

# *Development of a speed-based surrogate roundabout safety measure*



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# *Contents*

## **Introduction**

- Roundabout types
- Safety problems

## **The study**

- Data collection on turbo-roundabouts
- Surrogate measures (drivers behaviour, speed)

## **Results**

- Speed-based surrogate roundabout safety measure
- Conclusions

# *Roundabout types*

- Single-lane
- Multi-lane
- Turbo-roundabouts with dividers
- Turbo-roundabouts without dividers
- Various shape of roundabouts (eight)



# How to assess road safety?

- Low occurrence of accidents
- Variables at accident prediction models (traffic exposure, variables reflecting geometric features, and speed features)
- Accident prediction models based on speed:

$$Acc = e^{-16.61} \cdot Q_e^{0.47} \cdot Q_c^{0.26} \cdot S_C^{2.13} \text{ [Turner et al., 2009]}$$

$$Acc = e^{-12.80} \cdot Q_e^{0.81} \cdot e^{0.34 \cdot IAS} \text{ [Persaud et al., 2011]}$$

where:

$Acc$  = annual number of crashes

$Q_e$  = entering flow

$Q_c$  = circulating flow

$S_C$  = free-flow circulating speed

$IAS$  = inside average speed

- Speed through roundabouts = f (deflections, radii, geometric features)
- How to assess geometrical parameters for turbo-roundabouts?

# *Turbo-roundabouts*

- without dividers (trajectory changes are possible)

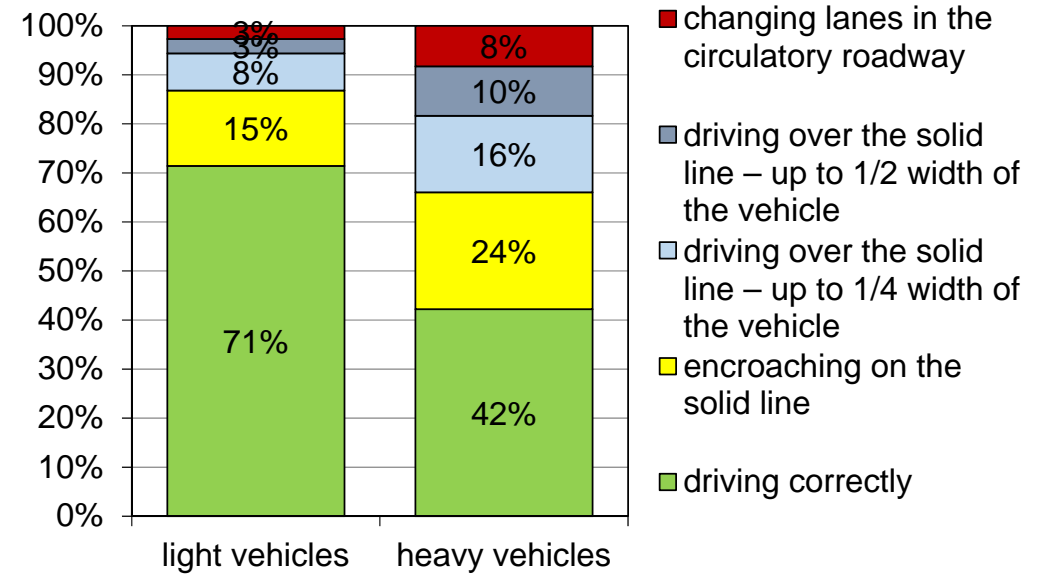
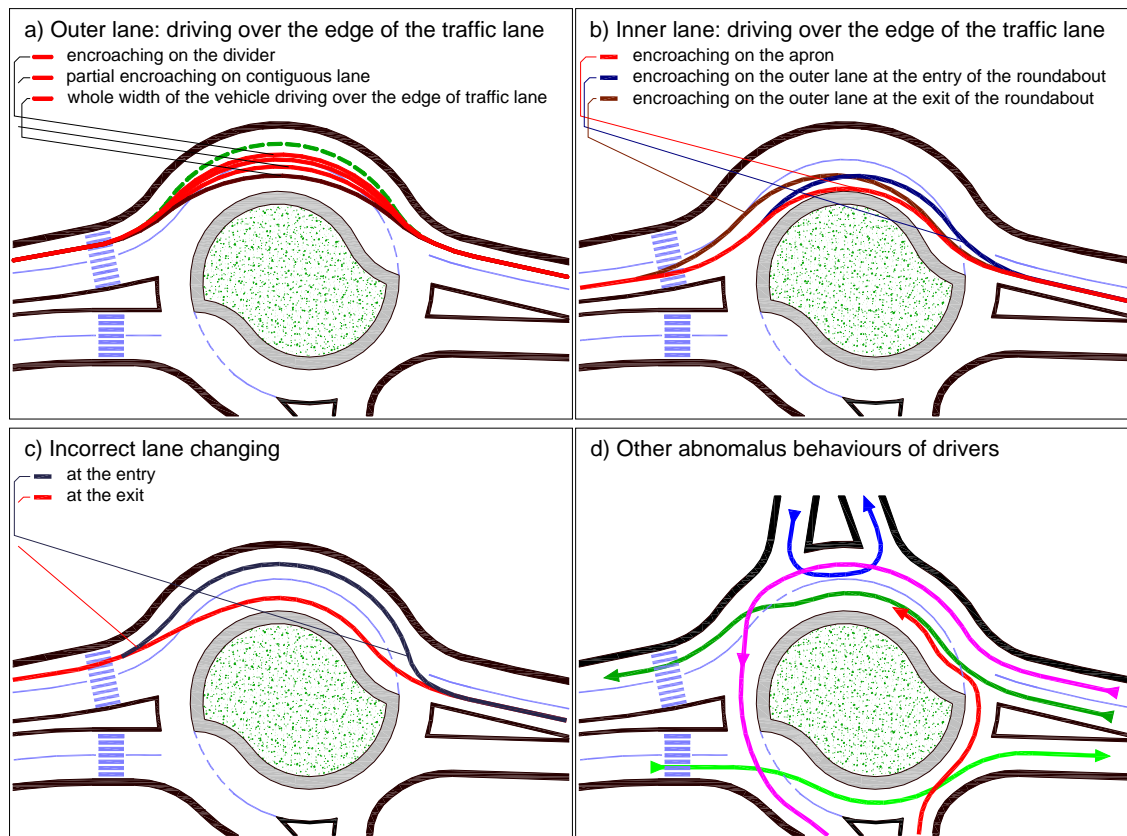


