



3rd EU-ASEAN Road Safety Workshop & Capacity Building



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Deciding on the most cost-effective and
appropriate road safety interventions

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Initial motivation

- Road crashes have plateaued in recent years (WHO, 2021); it is crucial to take **targeted action** to reduce crash occurrence and consequences.
- Road Safety is a typical field with high risk of important investments **not yielding results**.
- **Budget constraints** are especially important when struggling to maintain good performance levels and also in times of financial recessions or competing crises (e.g. Covid-19).
- Absence of **monitoring** and **accountability** can seriously hinder road safety performance.



Safe System Approach [1/3]

- It has been established that **humans are fallible** and road users may make mistakes.
- **The Safe System Approach (SSA)** establishes that road safety is now considered to be a **responsibility shared** by everyone.
- This includes **road users** and **also** road designers, constructors and operators, i.e. both citizens and authorities.
- All parts of transport networks must be **enhanced with redundancies**, so that if one part fails, the others can provide **back-up support** and protect human life.



Safe System Approach [2/3]

SSA:

- Aims to develop a road transport system better able to accommodate human error through better management of crash energy.
- Incorporates strategies for better management of crash forces (e.g. road network improvements, speed limits).
- Relies on strong economic analyses to understand the scale of the trauma problem and apply direct investments to achieve the greatest potential benefit to society.



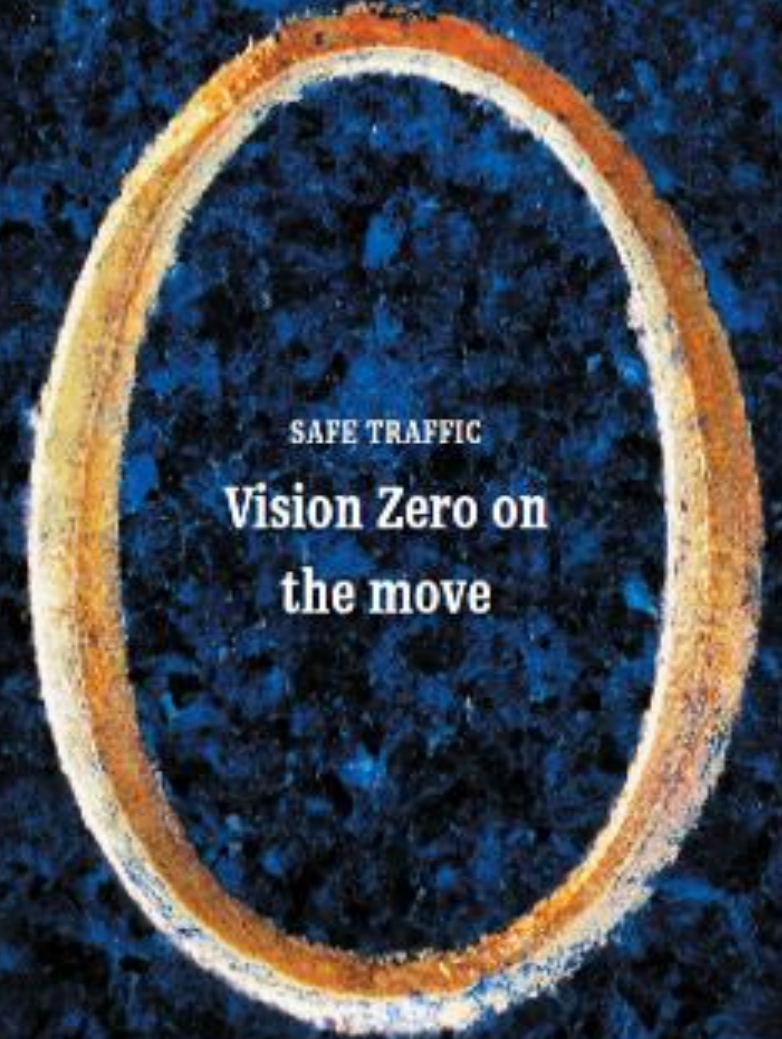
Safe System Approach [3/3]

- Key government agencies with a role in determining safe functions of the transport system are incorporated in **comprehensive management and communication structures**.
- Safety management decision making is aligned with a broader **societal decision making to meet economic goals and human and environmental health goals**, and to create a safe commercial transport environment.
- Embraces **"shared responsibility"** for road safety among the various actors of the road transport system.



The Vision Zero Concept [1/2]

- A traffic safety policy developed in Sweden (1997), expressing an **ethical imperative to eliminate death and serious injury** from the transport system.
- **Responsibility** for crashes and injuries is shared between the providers of the system and the road users.
- The **road user** remains responsible for following basic rules.
- The **system designers and enforcers** are responsible for the functioning of the system.
- When road users make errors or fail to follow the rules, the **responsibility reverts to the system designers** to ensure that these failings do not result in death or serious injuries.



The Vision Zero Concept [2/2]

- Human beings make errors and there is a critical limit beyond which survival and recovery from an injury are not possible.
- The road transport system should be able to take account of human failings and absorb errors in a way to avoid deaths and serious injuries. Crashes and minor injuries need to be accepted.
- The components of the road transport system (incl. road infrastructure, vehicles and restraint systems) must be designed so that they are linked to each other. The amount of energy in the system must be kept below critical limits by ensuring that speed is restricted.



Cost-Benefit Analysis - Overview

- Very often researchers are forced to look where the data are and **not where the problems and solutions** are.
- **Decision making** in road safety management is critically dependent on appropriate and high-quality data and calculations.
- **Cost-Benefit Analysis (CBA)** is a potent tool to decide on **most cost effective and appropriate road safety interventions**, providing the respective scientific basis
- CBA weighs crash mitigation figures against costs and allows for **financial optimization**



Cost-Benefit Analysis – Safety Performance

Road safety performance data primarily fall under three categories, equally crucial:

- **Crash data:**

As detailed as possible, describing crash circumstances accurately with as many variables as possible while mitigating underreporting

- **Exposure data:**

Augment crash data by standardizing risk measurement (e.g. vehicle/person-kilometres, vehicle fleet, road length, driver population)

- **KPI data:**

need to be present for additional context and to enable regional and seasonal comparisons



Cost-Benefit Analysis – Monitoring

➤ Monitoring Actions' Implementation

- systematic collection of information
- progress reports
- use of monitoring indicators

➤ Road Safety Performance Monitoring

- final road safety results (road crashes and casualties)
- interim results - KPIs (road users' behaviour, road infrastructure safety, vehicle safety, emergency response time)

➤ Evaluation of Actions' Effectiveness

- collection of necessary data
- appropriate methods and evaluation indicators
- reliable implementation of the evaluation methods
- publication of evaluation results



Data needed for Road Safety Decision Support

Data to identify the **problems**:

- Crash data
- Risk exposure and performance indicators

Data to identify the **solutions**:

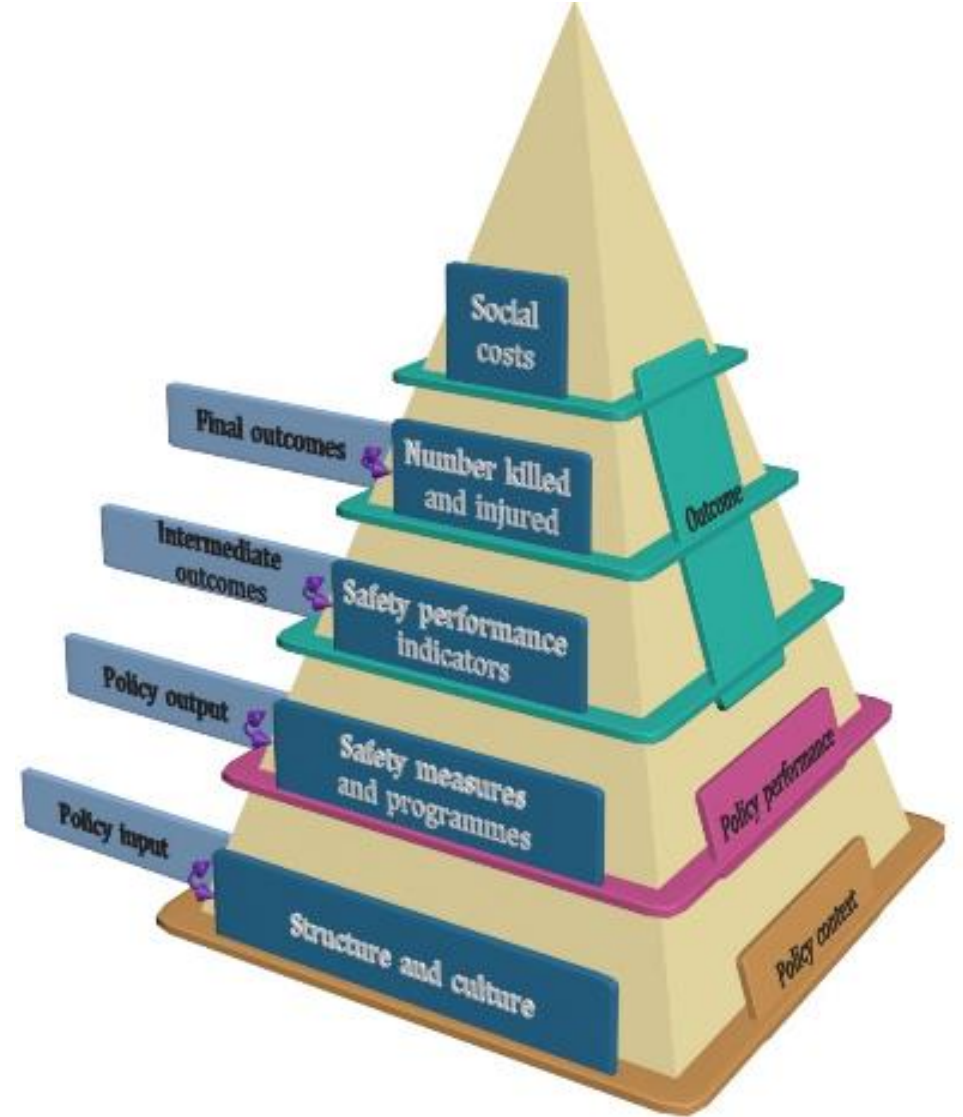
- Data on measure implementation
- Data on measure effectiveness

Macroscopic data:

- For the entire population
- For an arterial, city, region, country, globally

Microscopic data:

- driver, pedestrian, overall road user behaviour and performance
- junction, road segment, vicinity performance
- specific crash analysis data



Success in Cost-Benefit Analysis?

For a CBA to be successful, we need both sides of the 'scales', thus:

Good problem/
crash data

...combined with...



Good solution/
/intervention data!

... as assisted by
Road Safety
Observatories.



Road Safety Observatories and Decision Support Systems

...the basis for selection of the most cost effective & appropriate road safety interventions!



ERSO – European Road Safety Observatory
IRTAD, ITF Road Traffic and Accident Group
Regional/National Observatories
(African, Asia-Pacific, Ibero-American,
EASTT Partnership, Western Balkan)
NRSO – NTUA Road Safety Observatory

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



Road Safety Observatories



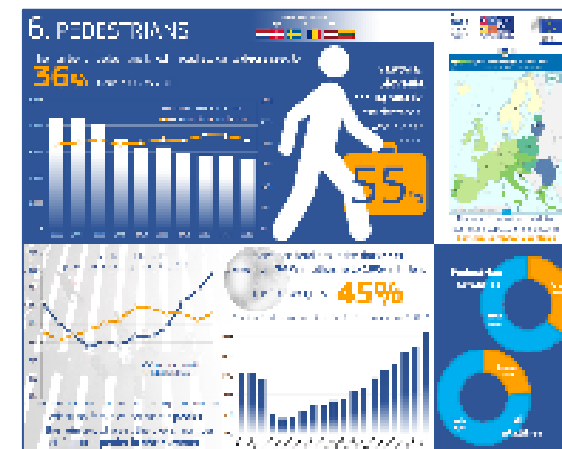
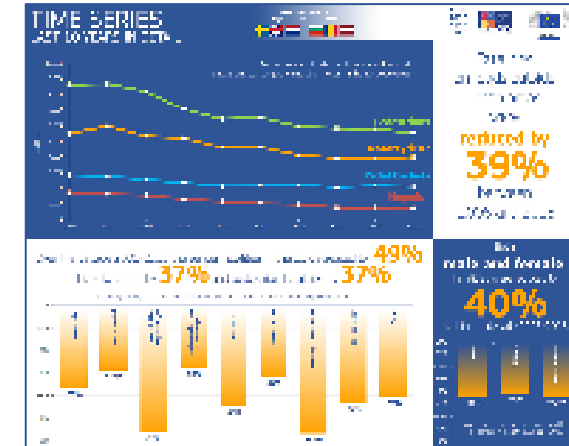
European Road Safety Observatory, EC [1/2]

The ERSO is the **information system** of the European Commission with specialist information on road safety practices and policy in European countries. ERSO and CARE are Managed by the EC – DG Move – Road Safety Unit

- Cooperation with **Eurostat** (EC Statistical Office)
- Assisted by the Road Accident Statistics National Experts Group (**CARE** Experts Group)

Methodology:

- **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



European Road Safety Observatory, EC [2/2]

