Ministry of Economy and Sustainable Development

UNECE

National Road Safety Policy development
trends and challenges
13-14 November 2018

The SafeFITS Model

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Background

- Road accidents constitute a **major social problem** in modern societies, with road traffic injuries being estimated as the eighth leading cause death globally.

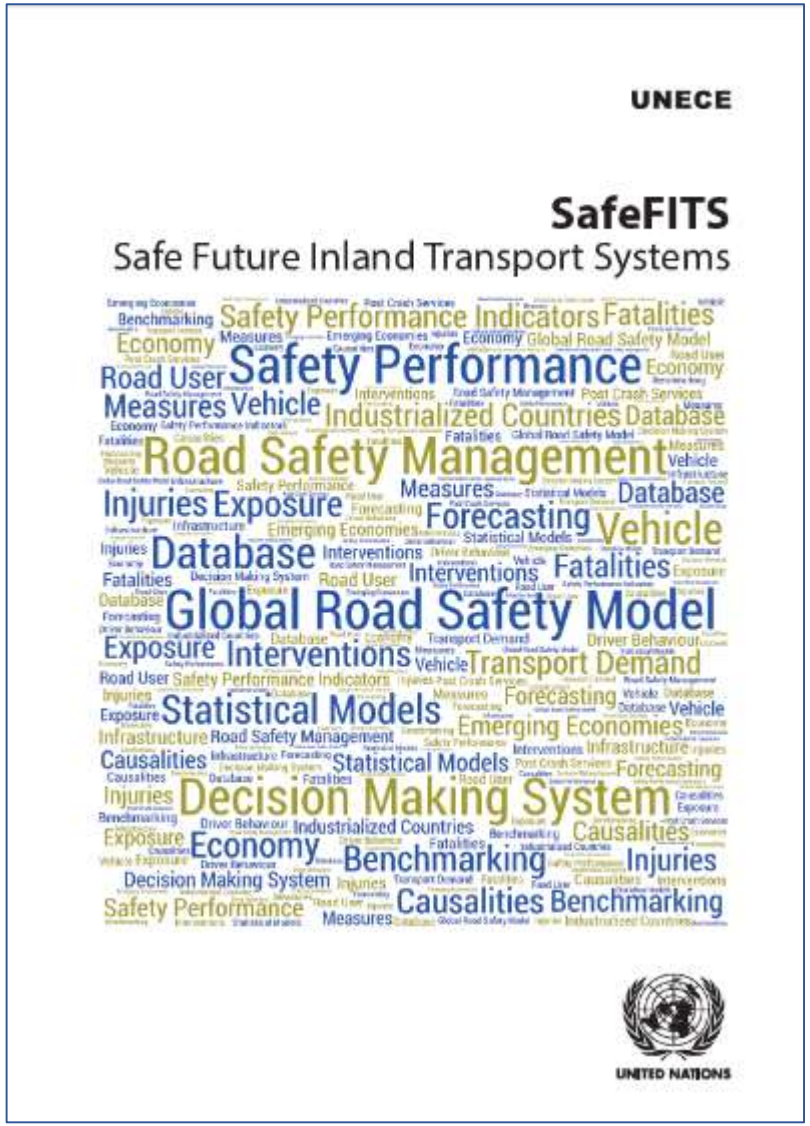
- Particularly in **low and middle income countries**, road traffic injuries are twice those in high income countries and still increasing.

- **UN Decade of Action:** need to strengthen global and national efforts for casualty reduction through evidence-based approaches.

Objective

- To develop a macroscopic **road safety decision making tool** that will assist governments and decision makers, both in developed and developing countries, to decide on the most appropriate road safety policies and measures in order to achieve tangible results.
- Based on work carried out in 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).

Available at: http://www.unece.org/?id=47239



Conceptual Framework

Based on the five pillars of WHO Global Plan of Action (WHO, 2011) and an improved version of the SUNflower pyramid (2002):