- with dividers (no trajectory changes)



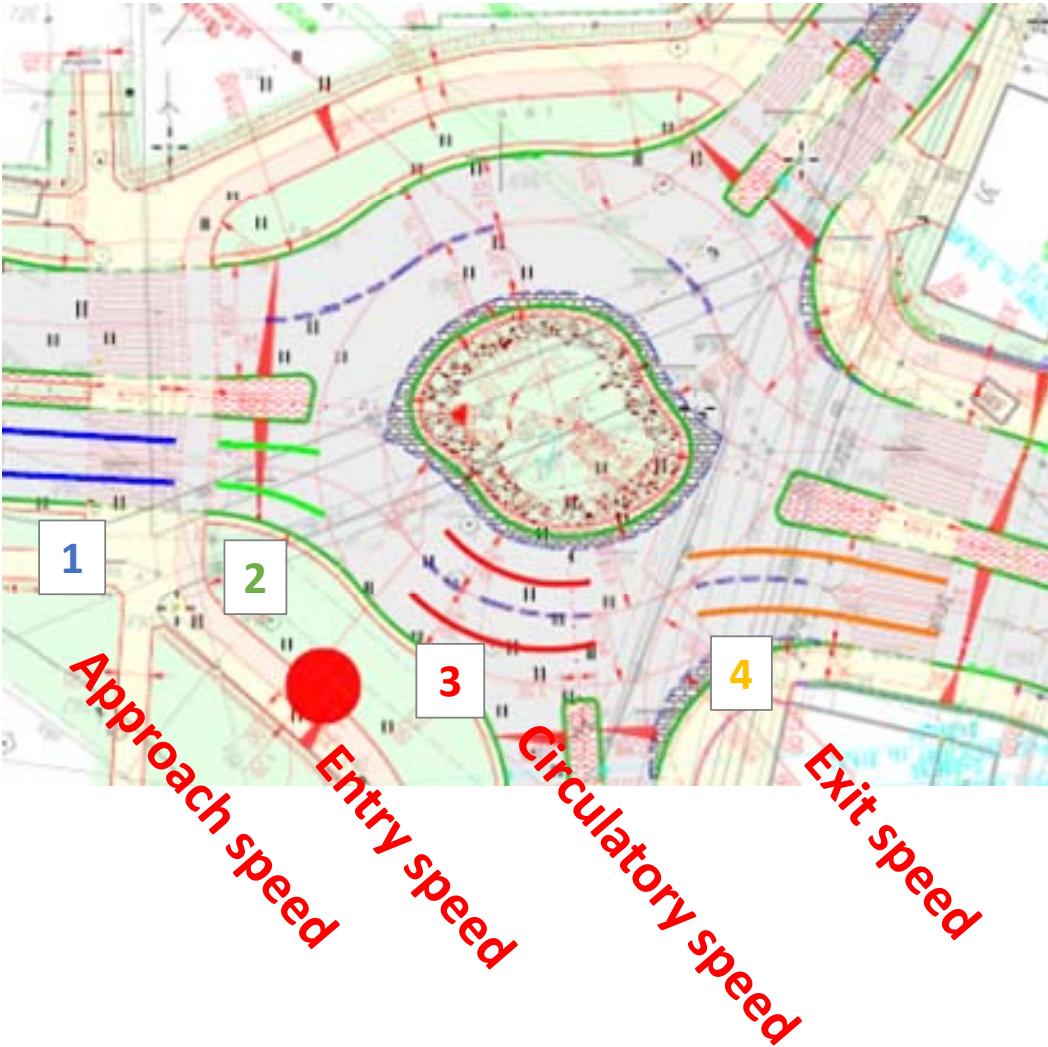