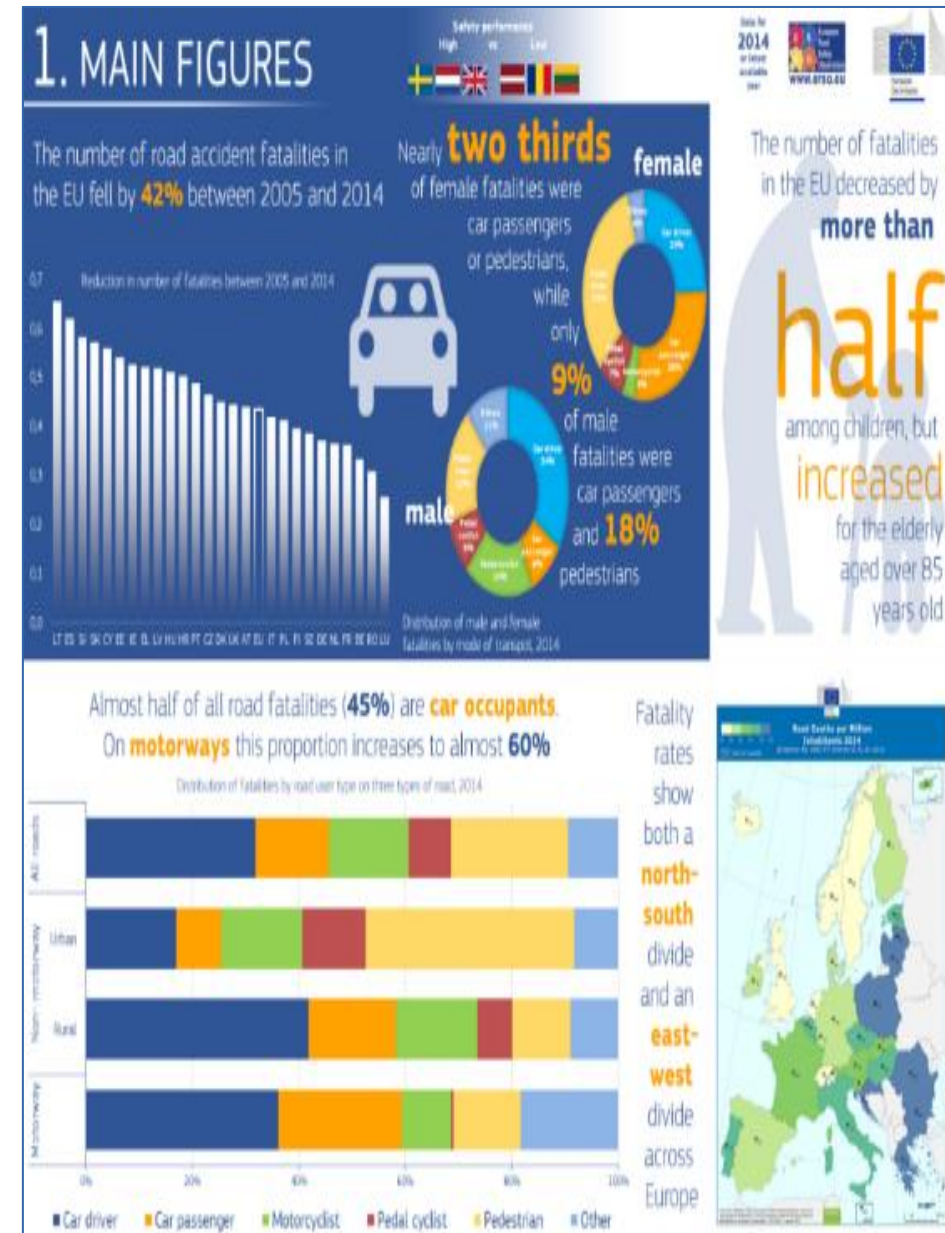
➤ 14 Thematic Reports (2021-2022)

- Advanced driver assistance systems (ADAS)
- Alcohol, drugs and medicines
- Cyclists
- Driver Distraction
- Fatigue
- Level Crossings
- Novice drivers
- Pedestrians
- Personal mobility devices
- Road Safety Performance Indicators (RSPIs)
- Seat belt and child restraint systems
- Seniors
- Serious injuries
- Speed

➤ Annual Statistical Report (2021)

➤ Country Profiles (27 EU & 3 EFTA)

➤ Facts & Figures (10 with 2019 data & 4 with 2020 data)



IRTAD, ITF/OECD [1/2]

IRTAD Objectives:

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

The IRTAD Group publishes **regularly special reports** on analyses of topical data collection and methodological issues and organizes **open conferences**.



**International Traffic Safety
Data and Analysis Group**



IRTAD, ITF/OECD [2/2]

➤ Information comes directly from relevant **national data providers**.

➤ Data provided in a **common format** and definitions, covering:

- Injury Crashes by Road Network
- Road Fatalities by Road Usage, Age, Gender and Age or by Road Network
- Hospitalised Road Users by Road Usage, Age or Road Network
- Crash Involvement by Road User Type and Casualty Data
- Risk Indicators: Fatalities, Hospitalised or Injury Crashes Related to Population or Mileage figures
- Population Figures by Age Bands
- Vehicle Population by Vehicle Types
- Network Length Classified by Road Network
- Mileage Classified by Road Network or Vehicles
- Passenger Mileage by Transport Mode
- Seat Belt Wearing Rates of Car Drivers by Road Network

➤ Data concern **55 countries**. Available at: <https://www.itf-oecd.org/IRTAD>



Speed and Crash Risk



NTUA Road Safety Observatory

- An **international reference website** - information system of road safety data and knowledge: www.nrso.ntua.gr
- More than **2100 items since 2007**, more than **800 scientific publications**
- All important **road safety news** in Greece, Europe and worldwide
- Updated **reports** covering all latest 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



George Yannis, Deciding on the most cost-effective and appropriate road safety interventions

The screenshot displays the NTUA Road Safety Observatory website. At the top, the header includes the NTUA logo and navigation links: Home, About, Knowledge, Data, Conferences, News, Links. The main content area is divided into several sections:

- Systems:** Includes logos for European Road Safety Observatory, European Road Safety Observatory, SafeFITS, pract-repository, and levitate.
- Cooperations:** Features a section for Europe with logos for Mobility and Transport, Research & Innovation, and European Investment Bank.
- 2022 EU ROAD SAFETY Results Conference:** A large banner for the conference held on 08 December 2022, organized by the European Commission.
- PHOEBE – Predictive Approaches For Safer Urban Environments: Stakeholder Questionnaire, 2023:** A call to action for a 20-minute survey.
- Upcoming Events:** A section for future events.
- Statistics:** A large infographic showing various metrics: 31 Ongoing Research Projects, 69 Scientific Committees, 28 Papers in Journals, 1500+ Citations to our papers, 50 Papers in Conferences, 115 Conference Participations, 76 Conference Presentations, 100+ Evaluations of Proposals, Faculty, PhDs, 15 Awards, and 500+ Journal/Conferences Paper Reviewed.
- Footer:** Includes the NTUA logo, the text "National Technical University of Athens Road Safety Observatory", the website URL "www.nrso.ntua.gr", and the year "2021".