SafeFITS layers

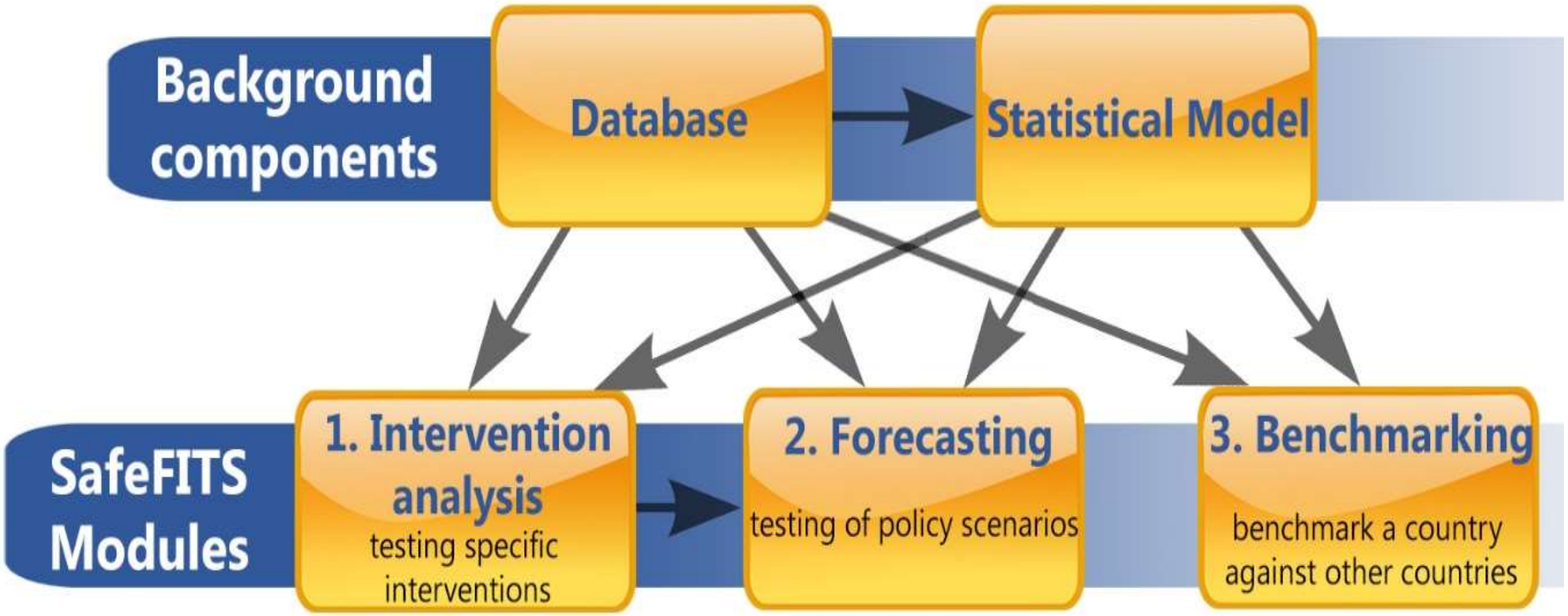
1. Economy and Management
2. Transport Demand and Exposure
3. Road Safety Measures
4. Road Safety Performance Indicators
5. Fatalities and Injuries

SafeFITS pillars

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

		PILLARS				
		1. Road Safety Management	2. Road Infrastructure	3. Vehicle	4. User	5. Post-Crash Services
LAYERS	1. Economy & Management	Economic Developments, Strategy & Targets, Regulatory framework (compliance with UN regulations)	Existence of motorways, of non-paved roads, of road tunnels, Existence of guidelines (for design, RSA etc.), Legislation on speeding	Number of registered vehicles, Vehicle age, Technical inspection legislation (maintenance, roadworthiness, overweight, ADR)	Requirements & regulations on drivers' licensing, Drivers' training, Medical exams of drivers, Legislation on alcohol / use of seatbelts / use of helmets	Trauma management sector level of development Number of hospitals / doctors / Intensive Care (IC) beds per population
	2. Transport demand & exposure	Transport Modal Split (road/rail, passenger/freight, private/public), Share of urban areas, Weather conditions	Exposure with regard to road type, Length of road per road type, Share of Motorway length out of the total road network, Number of railway level crossings	Exposure with regard to vehicle type, Share of PTW, HGV / carriage of dangerous goods vehicles in the vehicle fleet	Exposure with regard to age & gender	
	3. Road Safety Measures	Assessment of measures, Data collection & analysis, International comparisons, Vehicle taxation, Road pricing	Treatment of High Risk Sites, Road Safety Audits, Tunnel Road Safety Management, Improvement of signage, Installation of road restraint systems, Lighting, Speed limits in urban areasTraffic Calming	Renewal rate of vehicle fleet, Measures for second-hand vehicles, Vehicle related roadside controls, Automated driving	Enforcement, campaigns, Road safety education, Training	e-call, First aid training, Existence & organisation of trauma centers
	4. Road Safety Performance Indicators	Safety targets, stakeholders' involvement, detail of analysis for intervention selection, economic evaluation	Number of RSAs conducted, Percentage of High Risk Sites treated	Global NCAP score, Mean age of the vehicle fleet per vehicle type, Existence of safety equipment, e-safety	Speeding / Drink & drive infringements, Seatbelts use, Helmets use, Driver distraction, Driver fatigue	Emergency response time, Type of field treatment, Speed of treatment in hospital, Number of ambulances per population, Number of good samaritanians per population
	5. Fatalities & Injuries	Fatalities / injuries per million inhabitants, fatalities / injuries per million passenger cars, fatalities / injuries per 10 billion passenger-km	Fatalities / injuries in motorways, in 2-lane rural roads, in urban roads	Share of motorcycle fatalities out of the total fatalities	Share of pedestrian / bicyclist / motorcyclist fatalities out of the total fatalities, drink-driving related fatalities	Death rate, Hospitalization in IC Unit, Total length of hospitalization

