
# Bicycling crash risk assessment in road infrastructure types: a case study in Berlin

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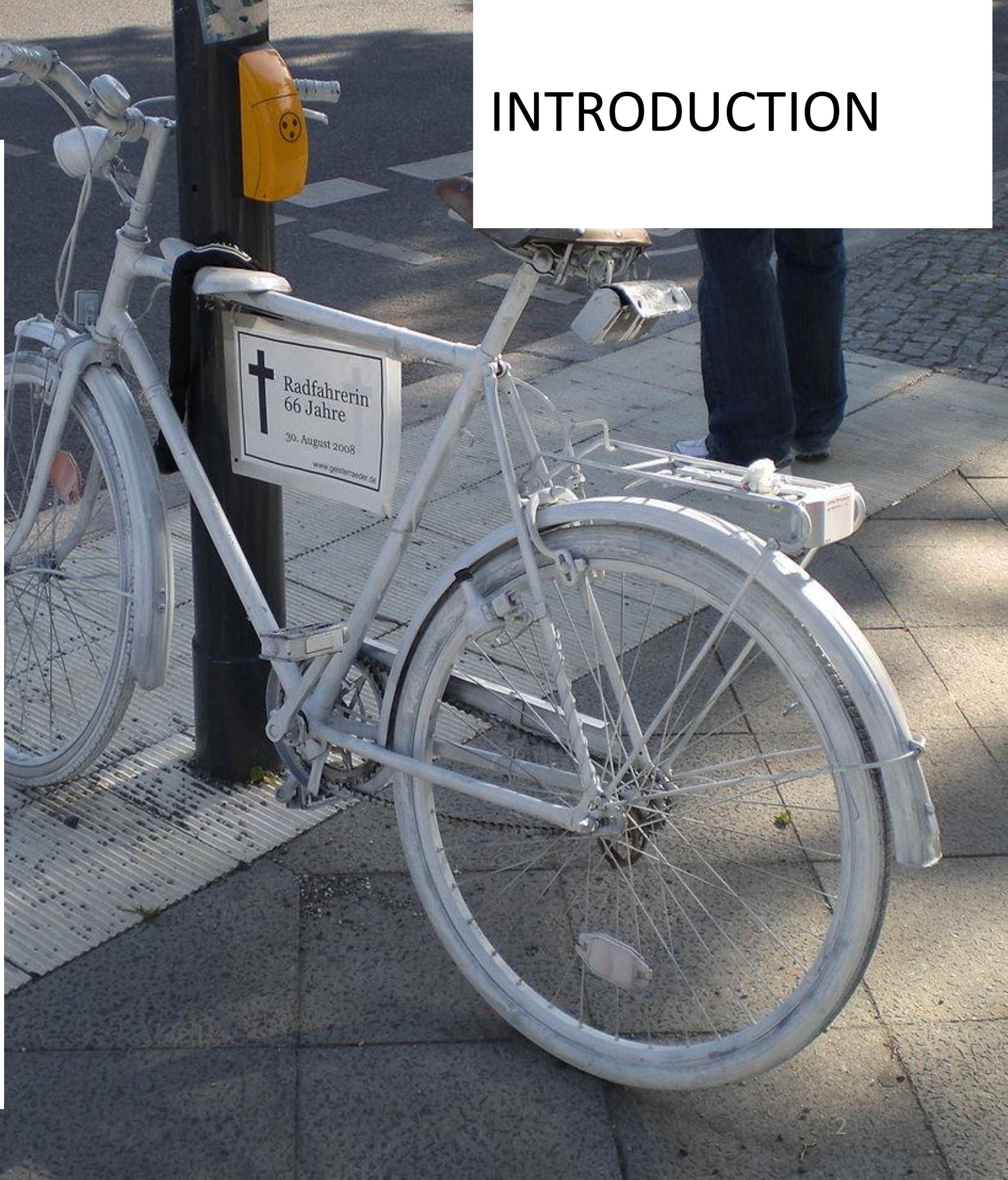
# INTRODUCTION

- Number of bicycling trips nearly quadrupled from 1975 to 2001
- Bicycle mode share grew from 5% in 1990 to 10% in 2007 (Broeg and Erl, 1996; Pucher, 1997; Pucher et al., 2010)
- Bicycle mode share grew from 8% to 13% between 2008 and 2013 (SRV and Berlin Senate, 2015)
- Private motorized trips share shrink from 38% to 30%; total number of urban road crashes, fatalities and injures dropped along the last 2 decades
- Berlin Senate increased yearly expenditures on bicycling infrastructure between 1995 and 2015, reaching 15 million Euros in 2015 (Lanzendorf and Busch-Geertsema, 2014; Buehler et al., 2016)
- However, that didn’t effect on the number of bicycling crashes, fatalities and injuries of a specific road user group: bicyclists



