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How to Simplify Road Network Safety Screening: Two Case Studies

TRANSPORT RESEARCH CENTRE

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INTRODUCTION

- Safety management process starts with network screening (hotspot identification), ideally using uses crash prediction models (or safety performance functions, SPFs) and empirical Bayes (EB) approach
- In the end a list is produced which enables ranking the locations from the most likely to least likely to reach a reduction in crash frequency through specific countermeasures

Typically SPFs are developed for intersections and road segments between them, but:

- Two lists are thus developed where to allocate budget?
- Traffic volume (AADT) for SPF needs to be completed on minor intersection legs

The objective: to use the approach that allows considering intersections and segments jointly, without having to collect AADT data for all missing intersection legs.

Inspired by the 1996 UK study (Mountain et al.), the study focused on proving feasibility of the UK approach on Czech roads. Two case studies were conducted for national and regional roads.

DATA

South Moravia region (SM)

- regional roads
- approx. 1000 km
- 39 segments & 61 intersections

Zlín region (ZL)

- national roads
- approx. 400 km
- 21 segments & 56 intersections

(approx. half of the intersections with unknown AADT)



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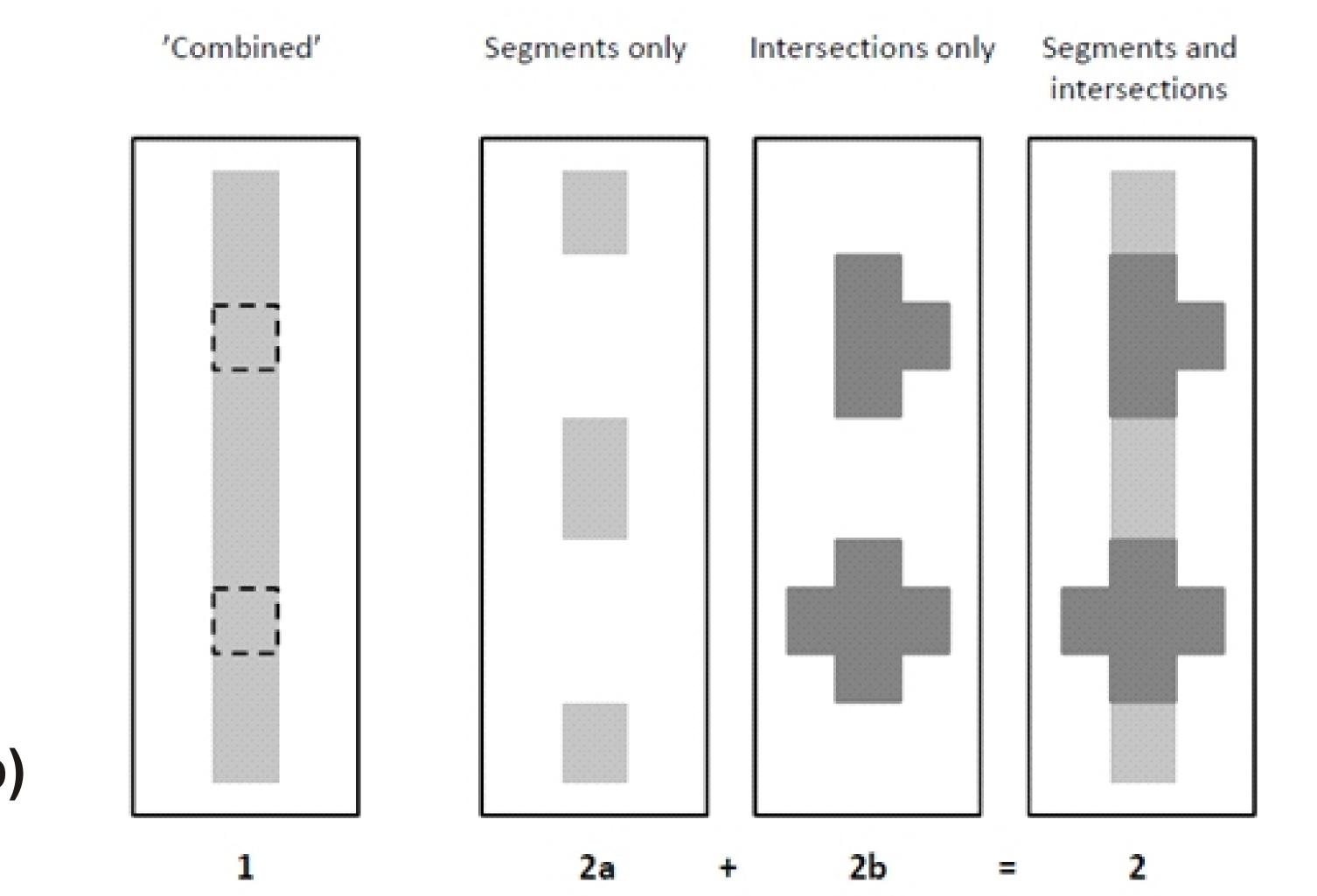
Data collection and post-processing: Vladimír Dufek, Ondřej Gogolín, Martin Kyselý, Stanislav Řehák, Richard Turek, Lucie Vyskočilová