Overview of the SafeFITS Model

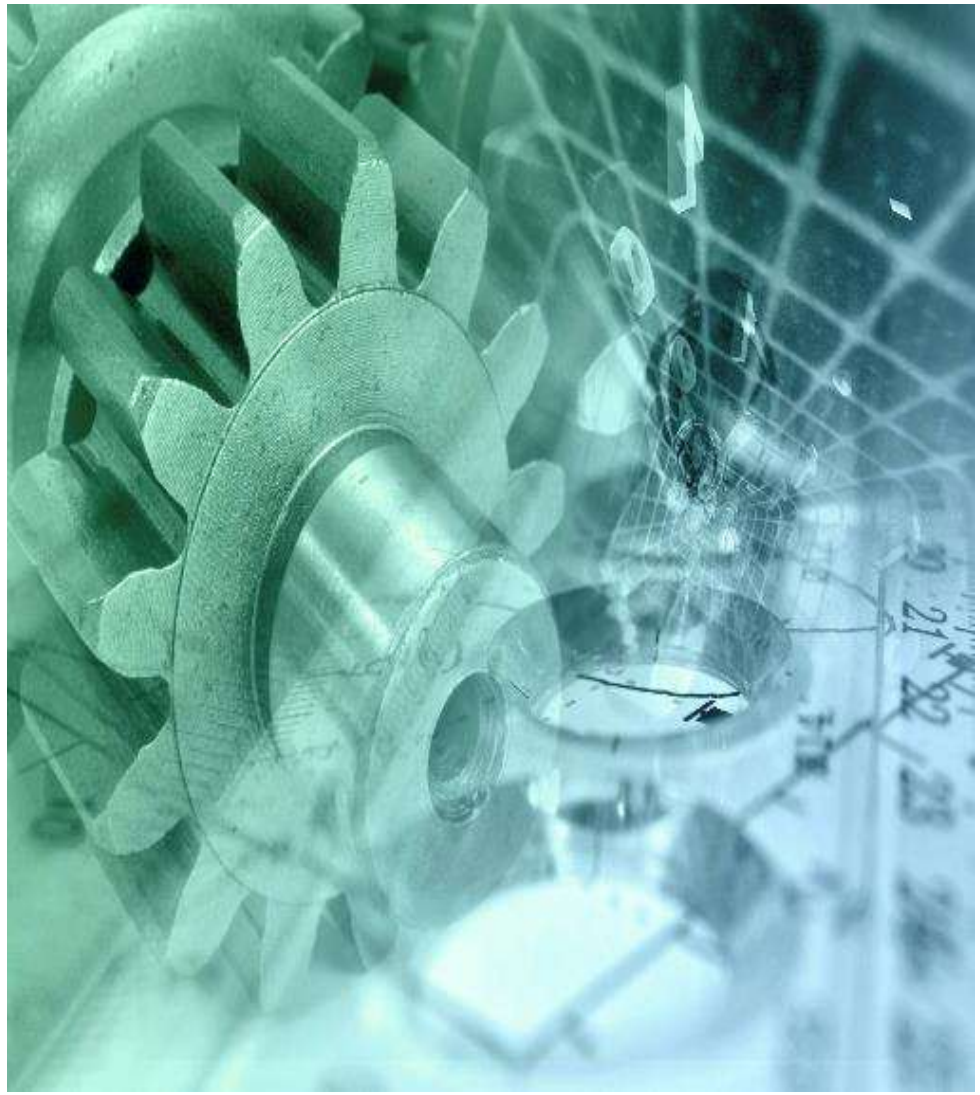


Architecture of the Database

- Data from the five layers and the five pillars
- **International databases** explored: WHO, UN, IRF, OECD, etc.
- Data for **130 countries** with population higher than 2,8 million inhabitants
- Data refer to **2013** or latest available year

