- Passenger Car Units (PCU)

**Passenger car units (PCU)**



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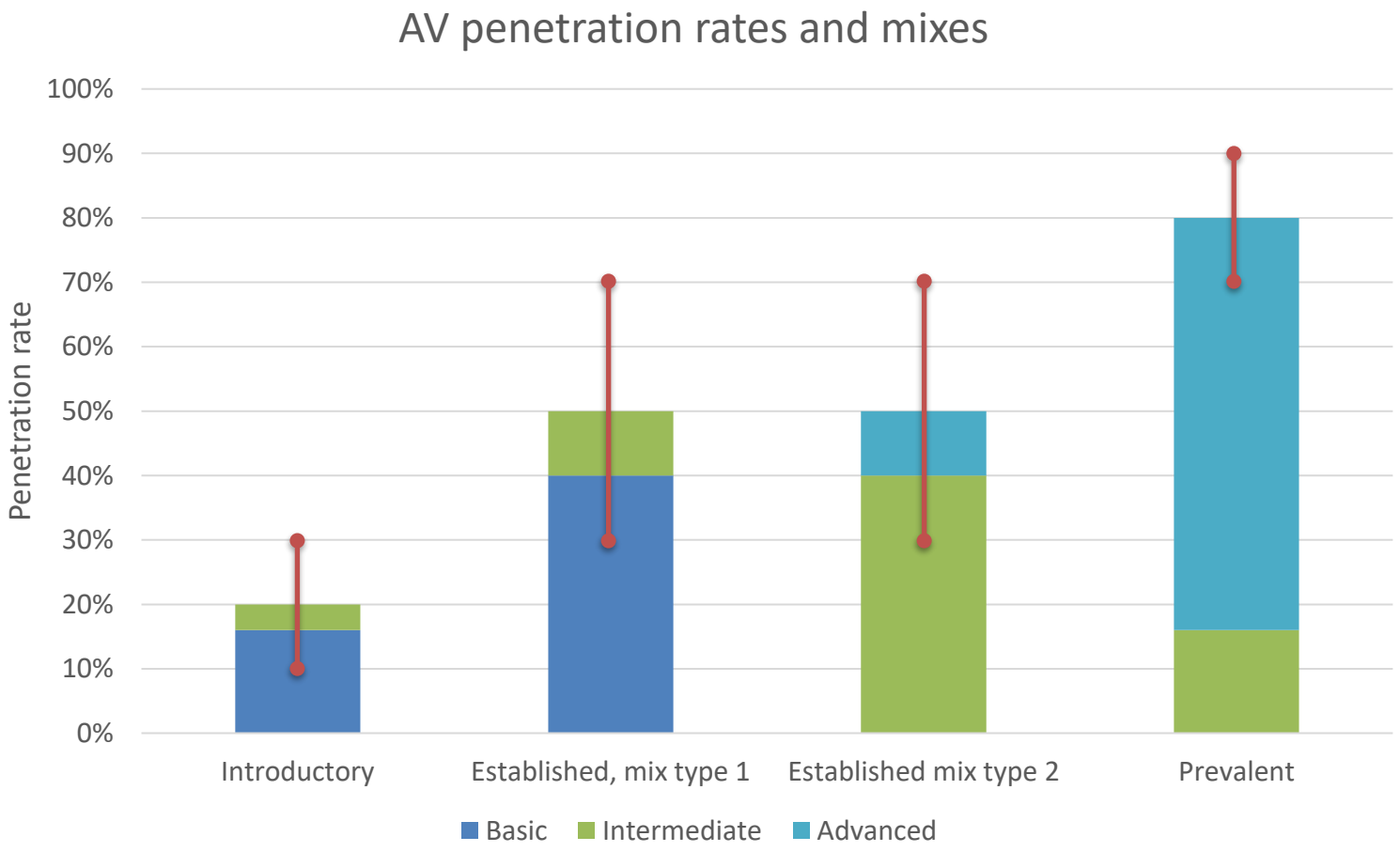
# Experimental design

- Uncertainty factors
  - Penetration rates
  - AV mixes
  - Demand
- Use case 2
  - 2 demand configurations
  - 60 experiments



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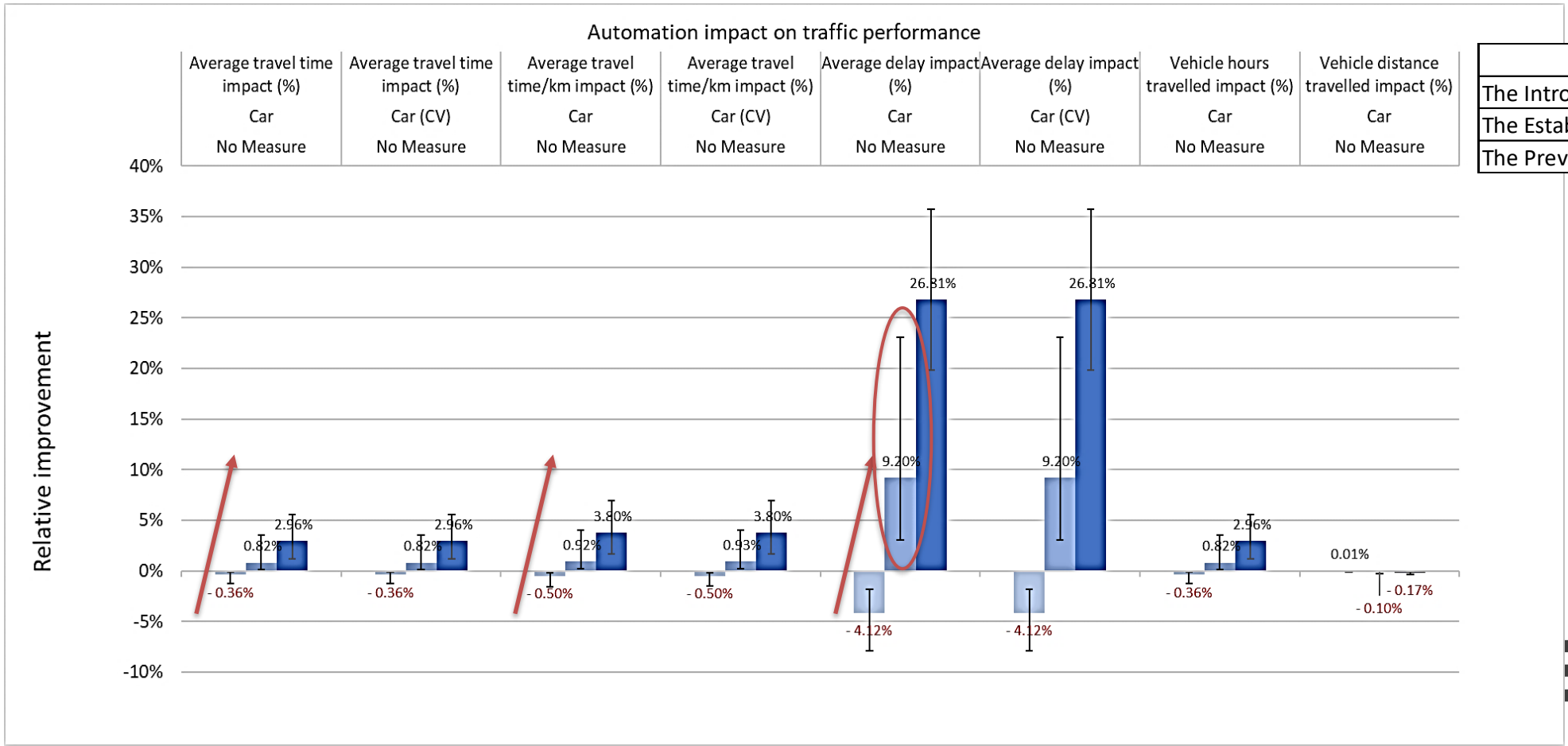
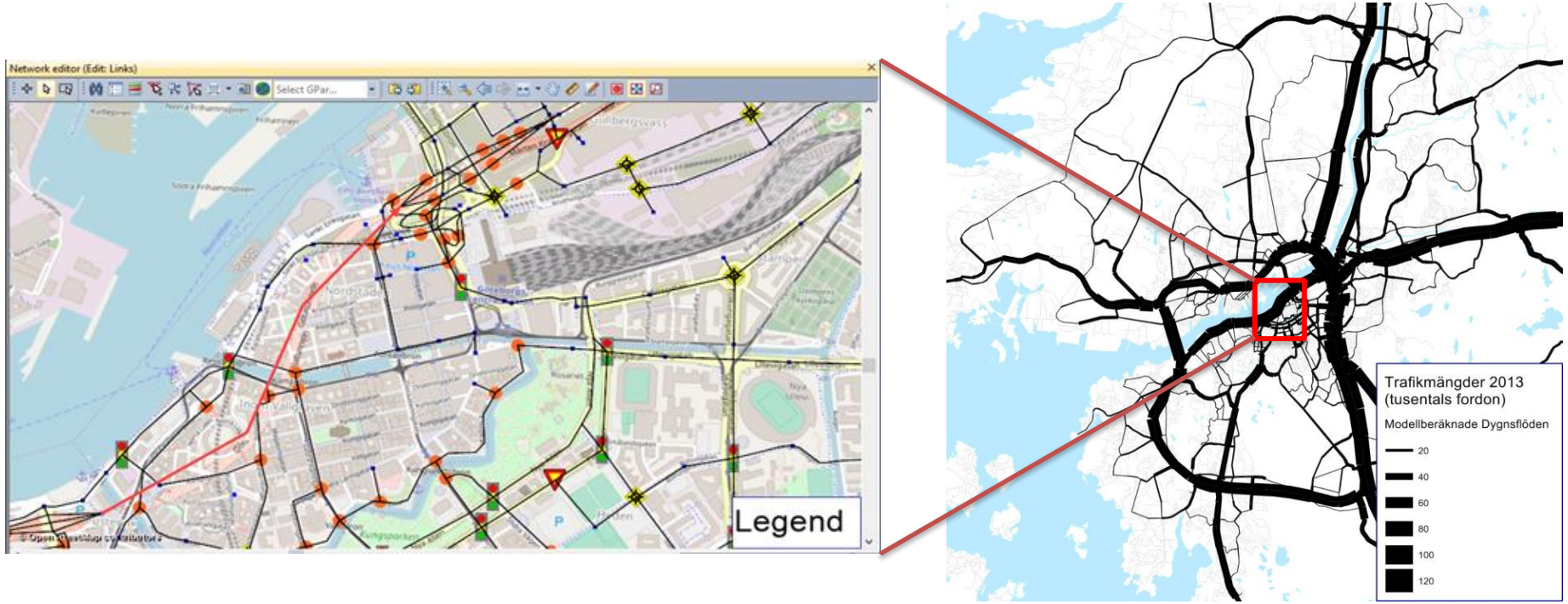
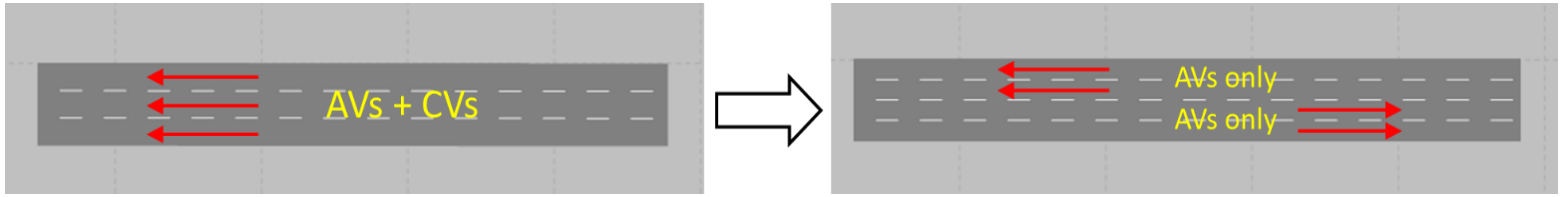
# The impacts of AVs on traffic performance

- Introductory (-); Established (++); Prevalent (+++)
- Large variation in the Established stage.
- No change in car vehicle km travelled → modal shift not considered.



# Measure 1: Two-way AV-only tunnel tube



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# Measure 1: Two-way AV-only tunnel tube

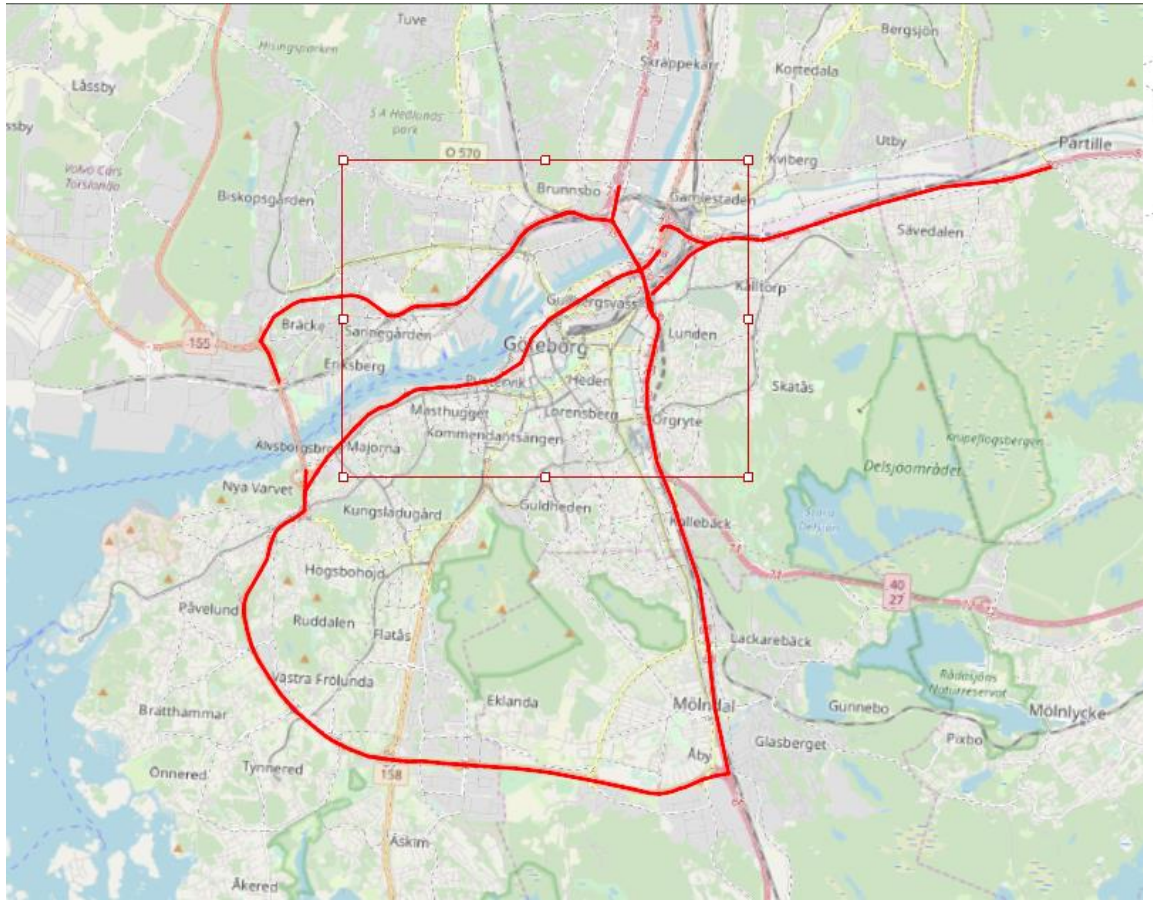
- Introductory (-); Established (+); Prevalent (++)
- Slight improvement in travel time and delay for CVs in Established and Prevalent stages.
  - Route shifts

