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NETWORKING FOR FIELD OPERATIONAL TESTS

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Scaling up FOT results

FOT-NET seminar, ITS Israel / ILTAM, 23-6-2010

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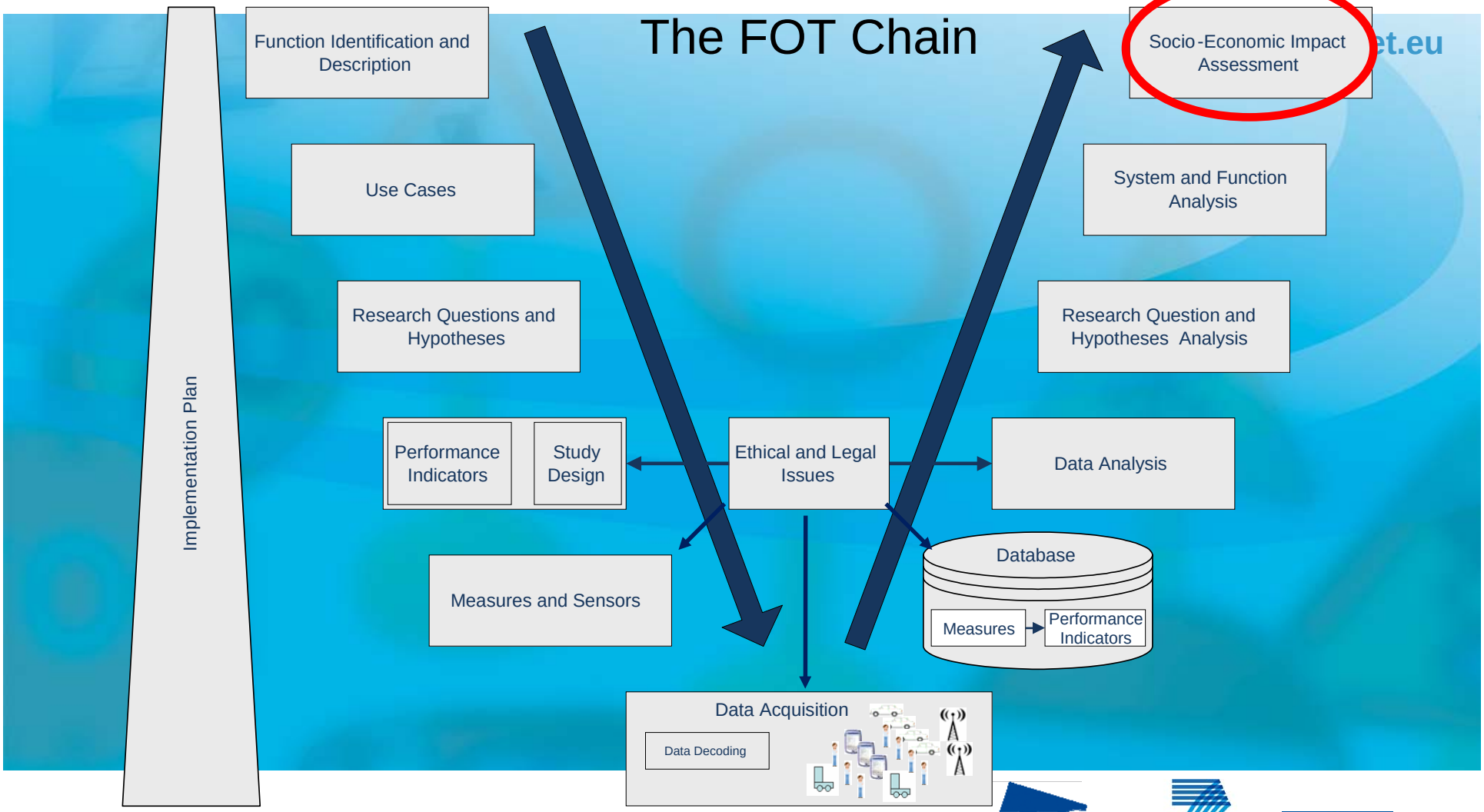
TNO

SEVENTH FRAMEWORK PROGRAMME

Where are we?


The FOT Chain
Function Identification and Description
Use Cases
Research Questions and Hypotheses
Performance Indicators
Study Design
Measures and Sensors
Implementation Plan
Ethical and Legal Issues
Data Acquisition
Data Decoding
Database
Measures
Performance Indicators
Data Analysis
Research Question and Hypotheses Analysis
System and Function Analysis
Socio-Economic Impact Assessment

What is scaling up?

- Term is not consistently used
- Here, scaling up means:
  - **Obtain society level effects…**
  - **…from vehicle level data**

- Geographical scale
- Time scale
- Time period (future) ➔ demand, equipment rate

- Transforming FOT data (speeds, headways, …) into societal impacts (fatalities, time savings, …)

Why scaling up?