Data Analysis Methodology

- **Two-step approach** of statistical modeling:
  - Estimation of **composite variables** (factor analysis) in order to take into account as many indicators as possible of each layer
  - Correlating road safety outcomes with indicators through composite variables by developing a **regression model with explicit consideration of the time dimension**



- **Model specification**

$$Log(Fatalities\ per\ Population)_{ti} = A_i + Log(Fatalities\ per\ Population)_{(t-\tau)} + B_i * GDP_{ti} + K_i * [Economy\ \&\ Management]_{ti} + Li * [Transport\ demand\ \&\ Exposure]_{ti} + M_i * [Road\ Safety\ Measures]_{ti} + N_i * [RSPI]_{ti} + \varepsilon_i$$

Where [Composite Variable]

Calculation of composite variables – Economy and Management

[Comp_EM] = -0.250 (EM2_lt15yo) + 0.229 (EM3_gt65yo) + 0.228 (EM4_UrbanPop) + 0.224 (EM7_NationalStrategy) + 0.221 (EM8_NationalStrategyFunded) + 0.222 (EM9_FatalityTargets)

Indicator loadings and coefficients on the estimated factor (composite variable) on Economy and Management

	Component	
	Loadings	Score coefficients
EM1_Popdensity	,091	,029
EM2_lt15yo	-,778	-,250
EM3_gt65yo	,714	,229
EM4_UrbanPop	,709	,228
EM5_LeadAgency	,284	,091
EM6_LeadAgencyFunded	,226	,073
EM7_NationalStrategy	,697	,224
EM8_NationalStrategyFunded	,626	,201
EM9_FatalityTargets	,692	,222

Calculation of composite variables – Transport Demand and Exposure

[[Comp_TE] = 0.161 (TE1_RoadNetworkDensity) + 0.149 (TE2_Motorways) + 0.238 (TE3_PavedRoads) + 0.272 (TE4_VehiclesPerPop) + 0.267 (TE5_PassCars) - 0.221 (TE7_PTW) - 0.117 (TE10_PassengerFreight)

Indicator loadings and coefficients on the estimated factor (composite variable) on Transport Demand and Exposure

	Component	
	Loadings	Score coefficients
TE1_RoadNetworkDensity	,497	,161
TE2_Motorways	,460	,149
TE3_PavedRoads	,734	,238
TE4_VehiclesPerPop	,839	,272
TE5_PassCars	,825	,267
TE6_VansLorries	-,132	-,043
TE7_PTW	-,681	-,221
TE8_Vehkm_Total	,269	,087
TE9_RailRoad	,136	,044
TE10_PassengerFreight	-,360	-,117

Calculation of composite variables - Measures

[Comp_ME] = 0.069(ME2_ADR) + 0.045(ME4_SpeedLimits_urban) + 0.064(ME6_SpeedLimits_motorways) + 0.088(ME7_VehStand_seatbelts) + 0.091(ME8_VehStand_SeatbeltAnchorages) + 0.092(ME9_VehStand_FrontImpact) + 0.091(ME10_VehStand_SideImpact) + 0.090(ME11_VehStand_ESC) + 0.087(ME12_VehStand_PedProtection) + 0.090(ME13_VehStand_ChildSeats) + 0.068(ME15_BAClimits) + 0.068(ME16_BAClimits_young) + 0.065(ME17_BAClimits_commercial) + 0.057(ME19_SeatBeltLaw_all) + 0.063(ME20_ChildRestraintLaw) + 0.034(ME22_HelmetFastened) + 0.038(ME23_HelmetStand) + 0.038(ME24_MobileLaw) + 0.035(ME25_MobileLaw_handheld) + 0.038(ME27_PenaltyPointSyst) + 0.040(ME29_EmergTrain_nurses)

Indicator loadings and coefficients on the estimated factor (composite variable) on Measures