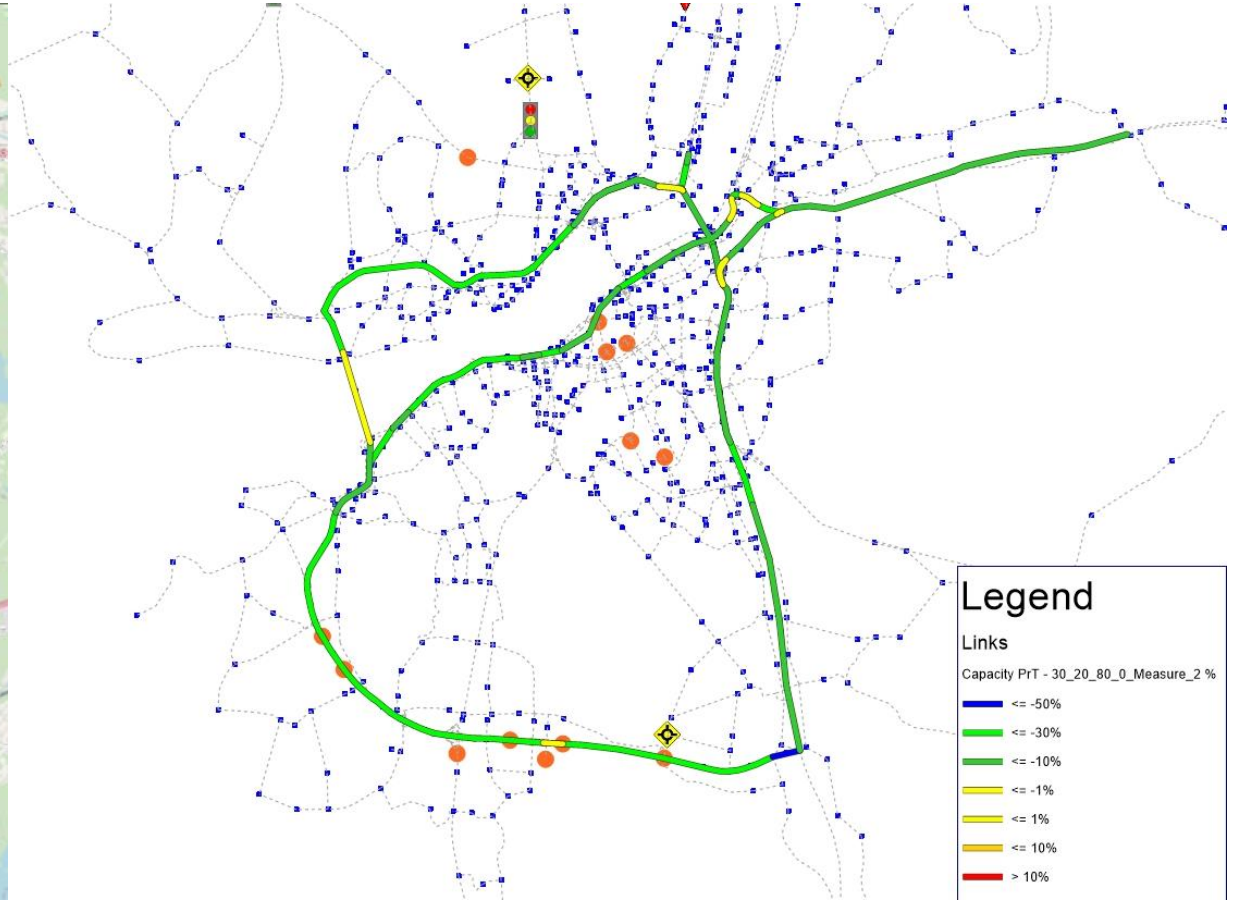
| Legend | |
|---|---|
| The Introductory stage | |
| The Established stage | |
| The Prevalent stage | |

Automation impact on traffic performance

| | Average travel time impact (%) | Average travel time impact (%) | Average travel time/km impact (%) | Average travel time/km impact (%) | Average delay impact (%) | Average delay impact (%) |
|---|---|---|---|---|---|---|
| | Car | Car | Car | Car | Car | Car |

# Measure 2: Reserved bus and AV lane on the motorway network



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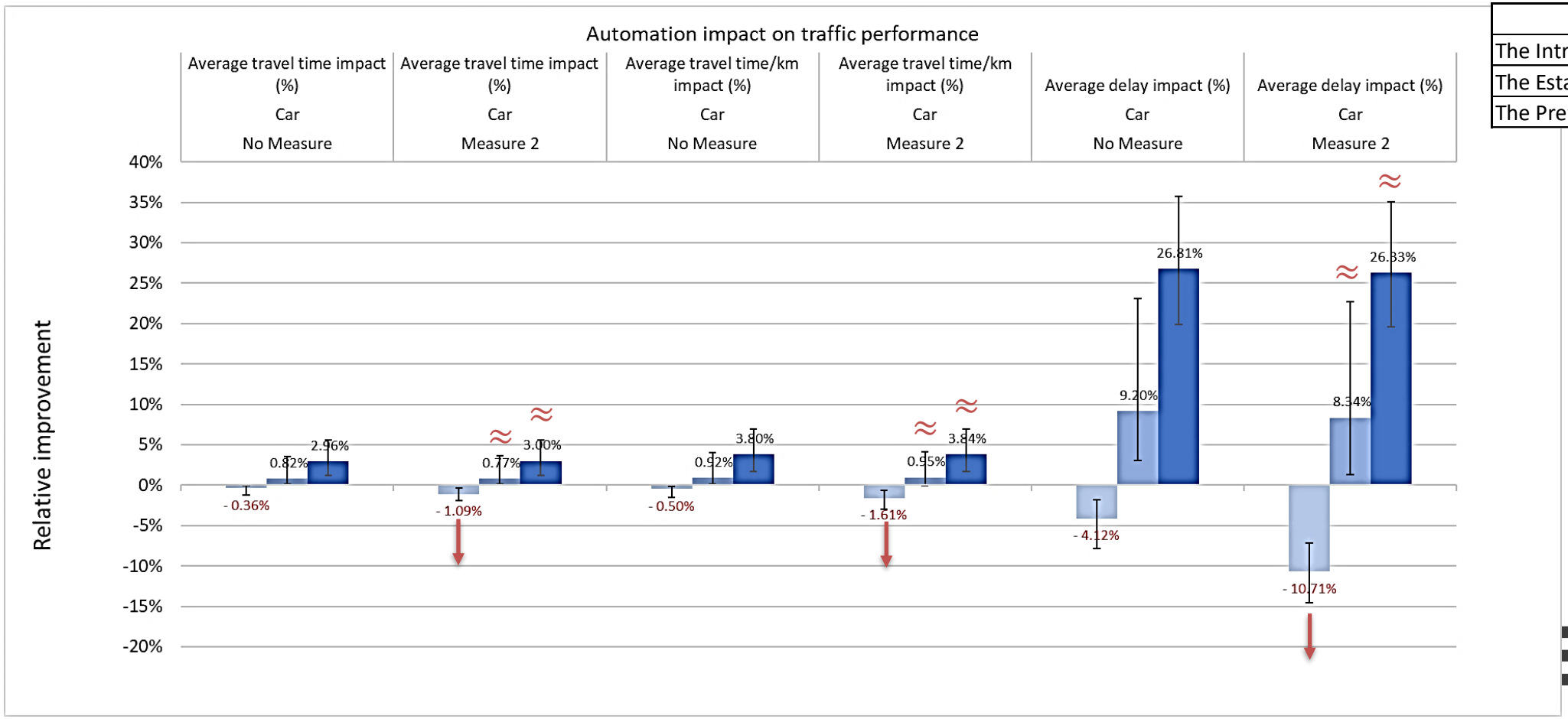
# Measure 2: Reserved bus and AV lane on the motorway network

- Introductory (-); Established (0); Prevalent (0)
- Travel time and delay of buses
  - Introductory stage (-); Established and Prevalent stages (+)

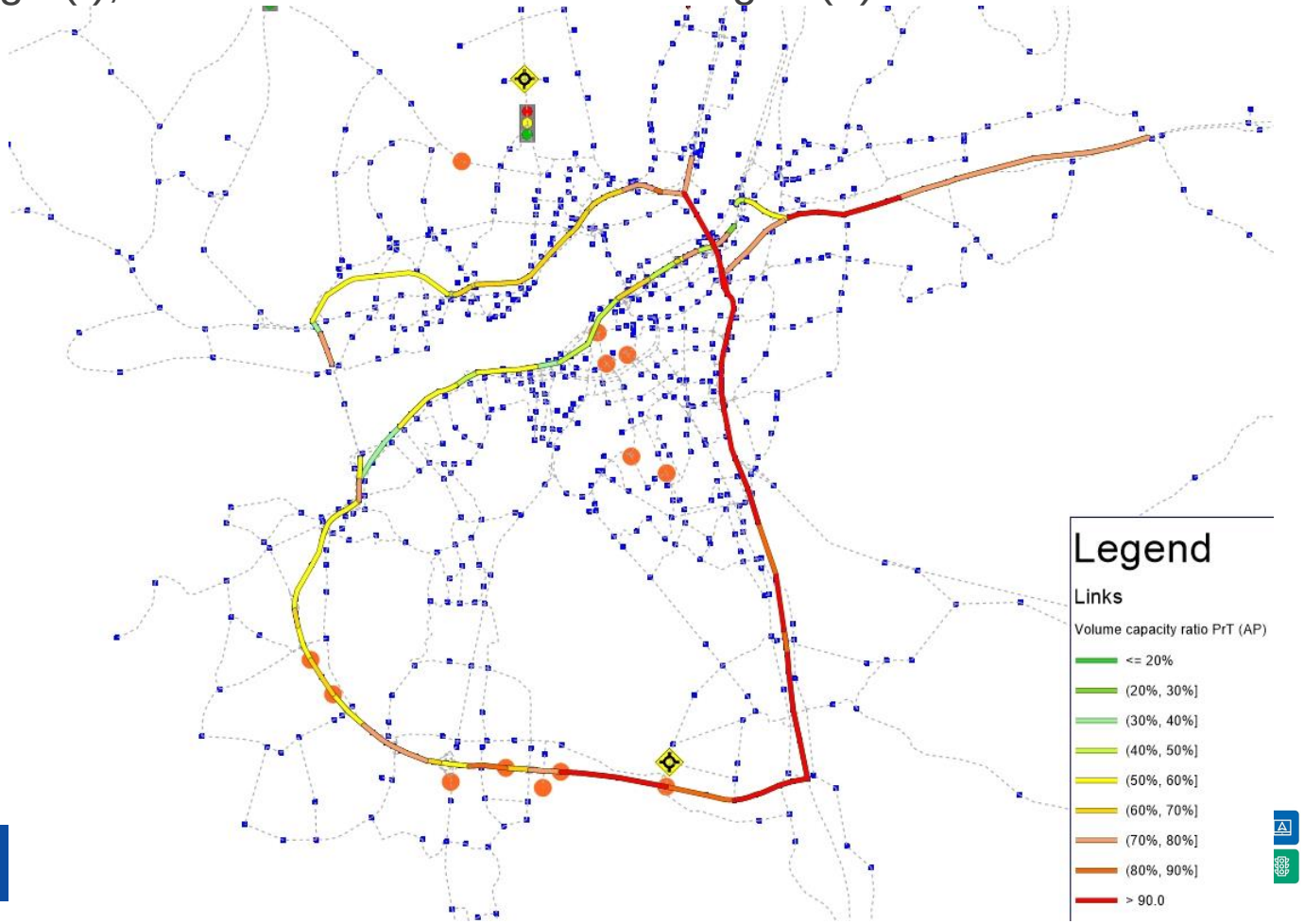



| Legend | |
|---|---|
| The Introductory stage | |
| The Established stage | |
| The Prevalent stage | |

EXist

# Measure 2: Reserved bus and AV lane on the motorway network

- Introductory (-); Established (0); Prevalent (0)
- Travel time and delay of buses
  - Introductory stage (-); Established and Prevalent stages (+)



# Conclusions

- The impacts of AVs on traffic performance
  - Introductory (-); Established (++); Prevalent (+++)
  - Large variation in the Established stage.
  - No change in car vehicle km travelled → modal shift not considered.
- Measure 1: Two-way AV-only tunnel tube
  - Introductory (-); Established (+); Prevalent (++)
  - Slight decrease in travel time and delay for CVs
- Measure 2: Reserved bus and AV lane on the motorway network
  - Introductory (-); Established (0); Prevalent (0)
  - Travel time and delay of buses: Introductory stage (-); Established and Prevalent stages (+)



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## Poll question

**How would you, as a pedestrian, act in the vicinity of automated minibuses in a shared space area? I would:**

- Have full trust in technology, assuming that they will "see"
- Behave as I do today
- Make sure that AVs "see" me before I cross their path
- Trust, but avoid crossing AVs paths as much as possible

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# CoEXist Virtual Final Conference - Part 1:
## Automation-ready tools and impact assessment findings

### Wednesday 25 March 2020

*CET (UTC+01:00)* — ***Moderator:*** *Siegfried Rupprecht, Rupprecht Consult*

13:45 Registration and technical support

**14:00** **Welcome**, Siegfried Rupprecht, *Rupprecht Consult* & INEA (tbc)

**Introduction to CoEXist**, *Daniel Franco, Rupprecht Consult*

**CoEXist tools**

Automation-ready transport modelling and infrastructure assessment

**14:10** **Overview of the CoEXist impact assessment approach and automation-ready transport (infrastructure) assessment tool**, *Johan Olstam, VTI*

14:25 Polls - Q&A

**14:30** **Automation-ready modelling tools: microscopic traffic flow simulation**, *Charlotte Fléchon, PTV Group*

14:45 Polls - Q&A

**14:50** **Automation-ready modelling tools: macroscopic travel demand simulation**, *Markus Friedrich, University of Stuttgart*

15:05 Polls - Q&A

**15.10** **Toward the Development of Analysis, Modelling, and Simulation (AMS) Tools for Connected and Automated Vehicles (CAVs),**
Rachel James, USDOT Federal Highway Administration (FHWA)

15:25 Polls - Q&A

15:30 *Break*

**CoEXist impact assessment findings**

Potential impact of vehicle automation in four cities, across eight scenarios:

**15:45** **Helmond (NL): (i) multimodal signalised intersection and (ii) highway-urban road transition**, *Frank van den Bosch, city of Helmond*

16:00 Polls - Q&A

**16:05** **Gothenburg (SE): (i) shared space; (ii) accessibility during long-term roadworks**, *Iman Pereira & Chengxi Liu, VTI*

16:20 Polls - Q&A

**16:25** **Milton Keynes (UK): (i) drop off and waiting for passengers; (ii) priority at roundabouts**, *John Miles, University of Cambridge*

16:40 Polls - Q&A

**16:45** **Stuttgart (DE): (i) network level travel time & mode choice; (ii) ridesharing**, *Jörg Sonnleitner, University of Stuttgart*

17:00 Polls – Q&A

**17:05** **Lessons learnt & conclusions,** *Wolfgang Backhaus, Rupprecht Consult*



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## Use Cases 5 & 6

Ammar Anwar
Brian Matthews
John Miles

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# Agenda

- Introduction
- Traffic Modelling Background
- Use Case 5 – A city-scale simulation
- Use Case 6  - An arterial road intersection (roundabout)