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METHODS

The study approach followed the original UK study in developing 3 SPFs:

- for total crashes on segments, including intersection density ('combined' model)
- for segment-only crashes, i.e. excluding intersection crashes (model 2a)
- for intersections (model 2b)

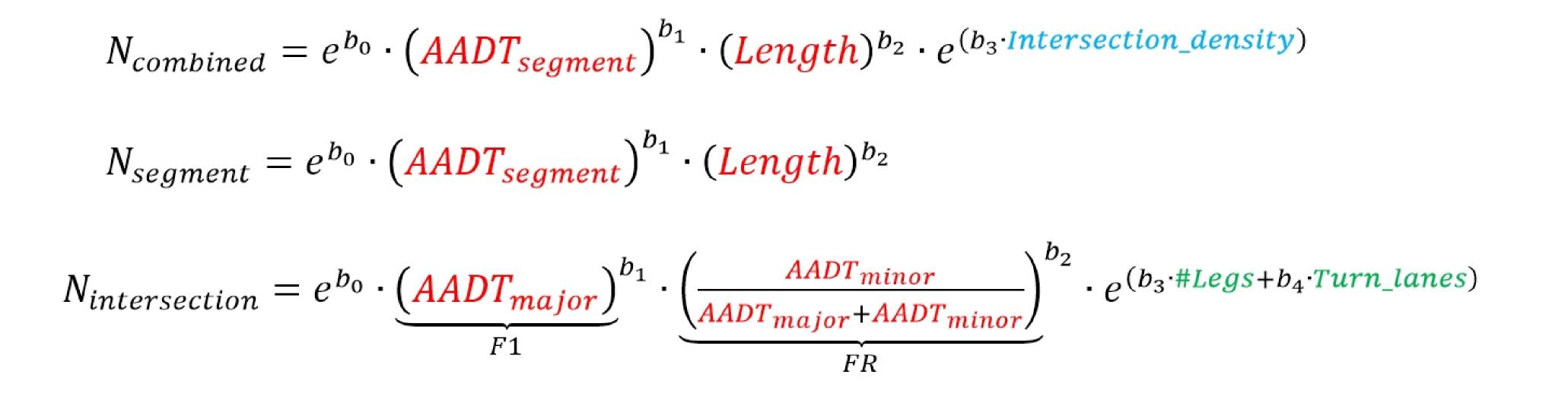


The objective: to compare

predictions 1 (from the combined model)

predictions 2 (sum of results from models 2a and 2b)

The model forms:



Explanatory values were

- for combined model: segment AADT, segment length, intersection density
- for segment-only model: segment AADT, segment length
- for intersection model: AADT on major and minor roads, number of legs, turn lanes

bi ... regression parameters to be estimated in modeling

N... injury crash frequency, 6-year period (2009 – 2014) (crashes within 100-meter area around the intersection considered intersection-related)

(rural roads, only unsignalized intersections)

For network screening, model predictions were adjusted according to empirical Bayes (EB) methodology, which combines predicted and reported crash frequencies (P and R), using weighted average (with weights w):

$$EB = w \cdot P + (1 - w) \cdot R$$

RESULTS

Models were successfully calibrated.