	Component	
	Loadings	Score coefficients
ME1_RSA	,245	,025
ME2_ADR	**,681**	**,069**
ME3_SpeedLaw	,229	,023
ME4_SpeedLimits_urban	**,443**	**,045**
ME5_SpeedLimits_rural	,200	,020
ME6_SpeedLimits_motorways	**,634**	**,064**
ME7_VehStand_seatbelts	**,877**	**,088**
ME8_VehStand_SeatbeltAnchorages	**,906**	**,091**
ME9_VehStand_FrontImpact	**,908**	**,092**
ME10_VehStand_SideImpact	**,904**	**,091**
ME11_VehStand_ESC	**,891**	**,090**
ME12_VehStand_PedProtection	**,862**	**,087**
ME13_VehStand_ChildSeats	**,896**	**,090**
ME14_DrinkDrivingLaw	,126	,013
ME15_BAClimits	**,670**	**,068**
ME16_BAClimits_young	**,670**	**,068**
ME17_BAClimits_commercial	**,645**	**,065**
ME18_SeatBeltLaw	,297	,030
ME19_SeatBeltLaw_all	**,570**	**,057**
ME20_ChildRestraintLaw	**,628**	**,063**
ME21_HelmetLaw	,236	,024
ME22_HelmetFastened	**,334**	**,034**
ME23_HelmetStand	**,379**	**,038**
ME24_MobileLaw	**,375**	**,038**
ME25_MobileLaw_handheld	**,350**	**,035**
ME26_MobileLaw_handsfree	-,295	-,030
ME27_PenaltyPointSyst	**,378**	**,038**
ME28_EmergTrain_doctors	,178	,018
ME29_EmergTrain_nurses	**,399**	**,040**

Calculation of composite variables - SPIs

[Comp_PI] = 0.144 (PI1_SeatBeltLaw_enf) + 0.155 (PI2_DrinkDrivingLaw_enf) + 0.152 (PI3_SpeedLaw_enf)+ 0.160 (PI4_HelmetLaw_enf) + 0.155 (PI5_SeatBelt_rates_front) + 0.146 (PI6_SeatBelt_rates_rear) + 0.150 (PI7_Helmet_rates_driver)+ 0.127 (PI8_SI_ambulance) + 0.116 (PI9_HospitalBeds)

Indicator loadings and coefficients on the estimated factor (composite variable) on **SPIs**

	Component	
	Loadings	Score coefficients
PI1_SeatBeltLaw_enf	,756	,144
PI2_DrinkDrivingLaw_enf	,812	,155
PI3_SpeedLaw_enf	,795	,152
PI4_HelmetLaw_enf	,837	,160
PI5_SeatBelt_rates_front	,811	,155
PI6_SeatBelt_rates_rear	,766	,146
PI7_Helmet_rates_driver	,784	,150
PI8_SI_ambulance	,667	,127
PI9_HospitalBeds	,607	,116