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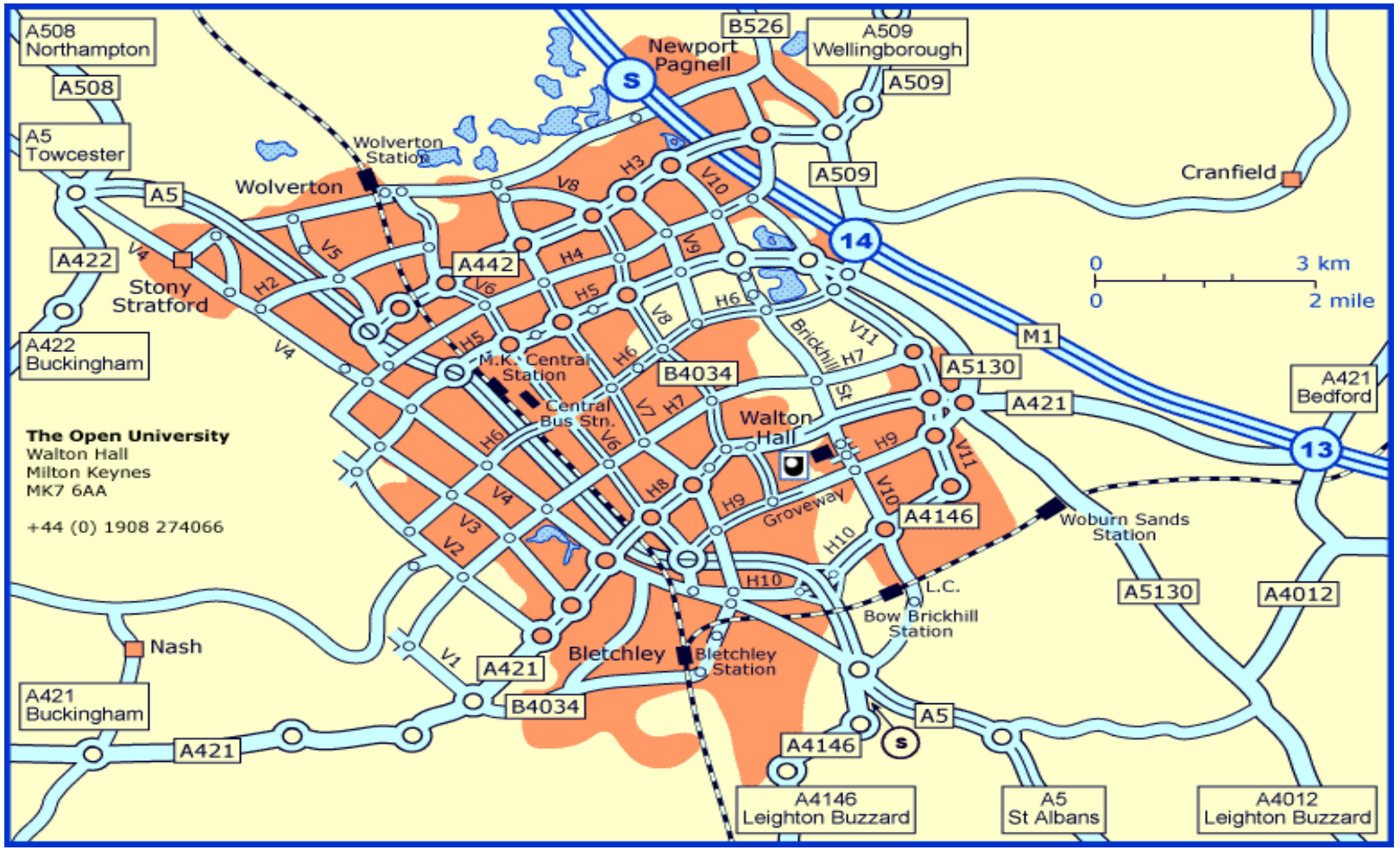
# Introduction



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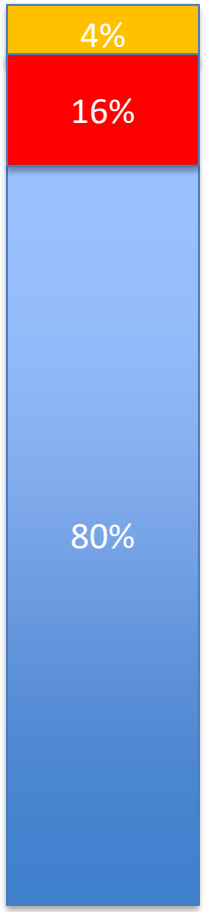
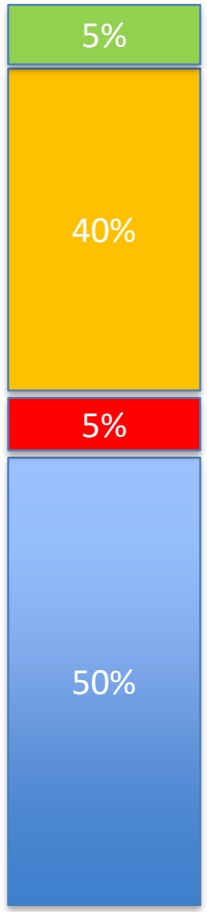
# Traffic Modelling Background

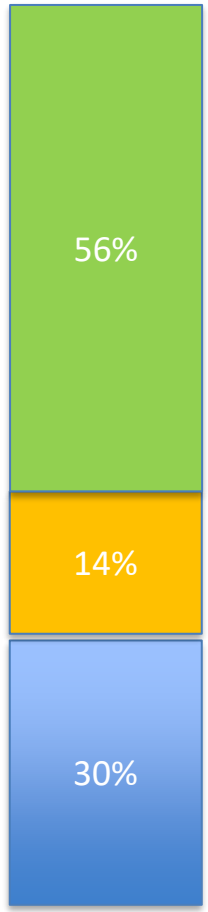
Traffic Density



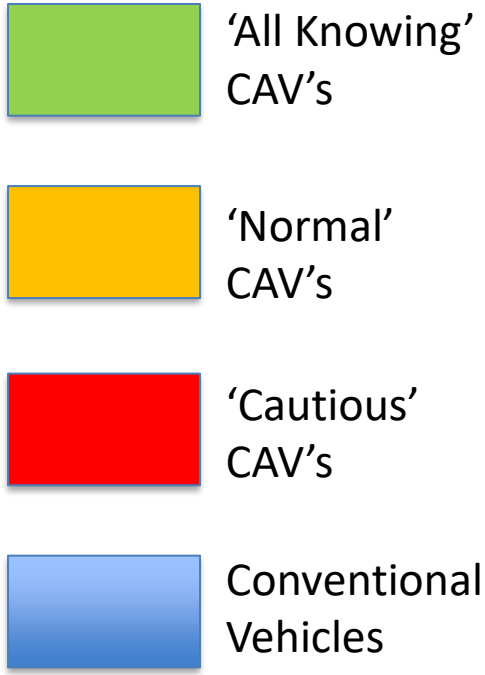

Introductory Stage




Established Stage




Prevalent Stage





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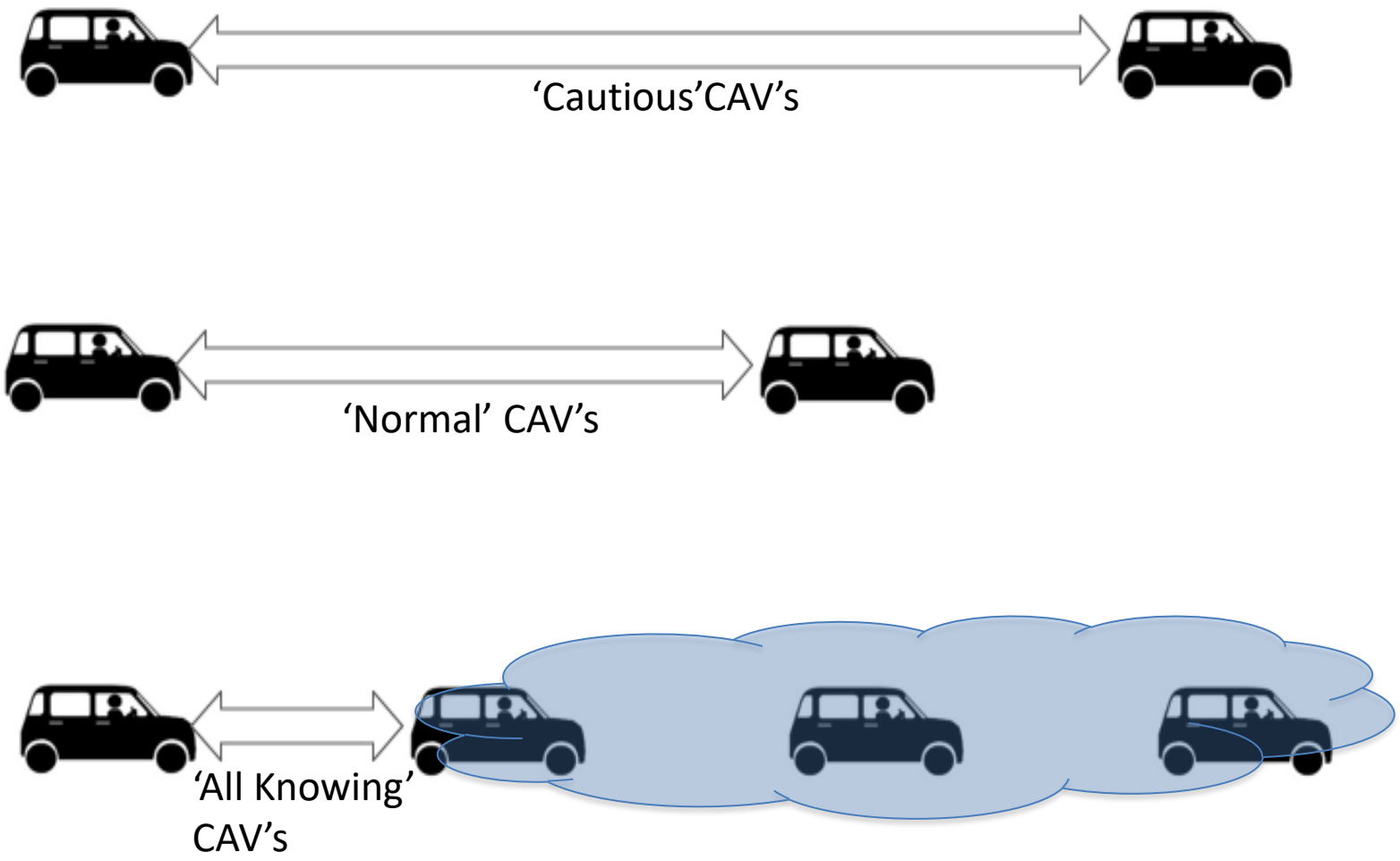
# Traffic Modelling Background



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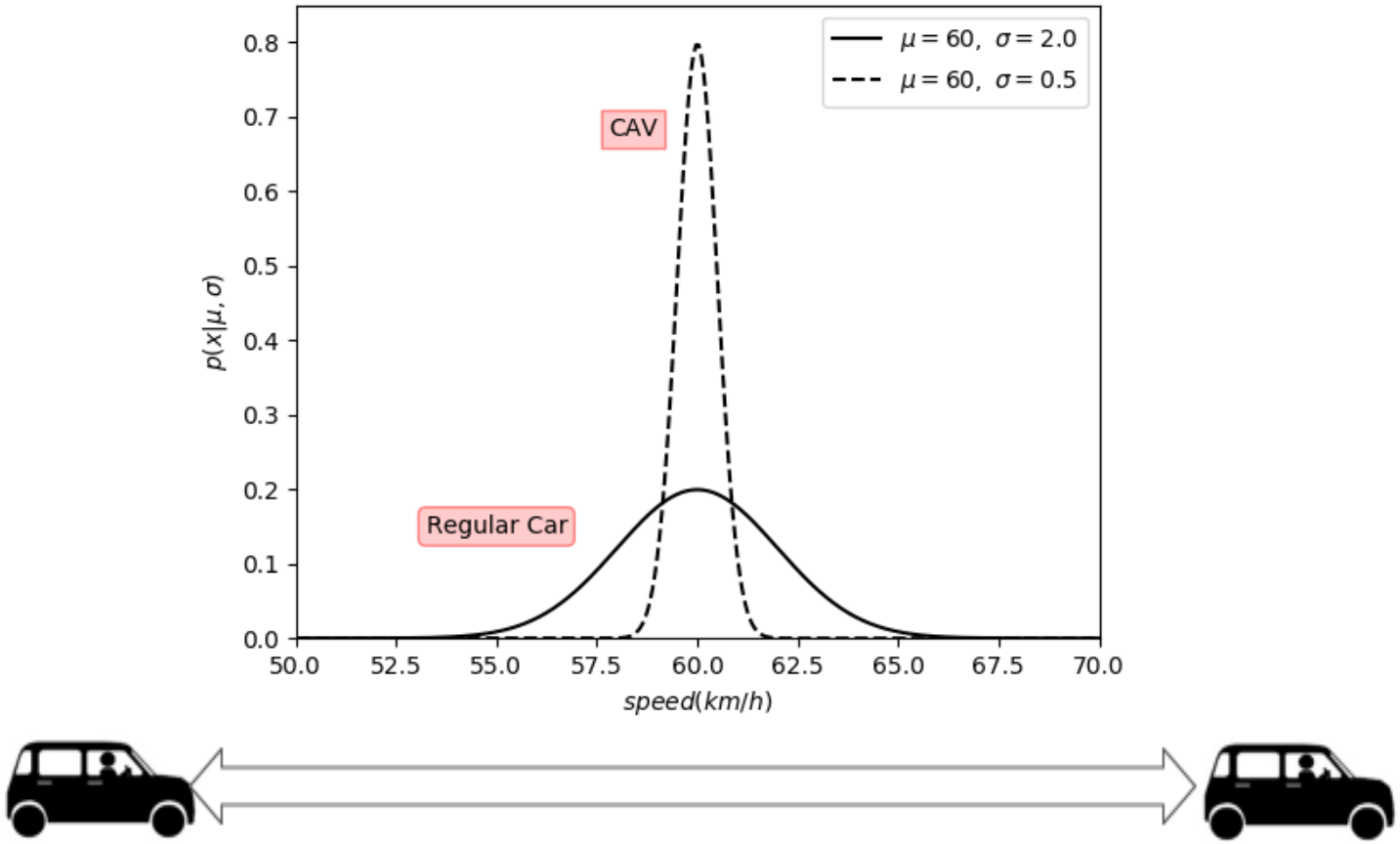
# Traffic Modelling Background



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# Use Case 5



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# Use Case 5: The Exam Question

**What would be the city-wide traffic consequences for Milton Keynes if CAV's become commonplace and the city-centre is re-defined as a car-free space?**




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# Use Case 5: The Baseline model




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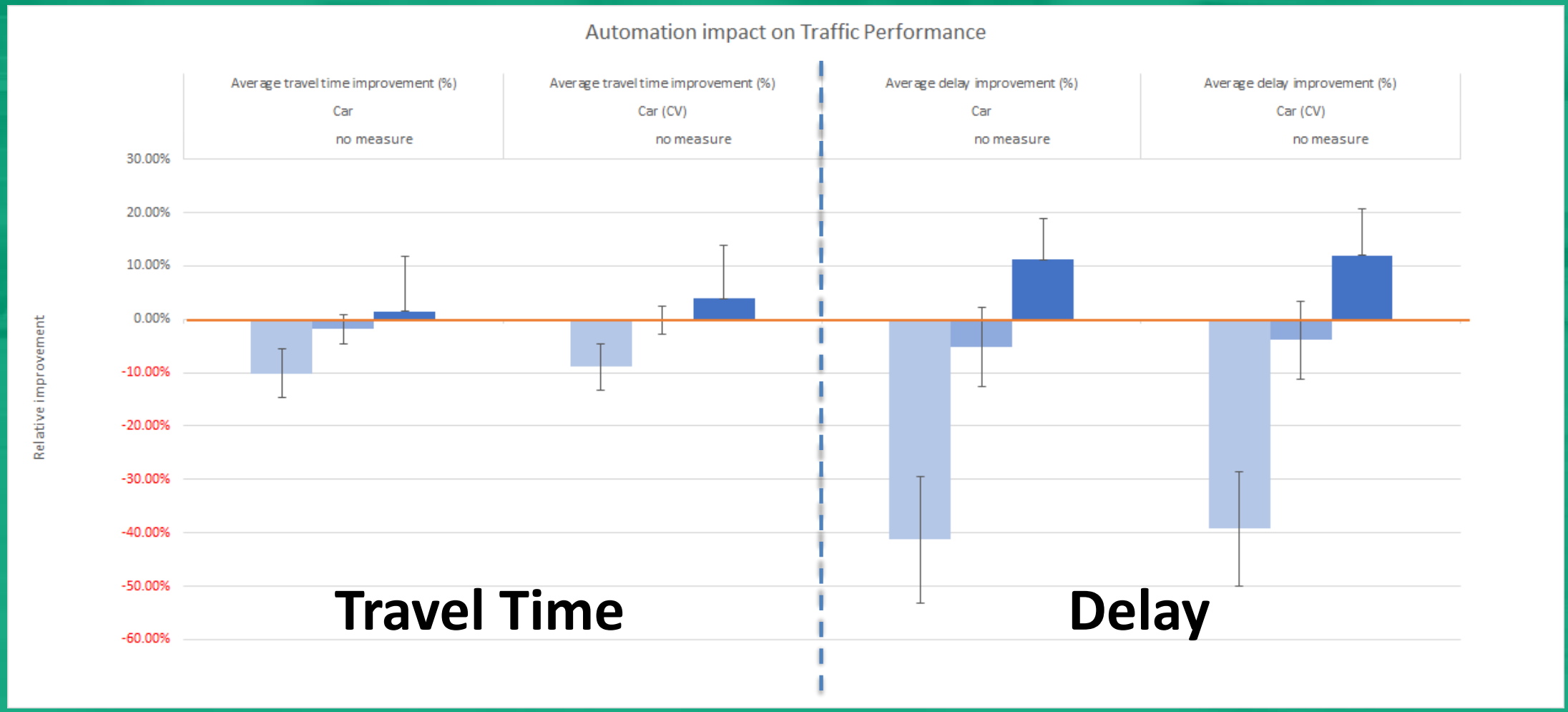
# Use Case 5: Baseline (No Measures)