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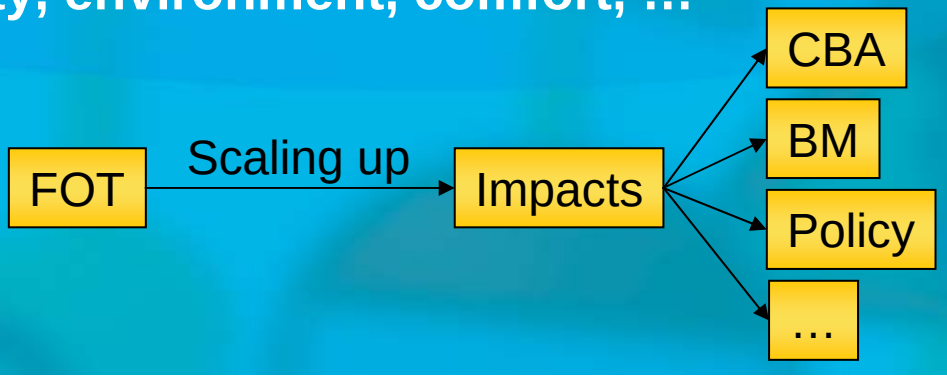
- FOT provides detailed data for realistic situations, but…
  - **For a limited fraction of the vehicle fleet**
  - **Needs further interpretation**

- What happens with large scale deployment?
  - **Impacts: efficiency, safety, environment, comfort, …**

  - **Cost-benefit analysis**
  - **Business models**
  - **Policies**
  - **…**



What is difficult about scaling up?

- Gap between FOT data and the performance indicators (parameters that are measured in the FOT)
- Missing FOT data (lateral accidents)
- Interaction between users and non-users
- Nonlinear in penetration rate (early adopters, cooperative systems)
- Different geography
- Different time period
- Driver behavior modeling

Vision on test environment

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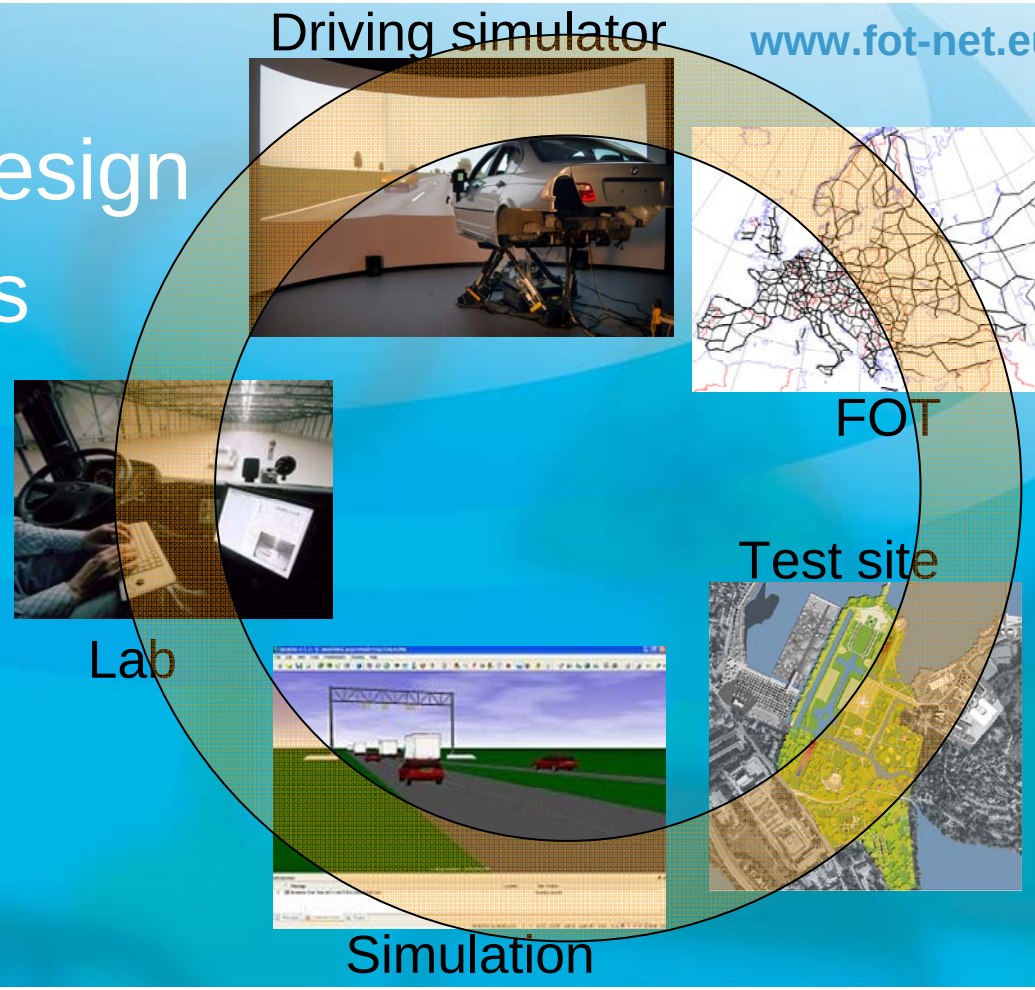
- Experimental design
- Combining tools

