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Road Safety Data Analysis
From Correlation to Causation and Policy Support

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Presentation Outline

Evidence-Based Road Safety Policies

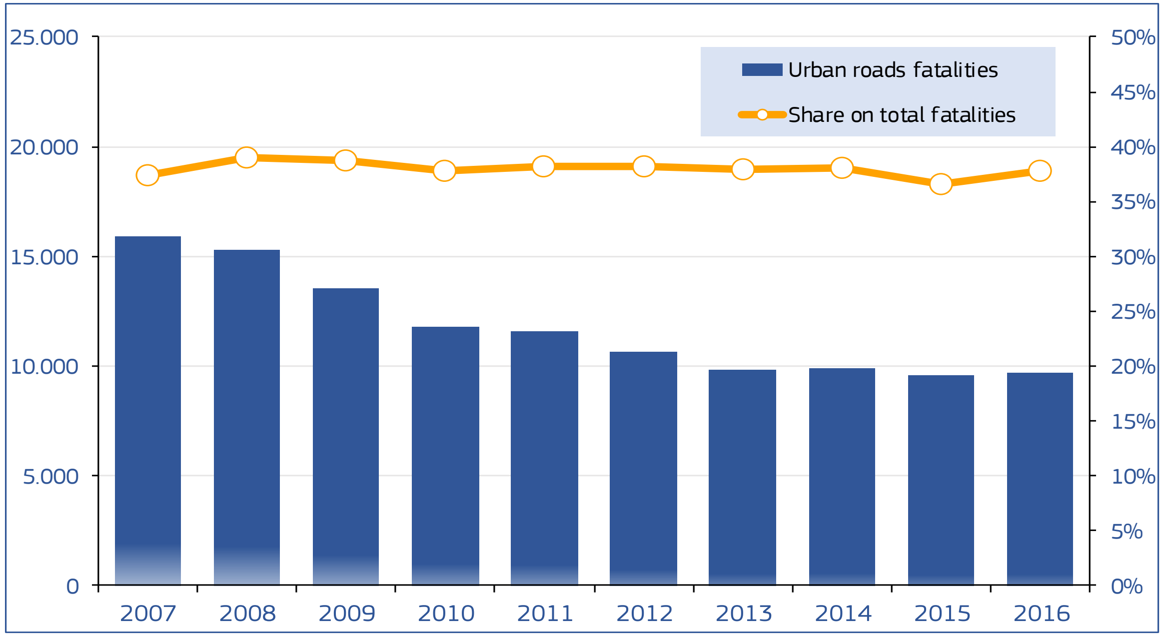
Critical Questions on Road Safety

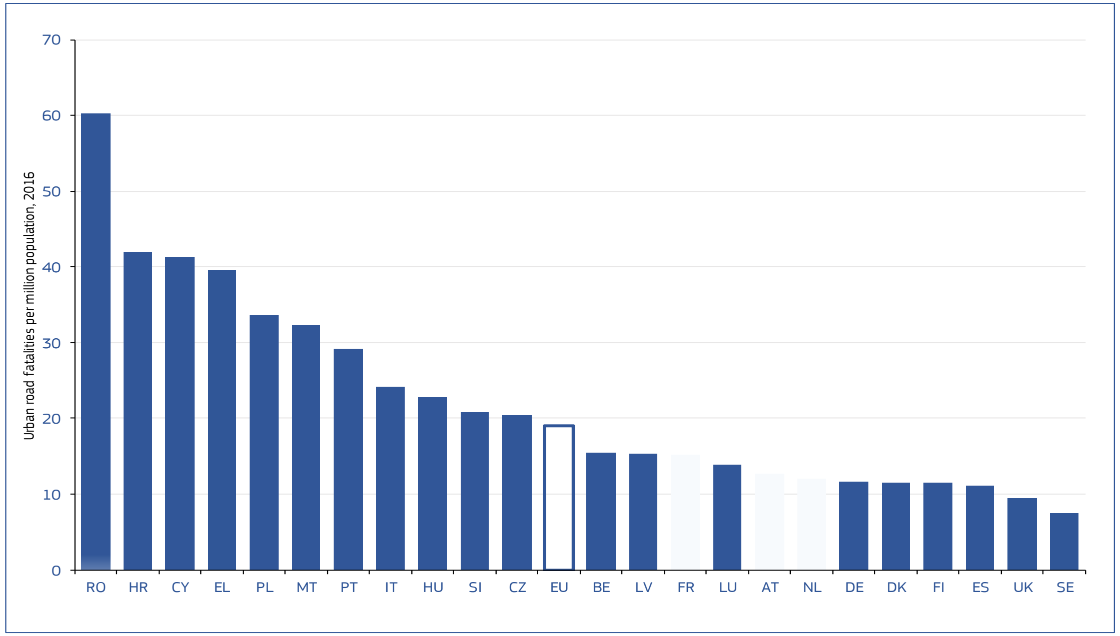
- Which are the current and future challenges of road accident data analysis?
- How critical are data and evidence based decision making?
- What is the role of high quality road safety data, as well as of appropriate analysis methodologies?
- How critical is the efficient assessment of measures?
- How to link statistical analyses (correlation) and the interpretation of their results (causation) to policy support?
- Is the analysis of road user behavior the key for the establishment of the links between accident causes and impacts?

Different Road Safety Progress in Different Countries

Road Fatalities change 2008-2017 (source: CARE)

	Urban Areas	
	Inside	Outside
North-Western Countries	-28,8%	-28,1%
Southern Countries	-31,5%	-39,0%
Eastern Countries	-48,7%	-43,6%





Different Urban Road Safety Patterns in EU regions

Road Fatalities 2017 (source: CARE)

Power Two Wheelers	Urban	Total	%
North-Western Countries	667	3.344	20%
Southern Countries	822	2.693	31%
Eastern Countries	274	3.404	8%
Cyclists	**Urban**	**Total**	**%**
North-Western Countries	531	3.344	16%
Southern Countries	196	2.693	7%
Eastern Countries	388	3.404	11%
Pedestrians	**Urban**	**Total**	**%**
North-Western Countries	1.182	3.344	35%
Southern Countries	920	2.693	34%
Eastern Countries	1.561	3.404	46%

Road Safety Choices

The high complexity of the road environment and road user behavior makes road safety choices a very difficult task, attempting to balance conflicting social needs and economical restraints, especially during the economic crisis.

- Traffic Efficiency (Speed) Versus Traffic Safety
- Vehicles Versus Vulnerable Road Users
- Expensive but safe Versus Cheap but unsafe (vehicle, infrastructure, management)
- Priorities in policies, measures, research, etc.

Why Road Safety Data?

- Road Safety is a typical field with high risk of important investments not bringing results.
- Absence of monitoring and accountability limits seriously road safety performance.
- Decision making in road safety management is highly dependent on appropriate and quality data.
- Very often we look where the data are and not where the problems and solutions are.

The Need for Evidence-Based Decision Making

- The policy making cycle
  - Vision and strategy;
  - Problem identification;
  - Target Setting and priority setting;
  - Development of measures;
  - Establishing and implementing the programme;
  - Monitoring of and evaluation of outcomes.

The use of high quality road safety data is involved in each stage

- Necessity to:
  - Consolidate and organize existing data
  - Make data and information available
  - Manage an holistic approach (analyses, methodologies, benchmarking tools)
  - Support road safety decision making at all stages

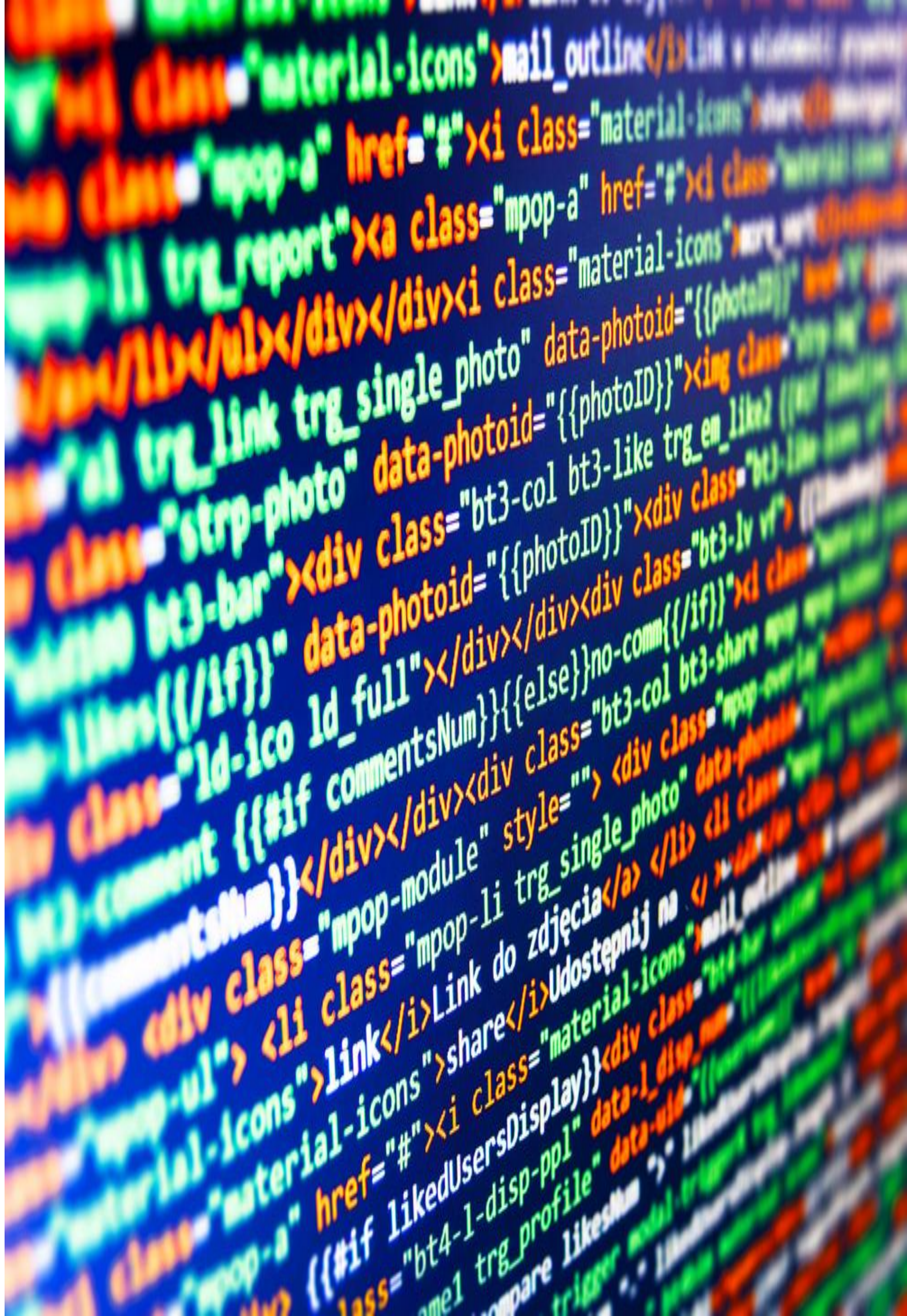
The 'Pyramid' of Road Safety Data Analysis

Road Safety Data to Support Evidence-based Policies

- Fatalities and their evolution
- Exposure
- Safety Performance Indicators
- Causation (in-depth accident investigations)
- Health indicators
- Economic indicators
- Driver behavior, attitudes etc.
- Road safety rules and regulations
- Road safety measures assessment

Do we have the data we need?

Do we need the data we have?



The Necessary Exposure Data and SPIs

- Exposure indicators
  - Vehicle- and person-kilometres of travel
  - Time spent in traffic
  - Number of trips
  - Vehicle fleet
  - Population

- Safety Performance Indicators
  - Road user behavior (e.g. speeding, alcohol)
  - Vehicles (e.g. crashworthiness, fleet age etc.)
  - Infrastructure (e.g. meeting design standards)

The most useful data are the least available

Global Road Safety Information Systems

Road Safety Observatories

- ERSO, European Road Safety Observatory
- OISEVI, Ibero-American Observatory
- African Road Safety Observatory
- IRTAD, ITF Road Traffic and Accident Group
- Dacota, EC Project – Knowledge Centre
- NRSO – NTUA Road Safety Observatory

European Road Safety Observatory, EC

- The ERSO is the information system of the European Commission with harmonised specialist information on road safety practices and policy in European countries.

- ERSO and CARE are Managed by the European Commission – DG Move – Road Safety Unit (EC DG Move),
  - Cooperation with Eurostat (EC Statistical Office)
  - Assisted by the Road Accident Statistics National Experts Group (CARE Experts Group)

Methodology

- Definition of common protocols for data collection
- Availability, systematic collection and analyses of data and information
- Presentation of the results responding to users’ needs
- Continuity in making all results publicly available

WB / FIA / ITF Regional Observatories

- MoU signed at the ITF Summit 2018 by the World Bank, the FIA and the ITF

- Objective: work together towards the establishment of regional road safety observatories

- Main targets:
  - Strengthening of OISEVI in Latin America
  - Establishment of a road safety observatory in Africa
  - Establishment of a road safety observatory in South East Asia

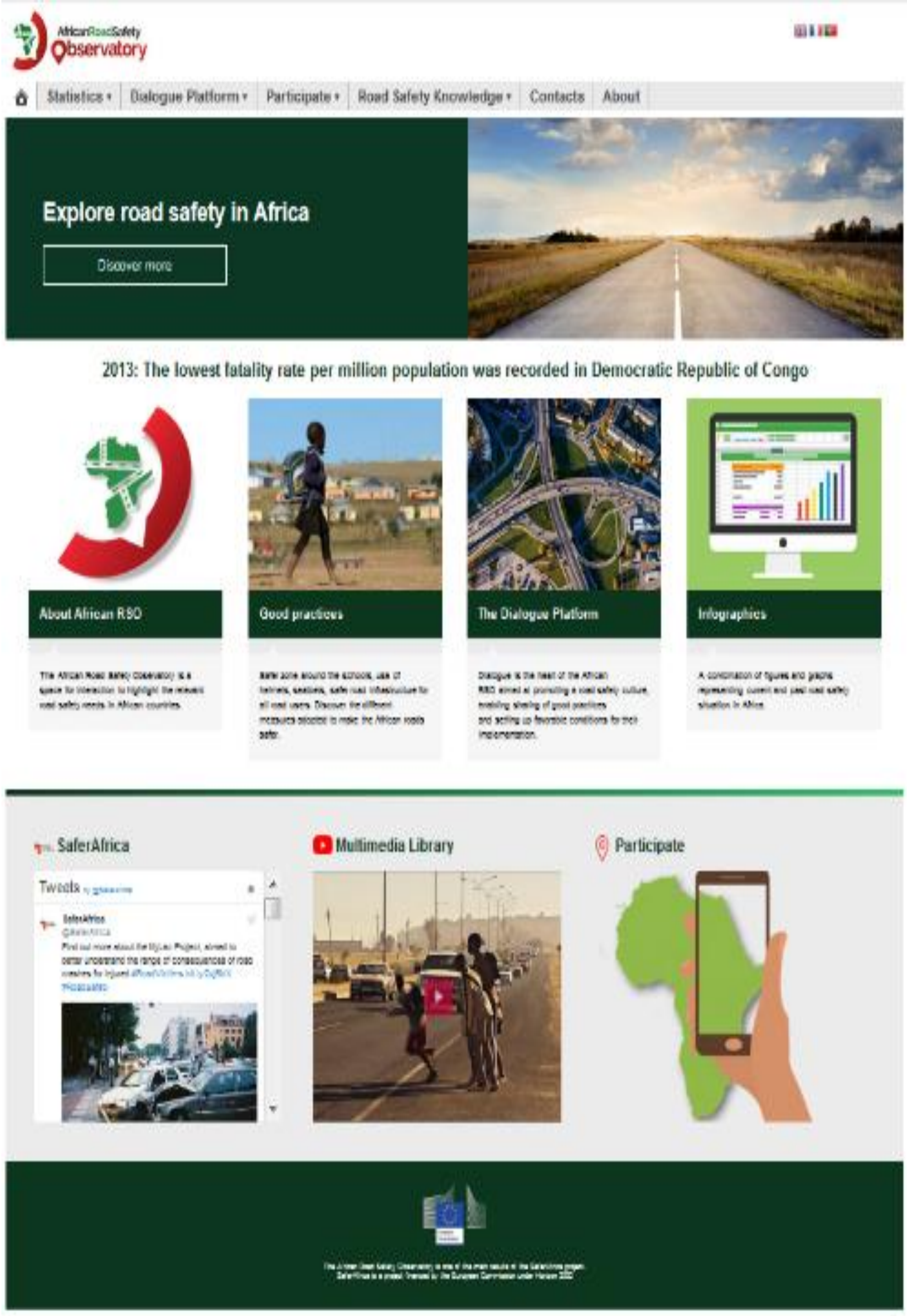
The Role of Regional Road Safety Observatories