# Surrogate measures based on driver behaviour

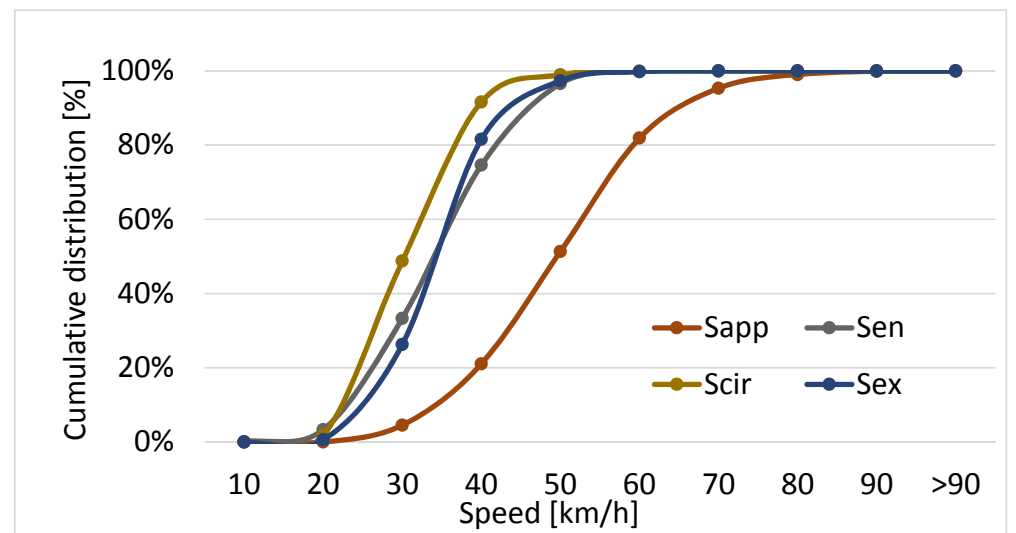
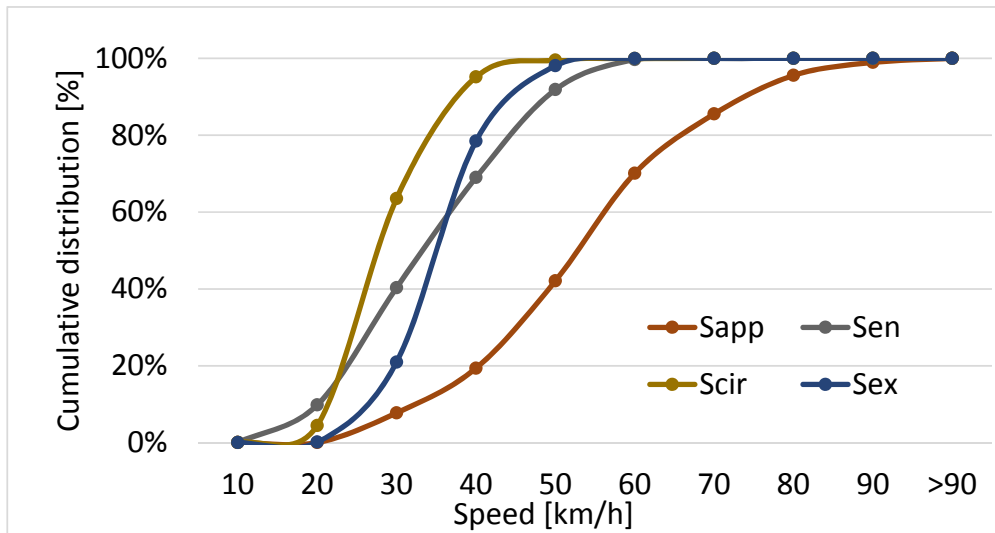