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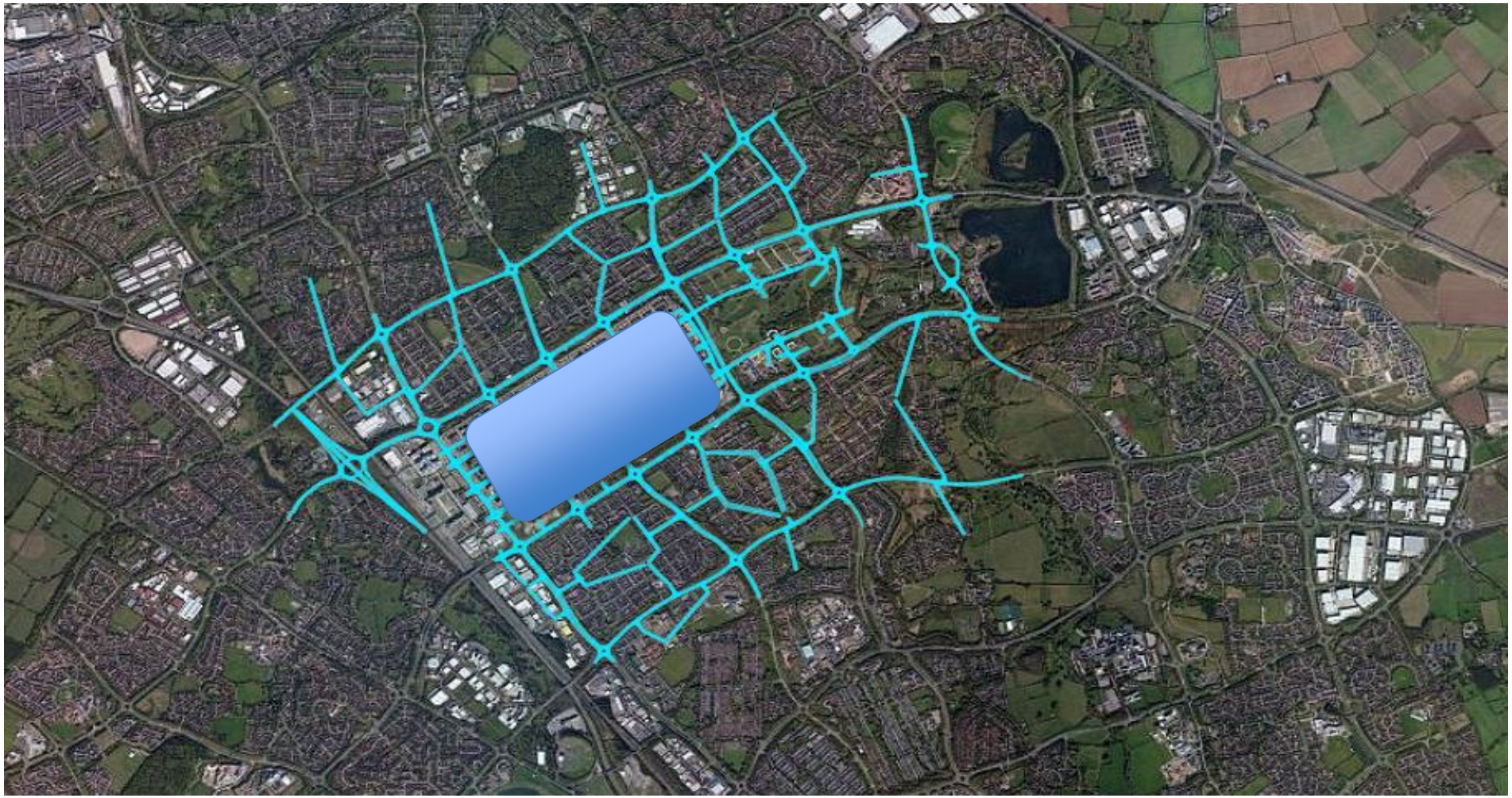
# Use Case 5: The ‘Car-Free’ Model





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# Use Case 5: The ‘Car-Free’ Model



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# Use Case 5: The ‘Car-Free’ Model



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# Use Case 5: Measure 1 (Pick & Drop)



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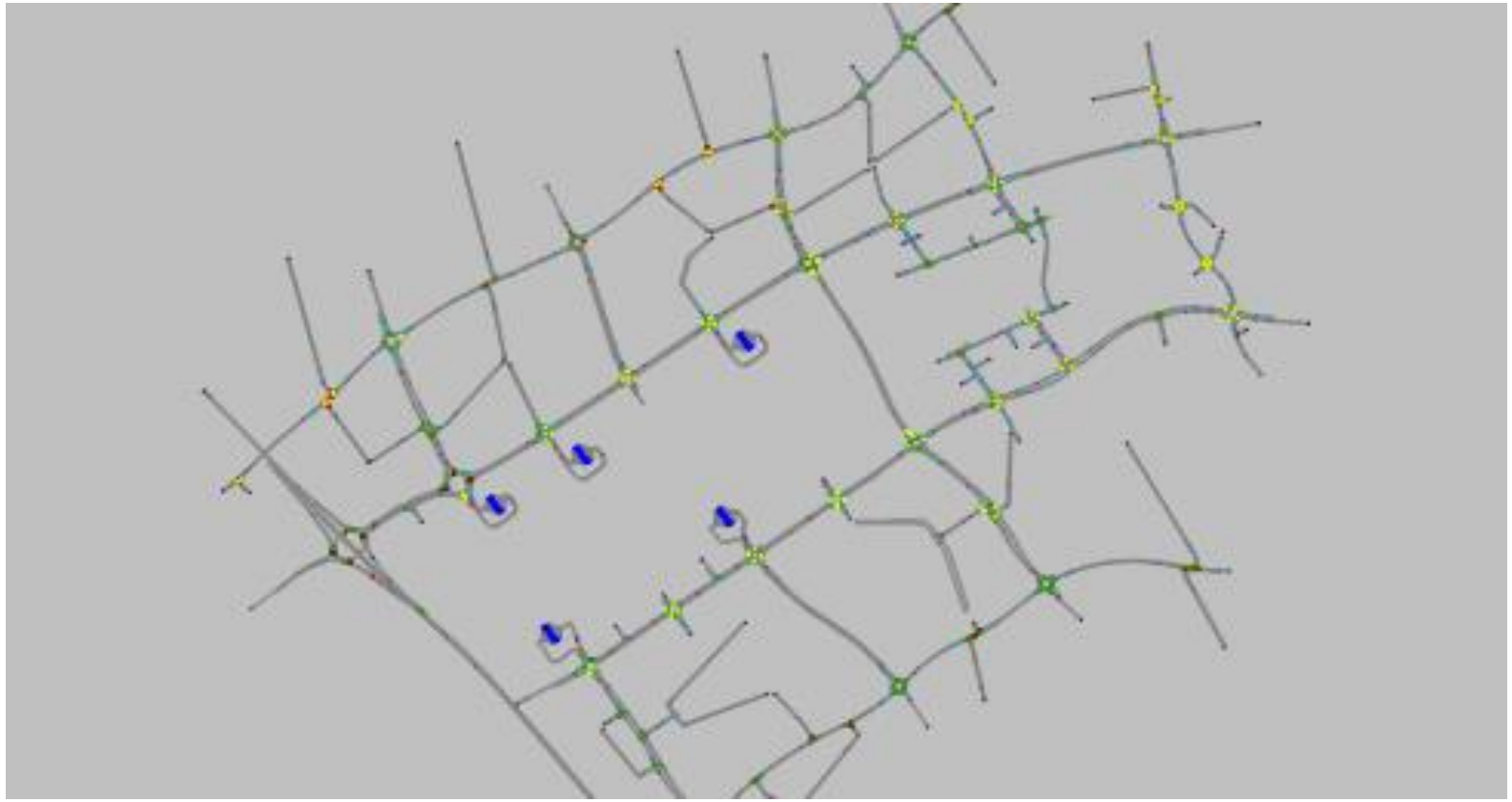
# Use Case 5: Measure1 (Pick & Drop)

**Access to centre restricted**

Pod handover at drop/off and pickup ground surface zones.  Calculated 14 lanes needed





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# Use Case 5: Measure1 (Pick & Drop)

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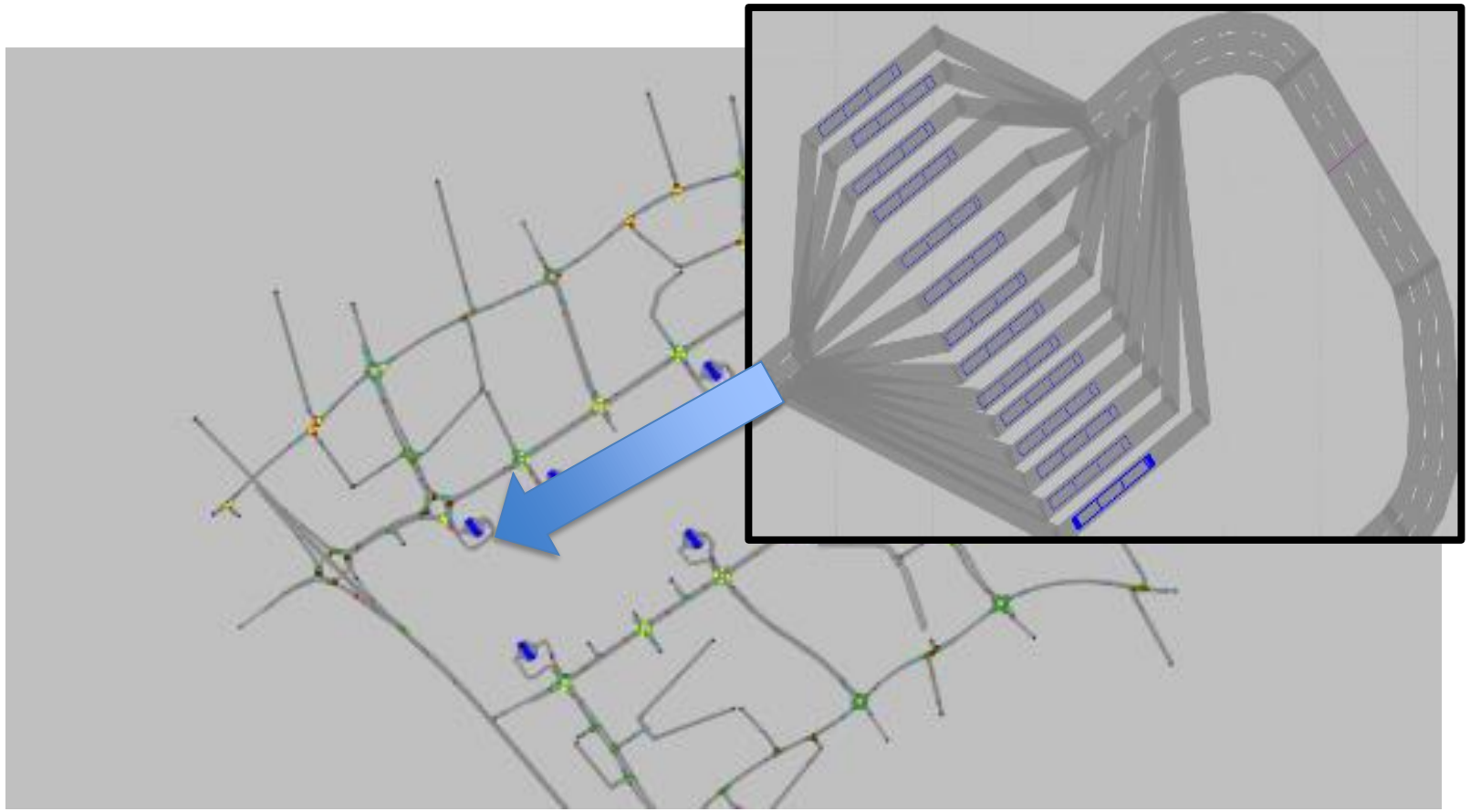



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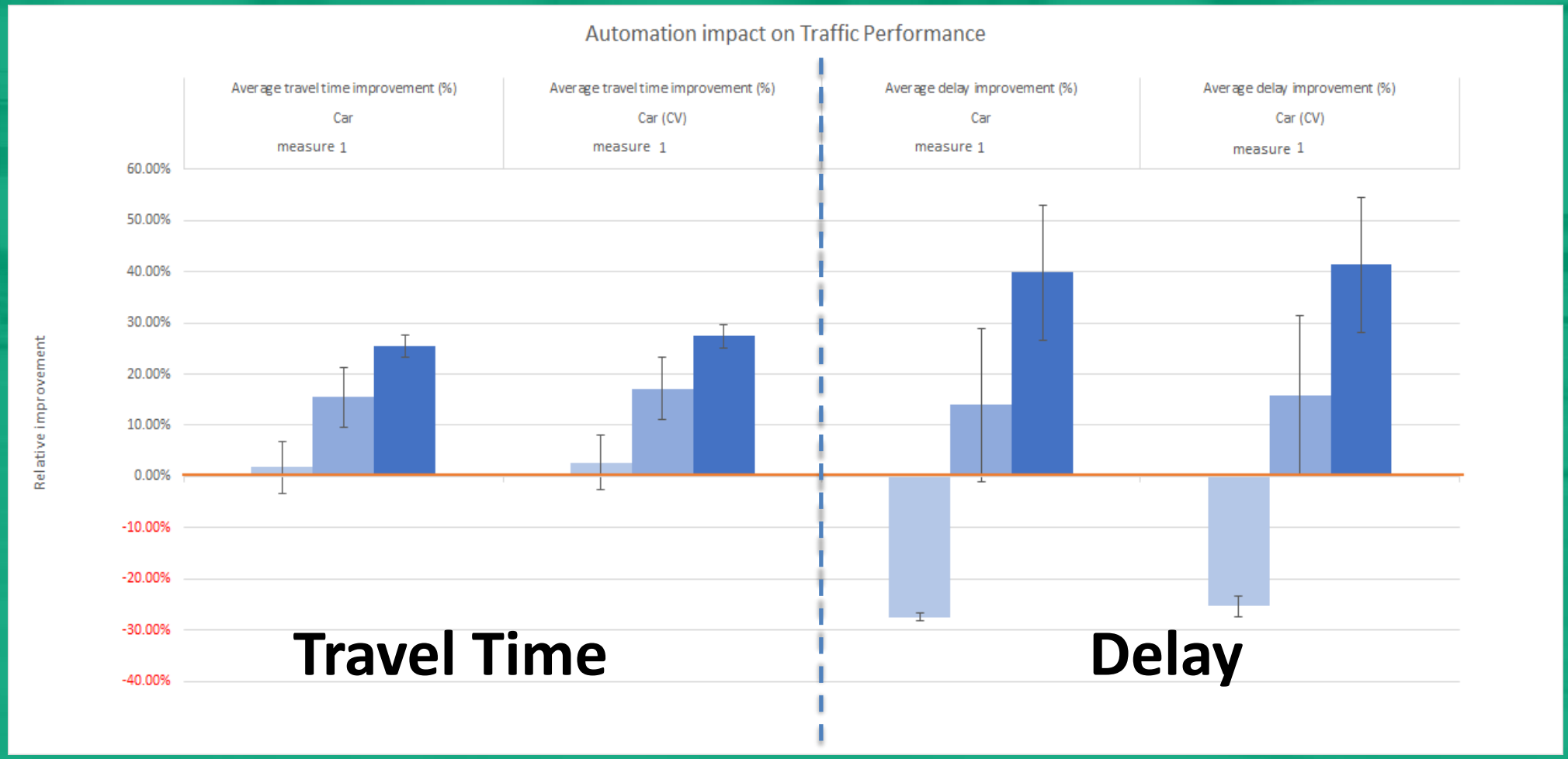
# Use Case5: Measure 1 (Pick & Drop)