# INTRODUCTION

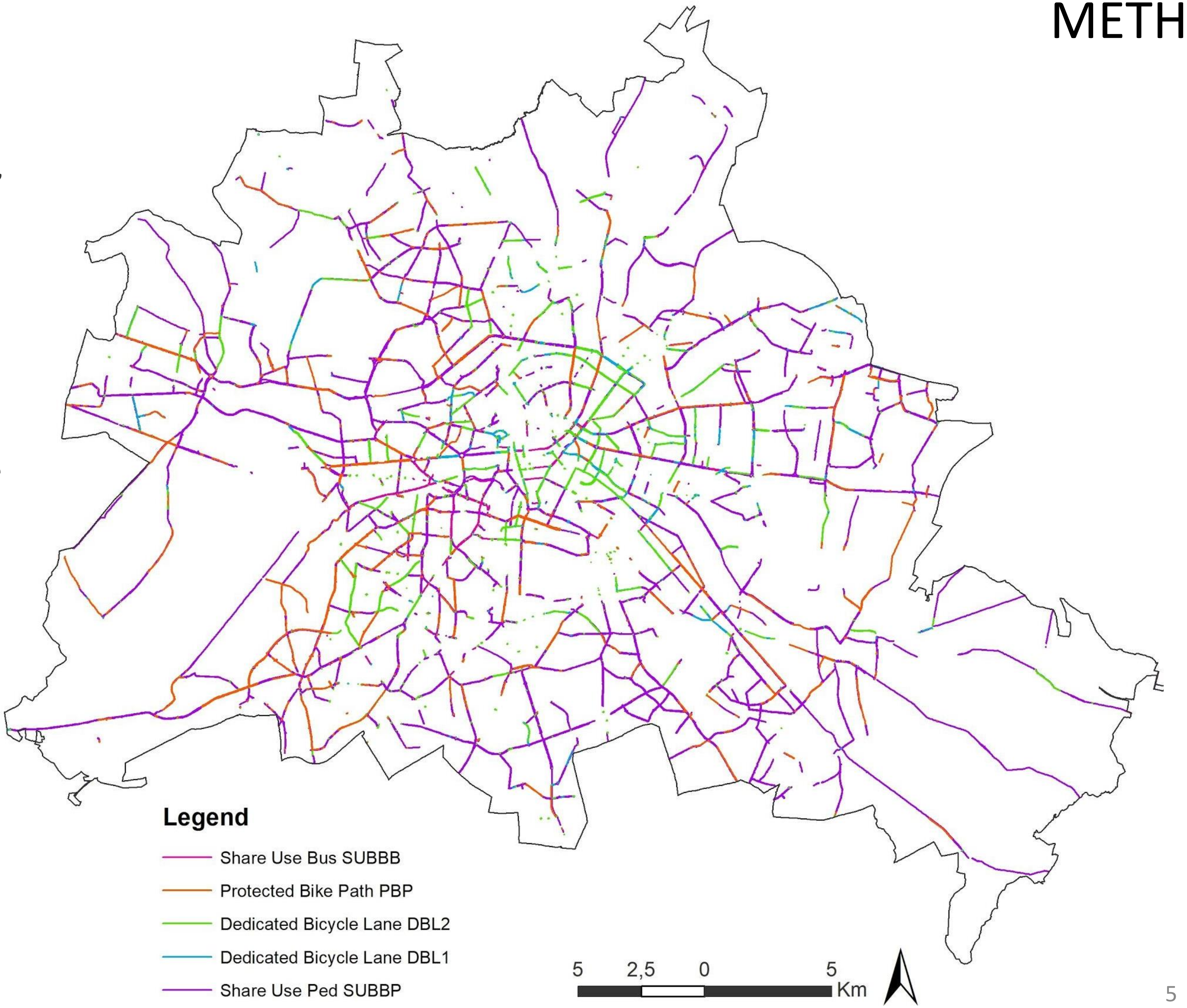
- Crashes and injuries among vulnerable road users such as bicyclists have become an accentuated public health problem in recent years (Johan de Hartog et al., 2010). In most urban areas, bicycling crash and injury rates are intolerably high. (World Health Organization [WHO], 2004; 2015)
- There are plenty of factors that influence risk, frequency, density, and crash injury. (Haddon, 1972; 1980; WHO, 2004; 2015; Elvik et al., 2009)
- Growing criticism on quantity and quality of urban crashes data; unsuitability of methods and erratic advice
- Study urban road safety within a systems perspective, simultaneously observing more than one mobility mode and their interdependence, as well as their effects on larger portions of the road infrastructure. (WHO, 2004, 2015; Kary, 2014; USNRC, 2018).
- Transport infrastructure, road design, and street layout are environmental factors to be considered in traffic crash causality causation analysis (Haddon, 1980; WHO, 2004, 2015). The presence of specific bicycle facilities on urban roadways is associated with lower collision risk (Reynolds et al, 2009).
- Haddon (1972; 1980) defines three factors that compose the crash risk matrix framework: (1) human, (2) vehicle and equipment, and (3) environment. We will address the third of these factors, namely bicycle roadway infrastructure (and the lack of bicycle road treatments) and how this type of facility influences traffic collision risk