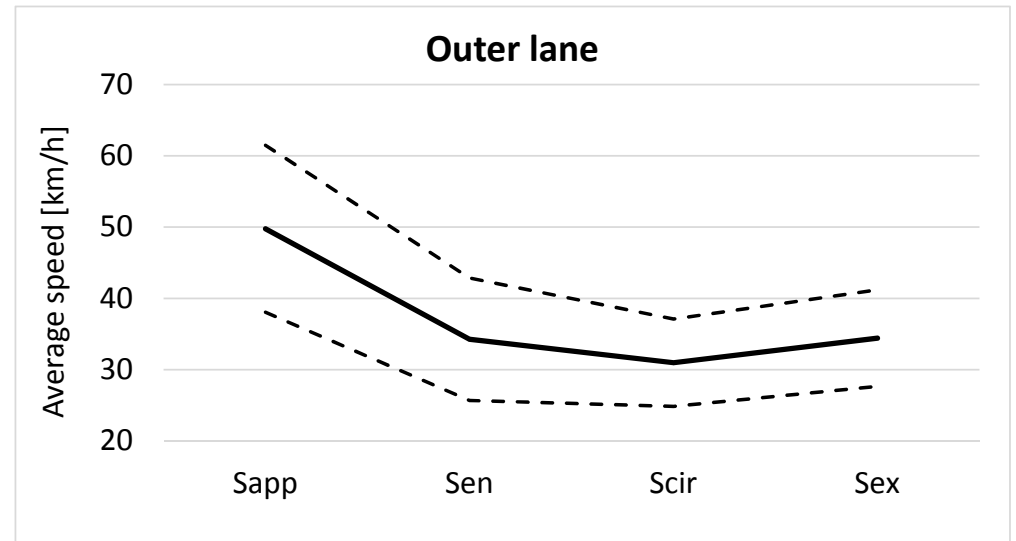
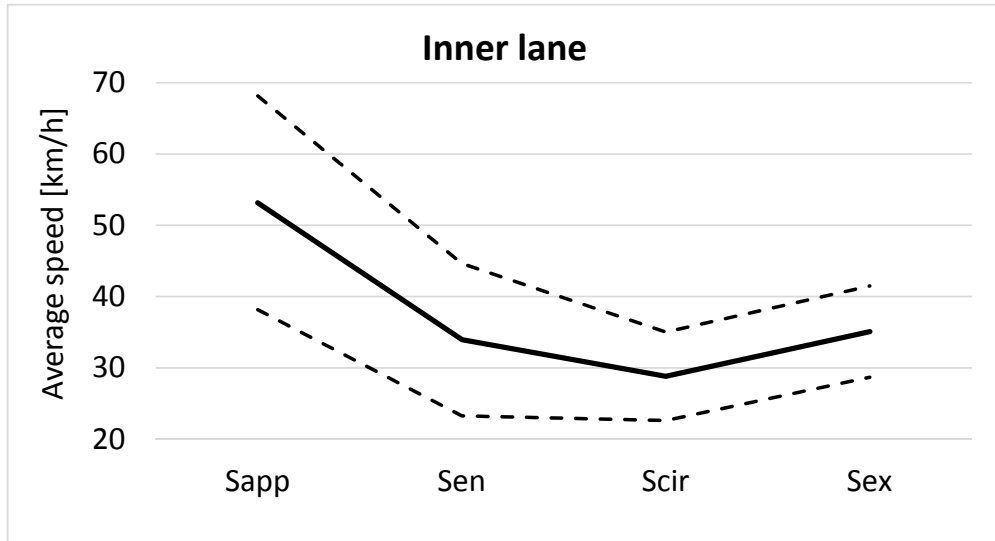