Regional Road Safety Observatories

➤ African Road Safety Observatory



➤ Asia Pacific Road Safety Observatory



➤ Ibero-American Road Safety Observatory



➤ EASTT Partnership Observatory



➤ Western Balkan Road Safety Observatory



➤ European Road Safety Observatory



Road Safety Decision Support Systems



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

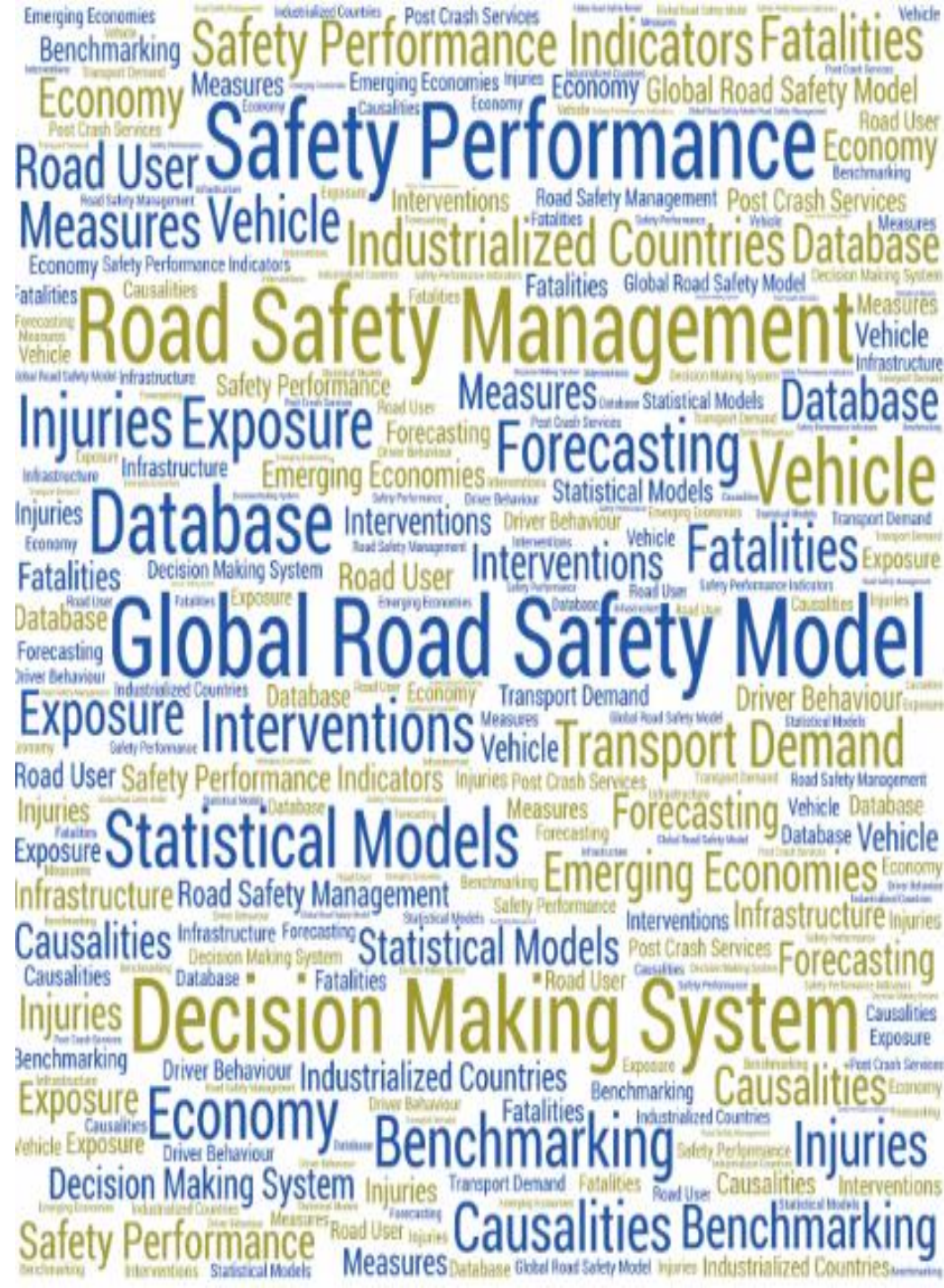
1. Economy and Management
2. Transport Demand & Exposure
3. Road Safety Measures
4. Safety Performance Indicators
5. Fatalities and Injuries

SafeFITS Pillars

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



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SafeFITS Global Model, UNECE [2/2]

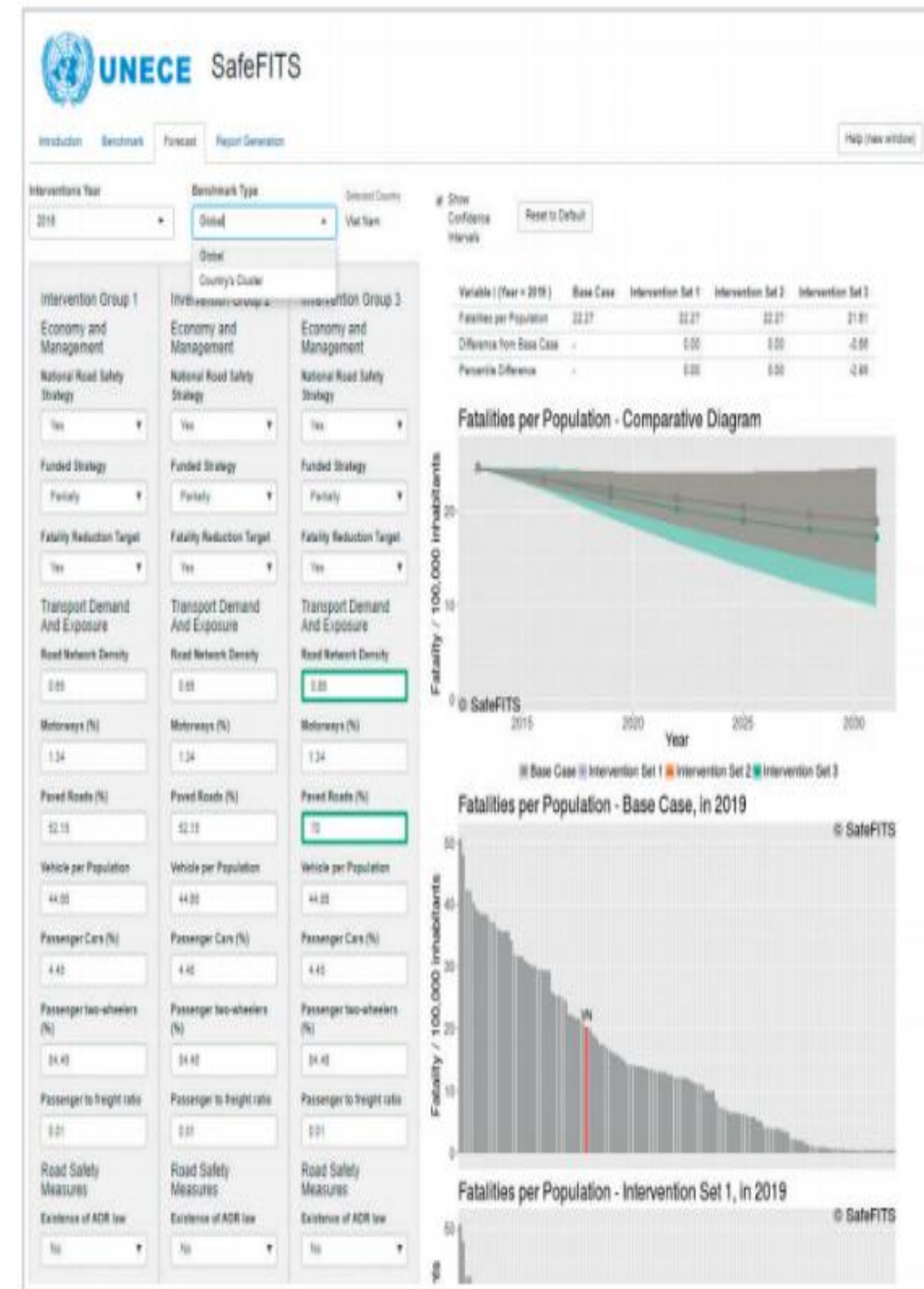
The SafeFITS Tool consists of **two background components**:

- **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 **3 complementary modules**:

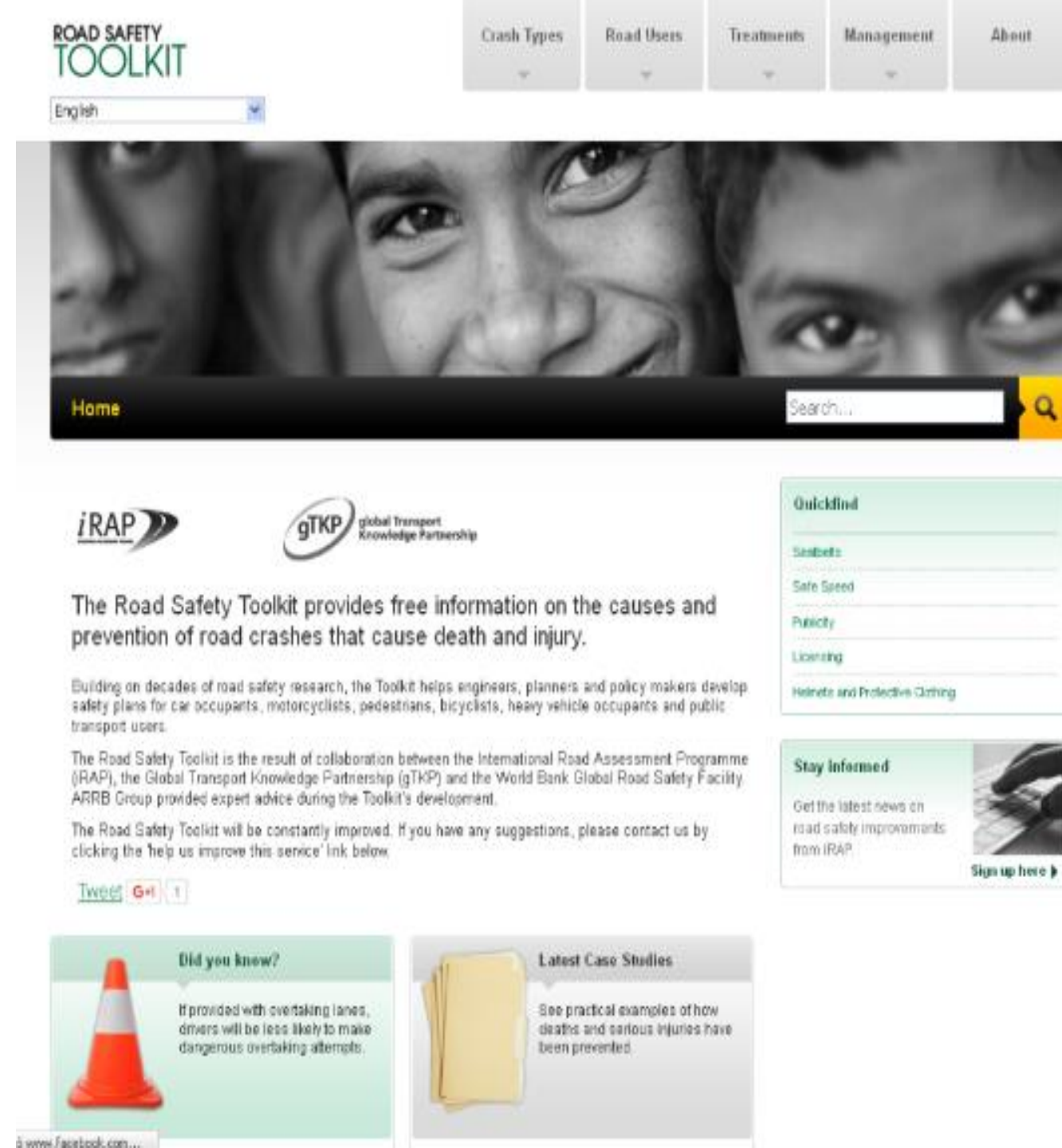
- **Intervention analysis**: allows the user to examine the effects of single interventions at national or country cluster level
- **Forecasting analysis**: allows the user to define own scenarios of measures (or combinations of measures) in a country and obtain medium/long term forecasts of each scenario
- **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)
- Available at: <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 at: www.pract-repository.eu

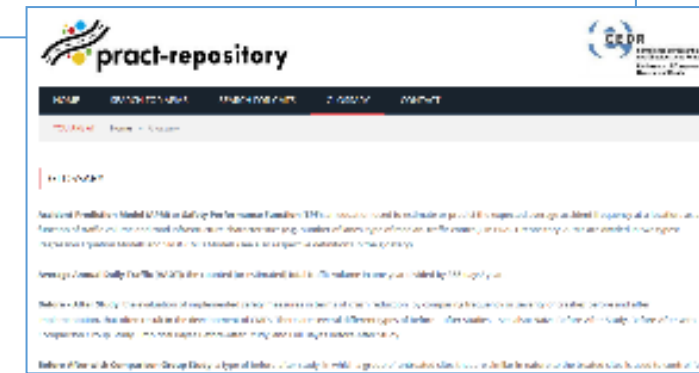


The screenshot shows the 'PRACT APM SEARCH PAGE'. It features a sidebar with filters for 'Types of APM', 'Application to highway segments', 'Minimum Speed Change Limit', 'Interchange Type', 'Duty Cycle Road Segments', 'Road Road Intersections', 'Road Elements', 'Road Types', 'Study Name', 'Year study published from', 'Year study published to', 'Authors', 'Geographic Data Origin', 'Index Type', 'Intersection/Interchange type', 'Traffic Control/Intersection', 'Crash severity', 'Crash types', and 'Number of crashes'. The main area contains search and clear buttons.