The bicycling fatality rate in Berlin is 3 riders per 100 million bicycling kilometers; in contrast, Germany has a rate of 1.3 fatalities per 100 million bicycling kilometers and in the United States (where bicycling is predominantly recreational and accounts for fewer than 1% mode share of urban trips) the rate is 4.2 (Buehler and Pucher, 2017).

## Which bicycle road infrastructure type present lower collision risk?

# METHOD

- 38,916 bicycle road crash records, encompassing all crashes reported between January 1, 2011 and December 31, 2015.
- 92% of fatalities and severe injuries for bicyclists falls into the crash type: one motorized vehicle and one bicycle
- In total there are 1578 km of bicycling road infrastructure.
- Prepared dataset have a total of 25,688 bicycle collisions with a motorized vehicle



PBP

SUBBP

SUBBB

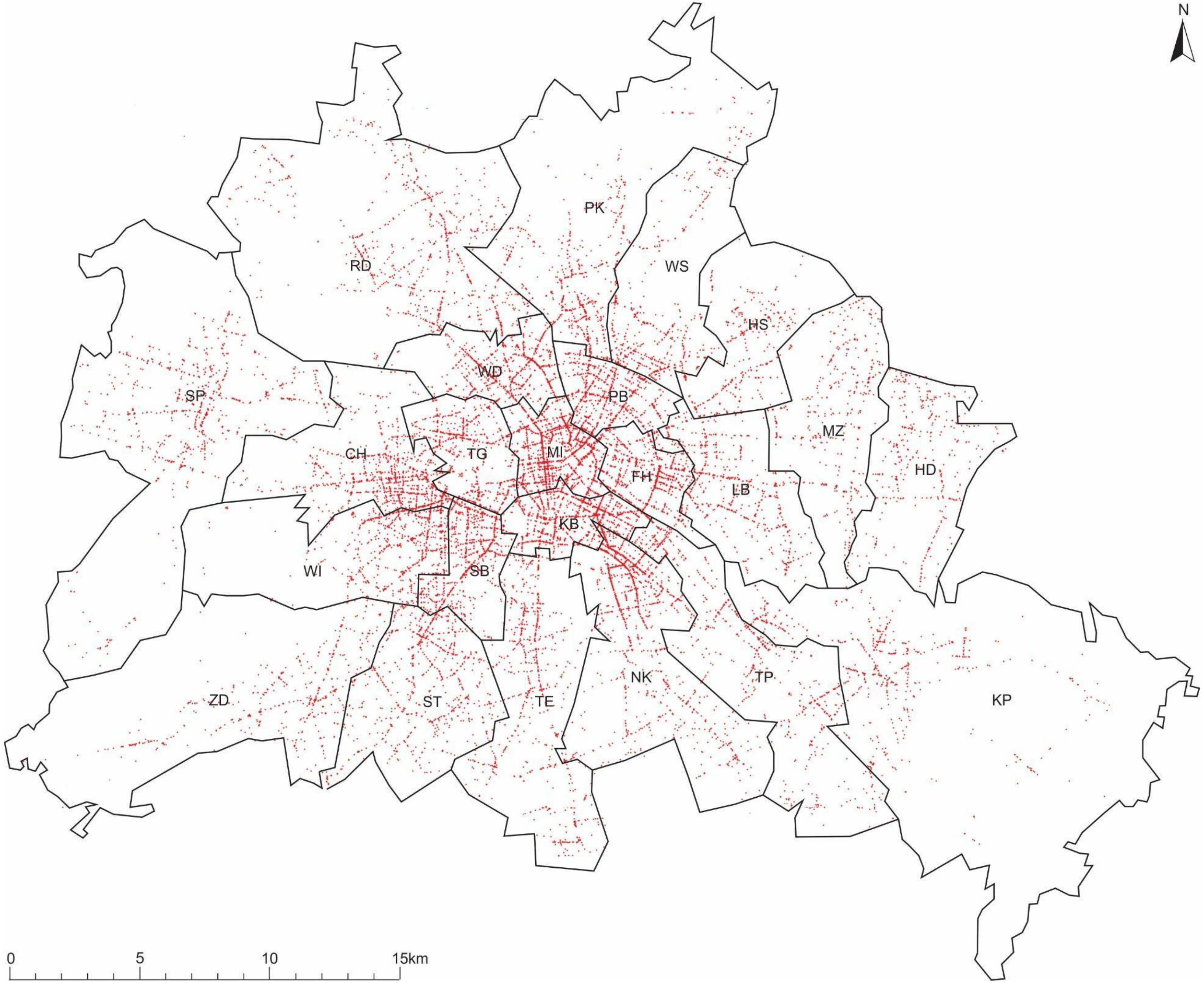
## METHOD

DBL 1

DBL 2

NBI

# RESULTS


N
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TP
ZD
ST
TE
KP
0
5
10
15km

# RESULTS

## PBP

$$N_1 = 70.9 - 3.7_{E-06}(M_{trip}) + 3.9_{E-06}*(B_{trip}) + 72.2(km_1)$$

$R^2$: 0.99 | F (Anova): 2.2E-11

| | Coefficients | P-value |
|---|---|---|
| *Intercept* | 70.9 | 0.5 |
| **M trip** | -3.7E-06 | 1.5E-04 |
| **B trip** | 3.9E-06 | 2.1E-07 |
| **km1** | 72.2 | 2.8E-04 |

## SUBBP

$$N_2 = 31.7 + 2_{E-06}(M_{trip}) + 8.8_{E-06}(B_{trip}) - 11.1(km_2)$$

$R^2$: 0.99 | F (Anova): 2.2E-11

| | Coefficients | P-value |
|---|---|---|
| *Intercept* | 31.7 | 0.5 |
| **M trip** | 2.0E-06 | 0.2 |
| **B trip** | 8.8E-07 | 4.3E-05 |
| **km2** | -11.1 | 0.2 |

## SUBBB

$$N_3 = -0.9 - 7.3_{E-08}(M_{trip}) + 3.6_{E-08}(B_{trip}) + 11.6(km_3)$$

$R^2$: 0.99 | F (Anova): 2.2E-11