- Existence of a formal platform to foster international co-operation on a regional basis.
- Provide tool for the collection and analysis of harmonized safety data, both accident data and SPIs.
- A great discrepancy between official accident statistics and WHO estimates exists.
  - e.g. in Africa, 63.000 fatalities have been recorded according to the official national statistics, while 240.000 fatalities are estimated by WHO.
- Experience in Latin America (OISEVI) has shown benefits:
  - road safety higher and more visible on the political agenda
  - positive emulation between countries

African Road Safety Observatory, a Horizons 2020 Project

- The African RSO aims to create favorable conditions and opportunities for the effective implementation of actions for road safety and traffic management in African countries
- Is being created alongside a Dialogue Platform between Africa and Europe (SaferAfrica project – until Sep 2019)
- Objectives:
  - Assess the implementation of the African Action Plan, alongside needs of stakeholders
  - Activate Twinning Programs between Africa and Europe
  - Conduct sharing of good practices, capacity-building activities and capacity reviews
- Structure:

- Statistics	- Road Safety Management
- Good Practices	- Capacity Building
- Dialogue Platform	- News



OISEVI, Ibero-American Member Countries

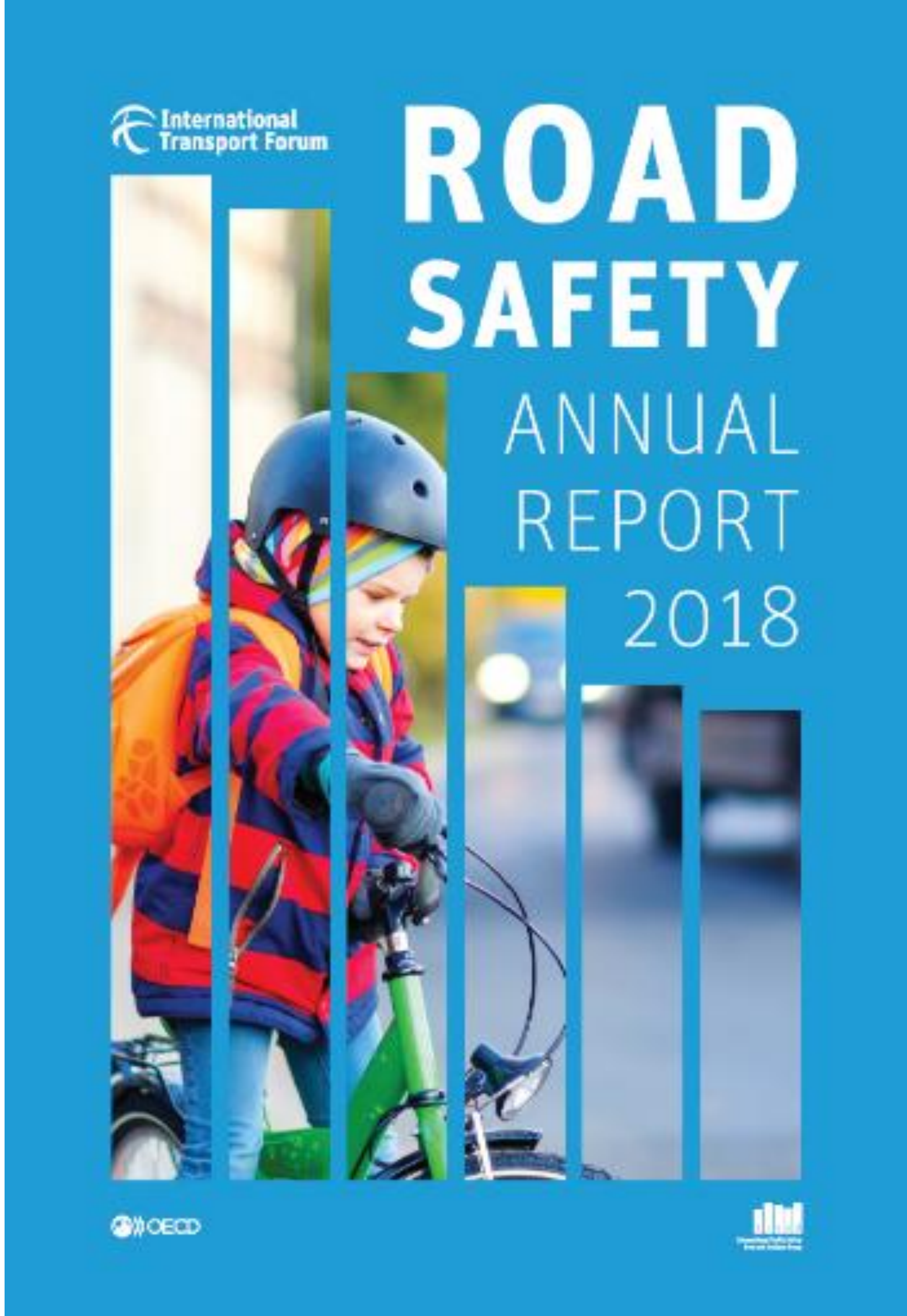
- The Ibero-American Road Safety Observatory (OISEVI): an international cooperation instrument comprising the highest road safety authorities of Ibero-American member countries.
- OISEVI conducts critical surveillance over national road safety policies and fosters their dissemination.
- A forum for analyzing public policies on road safety at the highest level of stakeholders
- Promotes public policy formulation for road safety, creation of National Lead Agencies or governing organizations and National Observatories.
- Standardizes traffic data collection, processing, analysis and dissemination.
- An Ibero-American database to reflect the evolution of road safety statistics and their comparability, for assessing actions.
- Promotes the participation of different technical or financial cooperation agencies

IRTAD, ITF/OECD

- IRTAD Objectives:
  - Exchange of information and methodologies on safety trends and road safety policies
  - Suggest possible improvements to road accident and related traffic data collection and analyses.
  - Collect accident data, complementary to other sources
  - Conduct data analysis to provide advice on specific road safety issues.
  - Contribute to international co-operation on road accident data and its analysis.

- The IRTAD Group publishes regularly special reports on its analyses of topical data collection and methodology issues.
- IRTAD organises open Conferences

- Information comes directly from relevant national data providers in a common format and common definitions.
- Data concern 55 countries.



NTUA Road Safety Observatory

- An international reference website - information system of road safety data and knowledge: www.nrso.ntua.gr
- More than 1.200 items since 2007, more than 500 scientific publications
- All important road safety news in Greece, in Europe and worldwide
- Updated reports covering all modern road safety issues
- Latest available road safety data for Greece and the European Union
- Scientific road safety conferences in Greece and worldwide
- Links to dozens of road safety resources worldwide.

Road Safety Decision Support Systems

- SafeFITS, UNECE-Global Road Safety Model
- SafetyCube, EU Road Safety DSS
- iRAP, Road Safety ToolKit
- PRACT, CEDR
- PIARC, WRA Road Safety Manual
- US NHTSA/FHWA CMF Clearinghouse
- AustRoads Road Safety Engineering Toolkit

SafetyCube, EC Horizons 2020 Project (1/2)

- SafetyCube DSS aims to provide the European and Global road safety community a user friendly, web-based, interactive Decision Support Tool.

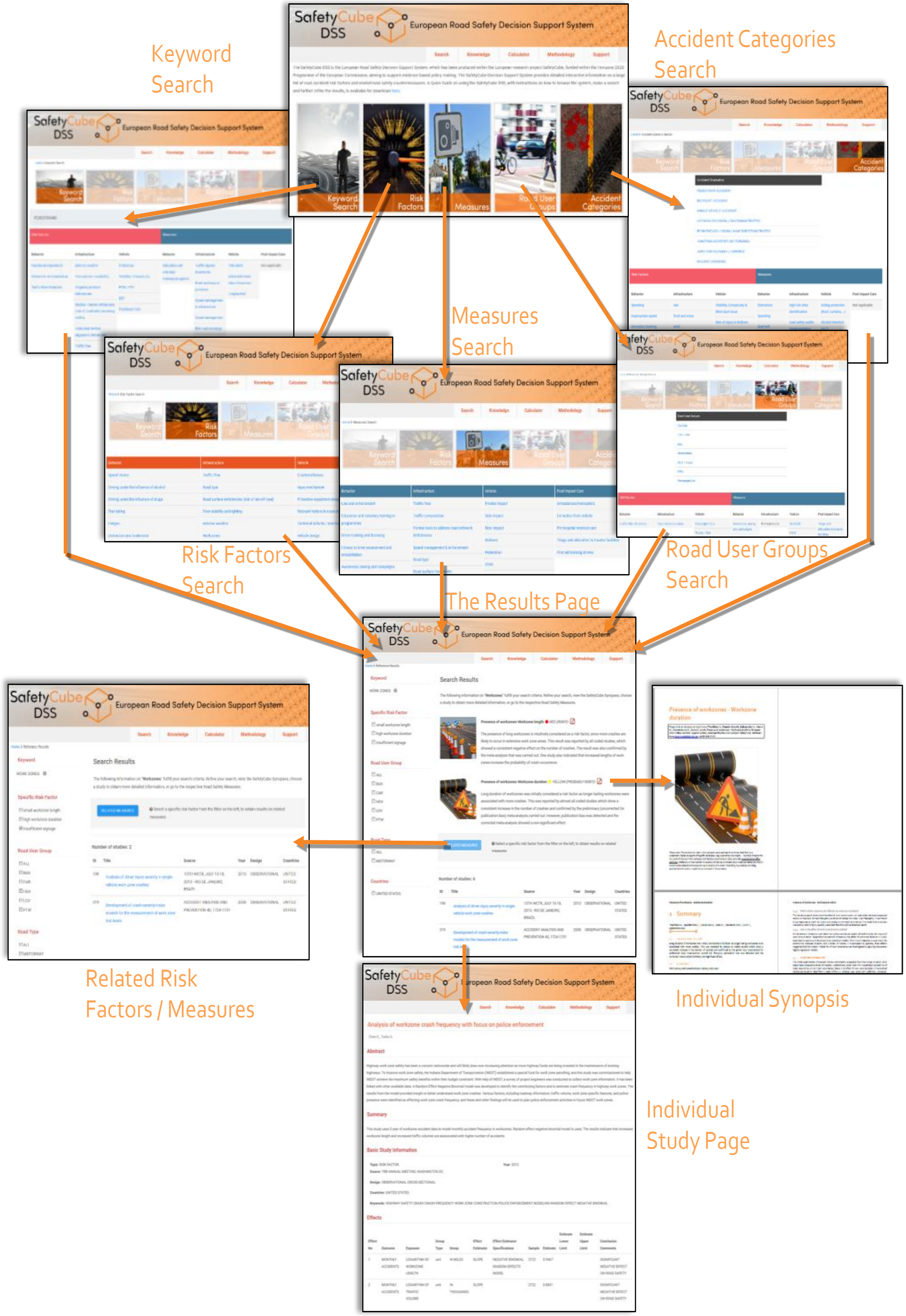
- SafetyCube DSS combines existing with novel road safety knowledge using scientific studies as basis.

- The main contents of the SafetyCube DSS concern:
  - road accident risk factors and problems
  - road safety measures
  - best estimate of effectiveness
  - cost-benefit evaluation
  - all related analytic background
- Special focus on linking road safety problems with related measures.

SafetyCube, EC Horizons 2020 Project (2/2)

- The SafetyCube DSS contains:
  - more than 1,250 scientific studies,
  - with more than 7,500 estimates of risks/measure effects on
  - 4 Categories: road user, infrastructure, vehicle, post impact care
  - 38 risks, 50 measures (88 in total) e.g. distraction, roadside factors,
  - 120 specific risks, 193 specific measures (313 in total) e.g. mobile phone use,
  - 211 Synopses
  - 36 cost-benefit analyses (adjustable)

- All available at: www.roadsafety-dss.eu/



SafeFITS Global Model, UNECE (1/2)

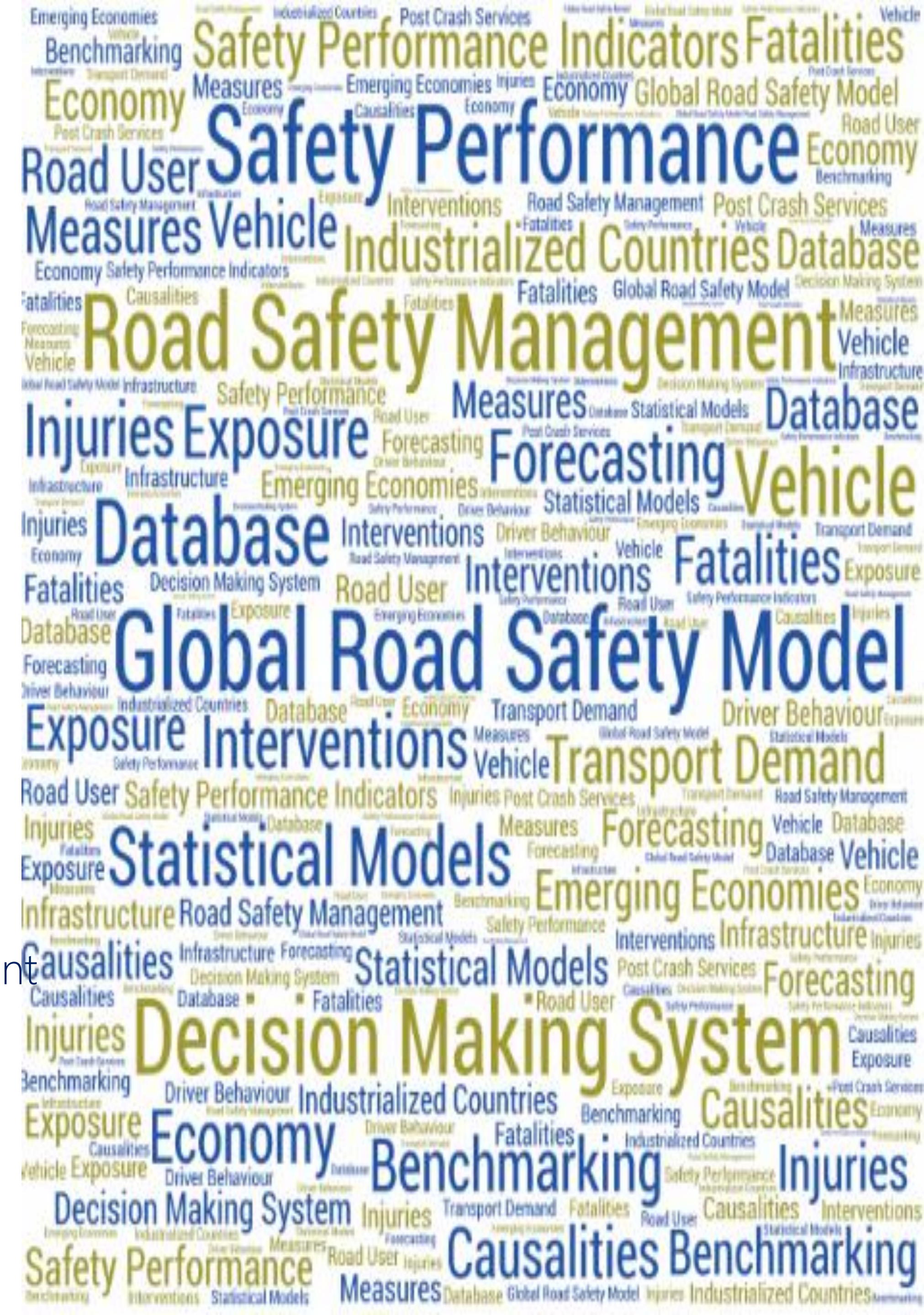
- A macroscopic road safety decision making tool to aid stakeholders in developed and developing countries, decide the most appropriate road safety policies - measures to achieve tangible results.
- Based on the related scientific knowledge available worldwide, with emphasis on recent academic research and project results.
- Developed within the framework of the “Safe Future Inland Transport Systems (SafeFITS)” project of the United Nations Economic Commission for Europe (UNECE), financed by the International Road Union (IRU).