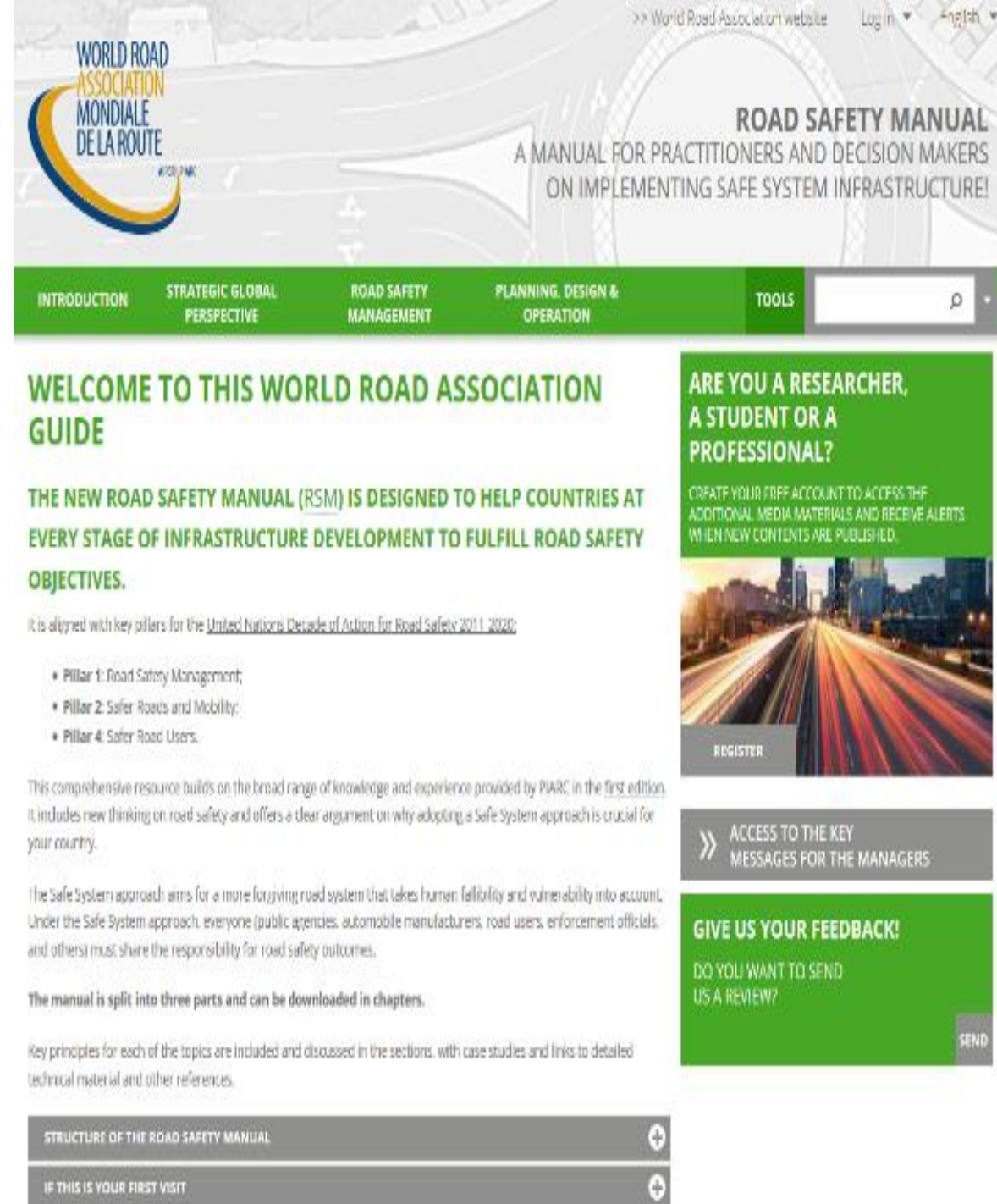
The screenshot shows the 'PRACT APM RESULTS' page. It includes a navigation bar with links to 'HOME', 'SEARCH FOR APMs', 'SEARCH FOR CMFs', 'GLOSSARY', and 'CONTACT'. Below the navigation bar, there is a table of results with columns: ID, Road Elements, Types of APM, Equation, Road Types, and Geographic Data. Two results are shown, both for 'Intersected on' road elements and 'Regression Equation' type.

ID	Road Elements	Types of APM	Equation	Road Types	Geographic Data
1-020	Intersected on	Regression Equation	$AF = 3.62 \times 10^{-11} \times (ADT)^{0.5} \times (ADT)^{0.05} \times 10^2$	Two and two-way rural road	Queensland - Australia
1-016	Intersected on	Regression Equation	$AF = 3.63 \times 10^{-14} \times (ADT)^{0.5} \times (ADT)^{0.05} \times (10^2)^{0.05} \times (10^2)^{0.05} \times (10^2)^{0.05}$	Two and two-way rural road	Queensland - Australia



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 at: <https://roadsafety.piarc.org/en>



The screenshot shows the homepage of the PIARC Road Safety Manual website. At the top, there is a header with the PIARC logo (World Road Association Mondiale de la Route) and the title "ROAD SAFETY MANUAL" with the subtitle "A MANUAL FOR PRACTITIONERS AND DECISION MAKERS ON IMPLEMENTING SAFE SYSTEM INFRASTRUCTURE!". Below the header is a green navigation bar with links: INTRODUCTION, STRATEGIC GLOBAL PERSPECTIVE, ROAD SAFETY MANAGEMENT, PLANNING, DESIGN & OPERATION, and TOOLS. The main content area features a "WELCOME TO THIS WORLD ROAD ASSOCIATION GUIDE" section, which states that the new Road Safety Manual (RSM) is designed to help countries at every stage of infrastructure development to fulfill road safety objectives. It also mentions alignment with the United Nations Decade of Action for Road Safety 2011-2020 and lists three pillars: Road Safety Management, Safer Roads and Mobility, and Safer Road Users. A "REGISTER" button is visible next to a promotional image of a road at night. On the right side, there is a green sidebar with a "GIVE US YOUR FEEDBACK!" section and a "SEND" button. At the bottom, there are two grey buttons: "STRUCTURE OF THE ROAD SAFETY MANUAL" and "IF THIS IS YOUR FIRST VISIT".

WORLD ROAD ASSOCIATION MONDIALE DE LA ROUTE

ROAD SAFETY MANUAL
A MANUAL FOR PRACTITIONERS AND DECISION MAKERS
ON IMPLEMENTING SAFE SYSTEM INFRASTRUCTURE!

INTRODUCTION STRATEGIC GLOBAL PERSPECTIVE ROAD SAFETY MANAGEMENT PLANNING, DESIGN & OPERATION TOOLS

WELCOME TO THIS WORLD ROAD ASSOCIATION GUIDE

THE NEW ROAD SAFETY MANUAL (RSM) IS DESIGNED TO HELP COUNTRIES AT EVERY STAGE OF INFRASTRUCTURE DEVELOPMENT TO FULFILL ROAD SAFETY OBJECTIVES.

It is aligned with key pillars for the United Nations Decade of Action for Road Safety 2011-2020:

- Pillar 1: Road Safety Management;
- Pillar 2: Safer Roads and Mobility;
- Pillar 4: Safer Road Users.

This comprehensive resource builds on the broad range of knowledge and experience provided by PIARC in the first edition. It includes new thinking on road safety and offers a clear argument on why adopting a Safe System approach is crucial for your country.

The Safe System approach aims for a more forgiving road system that takes human fallibility and vulnerability into account. Under the Safe System approach, everyone (public agencies, automobile manufacturers, road users, enforcement officials, and others) must share the responsibility for road safety outcomes.

The manual is split into three parts and can be downloaded in chapters.

Key principles for each of the topics are included and discussed in the sections, with case studies and links to detailed technical material and other references.

ARE YOU A RESEARCHER, A STUDENT OR A PROFESSIONAL?

CREATE YOUR FREE ACCOUNT TO ACCESS THE ADDITIONAL MEDIA MATERIALS AND RECEIVE ALERTS WHEN NEW CONTENTS ARE PUBLISHED.

REGISTER

ACCESS TO THE KEY MESSAGES FOR THE MANAGERS

GIVE US YOUR FEEDBACK!

DO YOU WANT TO SEND US A REVIEW?

SEND

STRUCTURE OF THE ROAD SAFETY MANUAL

IF THIS IS YOUR FIRST VISIT



US NHTSA/FHWA CMF Clearinghouse

- **Directly related** to the Highway Safety Manual (AASHTO, 2010)
- Includes **more than 8300 CMFs** on road infrastructure
- **Detailed background information** on presented CMFs is available
- Available online:
<http://www.cmfclearinghouse.org>



The screenshot shows the homepage of the CMF Clearinghouse. At the top, there is a navigation bar with links: Skip to main content, Site Map, Notice, Sign Up for our e-Newsletter, and Home. Below this is a secondary navigation bar with links: About CMFs, User Guide, Submit CMFs, Resources, and Contact. The main content area is divided into two columns. The left column features a search bar with the text 'Search for:' and a text input field containing 'enter search term(s)'. Below the input field is a dropdown menu labeled 'in:' with 'Countermeasure Name' selected. There are also links for 'Need Help?' and a 'Search CMFs' button. The right column has a header 'Get training on applying CMFs' and a paragraph about training opportunities. Below this is a section titled 'Recently Added CMFs' which lists three entries: 'Install right-turn lane' (CMF: 0.7, CRF: 30, Crash type: Rear end, Crash severity: All), 'Implement mobile speed cameras' (CMF: 0.73, CRF: 27, Crash type: All, Crash severity: All), and 'Place delineated shoulder (4 ft)' (CMF: 0.05, CRF: 5, Crash type: Fixed object, Head on/Run off road, Sideswipe, Crash severity: Serious injury/Minor injury). At the bottom, there is a footer with the FHWA logo, a statement about funding by the U.S. Department of Transportation, and contact information for Karen Bourry.