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# Use Case 5: Measure 2 (Car Parks)



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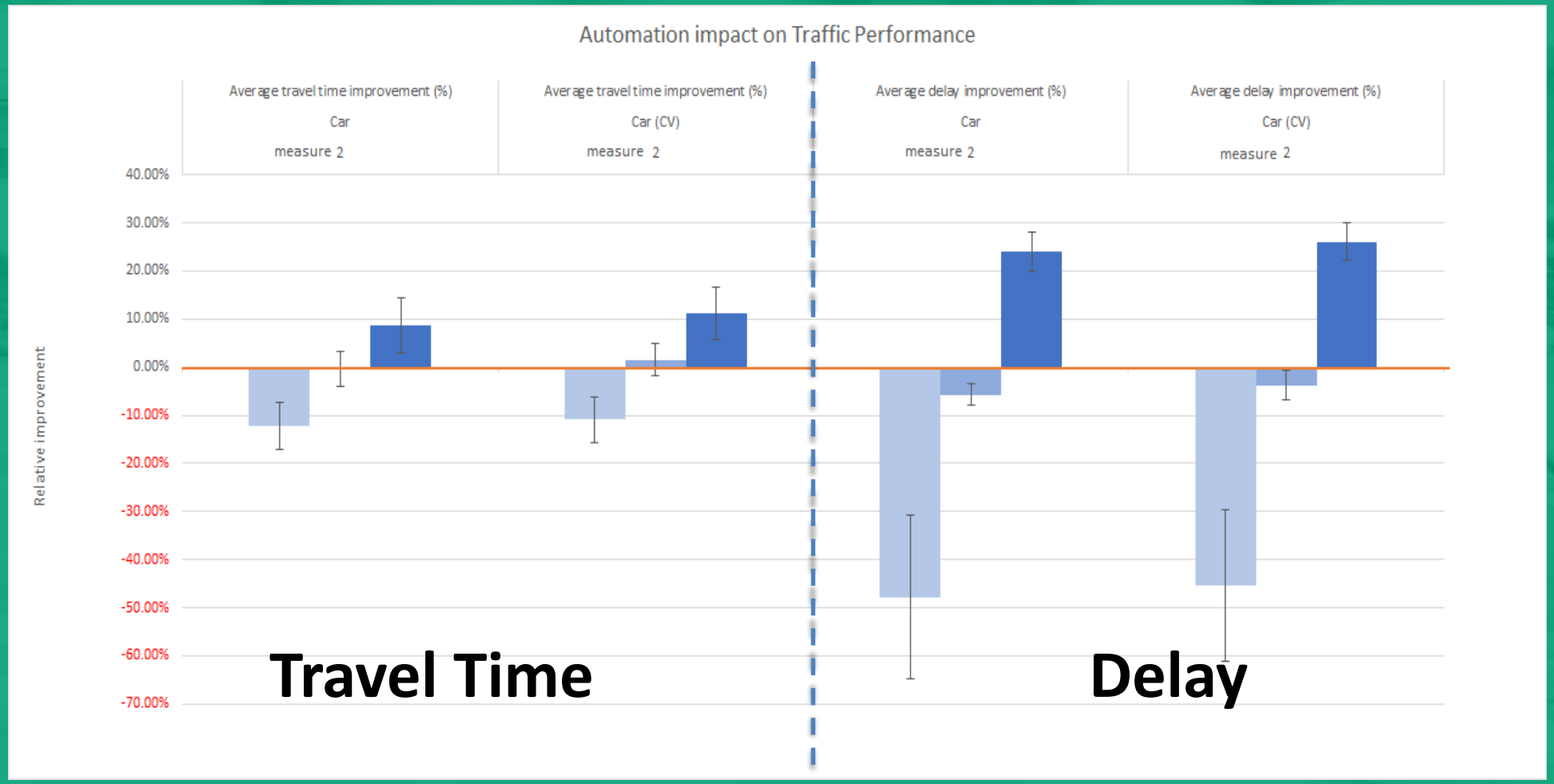
# Use Case 5: Measure 2 (Car-Parks)



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# Use Case 5: Measure 3 (Car Parks + Additional Lanes)



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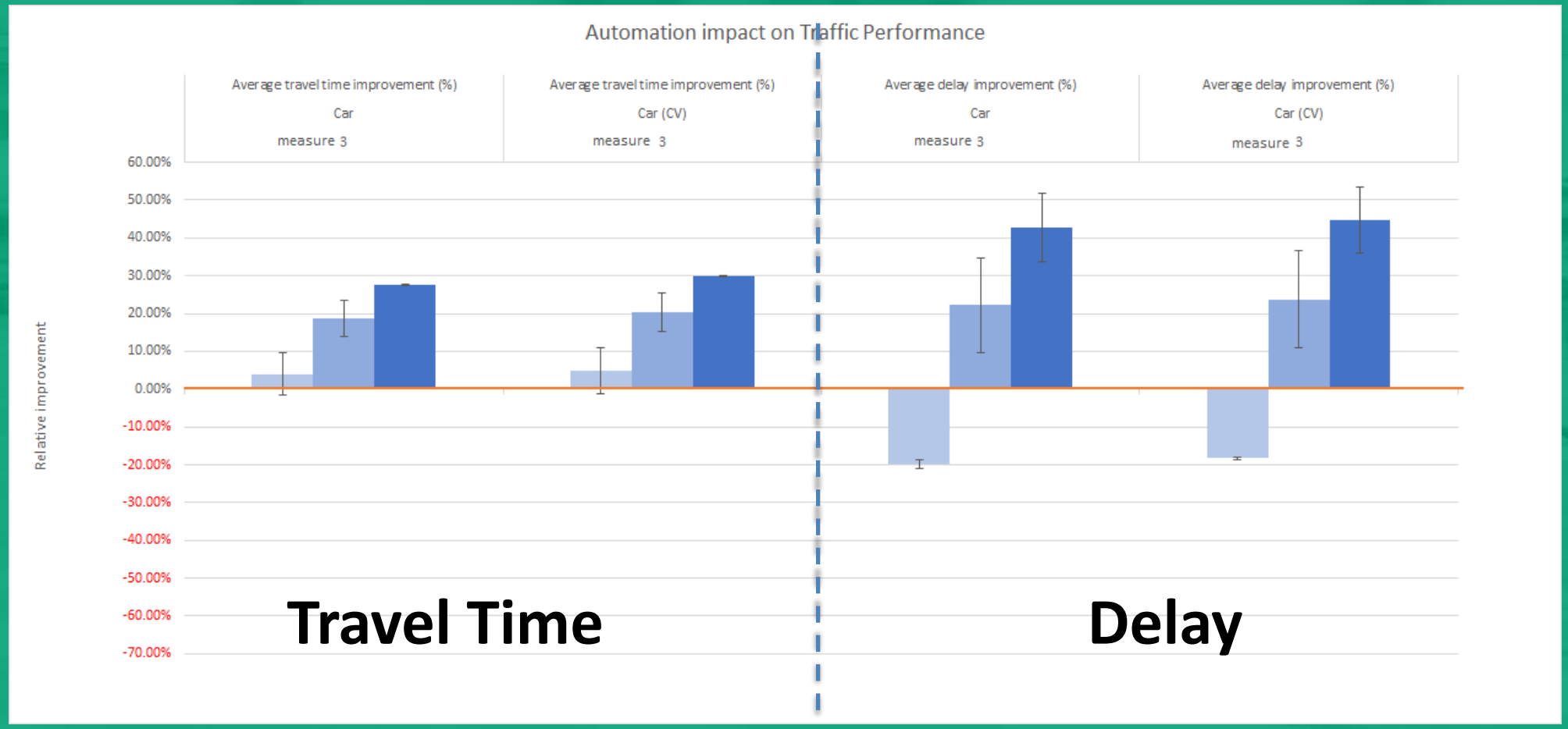
# Use Case 5: Measure 3 (Car Parks Additional Lane on Boundary Roads)



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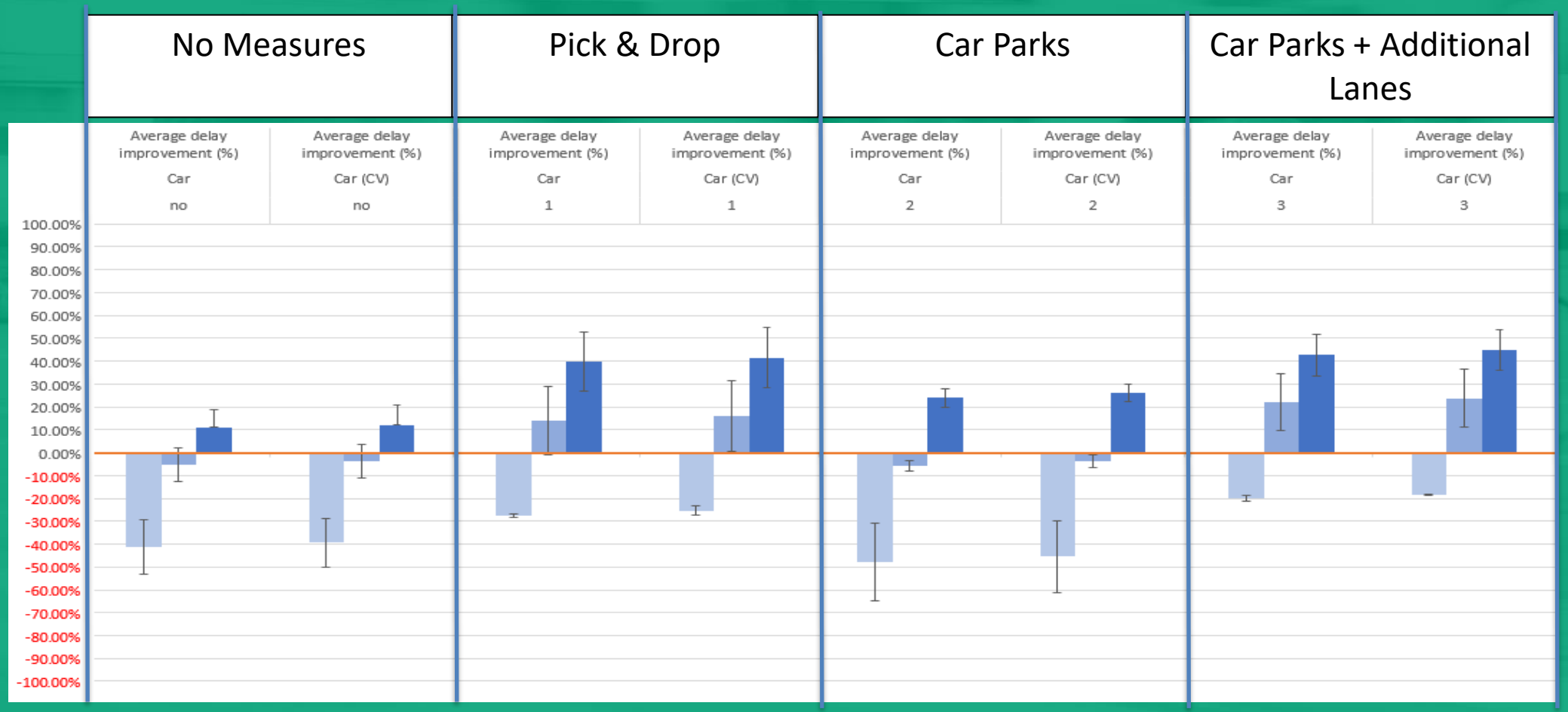
# Use Case 5: Summary Comparison of all Measures (Delay Times)



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# Use Case 5 – Qualitative Safety Assessment

## Urban Roads

| | Type of accident | Urban Pilot | | | | Fully automated private vehicles | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | ☹ | 😐 | 🙂 | 😀 | ☹ | 😐 | 🙂 | 😀 |
| 1 | Driving | | | | 4 | | | | 4 |
| 2 | Turning off | | | | 2 | | | | 2 |
| 3 | Turning-in / Crossing | | | | 4 | | | | 4 |
| 4 | Pedestrian | | | | | | | | |
| 5 | Accident with parking vehicles | | | | | | | | |
| 6 | Accident in lateral traffic | | | | 6 | | | | 6 |
| 7 | Other accident type | | | 1 | 5 | | | 1 | 5 |

Table 15 Qualitative safety assessment for use case 5 for urban roads. The number shows how many sub-accident types that the driving function is estimated to imply negative, none, positive or very positive impacts on safety.

## Arterial Roads

| | Type of accident | Arterial Pilot | | | | Fully automated private vehicles | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | ☹ | 😐 | 🙂 | 😀 | ☹ | 😐 | 🙂 | 😀 |
| 1 | Driving | | | | 7 | | | | 7 |
| 2 | Turning off | | | 1 | 2 | | | | 3 |
| 3 | Turning-in / Crossing | | | 1 | | | | | 1 |
| 4 | Pedestrian | | | | | | | | |
| 5 | Accident with parking vehicles | | | | | | | | |
| 6 | Accident in lateral traffic | | | | 5 | | | | 5 |
| 7 | Other accident type | | | 1 | 4 | | | 1 | 4 |

Table 16 Qualitative safety assessment for use case 5 for arterial roads. The number shows how many sub-accident types that the driving function is estimated to imply negative, none, positive or very positive impacts on safety.