SafeFITS layers

1. Economy and Management
2. Transport Demand & Exposure
3. Road Safety Measures
4. Road Safety Performance Indicators
5. Fatalities and Injuries

SafeFITS pillars

1. Road Safety Management
2. Road Infrastructure
3. Vehicle
4. User
5. Post-Crash Services

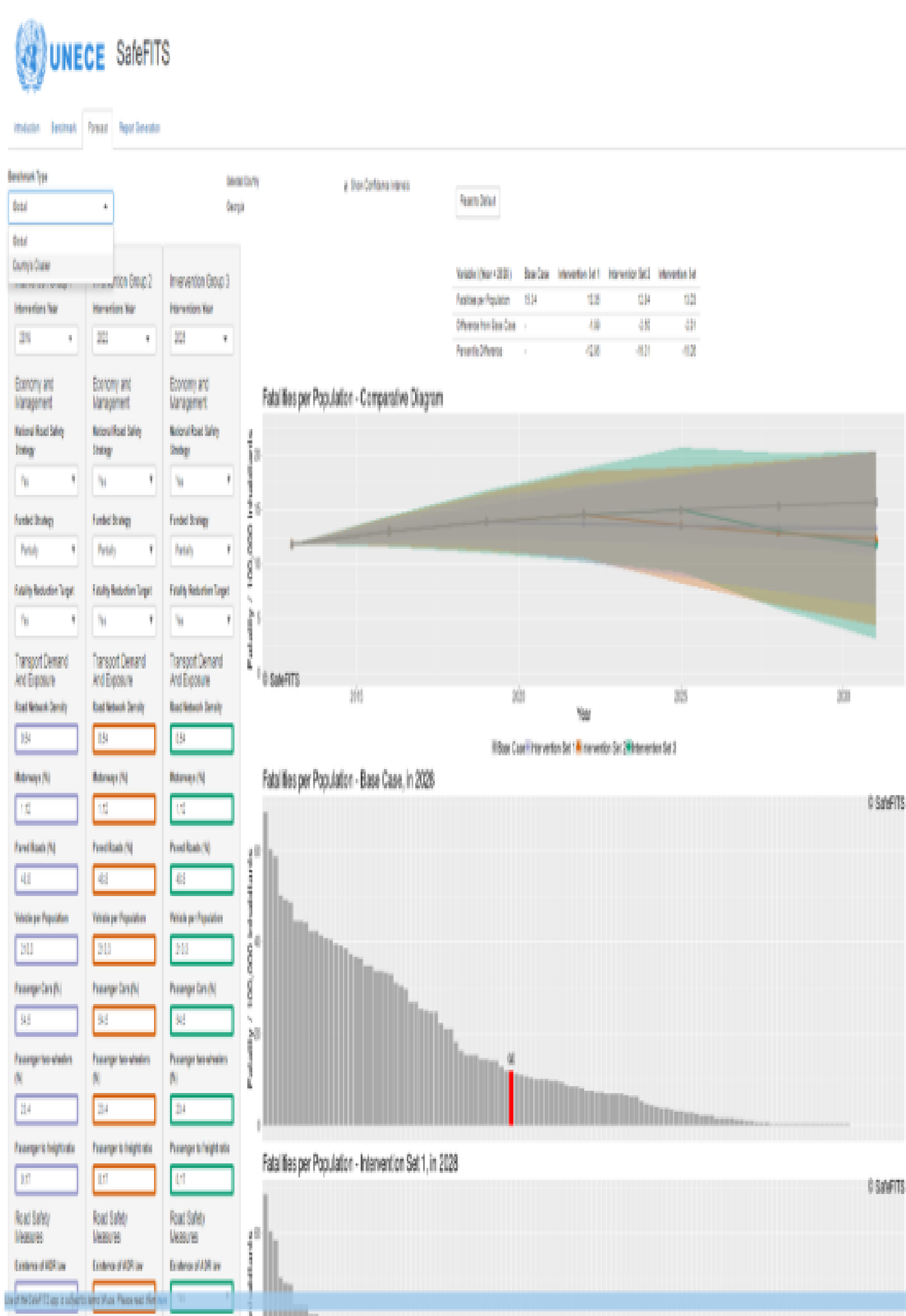


SafeFITS Global Model, UNECE (2/2)

- The SafeFITS Tool consists of two background components:
  - SafeFITS database with data on indicators from all layers of road safety management system for 130 countries worldwide
  - SafeFITS set of statistical models of global causalities, estimated on the basis of the database

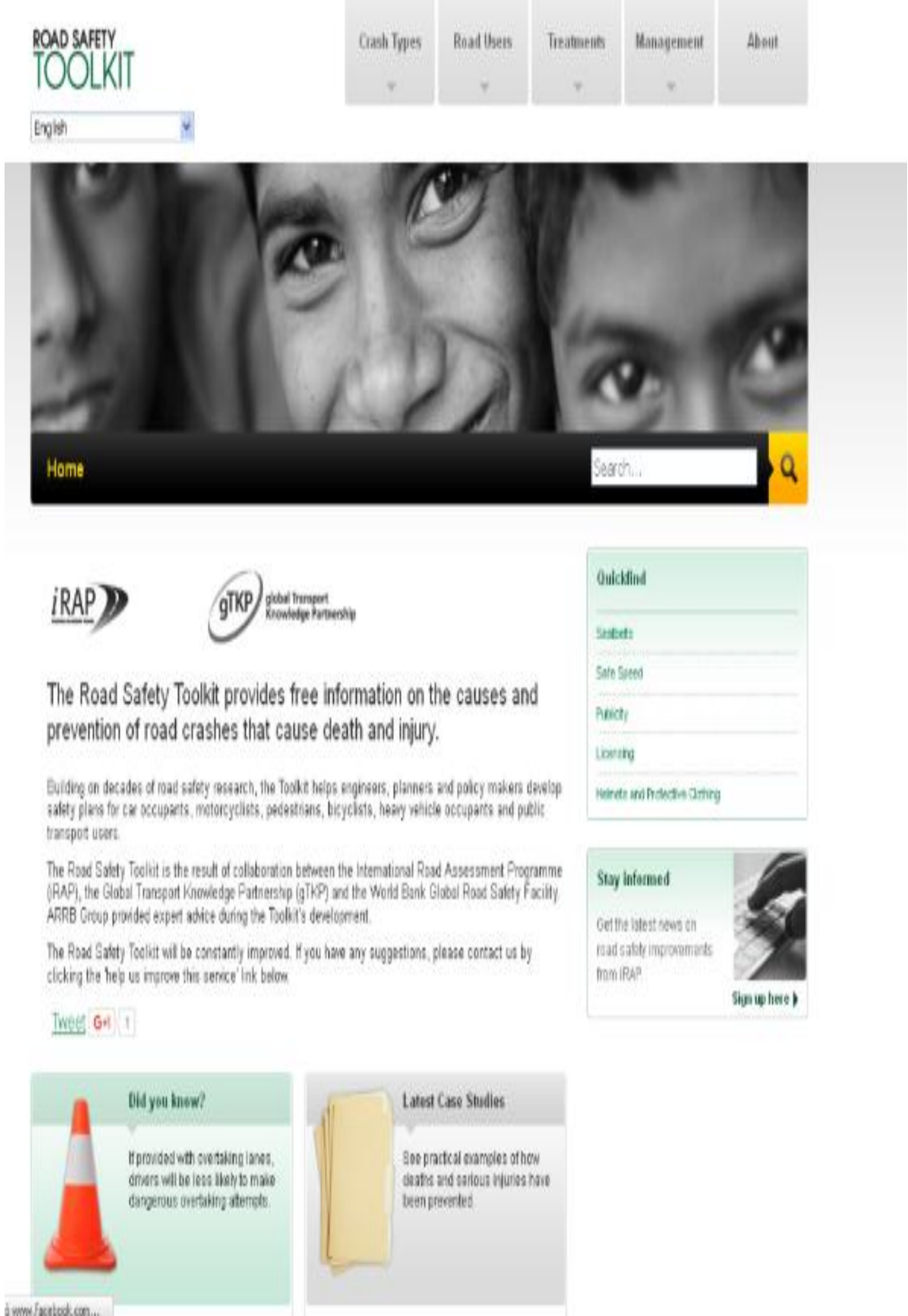
- The SafeFITS Tool is composed by three complementary modules:
  - Intervention analysis: allows the user to examine the effects of single interventions at national or country cluster level
  - Forecasting analysis: allows the user to define own scenarios of measures (or combinations of measures) in a country and obtain medium/long term forecasts of each scenario
  - Benchmarking analysis: allows the user to benchmark a country against a group of countries (e.g. all countries, countries of similar economic or road safety performance)

- Available at: https://unecetrans.shinyapps.io/safefits/



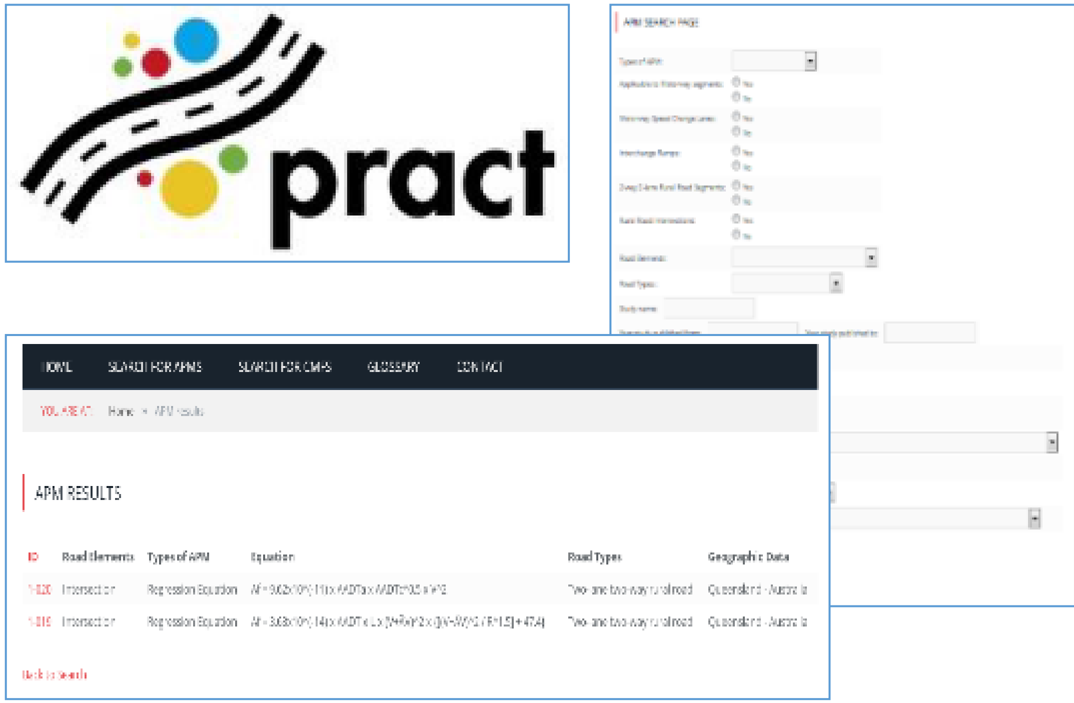
iRAP Road Safety Toolkit

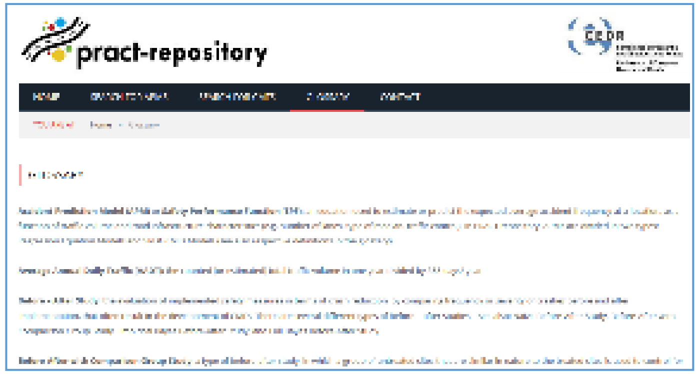
- Includes 58 treatments (infrastructure, vehicle & user related)
- No CMFs included
- Rough assessment of each treatment's effectiveness using a four scale system (0-10%, 10-25%, 25-40%, 60% or more)
- Is available online: http://toolkit.irap.org/