US NHTSA/FHWA CMF Clearinghouse

CRASH MODIFICATION FACTORS CLEARINGHOUSE

Search for:
enter search term(s)

in:
Countermeasure Name

Need Help? Search CMFs

Get training on applying CMFs

Find out about two CMF-related trainings offered through the National Highway Institute, *Application of Crash Modification Factors and Science of Crash Modification Factors*.

A crash modification factor (CMF) is a multiplicative factor used to compute the expected number of crashes after implementing a given countermeasure at a specific site. The Crash Modification Factors Clearinghouse houses a Web-based database of CMFs along with supporting documentation to help transportation engineers identify the most appropriate countermeasure for their safety needs. Using this site, you can search to find CMFs or [submit](#) your own CMFs to be included in the clearinghouse.

Recently Added CMFs

Install right-turn lane	Implement mobile speed cameras	Place delineated shoulder (4 ft)
CMF: 0.7	CMF: 0.73	CMF: 0.05
CRF: 30	CRF: 27	CRF: 5
Crash type: Rear end	Crash type: All	Crash type: Fixed object, Head on/Run off road, Sideswipe
Crash severity: All	Crash severity: All	Crash severity: Serious injury/Minor injury

U.S. Department of Transportation
Federal Highway Administration

This site is funded by the U.S. Department of Transportation Federal Highway Administration and maintained by the University of North Carolina Highway Safety Research Center.

For more information, contact Karen Bourry, FHWA Office of Safety Programs 800-637-4207



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

➤ Available online:

<http://www.engtoolkit.com.au>



The screenshot displays the AustRoads Road Safety Engineering Toolkit website. At the top, there is a header with the Austroads logo and a banner image showing a road scene with a 'SLOW' sign. Below the header, a navigation menu on the left includes links for Home, Search, Crash type, Safety deficiency, Treatment type, Road users, Road safety investigation, Safe System hierarchy of, Case study submission, and Contact ARRB. The main content area is titled 'Treatment type: Warning signs'. It contains three sections: 'Description', 'Benefits', and 'Implementation issues'. The 'Description' section explains that warning signs are used to alert motorists where visibility is obscured or there is a higher chance of encountering an unexpected hazard. It lists various situations where warning signs can be used, including hazardous curves, intersections, traffic control, vulnerable road users, lane narrowing, roadworks, and animals on the roadway. The 'Benefits' section lists that warning signs provide advance warning, raise driver vigilance, have low installation cost, reduce vehicle speed, and convey a simple clear meaning. The 'Implementation issues' section discusses the placement of signs, consistency in application, and the importance of using frangible posts. On the right side of the page, there are several sidebars: 'Pictures' showing a road with warning signs, 'Crash reduction effectiveness' with a bar chart showing effectiveness for various sign types (e.g., Speed advisory signs at 40%, Curve warning signs at 25%), 'Cost Rating' with a green dollar sign icon, 'Treatment life' with a five-star rating, and 'Other treatments to consider' with a list of additional measures like All-red time extension and Traffic signals operation review.



SafetyCube Road Safety DSS



Why SafetyCube?

- Before SafetyCube, road safety knowledge was **fragmented** and often purely **theoretical & academic**
- The more industry-oriented everyday practitioners lacked **evidence-based support** for measure selection and policymaking
- SafetyCube aimed to bridge this gap by collecting and crystallizing **scientific knowledge** for practical applications
- The SafetyCube DSS is the most **comprehensive, complete and accessible tool that can provide** insights for choosing appropriate road safety measures



SafetyCube, an EC Horizon 2020 Project

- SafetyCube aims to provide the European and Global road safety community a **user friendly, web-based, interactive** Decision Support System.
- The **SafetyCube DSS** can be **accessed freely**:
<https://www.roadssafety-dss.eu/#/>
- It combines **new and existing** road safety knowledge using scientific studies as basis.

The **main contents** of the SafetyCube DSS concern:

- Road crash risk factors and problems
- Road safety measures
- Best estimate of effectiveness
- Cost-benefit evaluations
- All related analytic background
- Special focus on linking road safety problems with related measures and interventions.



SafetyCube DSS Structure:

- **Search:**
(5 entry points)
- **Results pages:**
(Introduction, Colour codes, Synopses, Coded studies)
- **Individual Studies:** pages
(Disaggregate level, detailed effects listed, some studies not in synopses)
- **Calculator:**
Economic Efficiency Evaluation
- **Links between Risk Factors:**
Information about which risks can be remedied by which types of measures
- **Methodology:**
System documentation
- **Support:**
Contact, help, feedback



SafetyCube DSS Contents

The SafetyCube DSS contains:

- more than 1,250 scientific studies
- with more than 7,500 estimates of risks/measure effects on
- 4 pillars: road user, infrastructure, vehicle, post impact care
- 38 risk categories, 50 measure categories (88 in total) e.g. distraction, roadside factors,
- 120 specific risks, 193 specific measures (313 in total) e.g. mobile phone use,
- 211 summarizing Synopses documents
- 36 Cost-benefit Analyses (in a CBA calculator which the user can adjust according to their needs)



Behavior	Infrastructure	Vehicle	Post Impact Care
Law and enforcement	Traffic flow	Frontal impact	Ambulances/helicopters
Education and voluntary training or programmes	Traffic composition	Side impact	Extraction from vehicle
	Formal tools to address road network deficiencies	Rear impact	Pre-hospital medical care
Driver training and licensing	Speed management & enforcement	Rollover	Triage and allocation to trauma facilities
Fitness to drive assessment and rehabilitation		Pedestrian	First aid training drivers
Awareness raising and campaigns	Road type	Child	
	Road surface treatments	PTW	
	Visibility / Lighting treatments	Cyclist	
	Workzones	HGV	
	Horizontal & vertical alignment treatments	Longitudinal	

SafetyCube DSS Calculator [1/2]

- Combines information about the **effectiveness of a measure** (i.e. the percentage of crashes or casualties prevented) with the costs of this measure.
- Integrates updated information of **crash costs in European countries**
- Allows to express all costs and benefits of a measure in **monetary values** and conduct cost benefit analysis.