Characteristics:
- Realism
- Scale
- Cost
- Level of control
- Risk



The Challenge

- Goal: to understand some of the challenges in scaling up
- 4 cases, 1 per group.
- Find solutions to specific scaling up problems
  - **Brainstorm style**
    - Multiple answers are possible!
  - **Focus on the most important issues**

- Try to avoid:
  - **Discussing the merit of the case (yes, it is artificial)**
  - **Arguing which solution is the best**

Workshop

- 15 minutes group work
- 1 minute presentation by each group
- 5 minutes conclusion

Workshop

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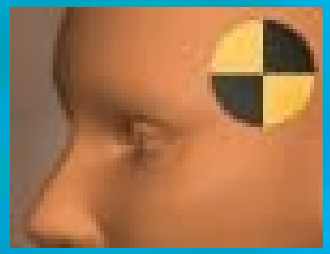
- 1 minute presentation by each group
- 5 minutes conclusion

- Approach of the EuroFOT project

Impacts needed in CBA

- Traffic:
  - **travel time costs: changes in travel times**



- Safety:
  - **accident costs: changes in no. of accidents (with fatalities, injuries, property damage only)**

picture of smoking car

- Environment:
  - **environmental costs: changes in emissions of NOx, PM10, CO2 (and other pollutants), noise**
  - **operating costs: change in fuel consumption**

Sources of data

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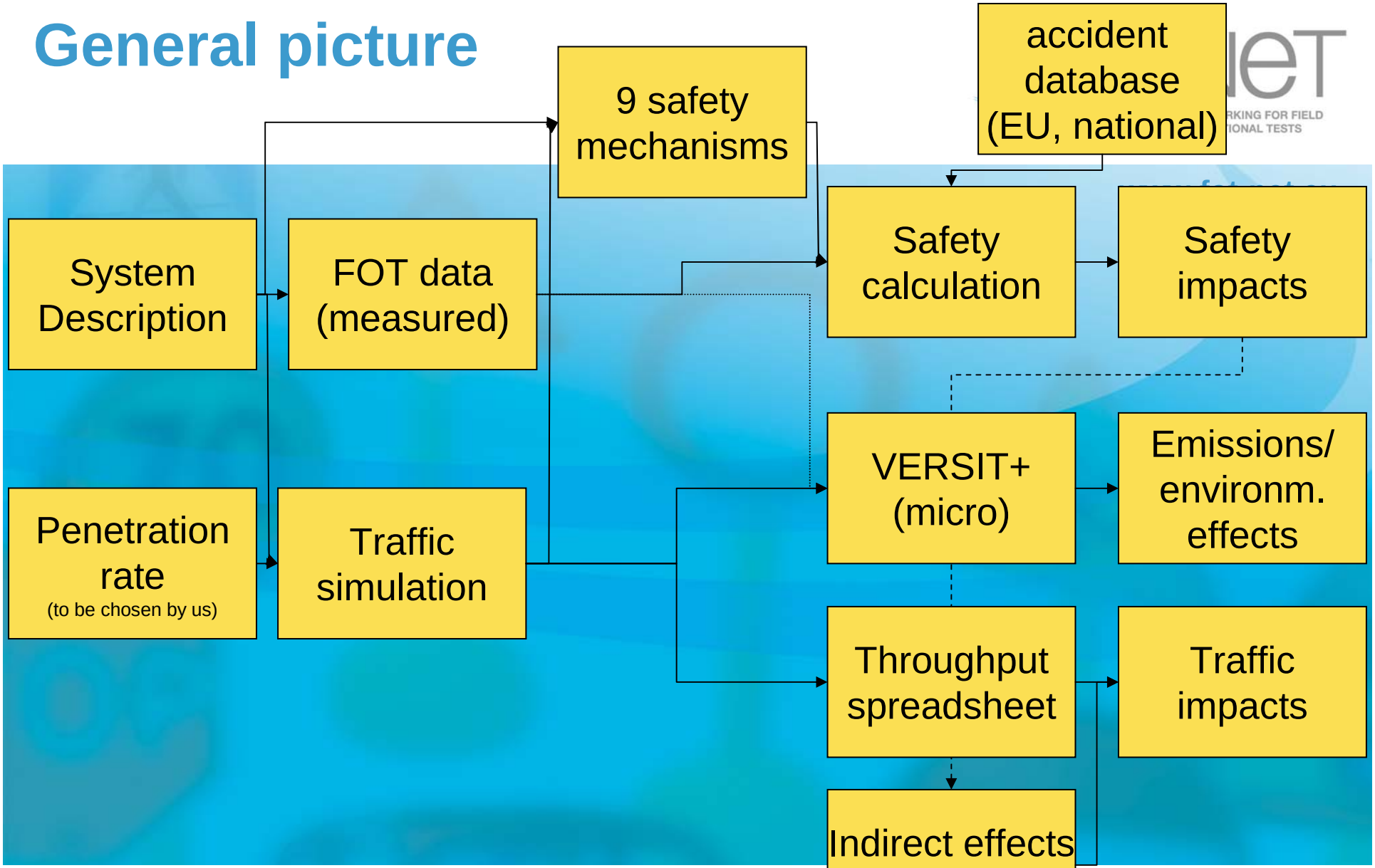
- directly from FOT
  - **only for equipped vehicles**
  - **penetration rate unknown but usually very very very very low**
  - **impacts possible to measure/derive:**
    - safety (speeds, some surrogate safety measures)
    - environment (emissions)