PRACT APM and CMF Repository, CEDR

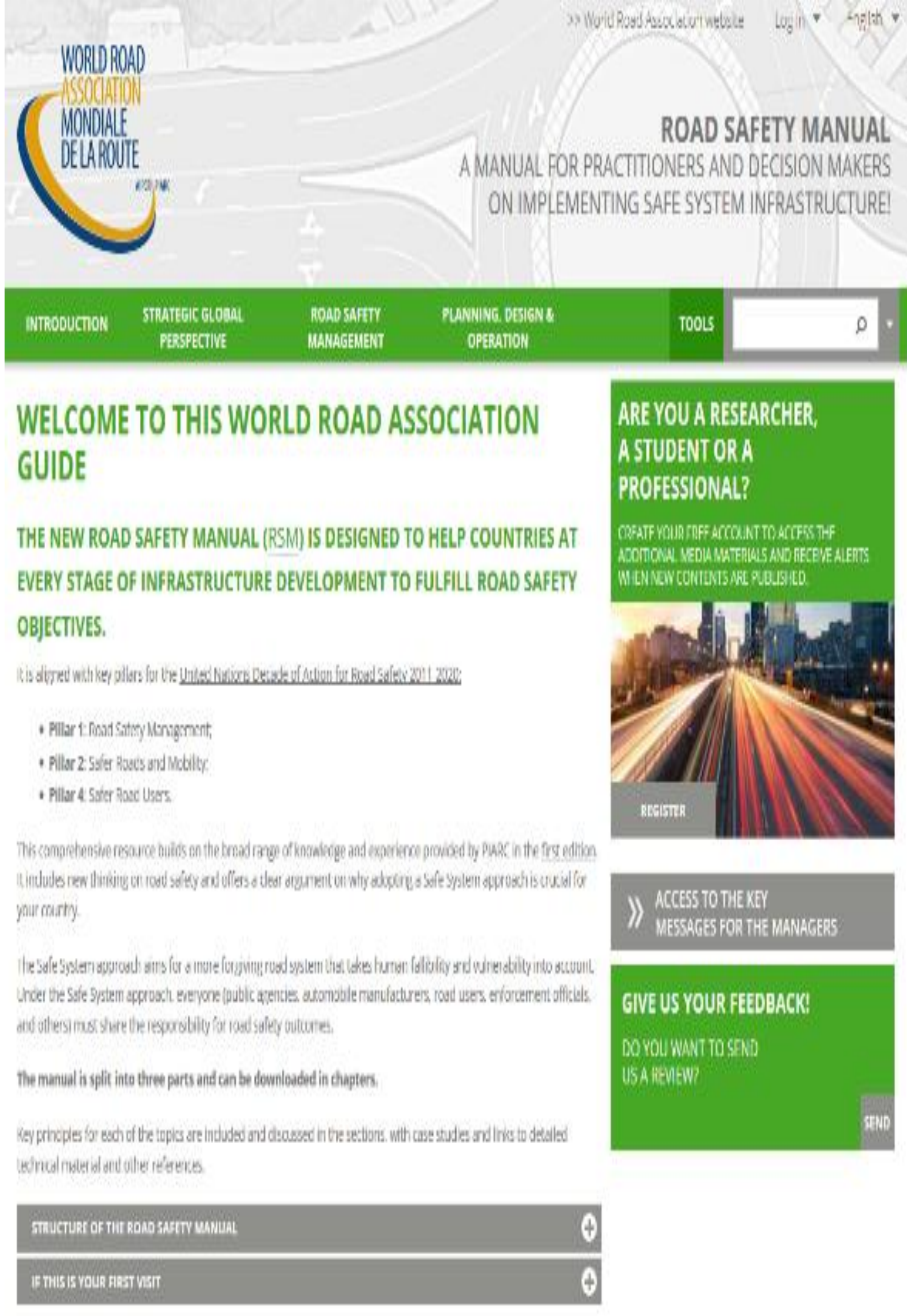
- A Trans-European Accident Prediction Model with a single structure and different parameters for different countries. The model has been fitted to data from 5 Countries (Italy, UK, Greece, Netherlands, Germany).
- A user friendly tool to assist in the application of APMs according to data availability and local conditions. Enables Search for APMs and CMFs.
- All types of data required in accident prediction are available (CMFs, SPFs, and Regression Equation APMs).
- The quality of included CMFs has been verified through an evaluation process.
- A procedure to check the transferability of CMFs, incorporated in the tool.
- A CMF and APM Repository has been developed and is freely available online: www.pract-repository.eu





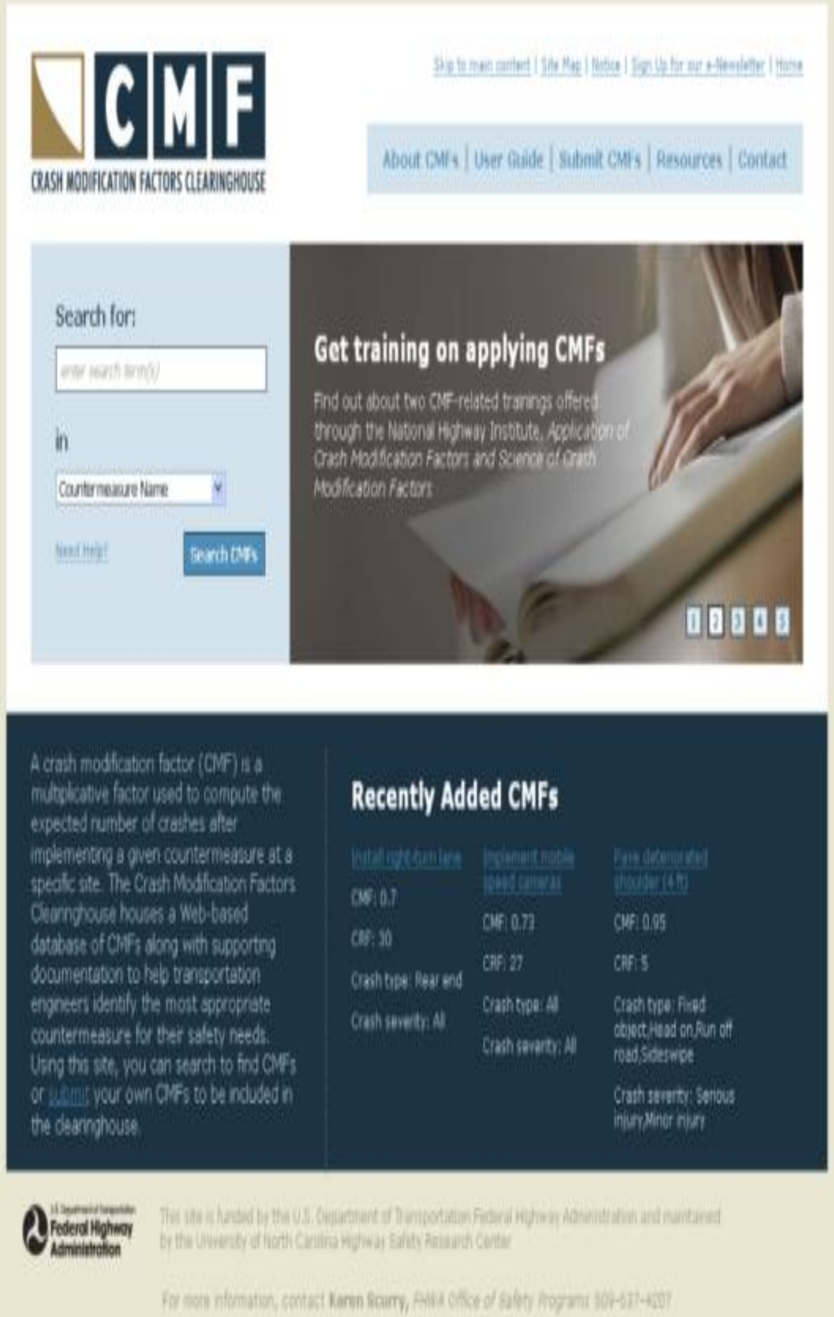
PIARC - WRA Road Safety Manual

- The PIARC Road Safety Manual is intended to provide clear and accessible information on the effective management of road safety infrastructure.
- Includes 15 case studies, with the possibility of additions and updates.
- Estimates of high/medium/low cost for up to 35 Treatments
- Categorized for 3 effectiveness categories and for up to 6 accident types.
- Organization of the Manual is in three Parts:
  - Part I "Strategic Global Perspective“
  - Part II "Road Safety Management"
  - Part III "Planning, Design & Operation"
- Available online: https://roadsafety.piarc.org/en



US NHTSA/FHWA CMF Clearinghouse

- Directly related to the Highway Safety Manual (AASHTO, 2010)
- Includes 5,378 CMFs on road infrastructure
- Detailed background information on presented CMFs is available
- Is available online: http://www.cmfclearinghouse.org



AustRoads Road Safety Engineering Toolkit

- 67 treatments are included
- Searchable database according to:
  - Treatment type/name,
  - Crash type,
  - Safety issue,
  - Road user group
- Detailed background information on included CMFs generally not available
- Is available online: http://www.engtoolkit.com.au

Road Safety Analysis Methods

The Use of Rigorous Analysis Techniques

Analysis techniques

- Descriptive and qualitative analysis
- Generalised Linear Models / Non-Linear Models
- Time series analysis
- Multilevel analysis
- Structural Equation Models
- Cost-Benefit Analysis

Conventional analysis techniques may not be appropriate for the complex and hierarchical nature of road safety outcomes.

Time Series Analysis

Commandeur et al., 2013, AAP journal

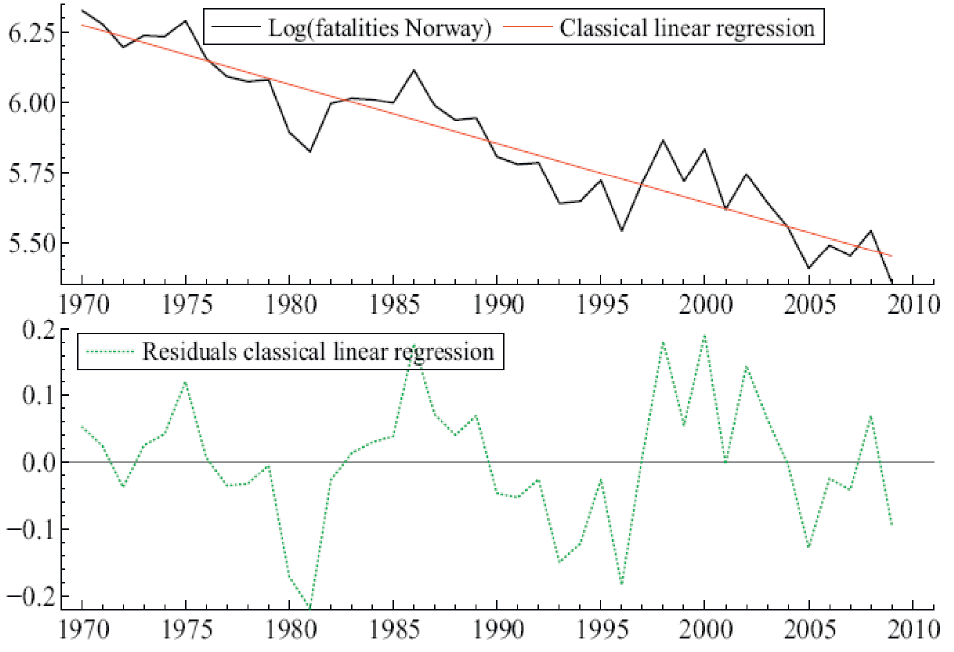
- Road safety observations are often serially correlated (time series) – autocorrelation

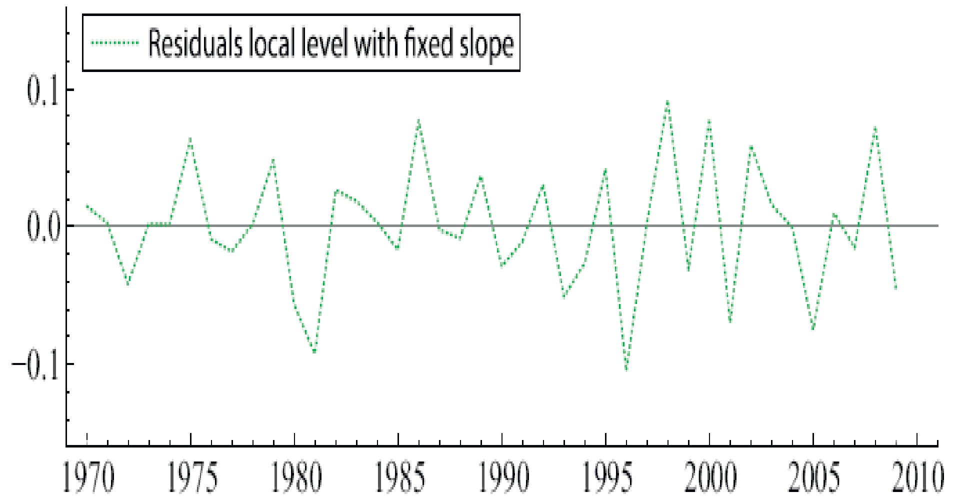
- Although linear and GLM models may, under certain conditions, be used for time series analysis, only dedicated techniques may fully account for this type of dependencies:

- ARIMA models

- State-space models

- Time series analysis components: Trend, Seasonality





Example: Forecasting fatalities in European Countries

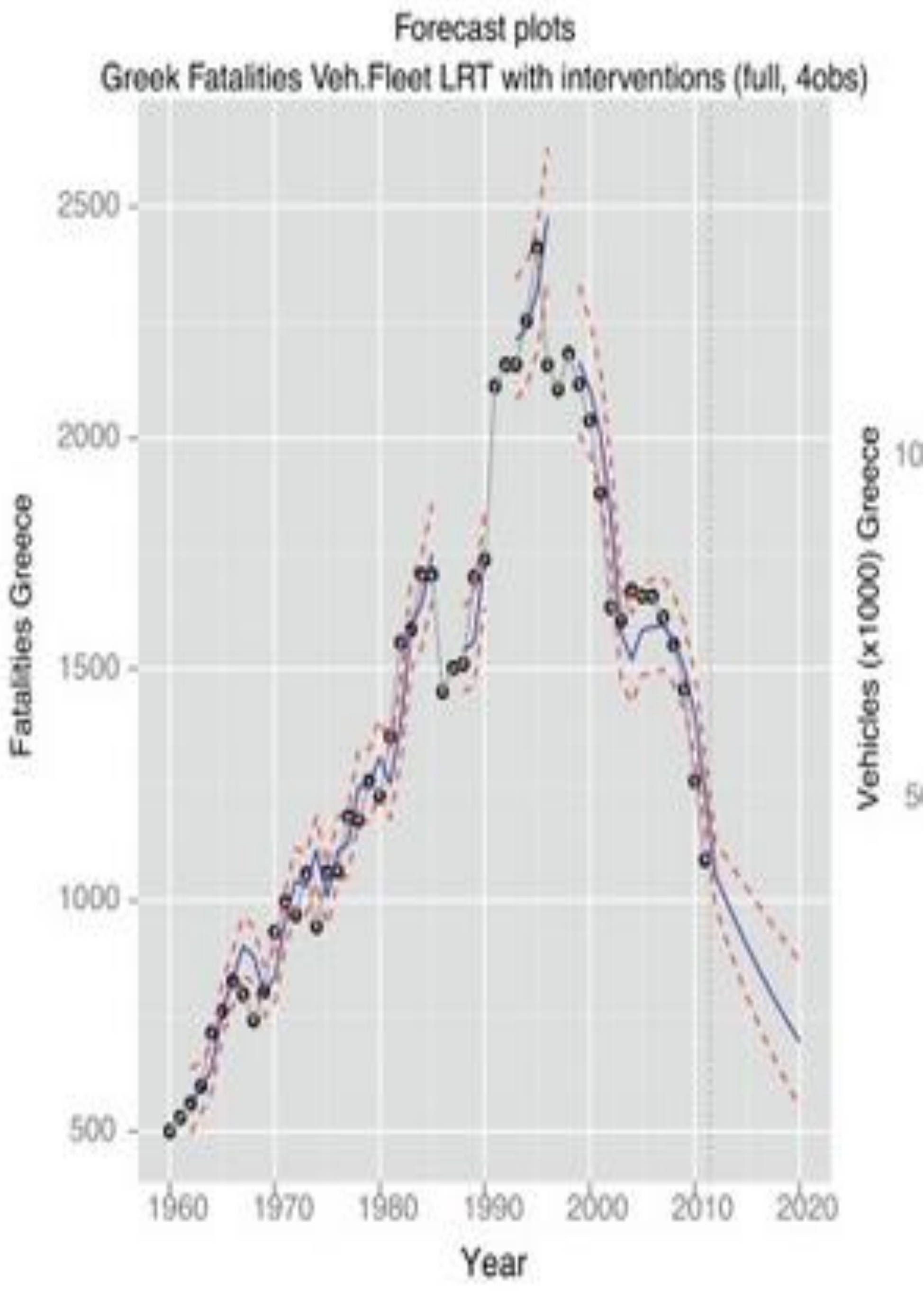
Dupont et al., 2014, AAP journal

- Data for the period 1960-2010 were used to forecast fatalities 2011-2020 in 30 European countries by means of state-space models
- Explicitly examined the presence or not of correlation between fatality series and exposure series.
- SUTSE (Seemingly unrelated time series model)
- LLT (Local Linear Trend model)
- LRT (Latent risk model)
- If fatalities and exposure are correlated, then the forecasts can be made on the basis of mobility scenarios (e.g. 20% increase in mobility by 2020)