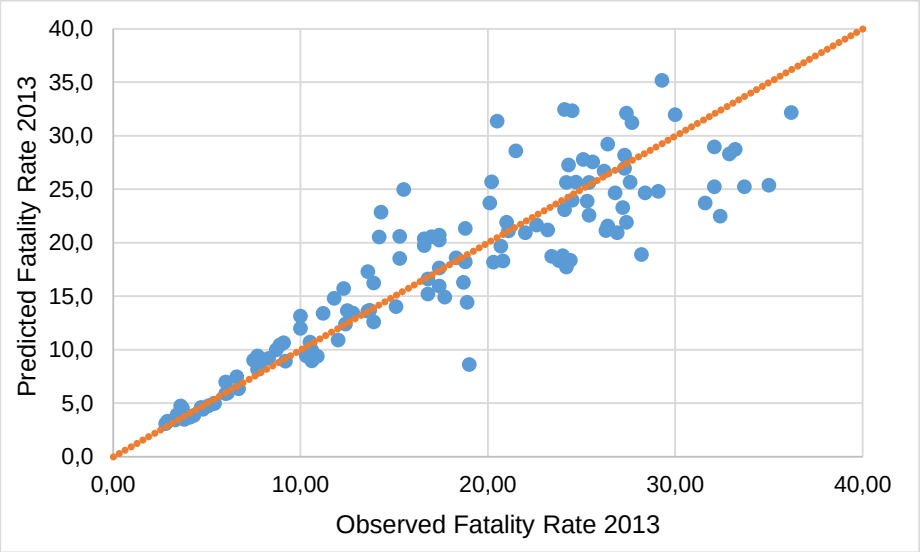
Final Statistical Model

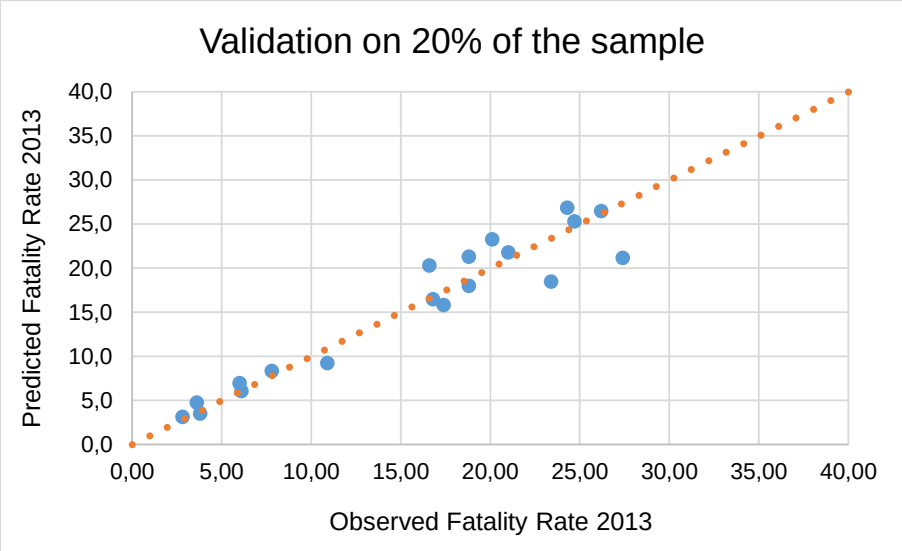
The **optimal performing model** for the purposes of SafeFITS

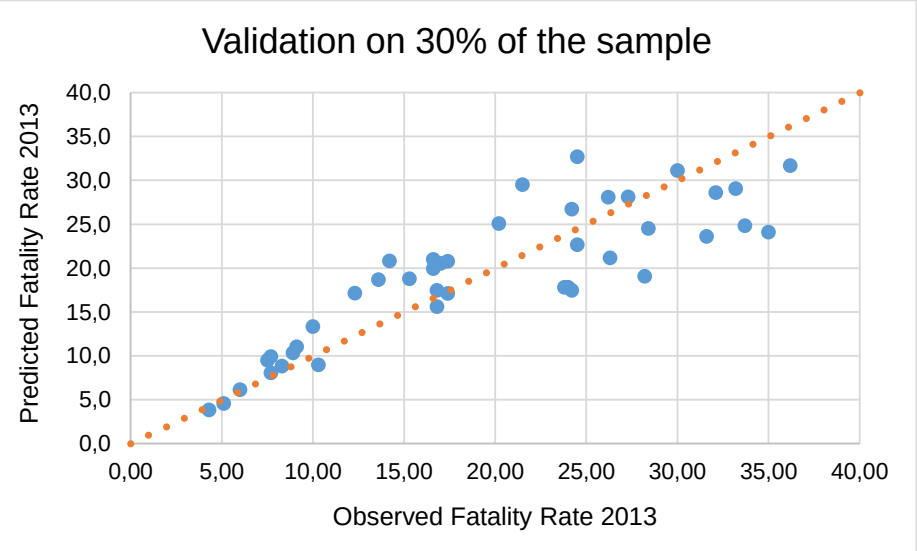
- **Dependent variable** is the logarithm of the fatality rate per population for 2013
- The main **explanatory variables** are the respective logarithm of fatality rate in 2010 and the respective logarithm of GNI per capita for 2013
- Four **composite** variables: the economy & management, the transport demand and exposure, the measures, and the SPIs

Parameter	B	Std. Error	95% Confidence Interval		Hypothesis Test		
			Lower	Upper	Wald Chi-Square	df	p-value
(Intercept)	1,694	,2737	1,157	2,230	38,291	1	<,001
Comp_ME	-,135	,0646	-,261	-,008	4,358	1	,037
Comp_TE	-,007	,0028	-,013	-,002	7,230	1	,007
Comp_PI	-,007	,0030	-,013	-,001	5,652	1	,017
Comp_EM	,007	,0051	-,003	,017	2,009	1	,156
LNFestim_2010	,769	,0462	,678	,859	276,322	1	<,001
LNGNI_2013	-,091	,0314	-,153	-,030	8,402	1	,004
(Scale)	,038						
Likelihood Ratio	1379,00						
df	6						
p-value	<,001						