- via models
  - **higher penetration rates possible**
  - **needed for impact assessment throughput**
  - **other impacts: at least same possibilities as from FOT data**
  - **includes effects such as how other vehicles are influenced by equipped vehicles**

General picture

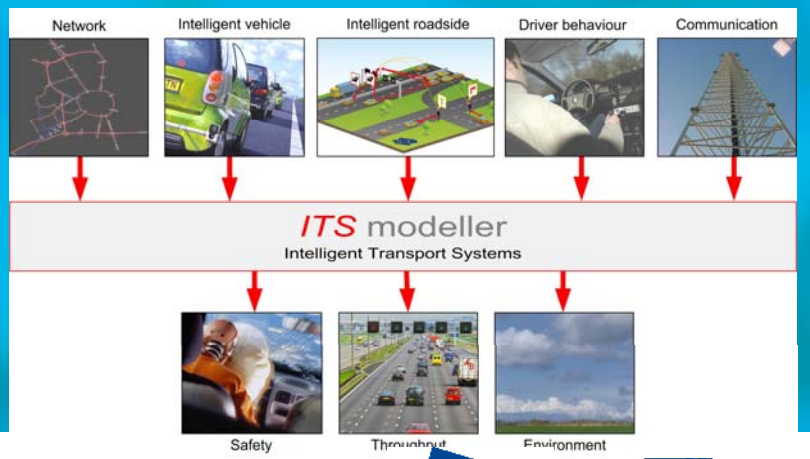


- Details

Traffic simulation: ITS modeller (and Pelops)

- Microscopic simulation model
- Shell for commercial models (e.g. Paramics, VISSIM)
- specific behaviour of equipped vehicles can be included (default behaviour is overruled)

- Output is as from normal microsimulation models
- → needs to be processed to obtain impacts

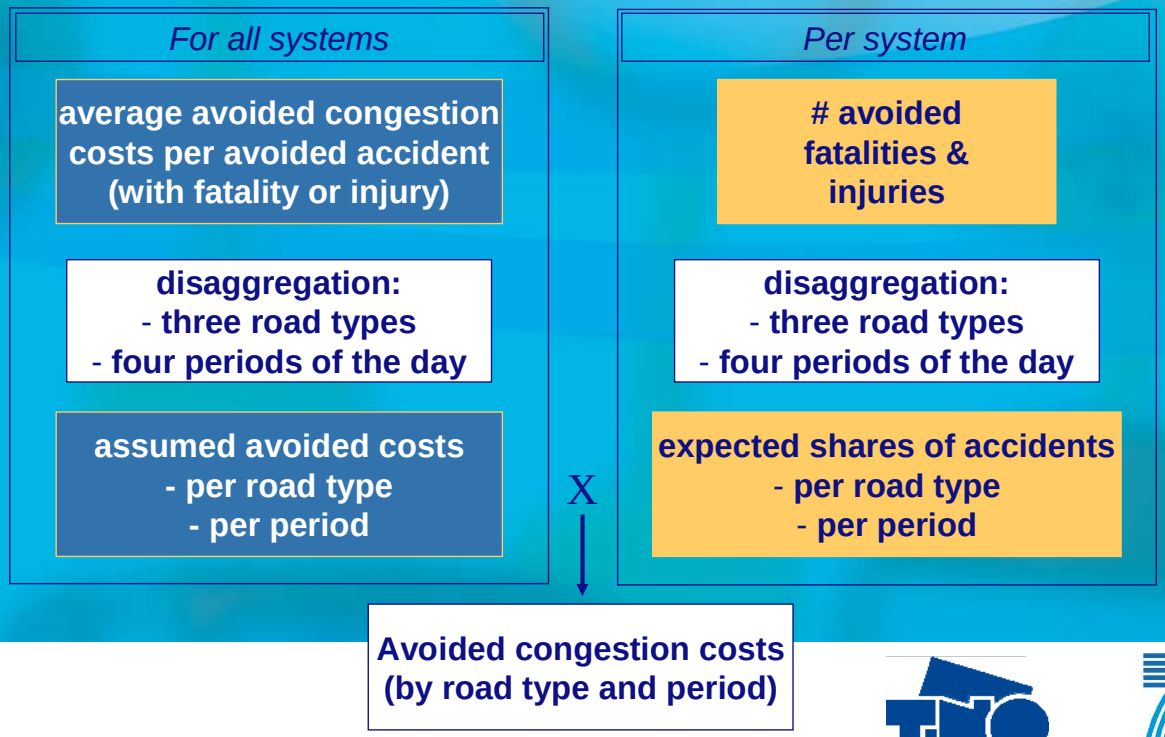


Direct effects spreadsheet

- uses ITS modeller output
- calculates average speeds, travel times, etc.
- (also calculates surrogate safety measures)