Example: Forecasting fatalities in Greece

Yannis & Antoniou, 2013, AAP Journal

- Data for the period 1960-2010
- Exposure (vehicle fleet) and fatalities found to be related
- LRT (Latent risk model)
- Intervention variables introduced to capture shocks / breaks in the series (e.g. 1986 financial crisis, 1991 old-car exchange scheme, 1996 new road fatality definition)
- An intervention variable to model the current economic recession, assuming it ends on 2013.
- Data for the period 2009-2011 used to validate the model
- Forecasts for 2012-2020: actual data for 2012, 2013 lie within the 95% confidence intervals of the forecasts

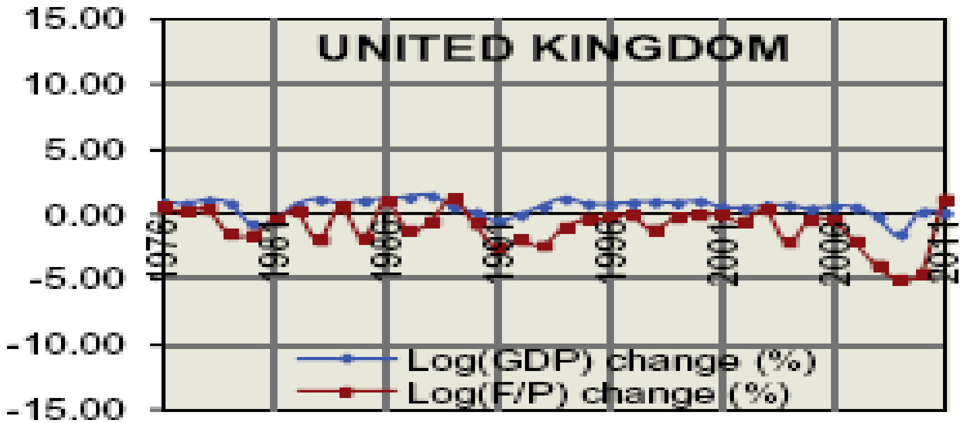


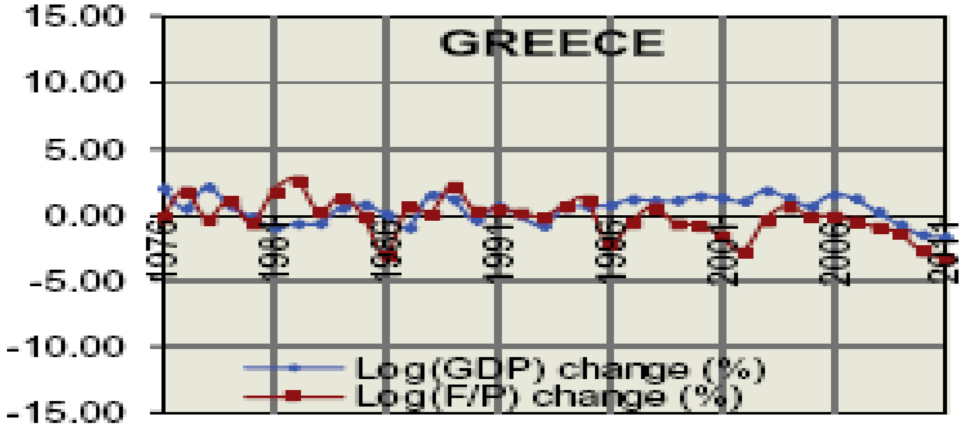
Example: Effects of GDP Changes on Road Fatalities

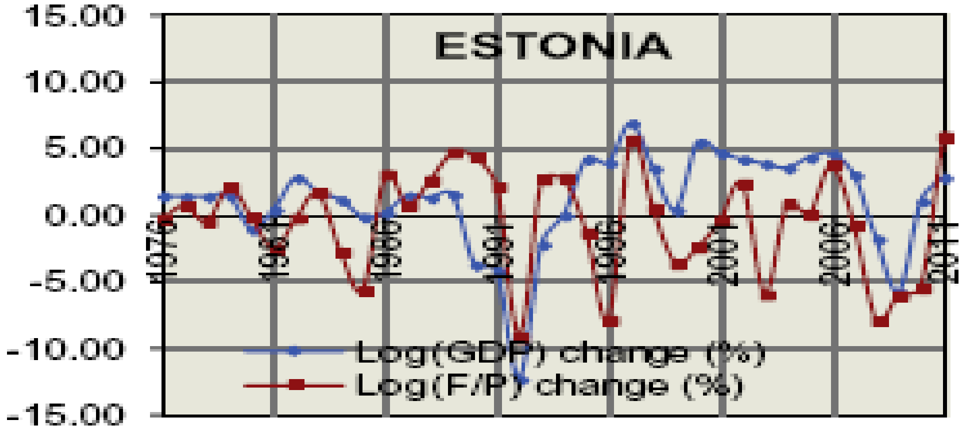
Yannis et al., 2013, Safety Science Journal

- The economic recession appears to have affected road fatalities in all European countries, due to decrease in mobility and other factors

- Modelling the annual change of fatality rate against annual change of GDP (short-term effects)







Example: Effects of GDP Changes on Road Fatalities

Yannis et al., 2013, Safety Science Journal

- Statistically significant relationship between annual GDP increase and fatality rate increase was established, as well as a statistically significant relationship between annual GDP decrease and fatality rate decrease.

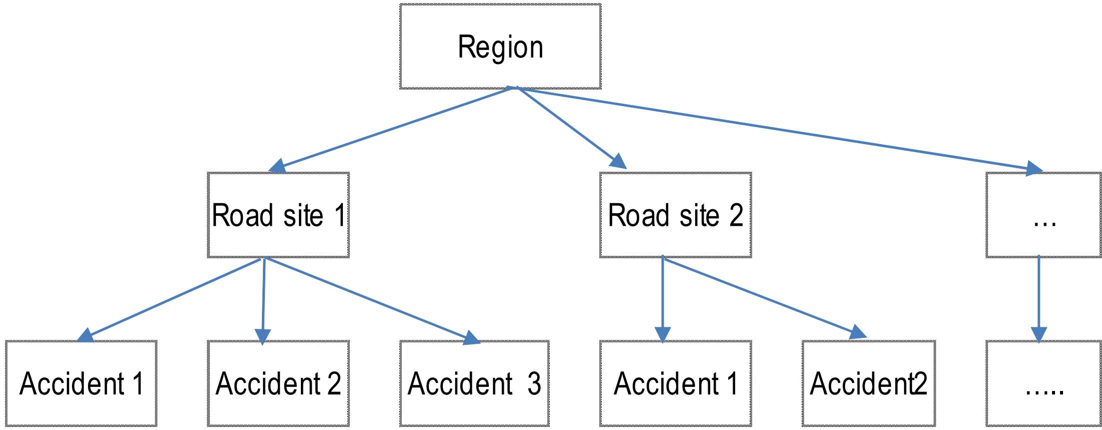
- Particularly in Northern / Western European countries, annual GDP decrease is associated with fatality rate decrease on the same year, as well as on one year later.

- Once the socioeconomic conditions improve, fatalities may temporarily increase, “correcting” for the effect of external factors (GDP change).

	Fatalities					GDP per capita				
	2007	2008	2009	2010	2011	2007	2008	2009	2010	2011
Belgium	1071	944	942	840	843	38.27	38.61	37.51	38.29	39.14
Czech Republic	1221	1076	901	802	769	13.80	14.15	13.58	13.91	14.29
Germany	4949	4477	4152	3648	4006	35.83	36.30	34.53	35.89	37.01
Estonia	196	132	100	79	101	12.48	11.92	10.33	10.58	11.31
Ireland	338	280	238	212	188	50.80	47.94	43.70	42.84	41.98
Greece	1612	1553	1456	1281	1100	24.79	25.01	24.46	23.34	22.16
Spain	3823	3100	2714	2478	2298	26.92	26.74	25.53	25.38	25.41
France	4620	4275	4273	3992	3969	35.11	34.88	33.73	34.05	34.42
Italy	5131	4725	4237	3934	3941	30.95	30.31	28.55	28.78	28.86
Lithuania	740	499	370	300	299	8.61	8.88	7.60	7.72	8.15
Hungary	1232	996	822	739	639	11.15	11.26	10.52	10.66	10.97
Netherlands	709	677	644	640	550	41.92	42.55	40.69	41.20	41.71
Austria	691	679	633	552	521	39.70	40.54	38.94	39.69	40.62
Poland	5583	5437	4572	3907	4164	8.95	9.41	9.57	9.94	10.36
Portugal	974	885	840	845	782	18.72	18.66	18.14	18.34	17.97
Finland	380	344	279	272	290	41.69	42.05	38.55	39.92	41.44
Sweden	471	397	358	266	311	44.22	43.87	41.47	43.70	45.55
United Kingdom	3059	2645	2222	1905	1998	39.29	39.02	36.90	37.15	37.32

Multilevel Analysis

Dupont et al. (2013), AAP Journal

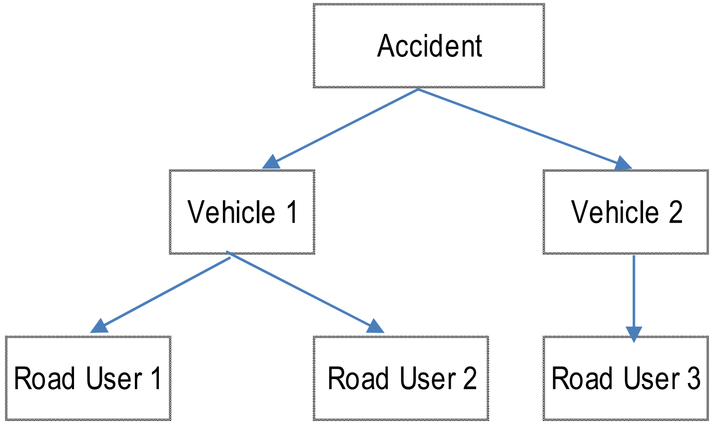


- Hierarchical structures in road safety data are receiving increasing attention in the literature
  - Geographic / spatial hierarchies
  - Accident components hierarchy

- ML models are regressions (linear or GLM) in which the parameters are assigned a probability model.

- This "higher-level" (probability) model has parameters of its own (mean, variance).

- They aim to capture dependencies among observations due to their hierarchical structure.



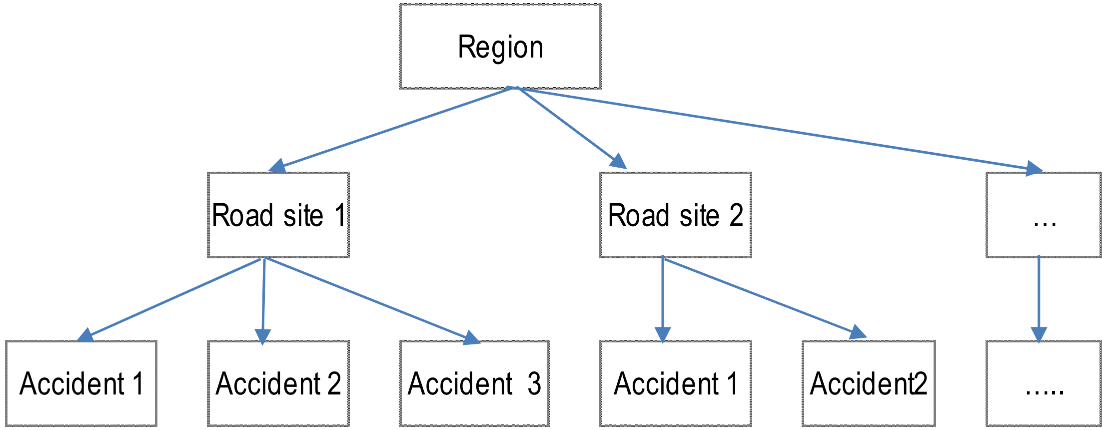
Multilevel Analysis

Basic Multilevel model formulation:

Observations i are nested within units j

$$y_{ij} = \beta_{0j} + \beta_{1J}\, x_{ij} + \varepsilon_{ij}$$

$$\beta_{0j} = \beta_0 + u_{0j} \qquad u_{0j} \sim N\,[0, \sigma^2_{0j}]$$
$$\beta_{1j} = \beta_1 + u_{1j} \qquad u_{1j} \sim N\,[0, \sigma^2_{1j}]$$

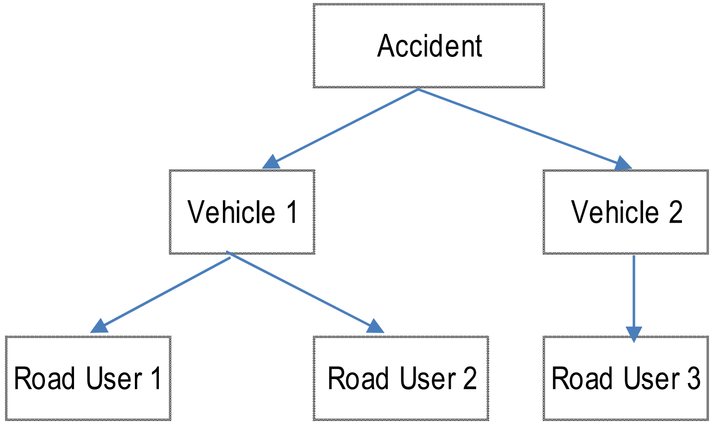


ML model formulations:

(i) allow improving the fit of the model to the data,

(ii) allow identifying and explaining random variation at specific levels of the hierarchy considered,

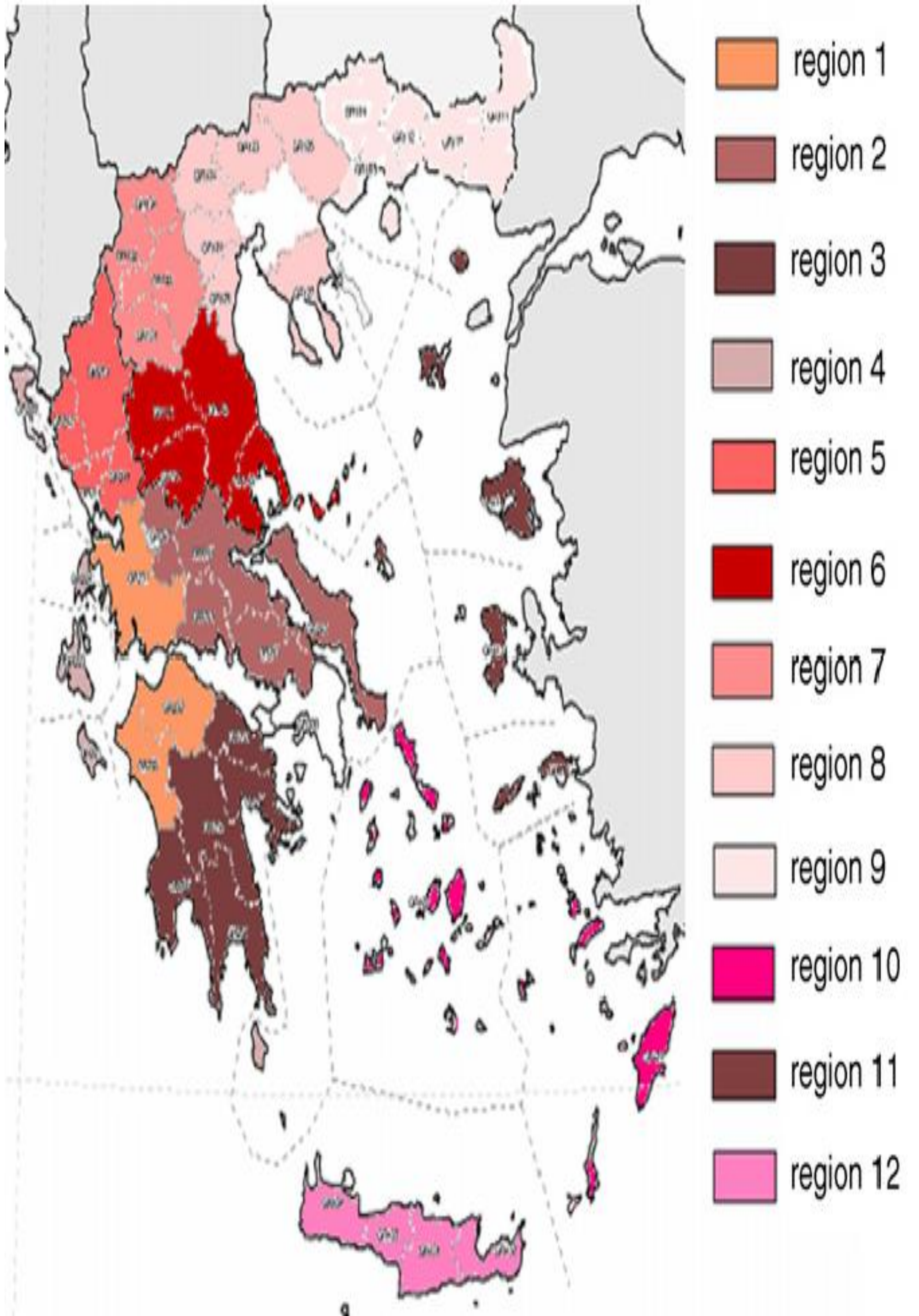
(iii) yield different (more correct) conclusions than single-level model formulations with respect to the significance of the parameter estimates.