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# Use Case 6



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# Use Case 6: The Exam Question

**What is the effect on traffic flows at un-signalised intersections (roundabouts) at various different stages of CAV take-up?**



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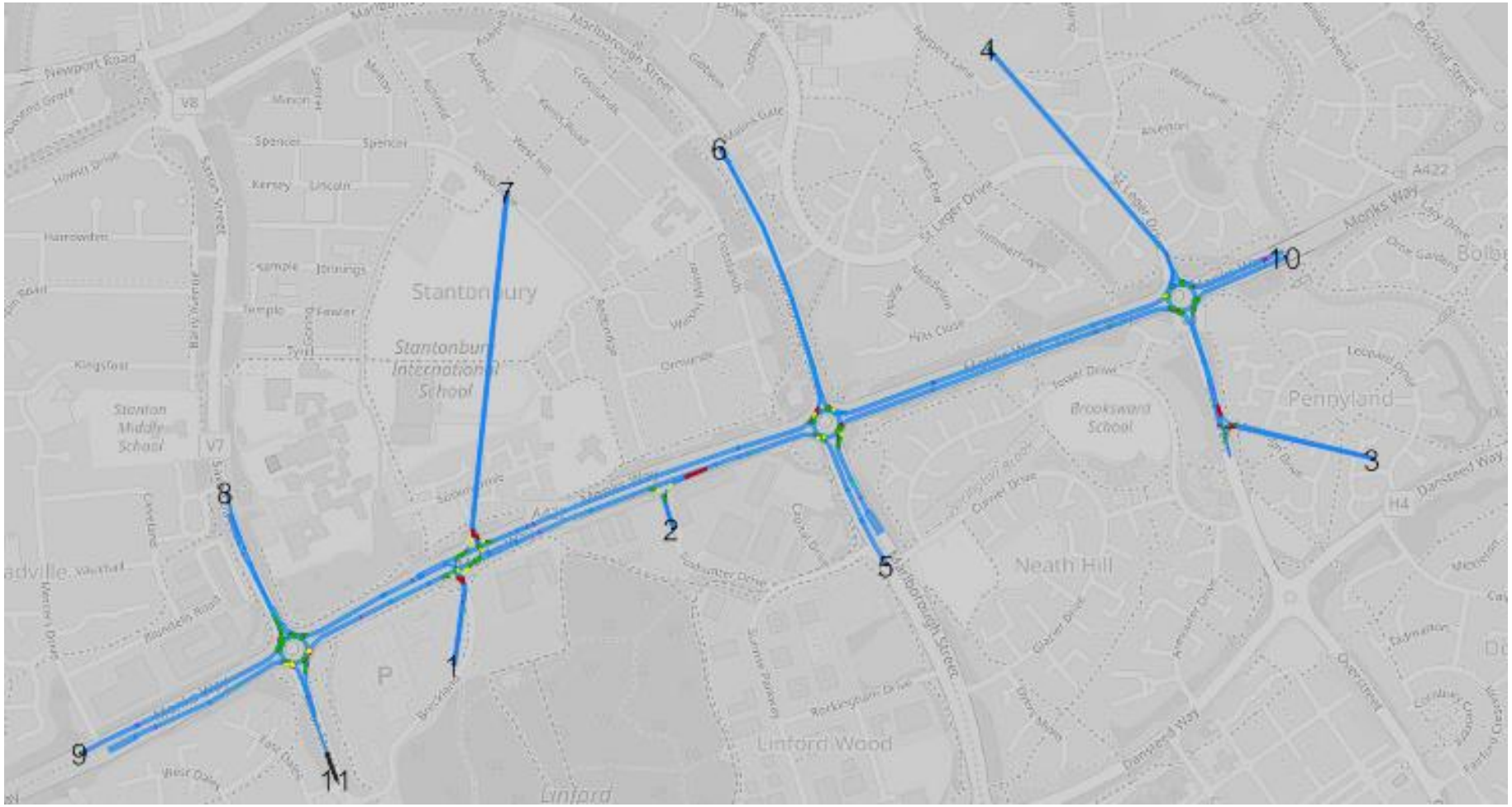
# Use Case 6: Base Model



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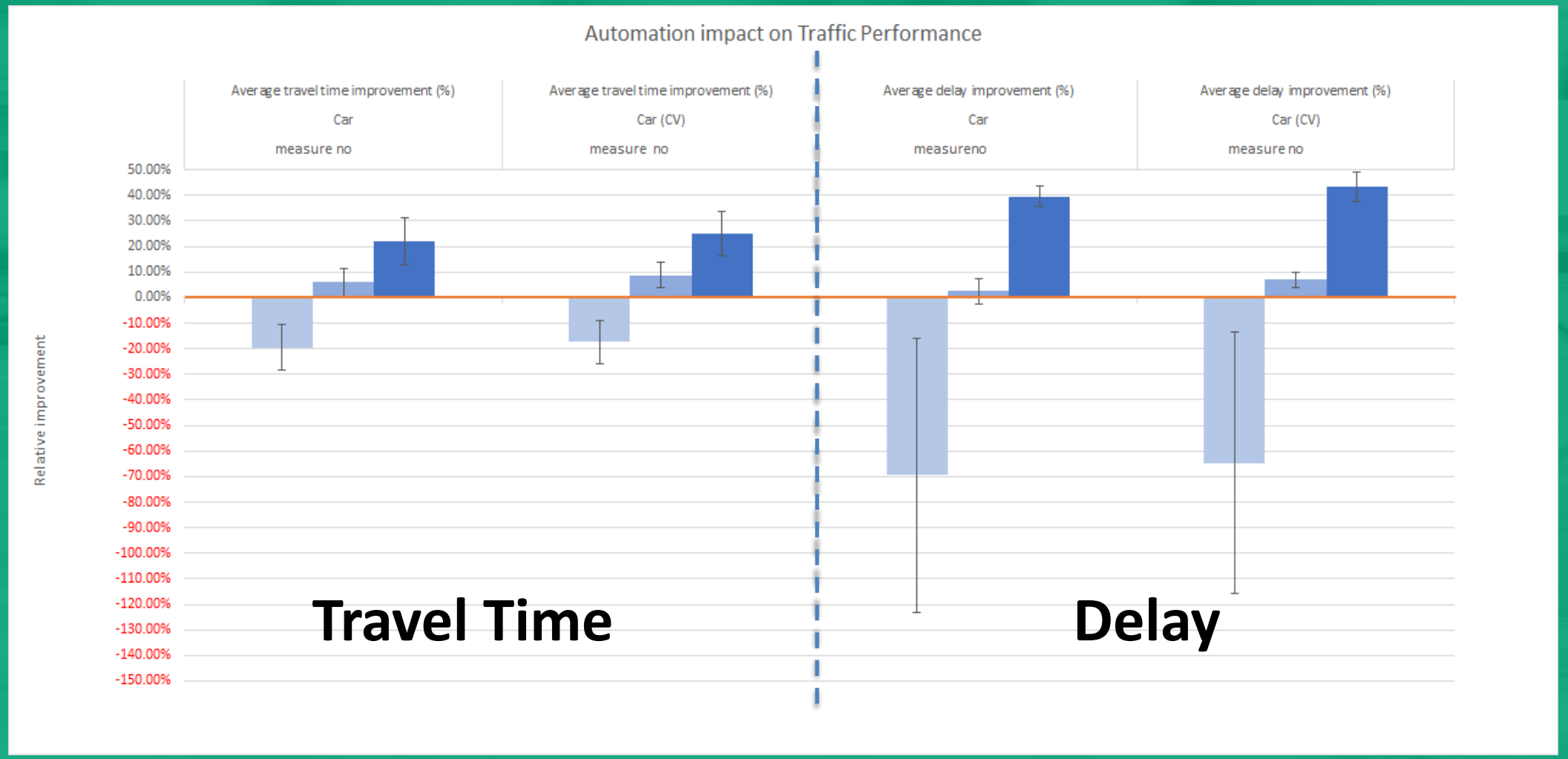
# Use Case 6: Baseline (No Measures)



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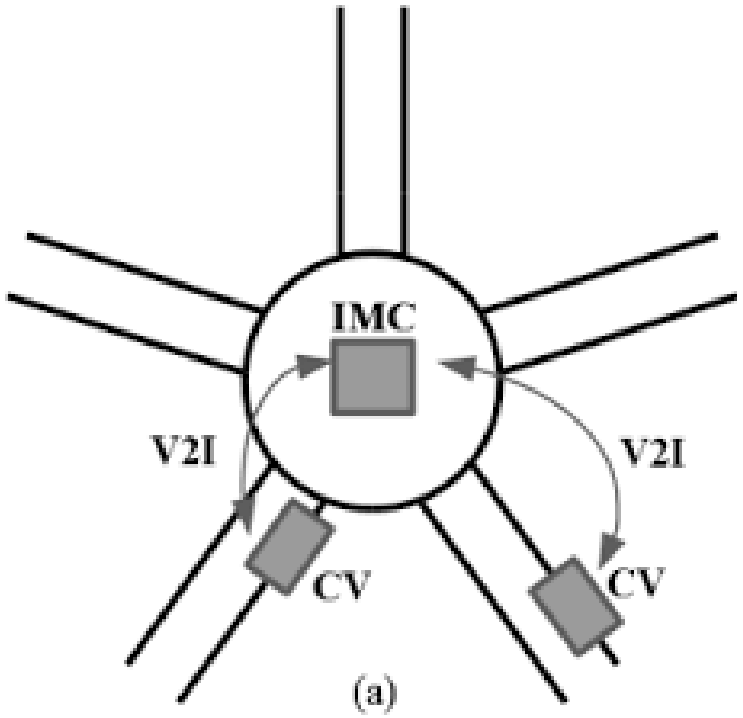
# Use Case 6: Measure1 (Traffic Control/V2V Communications)

- Infrastructure installed to enable vehicle-to-vehicle communication.



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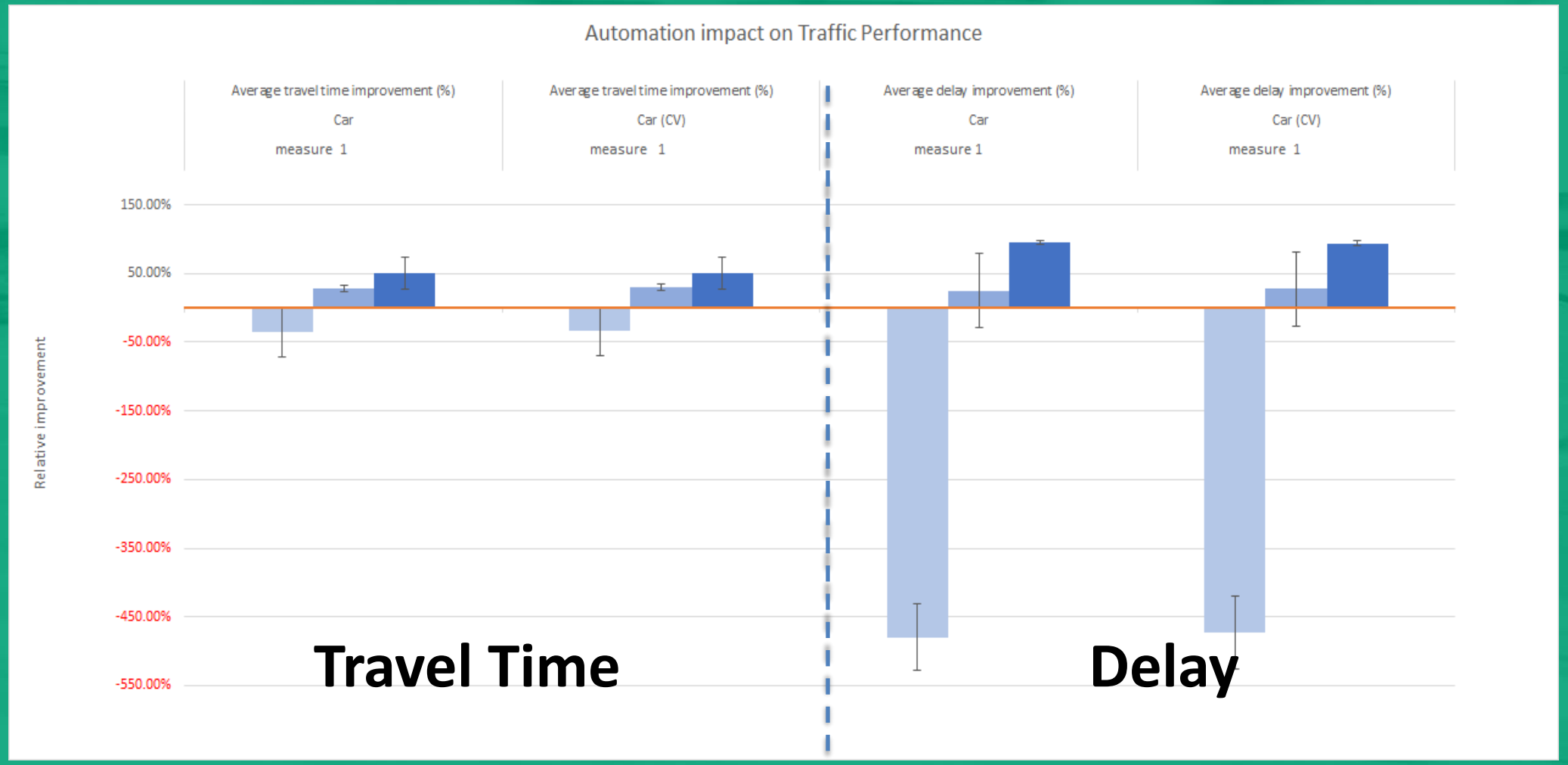
# Use Case 6 – Measure 1 (Traffic Control/V2V Communications)



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# Use Case 6: Measure2 (Additional Lane on Approach Carriageway)



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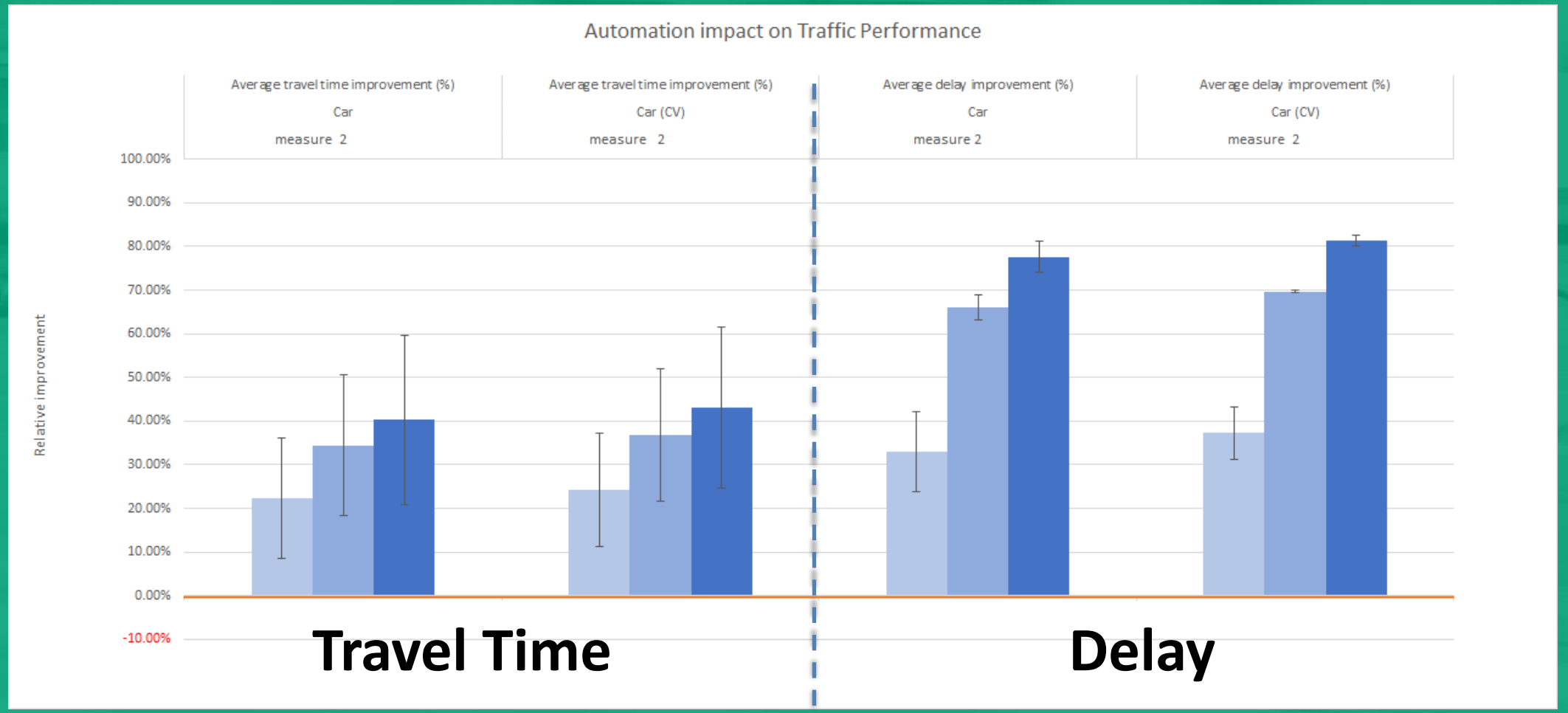
# Use Case 6: Measure 2 (Additional Lane on Approach Carriageway)





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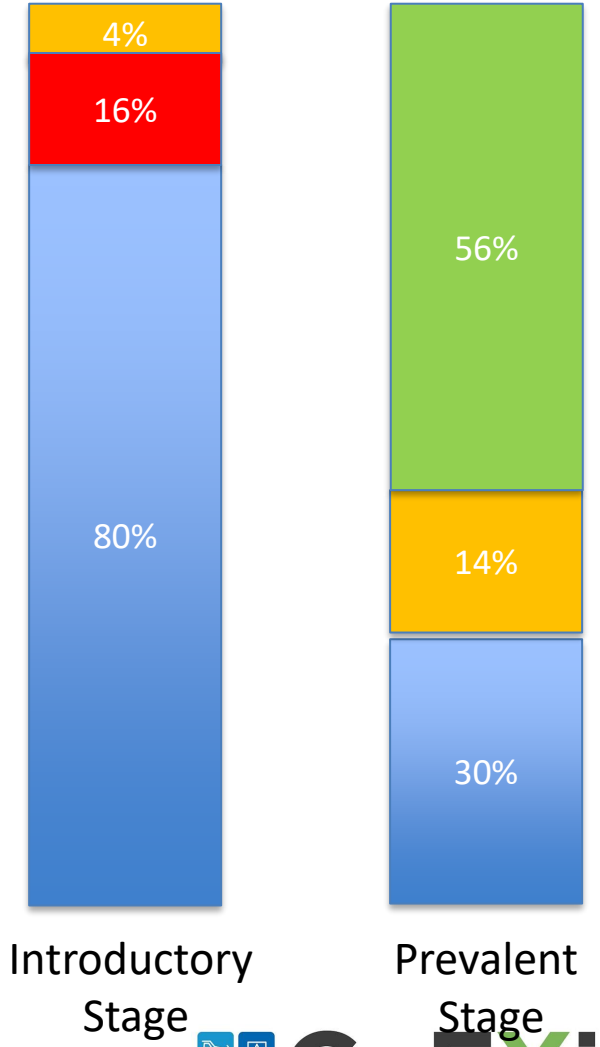
# ….. but this is not easily delivered



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# Use Case 6 – Qualitative Safety Assessment

## Arterial Roads

| | Type of accident | Arterial Pilot | | | | Fully automated private vehicles | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | ☹ | 😐 | 🙂 | 😀 | ☹ | 😐 | 🙂 | 😀 |
| 1 | Driving | | | | 7 | | | | 7 |
| 2 | Turning off | | | 1 | 2 | | | | 3 |
| 3 | Turning-in / Crossing | | | 1 | | | | | 1 |
| 4 | Pedestrian | | | | | | | | |
| 5 | Accident with parking vehicles | | | | | | | | |
| 6 | Accident in lateral traffic | | | | 5 | | | | 5 |
| 7 | Other accident type | | | 1 | 4 | | | 1 | 4 |

Table 22 Qualitative safety assessment for use case 6. The number shows how many sub-accident types that the driving function is estimated to imply negative, none, positive or very positive impacts on safety. Grey marked cells are accident types that are considered irrelevant for the driving function in the use case.