| | Coefficients | P-value |
|---|---|---|
| *Intercept* | -0.9 | 0.6 |
| **M trip** | - 7.3E-08 | 1.1E-11 |
| **B trip** | 3.6E-08 | 6.0E-05 |
| **km3** | 11.6 | 2.3E-16 |

## DBL1

$$N_4 = -0.6 - 1.2_{E-07}(M_{trip}) + 2.8_{E-07}(B_{trip}) + 7.9(km_4)$$

$R^2$: 0.99 | F (Anova): 1.3E-18

| | Coefficients | P-value |
|---|---|---|
| *Intercept* | -0.6 | 0.8 |
| **M trip** | - 1.2E-07 | 8.3E-15 |
| **B trip** | 2.8E-07 | 2.2E-11 |
| **km4** | 7.9 | 1.8E-14 |

# RESULTS

| DBL2 | | | NBI | | |
|---|---|---|---|---|---|
| $N_5= -8 -8.2_{E-08}(M_{trip})+7.7_{E-07}(B_{trip})+21(km_5)$ | | | $N_6= 185+3.1_{E-06}(M_{trip})+4.4_{E-06}(B_{trip})-3.9(km_6)$ | | |
| $R^2$: 0.97 | | F (Anova): 5.4E-09 | $R^2$: 0.99 | | F (Anova): 7.3E-13 |
| | Coefficients | P-value | | Coefficients | P-value |
| *Intercept* | - 8.0 | 0.8 | *Intercept* | 185 | 0.5 |
| **M trip** | - 8.2E-08 | 7.9-E02 | **M trip** | 3.17E-06 | 6.9E-03 |
| **B trip** | - 7.7E-07 | 5.1-E02 | **B trip** | 4.41E-06 | 7.8E-05 |
| **km5** | 21 | 1.5E-04 | **km6** | - 3.9 | 2.5E-02 |

# POLICY MAKING ADVICE AND FINAL REMARKS

- No bicycle road infrastructure (NBI) presented the highest risk of bicycling collision with a motorized vehicle, followed by PBP, SUBBP, DBL2, SUBBB. The bicycle road type that presented the lowest risk of cycling crash was DBL1
- Quality and quantity of Berlin road crashes data makes the city a reference in this type of data collection ( ICT and system )
- Predictive model and this risk assessment method can be made for any given city, with the same data sets are available
- DBL1 and SUBBB have relatively lower costs for implementation; results support policy making, planning and design of