Example: Effects of Enforcement on Road Accidents

Yannis et al. (2007), AAP Journal

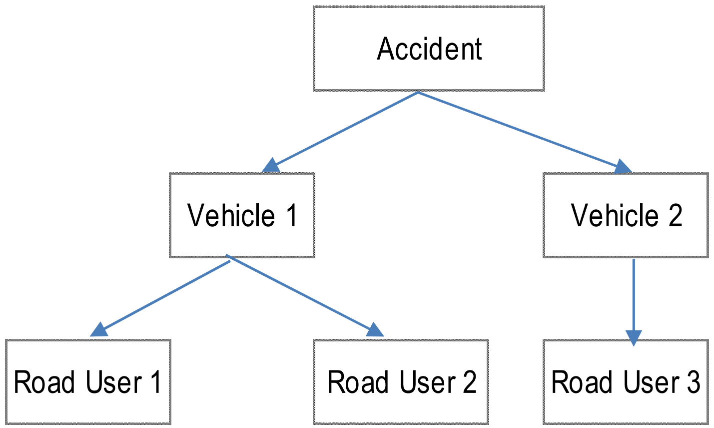
- Geographical Multilevel model
- Data for the period 1998-2002 for the 52 regions of Greece
  - Road fatalities
  - Number of speed / alcohol controls
  - Number of speed / alcohol violations
  - Demographics and vehicle fleet
- The Multilevel model shows that:
  - The effect of enforcement becomes more significant when considering the geographical hierarchy of the observations
  - The highest effect of enforcement was observed in those counties that had a low level of motorization and high violations rate.

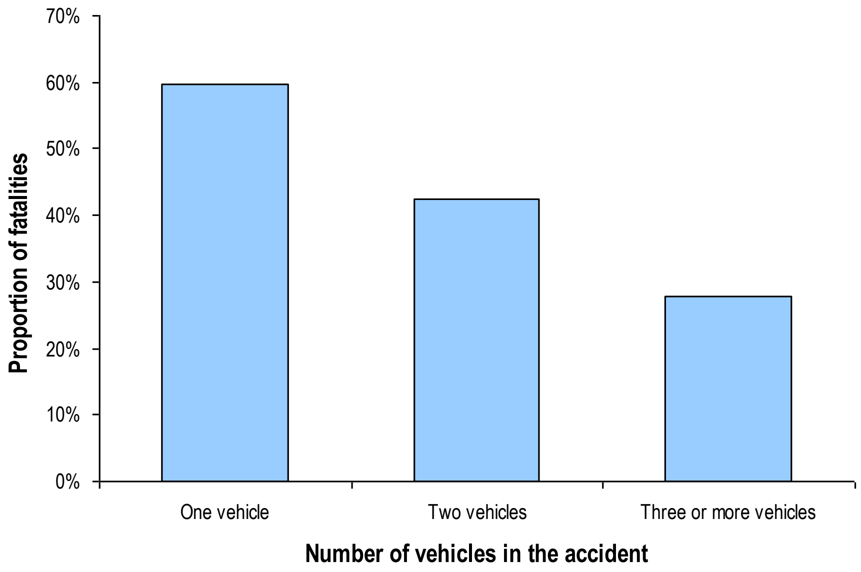


Example: Risk and Protection Factors in Fatal Accidents

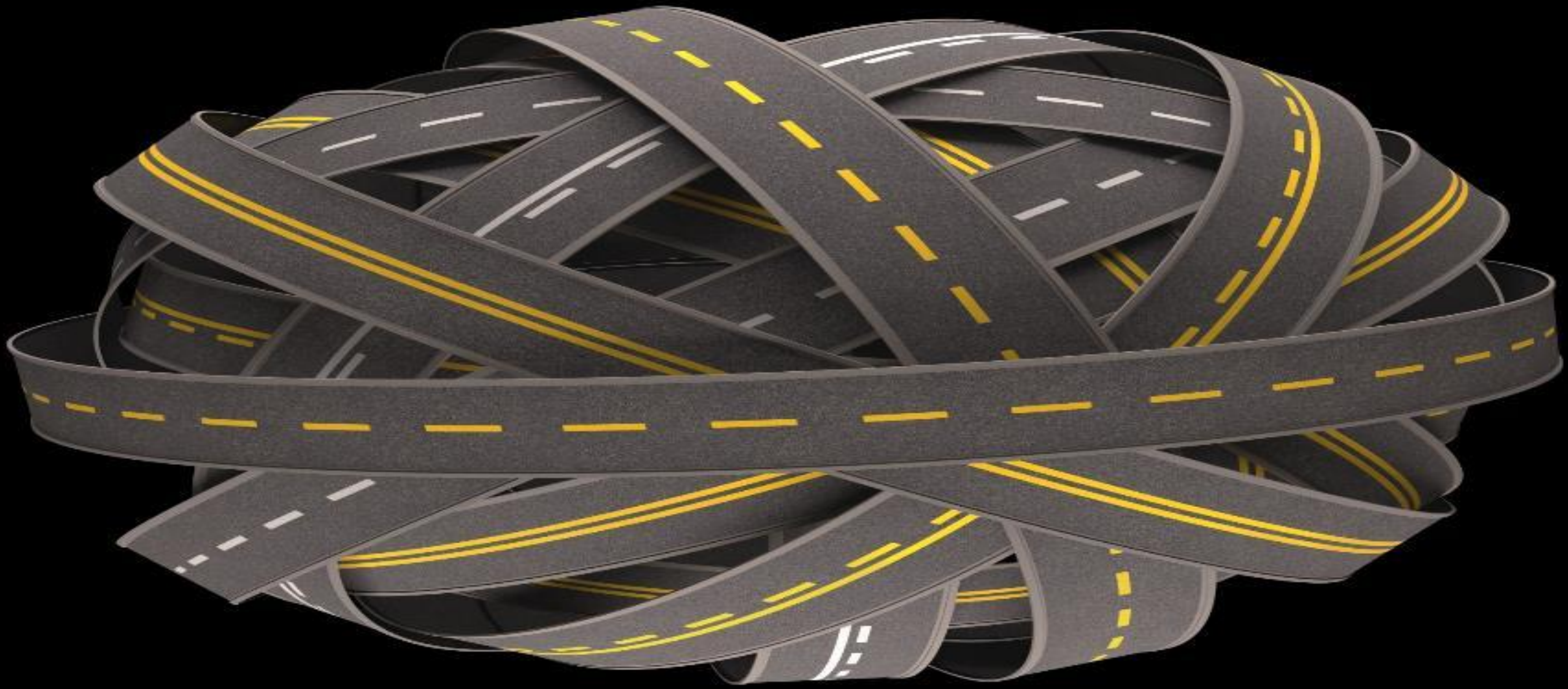
Yannis et al. 2013, Traffic Injury Prevention Journal

- Accident hierarchy ML model
- Disaggregate data for 1000 fatal accidents from in-depth investigation methods for 7 European countries
- The fatality risk largely depends on the vulnerability of the road user ('baseline risk') compared to the vulnerability of the collision opponent.
- Several road, traffic and individual factors interact in terms of injury severity
- The 'vehicle' random effect is necessary to better capture these effects





Assessment of Road Safety Measures



The Need for Efficiency Assessment

- Need to make sure that the limited funds available are used effectively.
- A synthesis of diverse evaluation results allows for more universal understanding and application of safety effectiveness measures.
- The narrower the efficiency assessment results distribution, the larger is the probability that policy decisions are correct.
- Efficiency assessment allows more rapid adoption and dissemination of new safety measures.
- Efficiency assessments are the basis for evidence based safety policies.

Efficiency Assessment Tools

- **Tools:** iRAP software (ViDA), FHWA' s Interactive Highway Safety Design Module (IHSDM), Manual application of AASHTO's HSM predictive method, PRACT Tool
- **Handbooks:** The R. Elvik Handbook of Safety Measures, the ROSEBUD Handbook, the SUPREME Handbook, the CEDR report on cost-effective infrastructure investments, etc.
- **Challenges for transferability**:
  - Lack of a uniform understanding of the value, importance and usage of CMFs in road safety decision making.
  - Need to assess the particularities of setting, context, and implementation features of a specific measure.

Methods for Prioritizing Measures (1/3)

Cost-Effectiveness Analysis (CEA)

Number of crashes prevented by the measure/
unit cost of implementing the measure

- **Benefits**
  - less information is necessary
  - not necessary to have an estimation of the monetary value of a crash
- **Limitations**
  - economic evaluation regarding only one outcome of the measure
  - not possible to account for different crash severity levels or different policy fields (environment, mobility)

Methods for Prioritizing Measures (2/3)

Cost-Utility Analysis (CUA)

Measures impact expressed by:
Quality Adjusted Life Years (QALY)

Fatalities assessed by Years of Life Lost (YLL)

Injuries assessed by Years Lived with Disability (YLD)

CUA calculates the cost per QALY

- Benefits
  - possibility to account for different crash severity levels
- Limitations
  - not possible to account for different policy fields (environment, mobility)

Methods for Prioritizing Measures (3/3)

Cost-Benefit Analysis (CBA)

Monetary values are assigned to each type of benefit that results from the measure. Sum of benefits is then compared to the measure costs. Ranking based on:

1. Net Present Value (NPV) = Benefits – Costs
2. Benefit-Cost Ratio (BCR) = Benefits / Costs

(If BCR > 1, measure is cost-effective)

- Benefits
  - possibility to account for different crash severity levels and different policy fields (environment, mobility)
  - determines right balance between safety and other objectives
- Limitations
  - requires more input than CEA, CUA

Indicative CBA Results of Infrastructure Safety Measures

Measure	Unit of analysis	Benefit-to-cost ratio (best estimate)	Net Present Value (in EUR EU-2015 PPP)	Total costs per unit of analysis (in EUR EU-2015 PPP)	Break-even measure cost (in EUR EU-2015 PPP)
Road safety audits - Light measure addition	1 km	21.7	€ 1 641 482	€ 79 189	€ 1 720 671
Road safety audits - Heavy measure addition	1 km	2.9	€ 1 121 380	€ 599 291	€ 1 720 671
High risk sites treatment	1 location (intersection)	16.1	€ 869 803	€ 57 561	€ 927 363
Dynamic speed limits	1 km	1.1	€ 31 548	€ 490 192	€ 521 739
Section control	1 km	19.5	€ 2 834 895	€ 152 913	€ 2 987 808
Installation of speed humps	1 area	18.2	€ 3 234 711	€ 187 953	€ 3 422 665
Implementation of 30-zones	1 area	1.6	€ 66 038	€ 110 226	€ 176 265[1]
Installation of lighting & Improvement of existing lighting	1 km	0.7	€ -24 888	€ 85962	€ 61073
Implementation of rumble strips at centreline	1 km	9.1	€ 7950	€ 987	€ 8938
Installation of chevron signs	1 location (curve)	2.7	€ 875	€ 504	€ 1379
Channelisation	1 location (intersection)	8.4	€ 1 452 858	€ 196 061	€ 1 648 919
Automatic barriers installation	1 location (level crossing)	0.05	-€ 197 399	€ 208 698	€ 11 299
Installation of traffic calming schemes	1 area	0.4	-€ 392 061	€ 612 633	€ 220 572
Installation of traffic calming schemes (b)	1 area	0.2	-€ 4 199 122	€ 5 389 225	€ 1 190 103
Road surface treatments	1 location (intersection)				€ 1 123 604
Winter maintenance	1 km	6.0	€ 2 609	€ 519	€ 3128
Safety barriers installation	1 km	19.5	€ 1 339 933	€ 72 314	€ 1 412 247
Convert junction to roundabout	1 location (intersection)	9.2	€ 3 749 171	€ 455 122	€ 4 204 293
Traffic signal installation	1 location (intersection)	1.1	€ 8 731	€ 98 285	€ 107 016
Traffic signal installation - highways	1 location (intersection)	3.7	€ 559 388	€ 206 874	€ 766 263

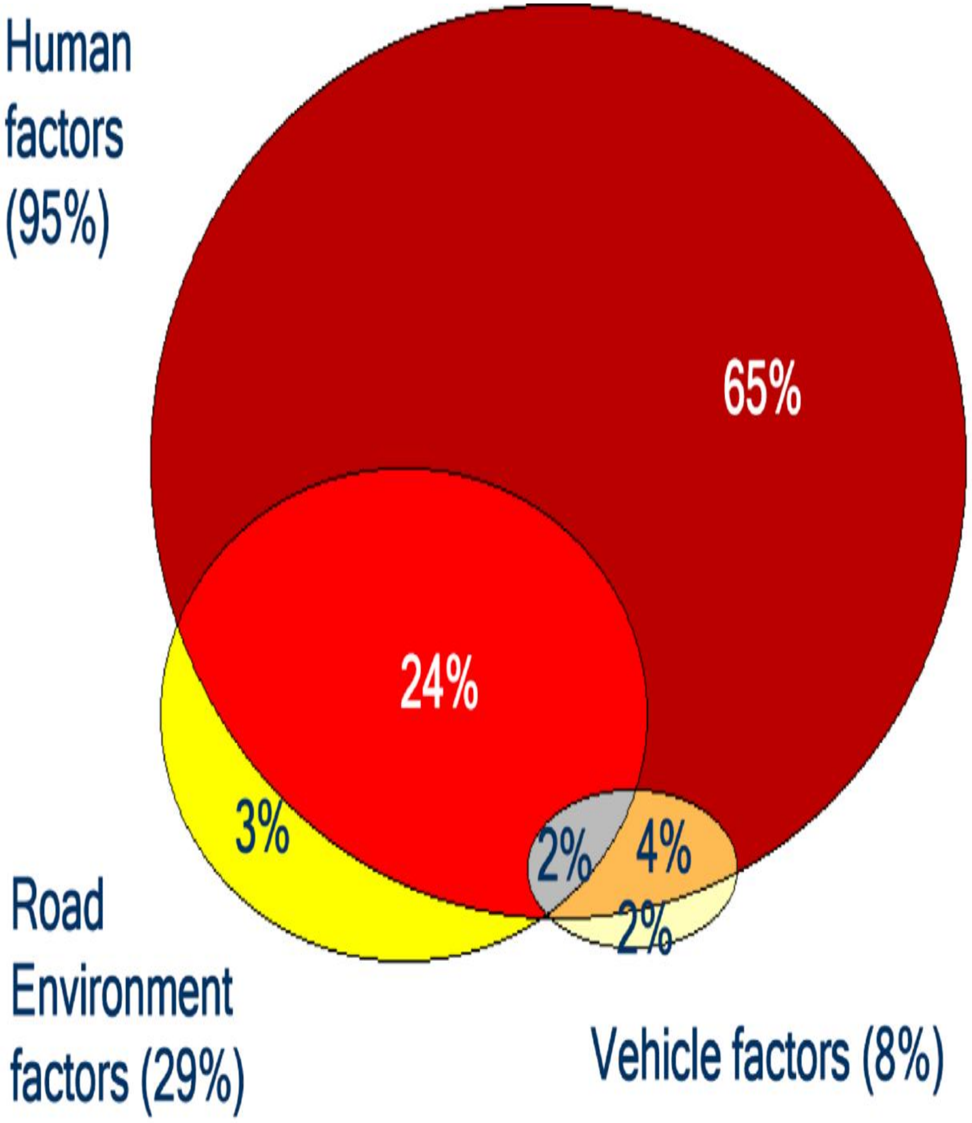
Indicative CBA Results of Road User Safety Measures