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## Thankyou

#H2020CoEXist
@H2020_CoEXist



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# CoEXist

## Poll question

**What level of ‘cautious CAV’ penetration might be required for the collective effect (to be noticeable) on macroscopic traffic flows?**

- 15 %
- 25 %
- 50 %
- 75 %
- 90 %

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# CoEXist Virtual Final Conference - Part 1:
## Automation-ready tools and impact assessment findings

### Wednesday 25 March 2020

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13:45 Registration and technical support

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**Introduction to CoEXist**, *Daniel Franco, Rupprecht Consult*

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Automation-ready transport modelling and infrastructure assessment

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# Stuttgart: Use case 7 & 8

Jörg Sonnleitner

University of Stuttgart
Germany

#H2020CoEXist
@H2020_CoEXist

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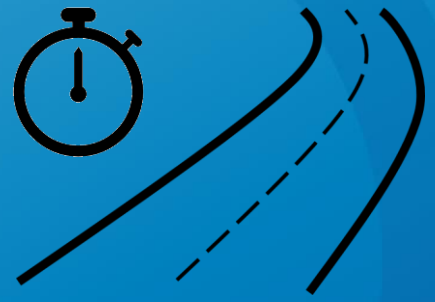
# Use case 7: Impacts of CAV on travel time and mode choice on a network level

**Impacts** caused by changes in

- supply: road capacity & performance
- demand: perception of travel time



**Expectation**: Impacts on supply & demand

- travel times
- mode choice
- destination & route choice



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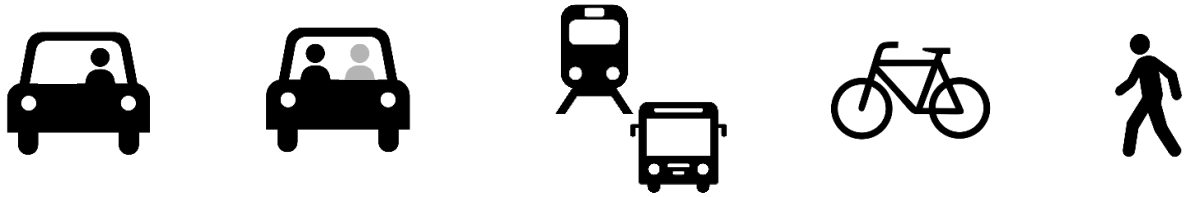
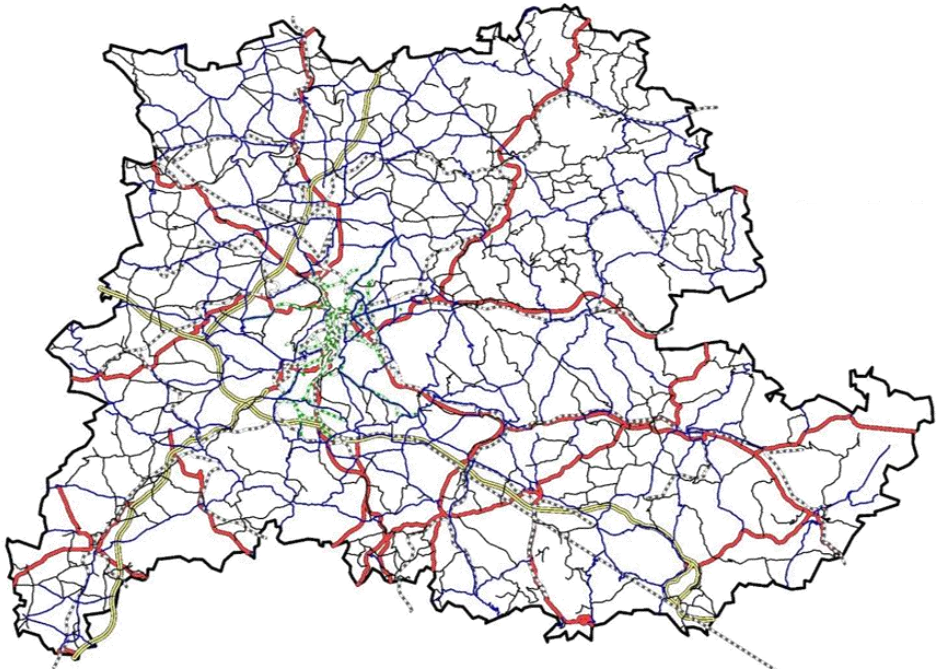
# The model

Macroscopic travel demand model of the Stuttgart Region

- covers trips of an average working day
- covers 2.7 million inhabitants
- includes all expected measures by 2025
- includes modes of transport



Car Driver | Car Passenger | Public Transport | Bike | Walk





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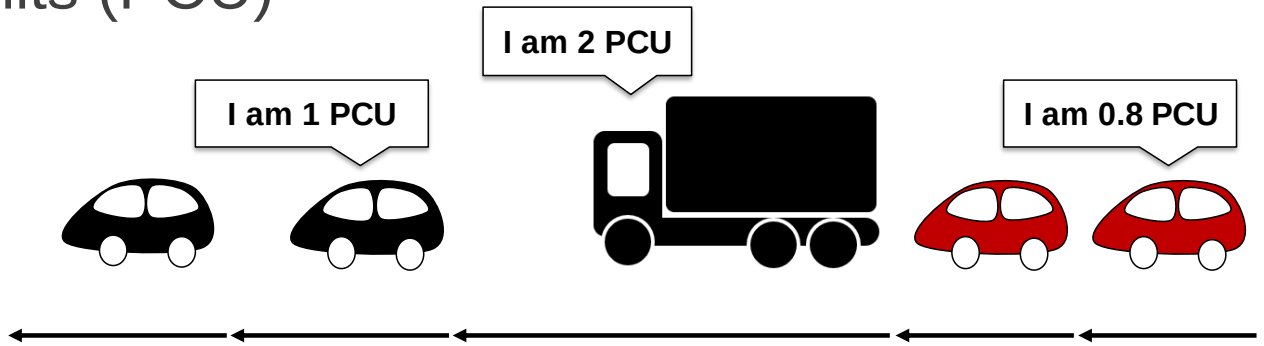
# Supply – Capacity & Performance

- CAV perform differently than conventional vehicles
  → use concept of passenger car units (PCU)




- incorporate behavior and capabilities of CAV on different road types
  → extend concept for CAV to be additionally road type dependent

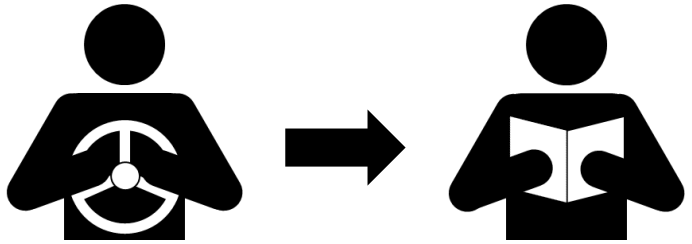
| Road type | Basic CAV | Intermediate CAV | Advanced CAV |
|---|---|---|---|
| Motorway | 1.20 | 0.77 | 0.73 |
| Arterial | 1.26 | 0.81 | 0.76 |
| Urban street | manual: 1.00 | 1.32 | 0.85 |
| Feeder road | manual: 1.00 | manual: 1.00 | manual: 1.00 |

"Main road"

# Demand – Perception of travel time

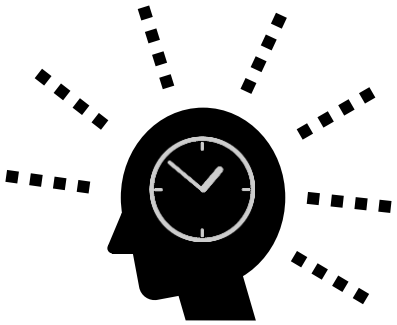
- Being driven in automated mode changes the perception of travel time

- Highly, but not fully automated CAV
  → transport system of mode ‘Car Driver’
  → influence attractiveness of this mode



Three assumptions

- no changes
- perceived travel time = travel time reduced by 15%
- perceived travel time = travel time reduced by 30%





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# Supply & Demand – Scenario design

Stage of CoEXistence
+
CAV-share
+
Perception of travel time
+
CAV-ready network
- motorway
- main road

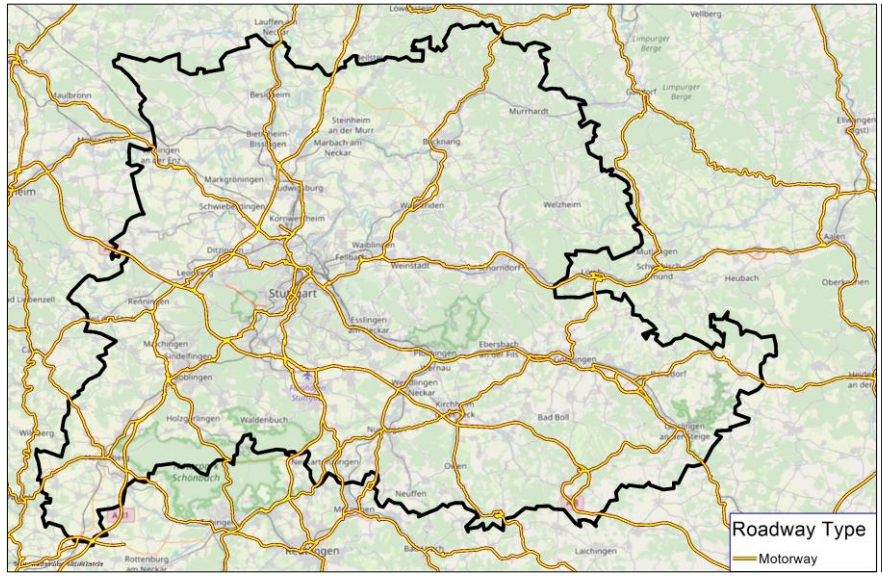
=

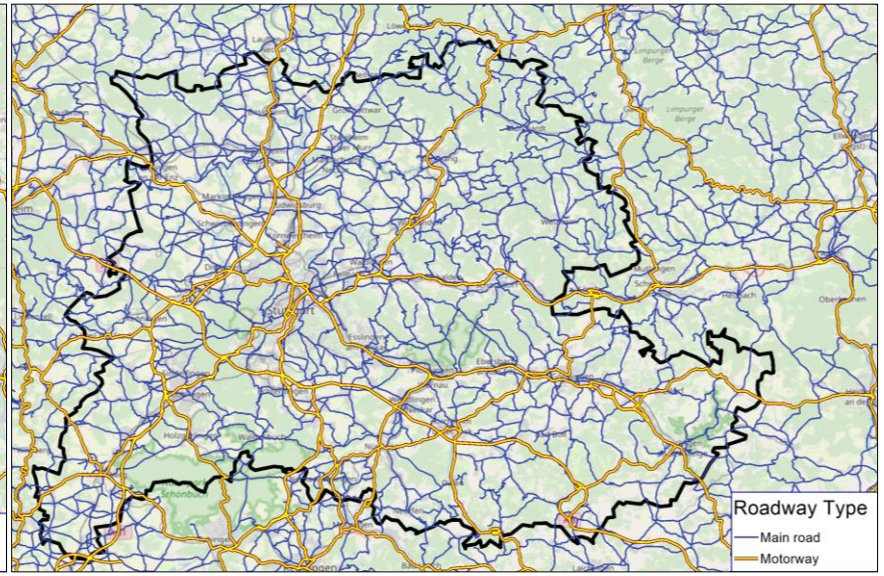
**Scenario**

- Introductory → Basic CAV
- Established → Intermediate CAV
- Prevalent → Advanced CAV

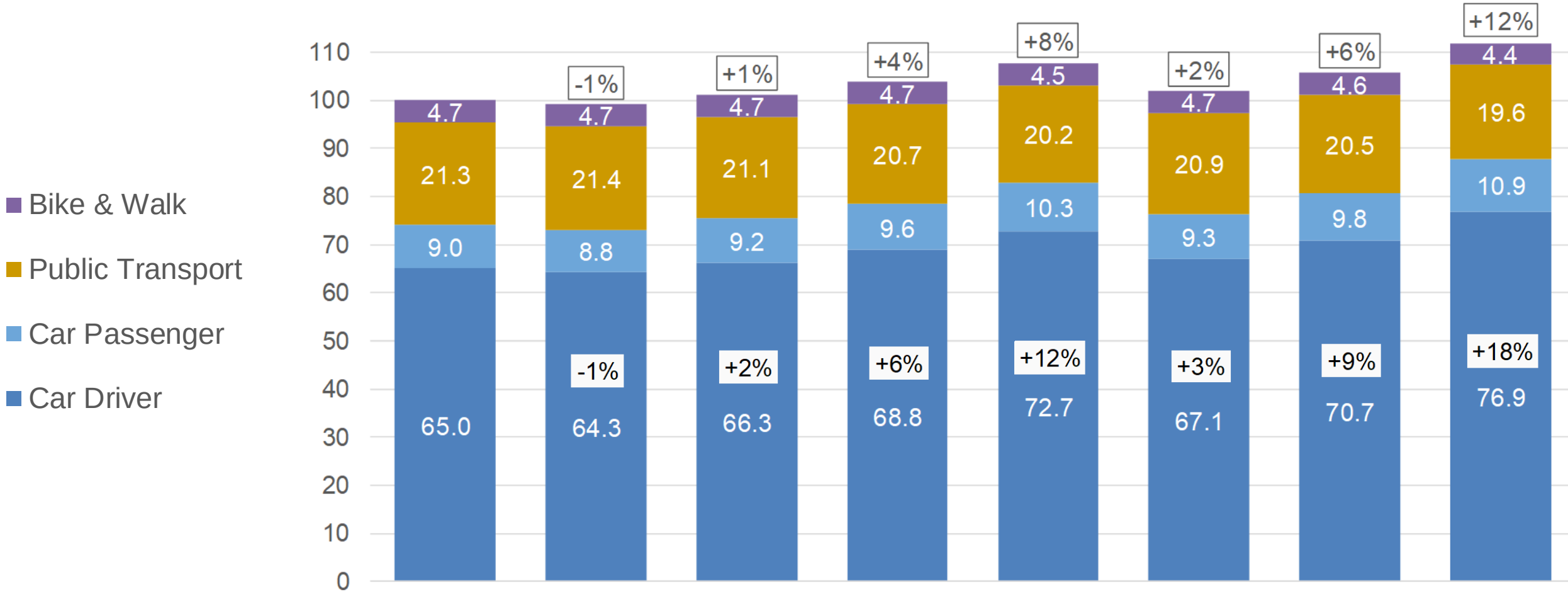
→ 20%, 40%, 60%, 80%, 100%

→ ±0%, −15%, −30%



# Total distance traveled, normalized to Base = 100




| **Stage of coexistence** | Base | Introductory | Estab Established | | | Prevalent | | |
|---|---|---|---|---|---|---|---|---|
| **CAV-share (%)** | 0 | 40 | 60 | 60 | | 80 | | |
| **Perception of travel time** | ±0% | ±0% | ±0% | -30% | -30% | ±0% | -30% | -30% |
| **CAV-ready network:** **Motorway** | ☐ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ |
| **Main road** | ☐ | ☐ | ☐ | ☐ | ☒ | ☐ | ☐ | ☒ |