Main Functions

- Perform cost-benefit analysis with **own input data**
- Select one of the **SafetyCube CBA examples**
- Measures with **high effectiveness**
- For which **reliable cost information** could be found



SafetyCube DSS Calculator [2/2]

Economic Efficiency Evaluation Tool (E3)

- Fully integrated in the DSS
- Enables users to create their custom CBA
 - “My Measure” function with free input on:
- Country, years of analyses
- Basis: Crashes or Casualties
- Costs (implementation and annual)
- Measure effectiveness (per severity category)
- Penetration rate and side effects

Contains all SafetyCube example CBAs on:

- Behaviour (12 examples)
- Infrastructure (19 examples)
- Vehicle systems (4 examples)
- Post-impact care (1 example)

The screenshot displays the SafetyCube DSS Calculator interface. The top navigation bar includes links for Search, Knowledge, Calculator, Methodology, and Support. The main content area is titled 'Calculator' and provides a brief description of the tool's purpose. Below this, the 'Input' section allows users to define their measure, select a country (EU), and specify the horizon (5 years). The 'Measure' section includes options for reduction in terms of casualties or crashes, with 'Crashes' selected. The 'Costs' section includes input fields for implementation and annual recurrent costs per unit. The 'Definition of Crashes Affected or Crashes Prevented' section includes options for expressing safety effect as percentage reduction or number of prevented crashes/casualties. The 'Cost-Benefit Analysis' section displays the results, including a table of costs (present values) and a table of benefits (present values).

Input

MY MEASURE: SELECT A SAFE (YOUR EXAMPLE)

Road surface treatments - road to surfacing to improve evenness

+ ADD SCENARIO - REMOVE SCENARIO

Description: Road resurfacing

Country: EU

Measure

Horizon (period of analysis): 5

Reduction in terms of casualties or crashes: ☐ Casualties ☒ Crashes

Number of units implemented: 136

Costs

☒ Cost breakdown Per Unit ☐ Total Costs Per Unit

Implementation costs per unit: 0

Annually recurrent costs per unit: 0

Definition of Crashes Affected or Crashes Prevented

☒ Express safety effect as percentage reduction and number of target crashes/casualties per year ☐ Express safety effect as number of prevented crashes/casualties (total over ...)

Cost-Benefit Analysis

Road surface treatments - road re-surfacing to improve evenness

Road resurfacing

Costs (present values)

Scenario 1	
One-time investment costs	EUR
Recurrent costs	EUR
Total costs excluding side effects	EUR
Side effects	EUR
Total costs including side effects	EUR

Benefits

Prevented Crashes / Casualties: EUR

Socio-economic return excluding side-effects

Net present value	EUR
Benefit-Cost Ratio	

Socio-economic return including side-effects

Net present value	EUR
Benefit-Cost Ratio	

Break-even cost for measure (per unit): EUR

A full description of the methods and data used in this example, as well as a sensitivity analysis, are available in the Cost-Benefit Analysis document.



SafetyCube CBA Methodology

For the selected measures:

- Crash cost data
 - Distinguishing between **injury severity categories**
- Measure **effectiveness and implementation costs**, obtained from high quality studies and reports

$$Benefits = \sum_s Target\ Crashes_s * Effectiveness_s * Crash\ costs_s$$

- Formation of a **common baseline**
Reference currency: €, Reference year: 2015

$$present\ value = \frac{actual\ value}{(1 + discount\ rate)^{year}}$$

- Different **scenario predictions** to mitigate uncertainty



SafetyCube CBA Scenarios

Formation of 7 possible prediction scenarios with respective Cost-Benefit Ratio (CBR) calculations:

1. Best estimate
2. Low measure effectiveness (lower limit of 95% CI)
3. High measure effectiveness (upper limit of 95% CI)
4. Low measure cost (-50%)
5. High measure cost (+100%)
6. Worst case (combining 2 and 5)
7. Best case (combining 3 and 4)



Example SafetyCube CBA outputs [1/2]

Example CBR calculations of the 7 scenarios for:

5 infrastructure measures & 2 behavior measures

(2 measures warranted separation into two sub-categories)

29 infrastructure CBRs also available in:

Daniels, S., Martensen, H., Schoeters, A., Van den Berghe, W., Papadimitriou, E., Ziakopoulos, A., ... & Perez, O. M. (2019). A systematic cost-benefit analysis of 29 road safety measures. Accident Analysis & Prevention, 133, 105292.

Measure		Benefit-to-cost ratio (BCR)						
		Best estimate	Low measure effect	High measure effect	Low measure cost: -50%	High measure cost: +100%	Worst case scenario = high cost + low effect	Best case scenario = low cost + high effect
Road infrastructure	Road safety audits – light measure case	21.7	16.4	27.0	43.5	10.9	8.2	54.0
	Installation of safety barriers	19.5	10.6	25.4	39.1	9.8	5.3	21.2
	High risk sites treatment	16.1	13.2	18.4	32.2	8.1	6.6	36.8
	Traffic signal installation – highways	3.7	1.8	5.2	7.4	1.9	0.9	10.5
	Road safety audits – heavy measure case	2.9	2.2	3.6	5.7	1.4	1.1	7.1
	Installation of chevron signs	2.7	1.4	5.5	5.5	1.4	0.7	10.9
	Traffic signal installation – county roads	1.1	0.5	1.5	2.2	0.5	0.3	3.1
Behavior	Law and enforcement – DUI checkpoints, breath testing	7.3	5.7	9.4	14.6	3.7	2.9	18.8
	Law and enforcement – General police enforcement of speeding	1.0	0.7	1.3	2.0	0.5	0.4	2.6

Example SafetyCube CBA outputs [2/2]

Interpreting the results:

- Road safety measures addressing **hotspots in a focused manner** (road safety audits, installation of safety barriers and high risk sites treatment) have highest BCRs
- Overall, most measures appear to be **cost-effective** ($BCR > 1$)
- 5 measures appear to be cost-effective **consistently** – in all 7 scenarios
- CBA is a tool to **enable comparisons**
- However, singular cases must be treated with **caution**, taking site/country particularities into account



Concluding Remarks



In summary [1/2]

- The need to decide on the most cost-effective and appropriate road safety interventions is **increasingly urgent** due to stagnation in crash reductions and budgetary constraints.
- The solution(s) can only come through the **extensive and systematic data collection and intervention monitoring** offered by Road Safety Observatories
- During the last 15 years, several Road Safety Observatories and Decision Support Systems have been developed, **adding significant value** to the quest for safer roads worldwide.



In summary [2/2]

- CBA is the main tool for **informed and effective** selection of road safety interventions
- Road Safety Information Systems with CBA capabilities are key management tools for **developing road safety capacity** and engaging stakeholders (not only for providing scientific evidence but also for monitoring efforts)
- The more developed Information Systems are associated with Countries and Regions with higher road safety performance and are a direct sign of **advanced road safety culture**.



Future Challenges

- The current **great potential** of current Road Safety Systems should be multiplied with:
 - more data and knowledge
 - broader geographical coverage
- Upgrading **usefulness of the systems** entail:
 - more accurate road accident data (LMIC Counties)
 - exposure data and performance indicators
 - measures and policies effectiveness evaluation
- Global **impact to be optimized** through:
 - a network of Regional Observatories (Global coverage)
 - standardisation of data, processes and systems
 - evidence-based & customized best practices



Conclusions

- Data, knowledge and systems require **considerable effort with equivalent budget**, but are highly profitable in terms of investment returns:
 - with thousands of lives and injuries saved and
 - road safety investments properly prioritized and exploited
- The **deployment** of national, regional and international road safety **observatories** and decision support **systems**, should be:
 - progressive
 - interconnected
 - properly funded
- Regional and Global **coordination and funding** are current key challenges for the serious upgrade of the current systems





3rd EU-ASEAN Road Safety Workshop & Capacity Building



7-9 February 2023, Bangkok, Thailand

Deciding on the most cost-effective and
appropriate road safety interventions

George Yannis, Professor NTUA

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