Measure	Unit of analysis	Total costs per unit of analysis (in EUR EU-2015 PPP)	BCR Best estimate	NPV (in EUR EU-2015 PPP)	Break-even measure cost
Law and enforcement – General police enforcement of speeding	One area of enforcement with a total length of 88 km.	€5,856,879	1.0	€122,489	€5,979,369
Law and enforcement – DUI checkpoints, selective and random breath testing	DUI testing for 100,000 drivers for a year	€3,284,143	7.3	€20,732,246	€24,007,389
Law and enforcement – seatbelt wearing	One country, increase of seatbelt enforcement by factor 2	€5,173,139	1.4	€2,030,188	€7,077,153
Fitness to drive assessment and rehabilitation – Alcohol interlock	Participation of a serious offender in an alcohol interlock programm	€3,068	10.9	€131,281,642	€32,130
Education – Hazard perception training	One harzad perception training	-	-	€120,155	€120,155
Law and enforcement – Red light cameras	One red light camera on an intersection, 253 implemented units	€109,400	3.7	€71,491,929	€388,358
Formal pre-license training – Graduated driver licensing	One training intervention	€132,620	125.1	€16,462,021	€16,594,642
Fitness to drive assessment and rehabilitation – Mandatory eyesight test	One visual mandatory eyesight test and treatment if necessary and possible	€47	0.5	-2,782,968	€24
Education and voluntary training – Child pedestrian training	One child pedestrian training	€574,689	2.6	€935,422	€1,510,111
Awareness raising and campaigns – Seatbelt	One national seatbelt campaign	€468,832	42.2	€19,300,582	€19,769,414
Awareness raising and campaigns – Child restraint	One nationwide booster seat programme 4-8-years old	€463,980	4.6	€1,671,196	€2,135,176
Awareness raising and campaigns – Drink-driving	One drink-driving advertising campaign	€862,157	2.1	€932,113	€1,794,270

Road User Behaviour

Understanding Road User Behaviour

- Human factors are the basic causes of road accident in 65-95% of road accidents.
- Human factors include a large number of specific factors that may be considered as accident causes, including:
  - driver injudicious action (speeding, traffic violations etc.),
  - driver error or reaction (loss of control, failure to keep safe distances, sudden braking etc.),
  - behaviour or inexperience (aggressive driving, nervousness, uncertainty etc.),
  - driver distraction or impairment (alcohol, fatigue, mobile phone use etc.).



Driving Behaviour Data Collection

- Driving Simulator Experiments
- Naturalistic Driving Experiments
- On road experiments
- In Depth Accident Investigations
- Surveys on Opinion and Stated Behaviour

Driving Simulator Experiments

Examination of a range of driving performance measures in a controlled, relatively realistic and safe driving environment.

Advantages

- Collection of data which would be very difficult to collect under real traffic conditions
- Exploration of any possible driving scenario
- Driving conditions are identical for all drivers

Disadvantages

- Non totally realistic simulated road environment
- Possibility of adopting a different driving behaviour
- Feeling of safety
- Simulator sickness

Naturalistic Driving Experiments

A research method for the observation of everyday driving behaviour of road users.

Advantages

- Large degree of control over the variables that affect driving behaviour
- Researchers study issues that cannot be investigated in a lab
- Help support the external validity of research

Disadvantages

- Difficult to determine the exact cause of a behaviour
- The experimenter cannot control outside factors
- Traffic incidents are very rare

On-road Experiments

Studies using instrumented test vehicles to gain greater insights into the factors that contribute to road user accident risk and the associated crash factors at specific conditions.

Advantages

- Large degree of control over the variables that affect driving behaviour
- Study of actual observed behaviour

Disadvantages

- Data not collected over a longer time period and in response to selected interventions

In Depth Accident Investigation

In-depth accident data describe the causes of accidents and injuries and aim to reveal detailed and factual information from an independent perspective on what happens in an accident.

Advantages

- Describe the accident process and determine appropriate countermeasures
- Provide a major contribution to the development of new safety policies

Disadvantages

- Insufficient reconstruction evidence

Surveys on Opinion and Stated Behaviour

In stated behaviour surveys, a reference questionnaire is built, based on a list of selected topics and a representative sample of population is interviewed.

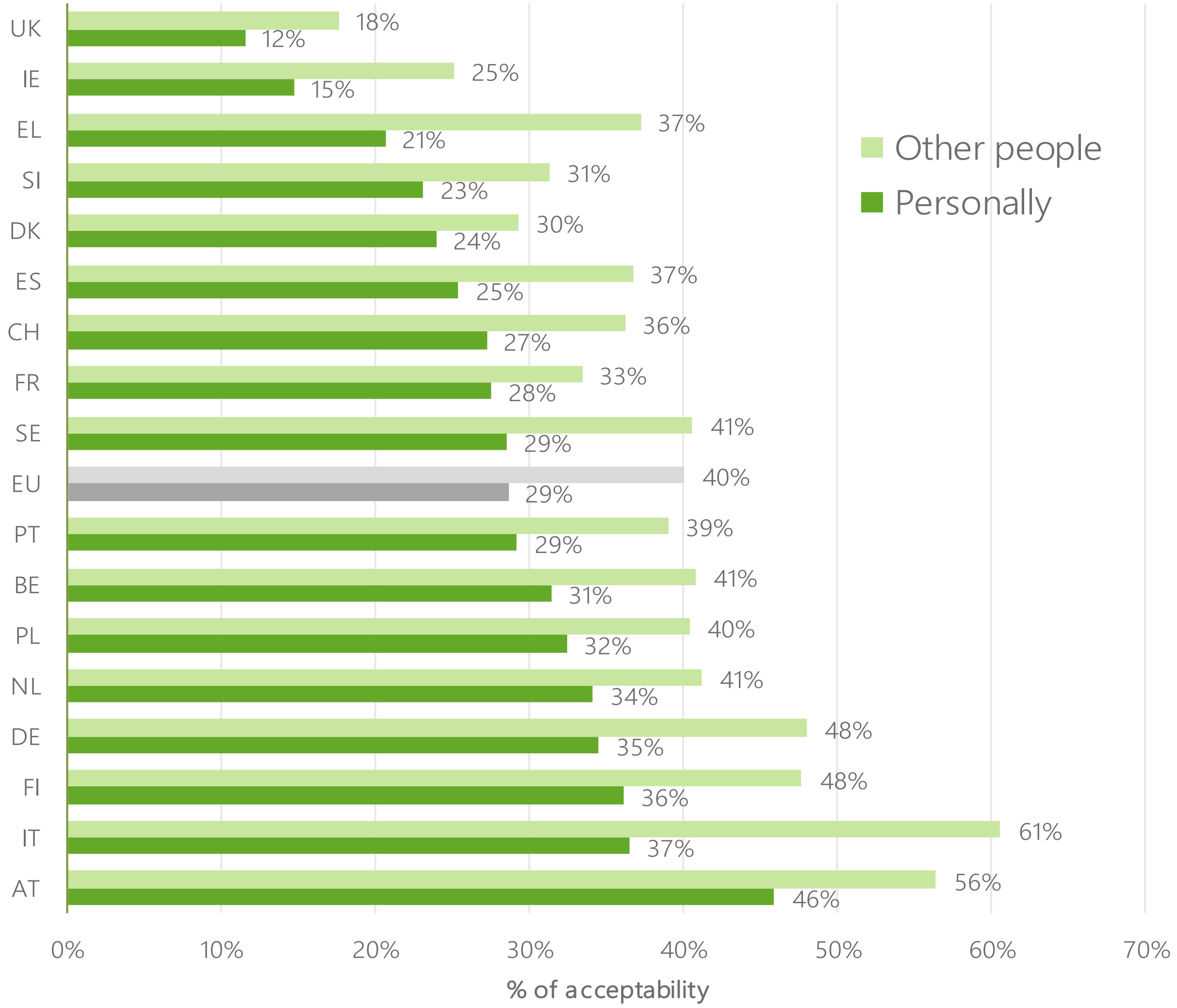
Advantages

- Survey design may control for external factors
- Allow to investigate new situations, outside the current set of experiences

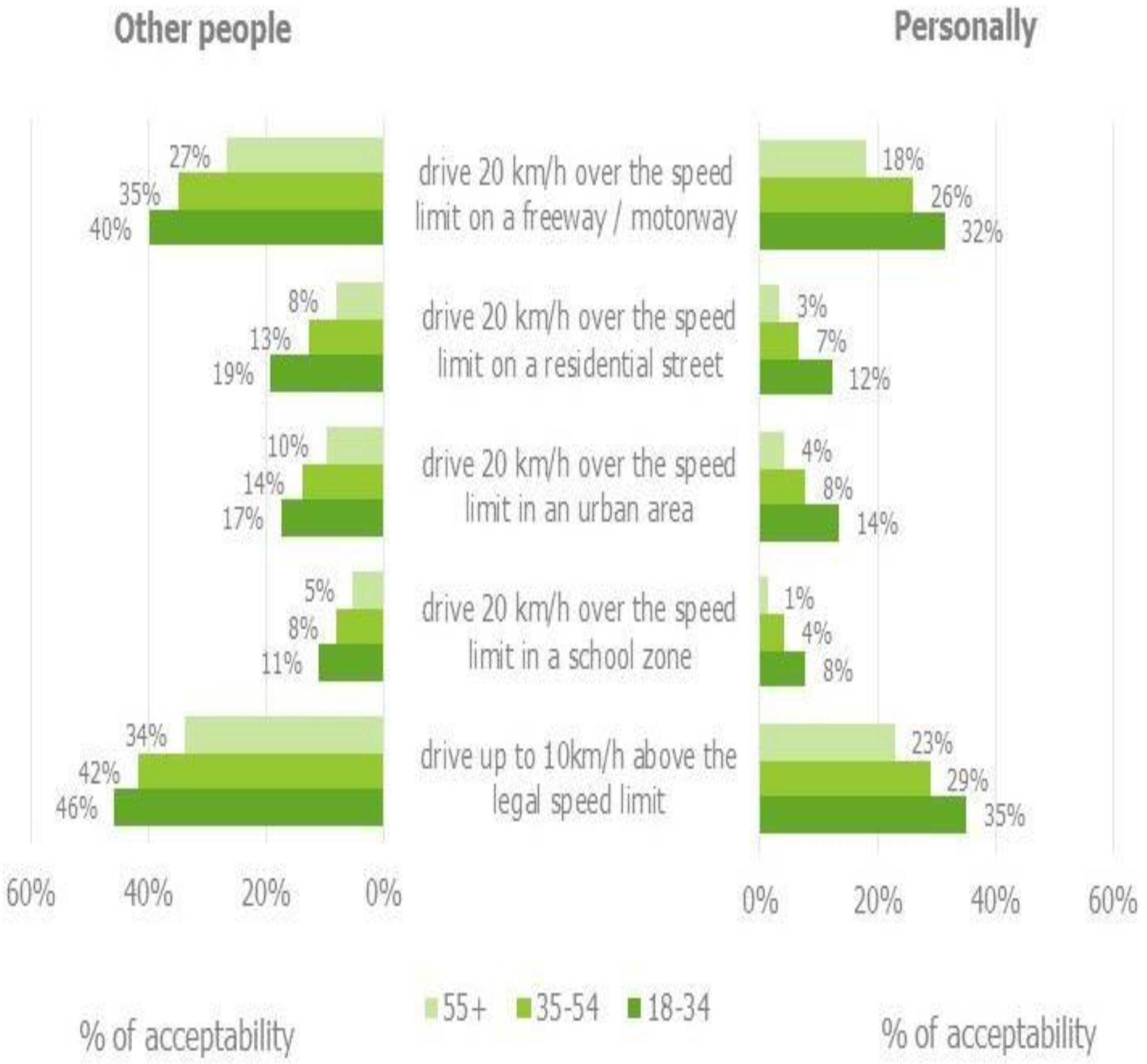
Disadvantages

- Often hypothetical nature of questions
- Actual behaviour is not observed
- Over- or under-representation of actual behaviour

ESRA Attitudes in Europe



Acceptability of driving 10 km/h over the legal speed limit, by country



Acceptability of behaviours related to speeding in Europe, by age group

Distracted Driving

Driver distraction: “The diversion of attention away from activities critical for safe driving toward a competing activity”

- Distracted driving sources: in-vehicle or external
- Mechanism

+ Distance from the central axis

+ reduced speed

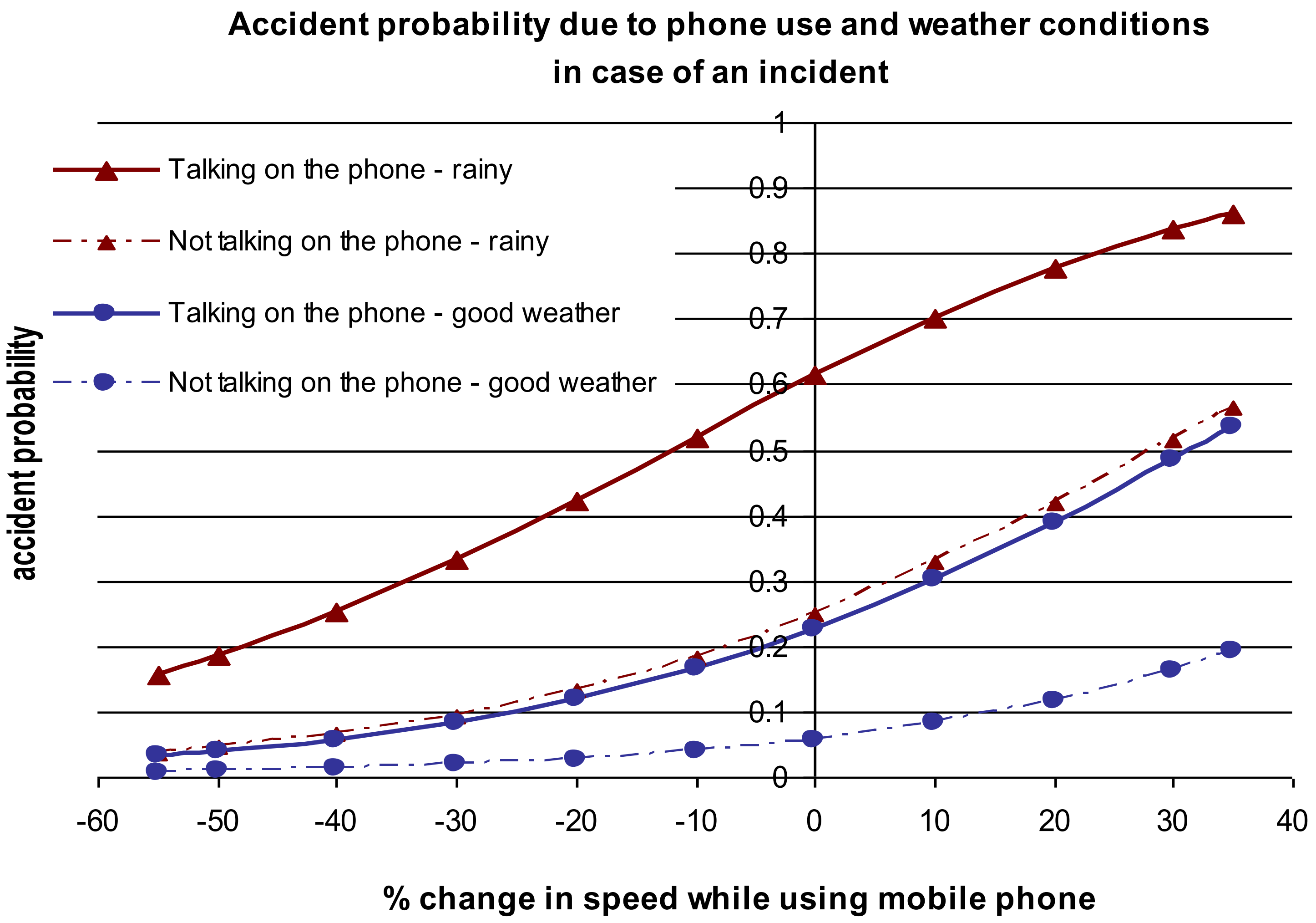
- Increased reaction time

- Increased accident probability

Mobile Phone Use, Driver Speed and Accident Probability

Mobile phone use leads to:

- Significant decrease of mean speed in urban and interurban environment.
- Increase of accident probability.