Indirect effects spreadsheet

- uses safety impacts (no. of accidents)
- calculates change in congestion costs (only for accident related congestion)



VERSIT+micro

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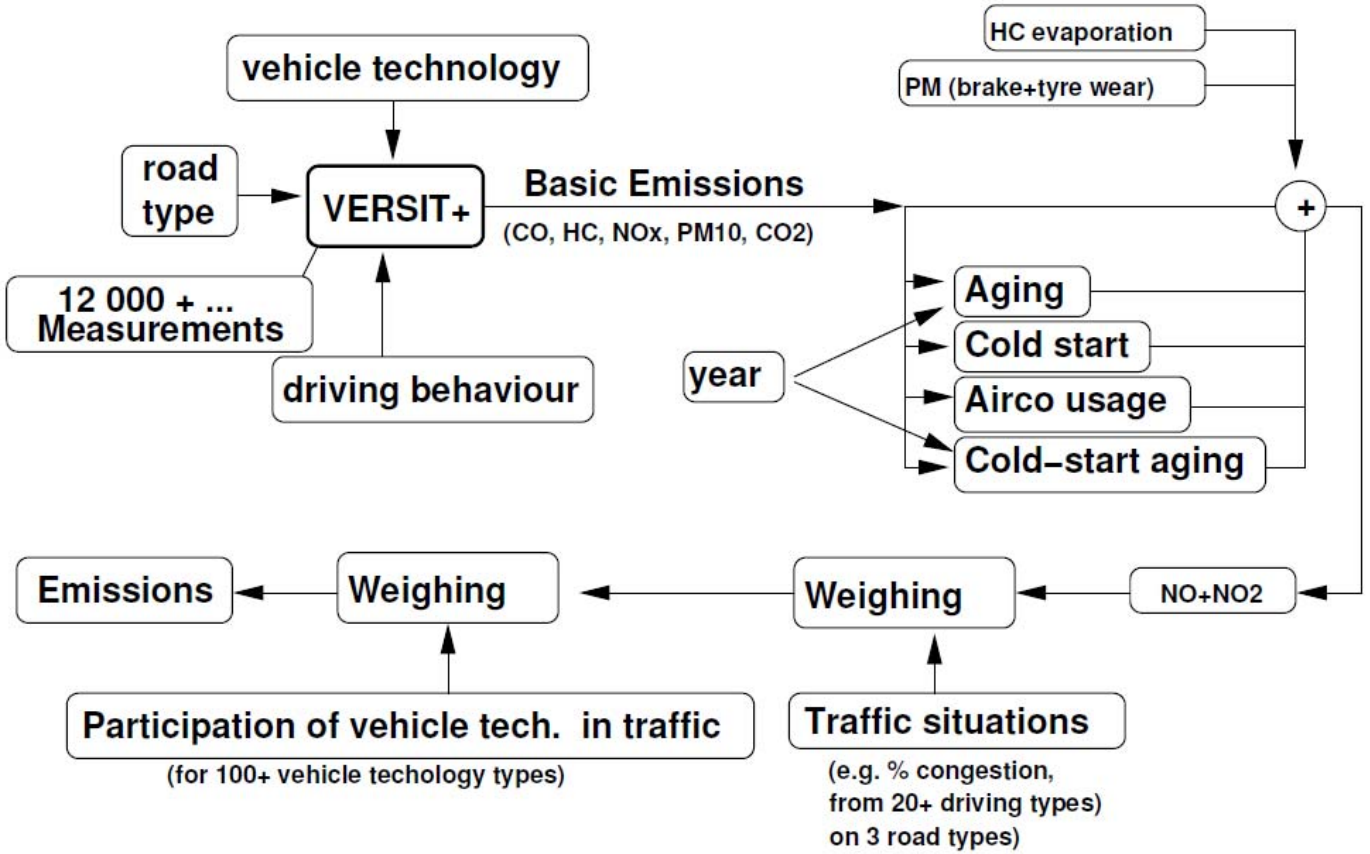
- uses speed over time patterns (1 Hz) from model or from FOT data
- calculates emissions per vehicle
  - **NOx**
  - **PM10**
  - **CO2**
- Based on extensive database with measurements from thousands of vehicles

picture of speed pattern
+ emissions

VERSIT+micro



9 safety mechanisms description

- from eIMPACT
- all intended AND unintended effects
- included effects on risk and exposure
- qualitative description
- input for quantitative evaluation

Safety mechanisms 1-5

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1. Direct in-car modification of the driving task
   - immediate effects on attention, behaviour, speed, distraction (all)
2. Direct influence by roadside systems
   automatic camera enforcement increases positive effects of SPE
3. Indirect modification of user behaviour
   DDM driver continues driving after long periods of driving
4. Indirect modification of non-user behaviour
   an equipped driver follows ESC driver in a curve too fast
5. Modification of interaction between users and non-users
   WLD driver forces cars behind to slow down