[Chodur and Bağ, 2016]

# Data collection on 15 turbo-roundabouts

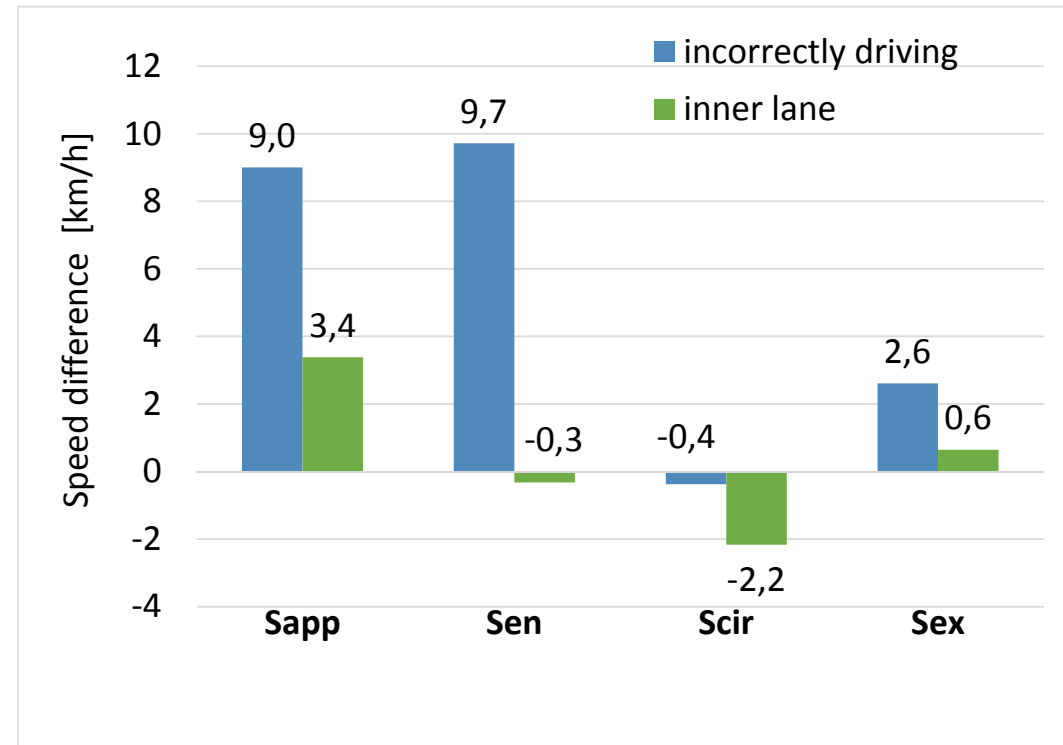
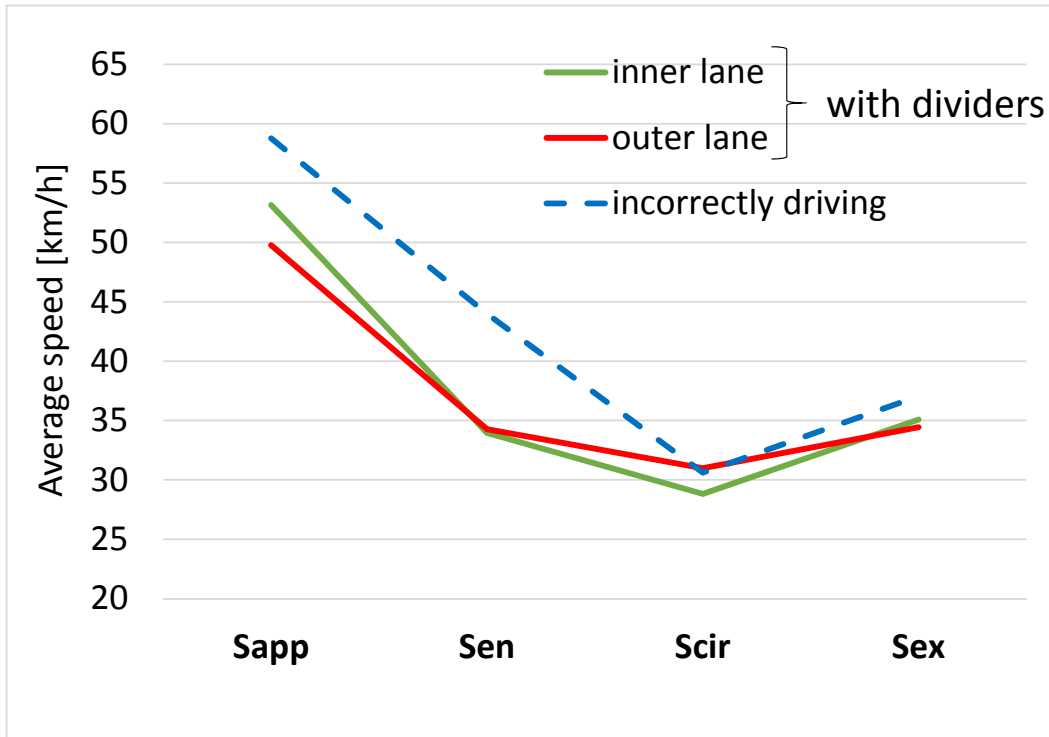