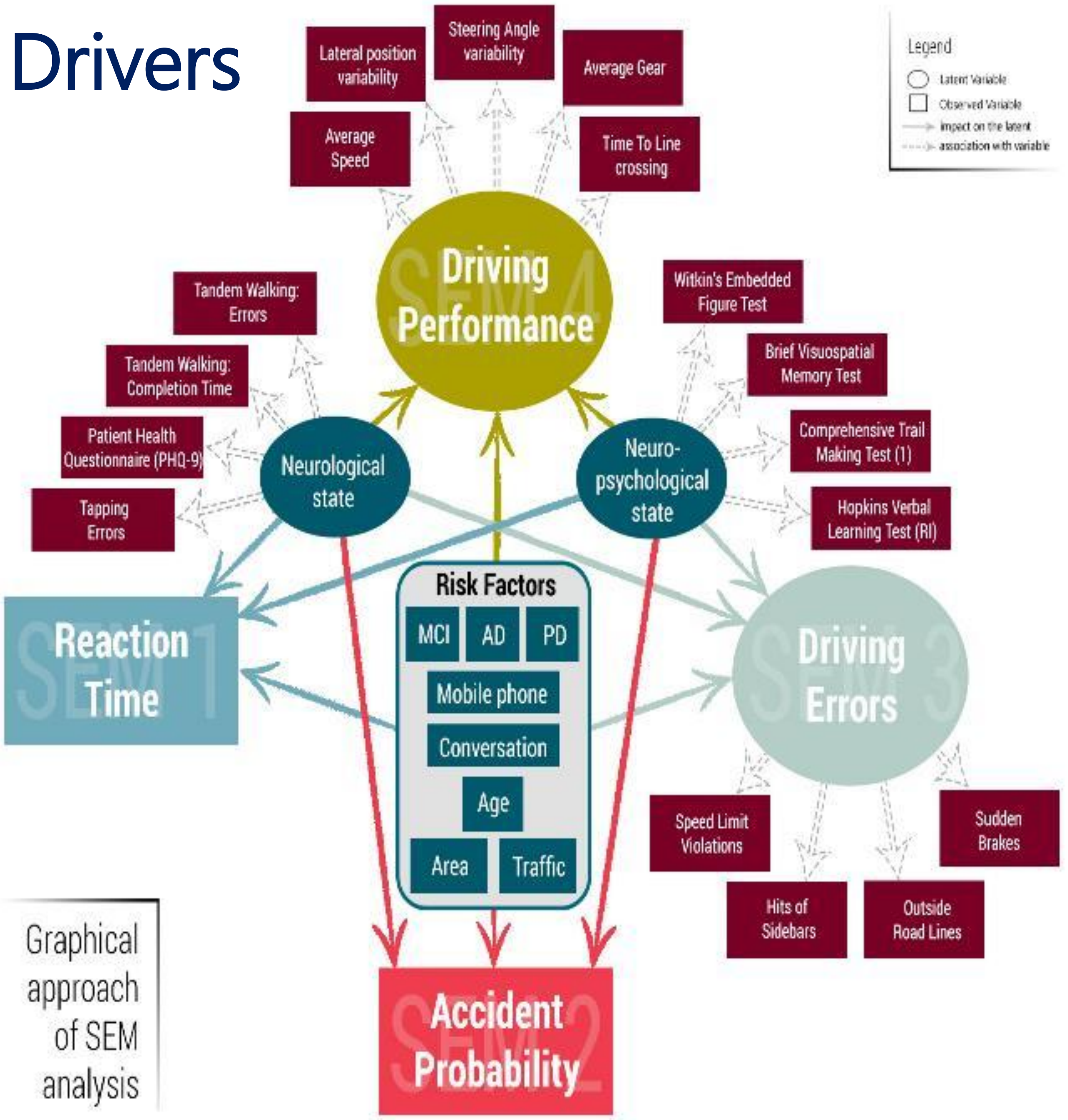
Example: Modelling Pedestrian Road Crossing Choices

Papadimitriou, 2012, Transportation Research F

- Two NTUA field surveys video-recording pedestrian behaviour:
- 2010: following 490 pedestrians (randomly selected)
- 2013: following and interviewing 75 pedestrians (selected panel)
- Sequential logit models of crossing choices
- Pedestrian behavior (i.e. road crossing) is affected by road, traffic and human factors:
  - Type of road
  - Traffic flow
  - Traffic signal
  - Walking speed
  - Risk-taking behavior
  - Walking motivations

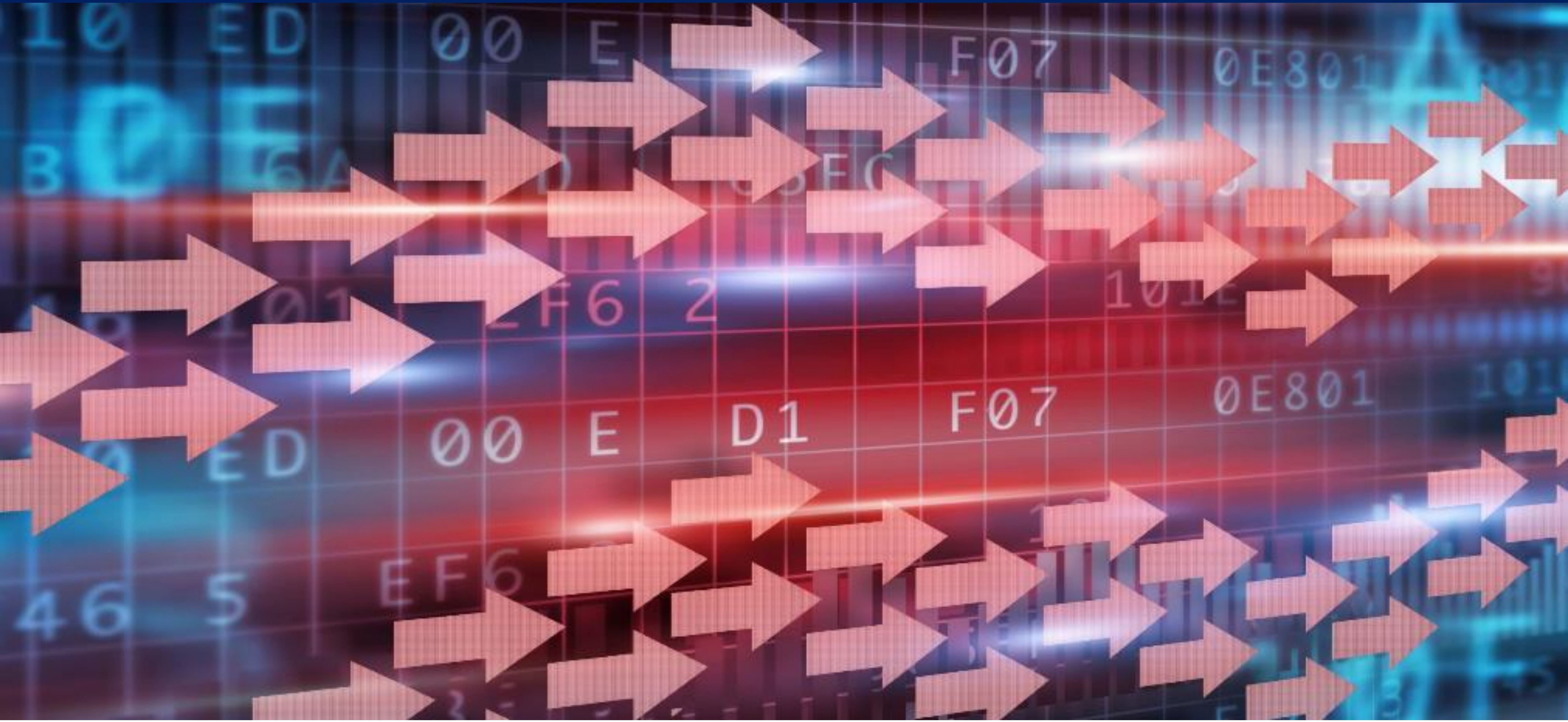
Traffic and Safety Behaviour of Drivers with Cognitive Impairment

- 4 latent variables: “driving performance”, “driving errors”, “neurological state” and “neuropsychological state”, developed by 17 observed variables
- 8 key observed variables (risk factors): MCI, AD, PD, urban area, low traffic conditions, advanced age, mobile phone use, and conversation with passenger
- 4 SEMs: regarding the impact of the 8 key risk factors and of 2 latent variables “neurological state” and “neuropsychological state” on the observed variables “reaction time” and “accident probability” and the latent ones “driving errors” and “driving performance”



Graphical approach of SEM analysis

From Correlation to Causation



Is Road Safety Management Linked to Safety Outcomes?

Papadimitriou & Yannis, 2013, AAP journal

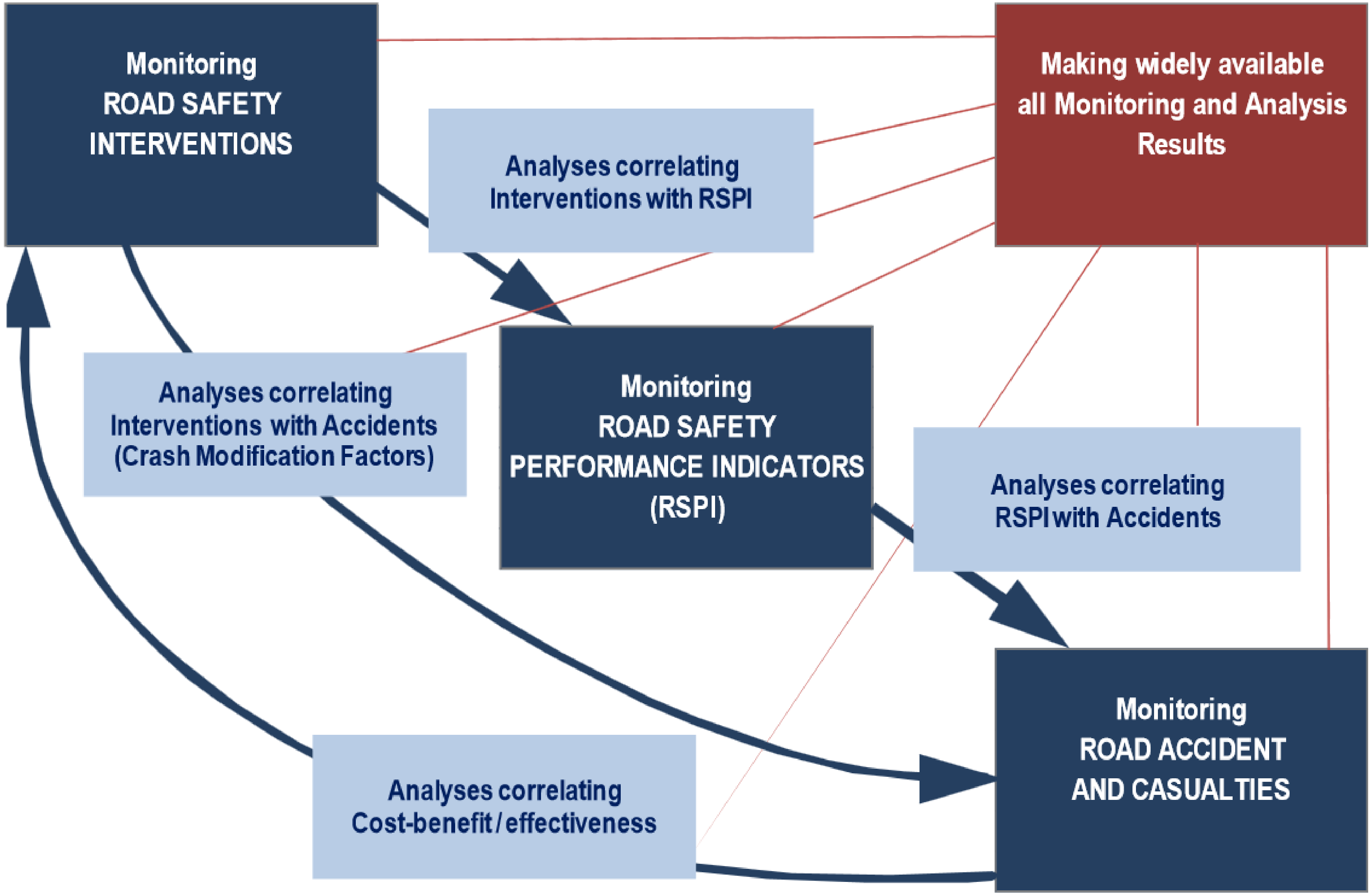
- A recent research examined the relationships between the layers of the pyramid by means of Poisson- and Beta-regression models on data for European countries.
- Road safety management does not appear to directly affect road safety outcomes.
- Road safety management appears to affect SPIs.
- SPIs are in turn strongly related to the final outcomes (fatalities).

Confirming the structure suggested by the road safety pyramid

From Correlation to Causation

- The use of rigorous methods for accident analysis provides evidence of the relationships between road safety and various factors.
- The use of efficiency assessment provides evidence for the effect of interventions on road safety.
- The interpretation of these analyses alone may not always explain the underlying causes of the effects.
- The intermediate level of SPIs is required for understanding the road safety process.
- The monitoring and analysis of road user behaviour allows the establishment of the underlying links between accident causes and impacts.

From Data Monitoring and Analysis to Policy Support



Concluding Remarks

Conclusions

- Despite the important improvements in road safety, the number of road accident casualties around the world is still unacceptable and there is need for intensification of efforts for further improvement.

- Effective road safety management systems need to be based on rigorous scientific evidence supporting the identification of accident causes and appropriate countermeasures.

- Open knowledge systems are key tools for evidence based policies (ERSO, SafetyCube, SafeFITS, etc.).

Fundamental Directions for Road Safety Research

- Streamline road safety monitoring by exploiting also new technological advances (big data).
- Establish the links between accident causation and injury causation.
- Establish the links:
  - between measures and behaviour
  - between behaviour and risk
- Focus on the most cost-effective measures.
- Improve the transferability of methods and experiences.
- Bridge the gaps between research and policy.

The Future Road Safety Challenges

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University of Hasselt
Wednesday 27 March 2019

Road Safety Data Analysis
From Correlation to Causation and Policy Support

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