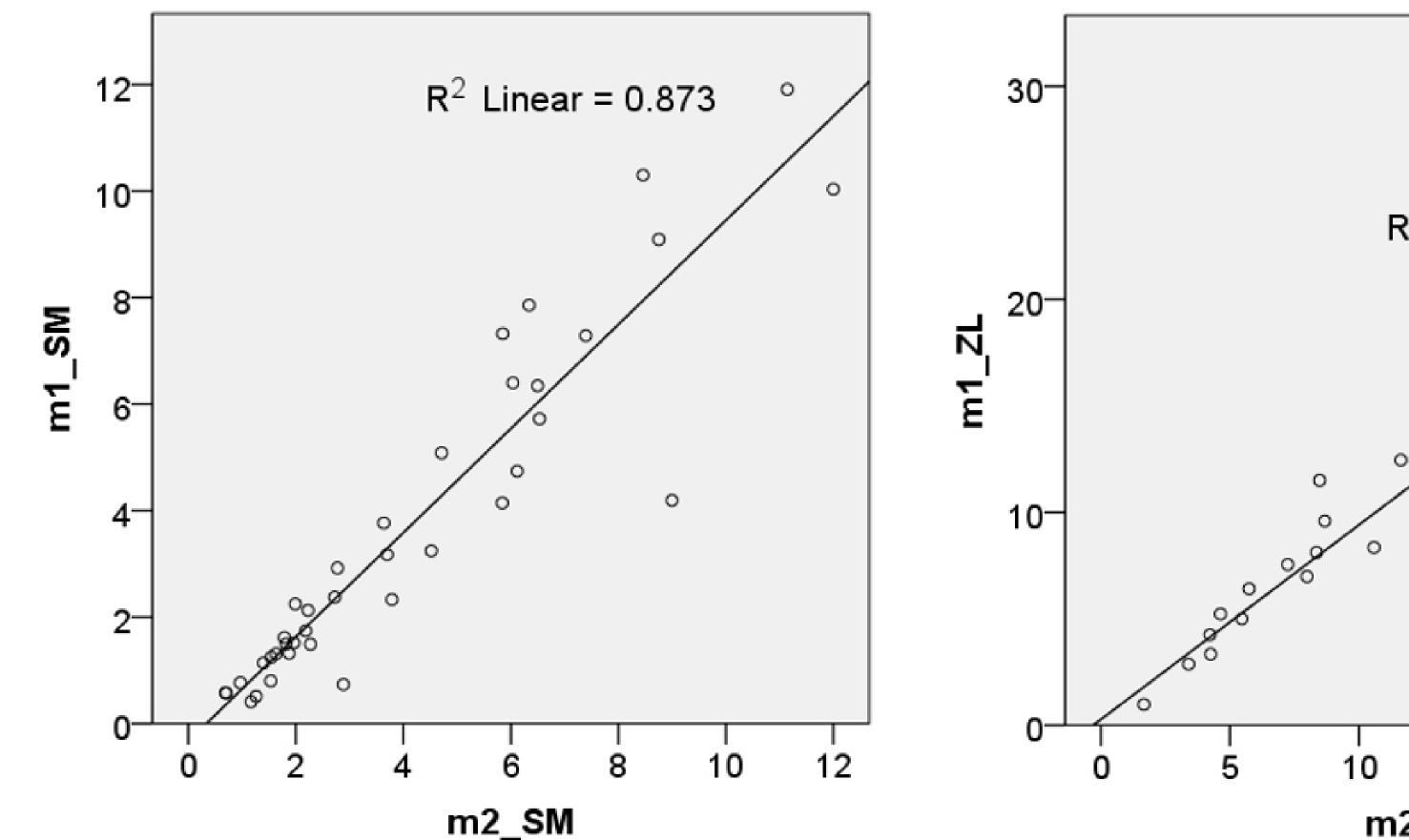
All variables had systematic influence at the level of statistical significance 10%.