# Speed results (1): turbo-roundabouts with dividers





# Speed results (2): turbo-roundabouts without dividers



# *Speed-based surrogate roundabout safety measure*

- Section speed

$$\begin{array}{lll} S_{en} = 5,54 + 0,485 \cdot S_{app} + 0,432 \cdot R_{en} & R^2 = 0,74 & (R_{min} = 12\text{m}, R_{max} = 32\text{m}) \\ S_{cir} = 22,2 + 0,358 \cdot R_{cir} & R^2 = 0,36 & (R_{min} = 11\text{m}, R_{max} = 34\text{m}) \\ S_{ex} = 27,28 + 0,384 \cdot R_{ex} & R^2 = 0,24 & (R_{min} = 12\text{m}, R_{max} = 30\text{m}) \end{array}$$

- Turbo-roundabouts with dividers

$$\begin{array}{ll} IAS_d - \text{inside average speed [km/h]} & (IAS_{min} = 25 \text{ km/h}, IAS_{max} = 42 \text{ km/h}) \\ IAS_d = -6,87 + 0,334 \cdot S_{en} + 0,394 \cdot S_{cir} + 0,482 \cdot S_{ex} & R^2 = 0,98 \end{array}$$

- Turbo-roundabouts without dividers

$$\begin{array}{ll} IAS_{nd} - \text{inside average speed with improper driving [km/h]} & \\ IAS_{nd} = IAS_d + 3,66 + 0,021 \cdot P_{impdrv} & R^2 = 0,81 \\ P_{impdrv} - \text{percent of improper driving [\%]} & (\text{min} = 15\%, \text{max} = 40\%) \end{array}$$

# *Conclusions*

- The method allows to evaluate the relative changes in road safety based on observed or calculated speed.
- The use of observed speed, as a surrogate safety measure, allowed to estimate road safety on turbo roundabouts with and without dividers, including driver behaviour.
- Estimation of speed could be improved by using floating car data (speed profiles and trajectories).
- It will be necessary to develop and validate accident prediction models.

*Thank you for your attention*



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