# Conclusions use case 7

- Highly automated vehicles may have a substantial impact on travel demand
- Total distance traveled will increase in the long term

Reason: CAV perform better than CV

- Car modes gain attractiveness → modal shift from Public Transport
- People travel further
- Perception of travel time strengthens the effect

More and longer car trips → Total time spent & distance traveled increase

***Rebound effects on travel demand may reduce positive impacts of CAV on capacity***

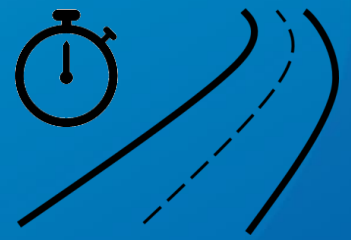
# Use case 8: Impacts of driverless car- and ridesharing services

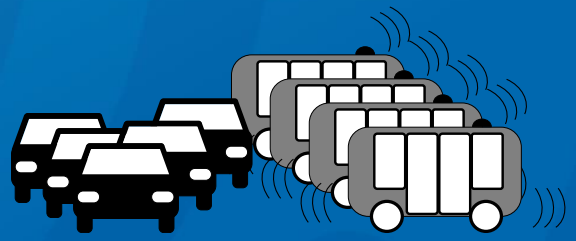
Impacts caused by CAV fleets as part of driverless mobility services like

- carsharing system
- ridesharing systems (public vs. private system)

Impacts on supply & demand

- mode choice
- travel times
- required fleet size
- empty trips and vehicle distance traveled





- Stuttgart Region macroscopic model extended by methods and algorithms



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# Scenario specification and selected results

| Case | Public transport | | | Car transport | | | Vehicle distance traveled | | | | Vehicles required | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Bus | Rail | Ridesharing RS+ | No sharing NS | Carsharing CS | Ridesharing RS- | Private cars | | All cars | | | |
| | | | | | | | 0% | 50% | 0% | 50% | 0% | 50% |
| 0 | yes | yes | no | yes | no | no | → | ↓ | | | | ↓ |
| 1 | yes | yes | no | yes | no | yes | → | ↓ | | | | ↓ |
| 2 | yes | yes | no | yes | yes | no | → | ↓ | | | | ↓ |
| 3 | yes | yes | yes | yes | no | no | ↘ | ↓↓ | ↗ | ↘ | ↘ | ↓↓ |
| 4 | no | yes | yes | yes | no | no | ↘ | ↓↓ | ↗ | ↘ | ↘ | ↓↓ |
| 5 | no | yes | yes | yes | yes | no | ↘ | ↓↓ | ↗ | ↘ | ↘ | ↓↓ |

shift from PuT and private car to sharing

shift from PuT to sharing

**NS** No Sharing (= private car)

**CS** Carsharing (= ride hailing)

**RS-** Ridesharing competing with public transport

**RS+** Ridesharing integrated in public transport

**0%** all persons with access to a private car, are likely to keep and use their car

**50%** half of the persons with access to a private car, give up car ownership

# Conclusions use case 8

- Assumptions on willingness to give up private car ownership and price levels of mobility services have a large impact

- with car ownership as today and out-of-pocket costs +50% to private cars → sharing services will attract a relatively small amount of trips (2.5%)

- Today: parking prices and congestion limit car demand in cities
- Future: Ridehailing services eliminate parking costs and increase car demand in cities more than in rural areas



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## Poll question

**How and where should automation FIRST be deployed to rip the most benefits?**

- In privately owned vehicles
- Ridesharing (e.g. Uber) and vehicle sharing (e.g. car2go)
- Road-based public transport (e.g. buses, shuttles)
- None of the above / other forms (specify in question box)

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# Lessons learnt and conclusions

Wolfgang Backhaus, Rupprecht Consult

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# Main achievements & lessons learned

- CoEXist tools support decision-making towards CCAM scenarios: from “gut feeling” to a structured & informed decision-making! But know/communicate your assumptions (about how CAVs should or will behave).
- Tools developed enable assessment of CCAM use cases, but all use cases show mobility improvements mainly for high automation and penetration levels.
- All use case simulations show “hell” scenario before “heaven” scenario; transition phase!
- Cities’ expectation management: findings challenge the positive hype around CAVs- in particular for the transition phase. Main lessons learned around “how to prepare for planning!”
- All uncertainty requires a structured way of planning mobility with CCAM scenarios. CoEXist delivered the tools for a structured approach (e.g. automation-ready modelling and planning framework).



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# CoEXist Virtual Final Conference - Part 2:
## What next for Cities and CAVs?

TOMORROW!

**Workshop: What next for cities and CAVs?**

*moderated by Siegfried Rupprecht, Rupprecht Consult*

**14:00** ***Welcome,*** *Siegfried Rupprecht*

**14:05** **Automation-ready framework for city authorities,**
*Wolfgang Backhaus, Rupprecht Consult*

**14:20** **CoEXist – Roadmap towards automation-ready cities**
*Brian Matthews, Milton Keynes city council*
*Susanne Scherz, city of Stuttgart*
*Mikael Ivari, city of Gothenburg*
*Frank van den Bosch, city of Helmond*

*10 min per speaker (including 3min Q&A)*

15:00 *Poll & self-assessment of automation-readiness*

**15:15** **Towards automation readiness - challenges for infrastructure,**
*Suzanne Hoadley, Polis*

**15:30** **Interactive group discussion**
Key issues for cities, including change and expectations management, future proofing sustainable mobility policy, future proofing infrastructure investment and citizens engagement citizens.

**15:50** **Lessons learnt and conclusions,** *Wolfgang Backhaus, Rupprecht Consult*

16:00 End of the session



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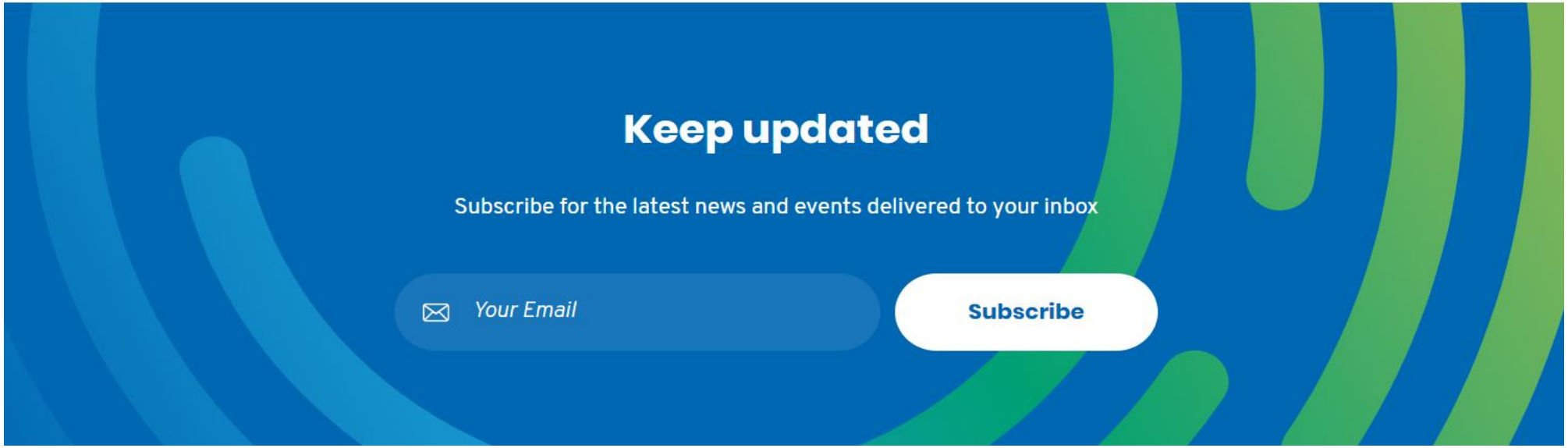
# Next webinar!

**Automation-ready road infrastructure assessment**

Learn more from CoEXist's automation-ready infrastructure assessment tool and safety assessment methodology!

To be scheduled: **April 2020**
https://www.h2020-coexist.eu/events/#upcoming-events

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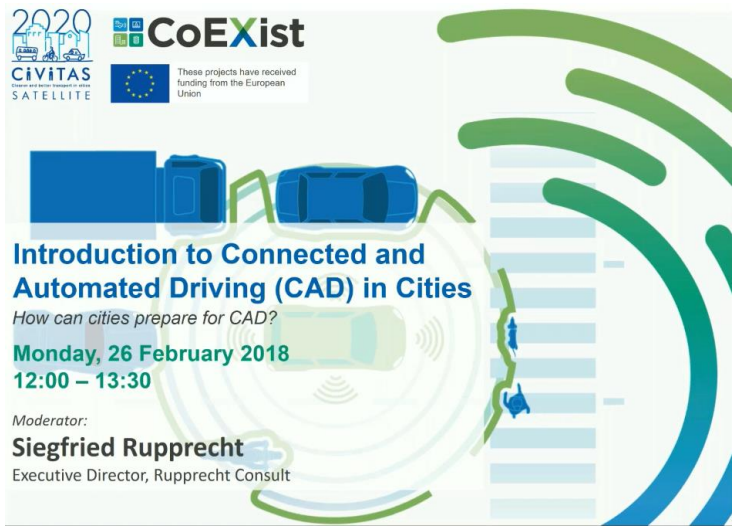
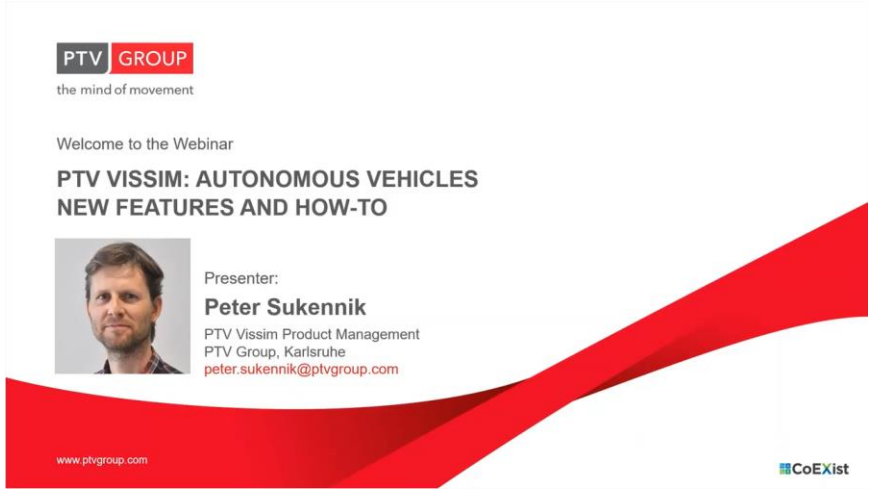
# Learn more from CoEXist!

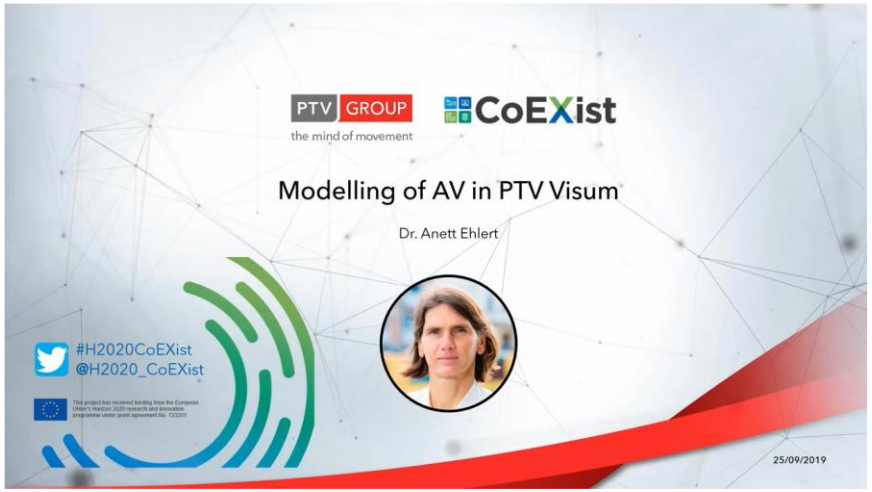
Find all our previous webinars in our YouTube channel at:

**http://tiny.cc/CoEXist-Webinars**







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# CoEXist Partners

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POLIS
CITIES AND REGIONS FOR TRANSPORT INNOVATION

FEHRL

City of Gothenburg

STUTTGART

milton keynes council

Gemeente Helmond



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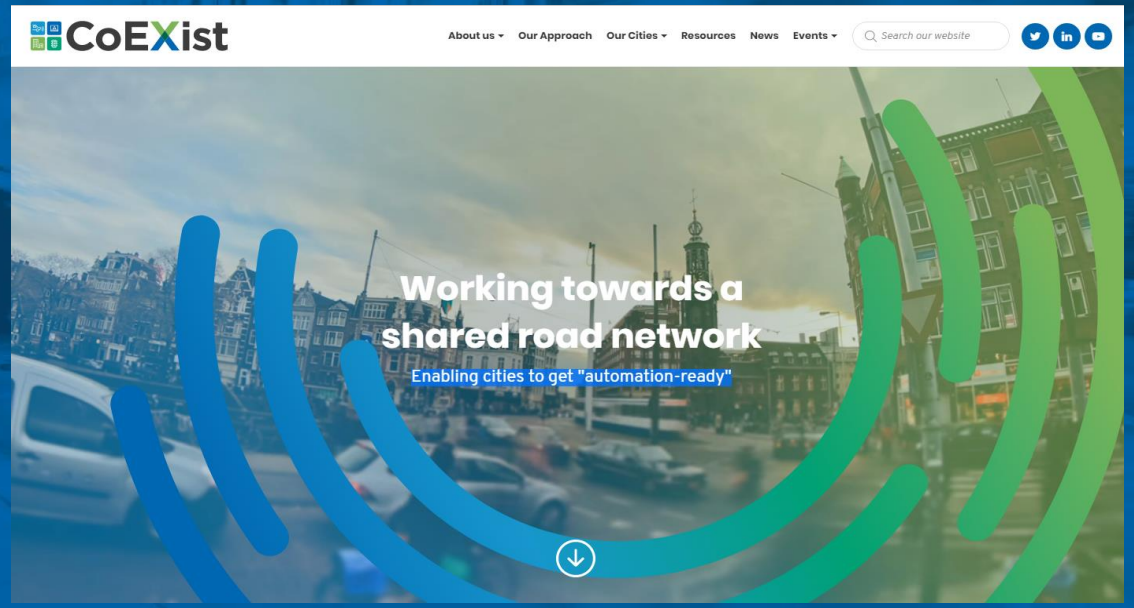
# Thank you for your attention!

# Get in touch with us!

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