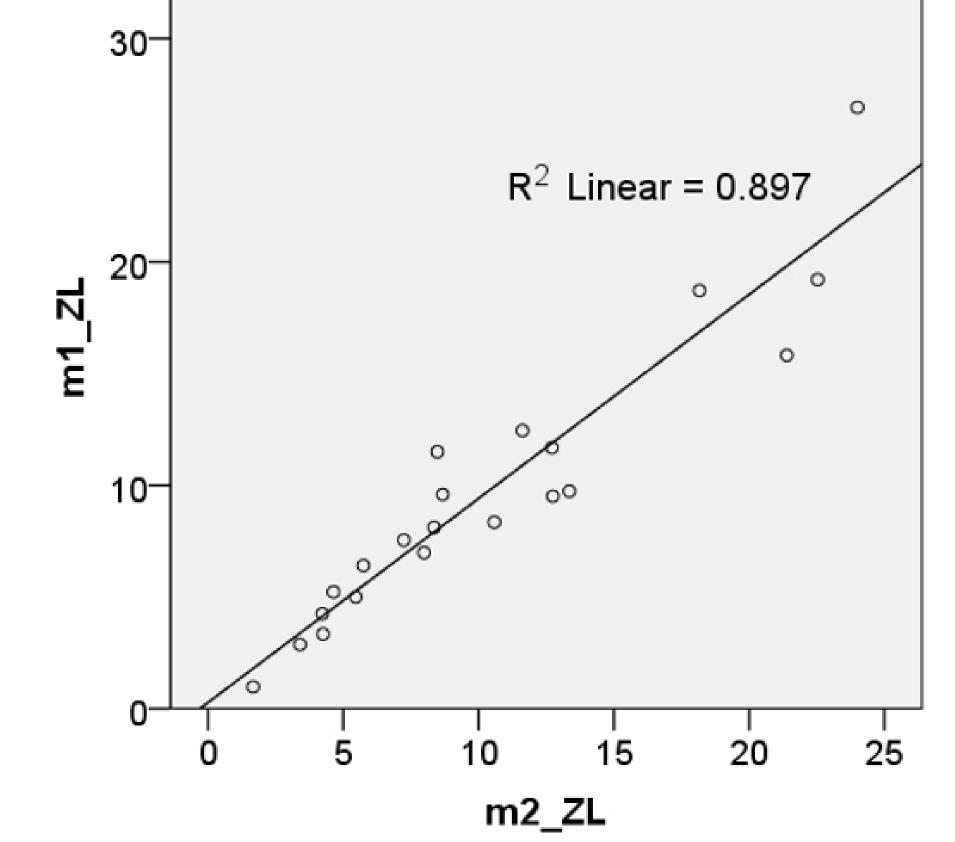
The signs of regression coefficients confirmed expectations:

- AADT, Length, Intersection density ... positive coefficient (their increase is associated with increasing crash frequency).
- Number of intersection legs ... negative coefficient (3-leg intersections have lower crash occurrence compared to 4-leg ones)
- Turn lanes ... negative coefficient (intersection with turn lanes are safer than those without turn lanes)

Model goodness-of-fit (proportion of systematic variation explained): increased by 4% for the combined model (comparable to 5% in the UK study)

The relationship between predictions *m*₁ and *m*₂ for SM and ZL samples:





Method consistency assessed for top segments with the highest EB estimates:

- The selected 10 segments in list 1 (according to model 1) overlapped with 9 segments in list 2a (segments ranked according to model 2a).
- This equals to consistency 90% for top 10 segments.

CONCLUSIONS

- Using the intersection density is a potential simplification which would allow omitting data collection for intersection SPF.
- The aim of the paper was to verify the applicability of this approach in Czech conditions, both for regional and national road networks.
- The method was found feasible simplified predictions with intersection density were very close to predictions based on a combination of segments and intersections. Goodness-of-fit of simplified models even improved.

The approach enables performing the network screening without having to conduct additional traffic surveys to complement the missing AADT data on intersections. This simplification will increase efficiency of network screening and allow a wider practical application for Czech regional administrators.