Safety mechanisms 6-9

- 6. Modification of road user exposure

  because more comfort tiny amount of extra exposure = mobility

- 7. Modification of modal choice

  NIW driver used bus more often before

- 8. Modification of route choice

  motorways are more appealing for FSR driver

- 9. Modification of accident consequences

  because swifter arrival of help consequences are mitigated for ECA

safety spreadsheet

M1

A. Type of accidents	ALL	Collision on the road with pedestrian	Collision on the road with all other ocstables	Collision besides the road with pedestrian or obstacle or other single vehicle accidents	Frontal collision	Side-by-side collision	Angle collision	Rear collision	Other accidents with two vehicles
percentage of fatalities	7882	15%	2%	33%	20%	2%	17%	4%	7%
- mean effect on fatalities	**-7.6 %**	**0.0%**	**-24.0%**	**-12.0%**	**0.0%**	**0.0%**	**-6.0%**	**-30.0%**	**-12.0%**
effectiveness factor	100.0%	0.0	3.2	1.6	0.0	0.0	0.8	3.9	1.6
Calibration factor	1.00	0.0	3.2	1.6	0.0	0.0	0.8	3.9	1.6
percentage of injuries	611101	9%	6%	16%	11%	5%	28%	16%	8%
- mean effect on injuries	**-9.1 %**	**0.0%**	**-20.0%**	**-10.0%**	**0.0%**	**0.0%**	**-5.0%**	**-25.0%**	**-10.0%**
effectiveness factor	100.0%	0.0	2.2	1.1	0.0	0.0	0.5	2.7	1.1
Calibration factor	1.00	0.0	2.2	1.1	0.0	0.0	0.5	2.7	1.1

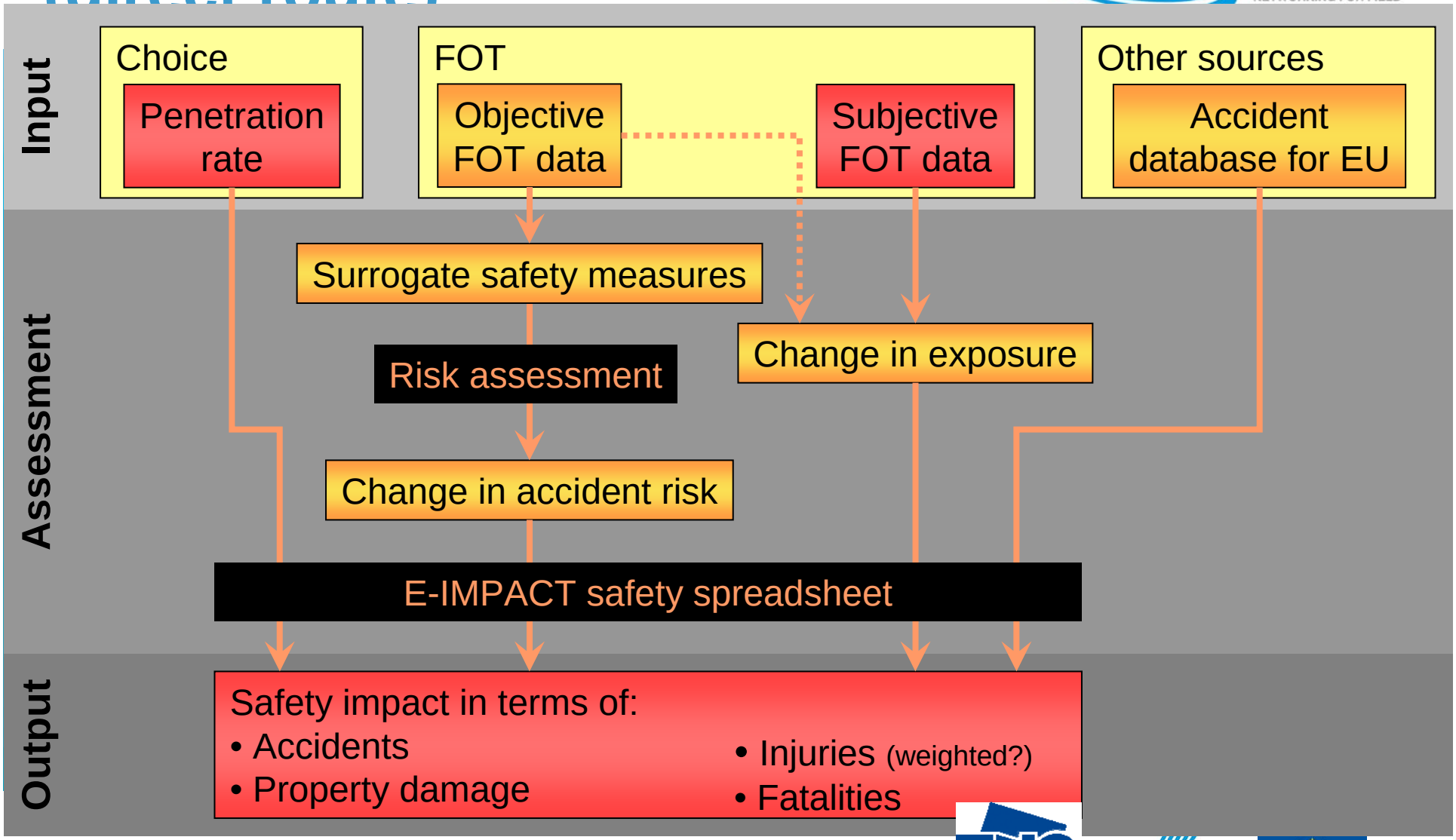
M1

F. Link / Intersection	ALL	Link	Intersection
percentage of fatalities	7882.250618	58%	42%
- mean effect on fatalities	**-7.6 %**	-11.5%	-2.3%
effectiveness factor	66.2%	**1.0**	**0.2**
Calibration factor	1.51	1.5	0.3
percentage of injuries	611101	30%	70%
- mean effect on injuries	**-9.1 %**	-20.9%	-4.2%
effectiveness factor	43.6%	**1.0**	**0.2**
Calibration factor	2.29	2.3	0.5

- very complicated spreadsheet
- based on qualitative assessment
- uses data from EU or national database
- calculates change in number of fatalities and injuries

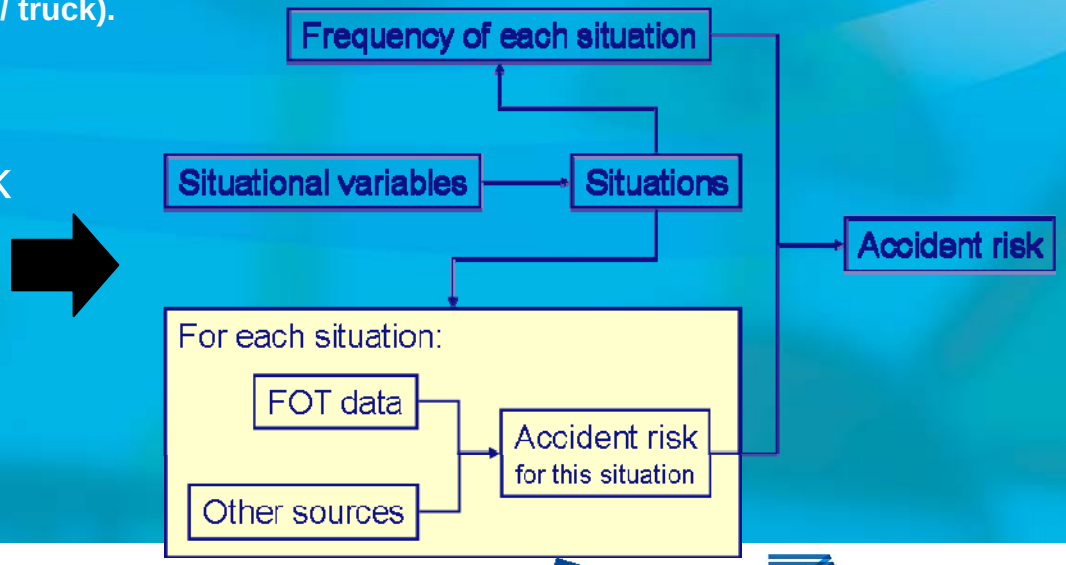
						General data 2005 (n)					Data 2010					Data 2020					Risks			2005 Effects (n)		
Vehicle type	Collision type	Place	Weather	Light	Junction	Injury Acci-	Fata-lities	Inju-ries	of which		Injury Acci-	Fata-lities	Inju-ries	of which		Injury Acci-	Fata-lities	Inju-ries	of which							
Vehicle type	Collision type	Place	Weather	Light	Junction	Injury Acci-dents 2005	Fata-lities 2005	Inju-ries 2005	seriously injured 2005	slightly injured 2005	Injury Acci-dents 2010	Fata-lities 2010	Inju-ries 2010	seriously injured 2010	slightly injured 2010	Injury Acci-dents 2020	Fata-lities 2020	Inju-ries 2020	seriously injured 2020	slightly injured 2020	Crash risk	Fatality risk	Injury risk	Injury accident risk2005	fatalities risk2005	injuries risk2005
Heavy	1. Single	Motorway (urban or	Normal	Daylight or	No junction	8	3	6	3	4	7	2	5	2	3	4	2	3	2	2	0.0	0.0	0.0	0.0	0.0	0.0
Heavy	1. Single	Motorway (urban or	Normal	Daylight or	At junction	2	0	2	0	1	2	0	1	0	1	1	0	1	0	1	0.0	0.0	0.0	0.0	0.0	0.0
Heavy	1. Single	Motorway (urban or	Normal	Darkness	No junction	6	6	2	1	2	5	5	2	1	1	3	3	1	0	1	0.0	0.0	0.0	0.0	0.0	0.0
Heavy	1. Single vehicle accident: collision on the road with	Motorway (urban or rural)	Normal	Darkness	At junction	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
Heavy	1. Single	motorway (urban or	Bad	Daylight or	No junction	1	0	1	0	0	1	0	1	0	0	1	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
Heavy	1. Single	Motorway (urban or	Bad	Daylight or	At junction	1	0	1	1	0	1	0	1	1	0	1	0	1	1	0	0.0	0.0	0.0	0.0	0.0	0.0
Heavy	1. Single	Motorway (urban or	Bad	Darkness	No junction	2	2	1	0	0	2	1	0	0	0	1	1	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
Heavy	1. Single	Motorway (urban or	Bad	Darkness	At junction	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
Heavy	1. Single vehicle	Outside urban area,	Normal	Daylight or twilight or	No junction	28	4	25	9	17	23	3	21	8	14	14	2	13	5	9	0.0	0.0	0.0	0.0	0.0	0.0
Heavy	1. Single	Outside urban area	Normal	Daylight or	At junction	28	10	25	7	17	23	8	20	6	14	14	5	13	4	9	0.0	0.0	0.0	0.0	0.0	0.0
Heavy	1. Single	Outside urban area	Normal	Darkness	No junction	23	6	17	9	9	19	5	14	8	7	12	3	9	5	5	0.0	0.0	0.0	0.0	0.0	0.0
Heavy	1. Single	Outside urban area	Normal	Darkness	At junction	7	1	8	4	4	6	0	6	3	3	4	0	4	2	2	0.0	0.0	0.0	0.0	0.0	0.0
Heavy	1. Single	Outside urban area	Bad	Daylight or	No junction	8	1	6	3	3	6	1	5	2	3	4	1	3	2	2	0.0	0.0	0.0	0.0	0.0	0.0
Heavy	1. Single	Outside urban area	Bad	Daylight or	At junction	4	2	2	1	1	3	2	2	0	1	2	1	1	0	1	0.0	0.0	0.0	0.0	0.0	0.0
Heavy	1. Single	Outside urban area	Bad	Darkness	No junction	4	2	2	2	0	3	1	2	2	0	2	1	1	1	0	0.0	0.0	0.0	0.0	0.0	0.0
Heavy	1. Single	Outside urban area	Bad	Darkness	At junction	2	1	1	0	0	2	1	1	0	0	1	1	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
Heavy	1. Single	Inside urban area, no	Normal	Daylight or	No junction	763	41	803	196	621	625	33	658	161	509	391	21	411	100	318	0.0	0.0	0.0	0.0	0.0	0.0
Heavy	1. Single vehicle accident: collision on the road with	Inside urban area, no motorway	Normal	Daylight or twilight or unknown	At junction	1,415	74	1,505	426	1,086	1,160	60	1,234	349	890	725	38	771	218	557	0.0	0.0	0.0	0.0	0.0	0.0
Heavy	1. Single	Inside urban area, no	Normal	Darkness	No junction	159	9	156	58	102	130	7	128	48	84	82	4	80	30	52	0.0	0.0	0.0	0.0	0.0	0.0
Heavy	1. Single	Inside urban area, no	Normal	Darkness	At junction	271	16	278	87	193	222	13	228	71	158	139	8	142	44	99	0.0	0.0	0.0	0.0	0.0	0.0
Heavy	1. Single	Inside urban area, no	Bad	Daylight or	No junction	75	7	80	24	57	62	6	66	20	47	39	4	41	12	29	0.0	0.0	0.0	0.0	0.0	0.0
Heavy	1. Single	Inside urban area, no	Bad	Daylight or	At junction	170	5	190	37	148	139	4	156	30	121	87	3	97	19	76	0.0	0.0	0.0	0.0	0.0	0.0
Heavy	1. Single vehicle accident:	Inside urban area, no motorway	Bad	Darkness	No junction	23	0	23	10	13	19	0	19	9	11	12	0	12	5	7	0.0	0.0	0.0	0.0	0.0	0.0
Heavy	1. Single	Inside urban area, no	Bad	Darkness	At junction	67	7	64	20	43	55	6	52	16	35	34	4	33	10	22	0.0	0.0	0.0	0.0	0.0	0.0
Heavy	2. Single	Motorway (urban or	Normal	Daylight or	No junction	91	14	113	46	71	74	12	92	38	58	46	7	58	24	36	0.0	0.0	0.0	-74.9	-6.8	-93.4
Heavy	2. Single	Motorway (urban or	Normal	Daylight or	At junction	12	1	21	6	15	15	1	18	6	11	9	1	11	4	7	0.0	0.0	0.0	-3.0	-0.1	-3.5
Heavy	2. Single	Motorway (urban or	Normal	Darkness	No junction	34	3	43	20	23	28	3	35	16	20	18	2	22	10	13	0.0	0.0	0.0	-42.5	-2.5	-53.1

Safety impact assessment (direct route)



Approach

- Split accident risk by (combinations of) situational variables:
  - **Road type (urban / rural / motorway).**
  - **Weather (normal / adverse).**
  - **Lighting (light / dark).**
  - **Time of day (morning peak / evening peak / night / rest of the day).**
  - **Road form if road type is not motorway (link / intersection).**
  - **Traffic situation if road type is motorway (congestion / free flow).**
  - **Vehicle type (passenger car / truck).**
  - **For trucks: empty / loaded.**
- Compute accident risk per accident type
- FOT-data is used



Thank you for your attention!

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More information or want to cooperate?

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