Statistical Model Assessment and Validation



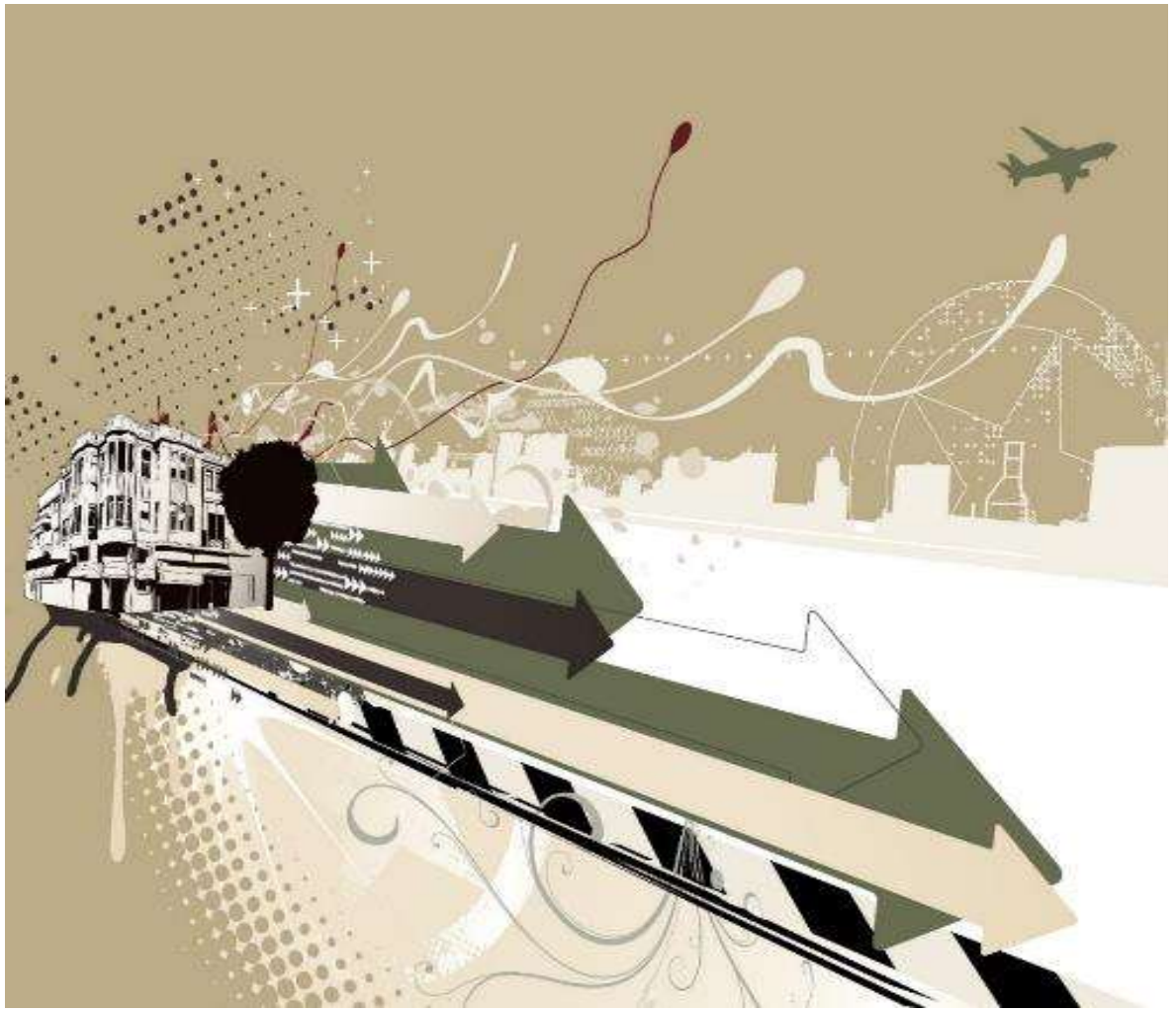




SafeFITS Model Demonstration

The overall model implementation includes 3 distinct steps:

- Step 1 – **Countries Benchmark**
- Step 2 – **Forecast with no new interventions**
- Step 3 – **Forecast with interventions**



Access the SafeFITS model at: https://unecetrans.shinyapps.io/safefits/

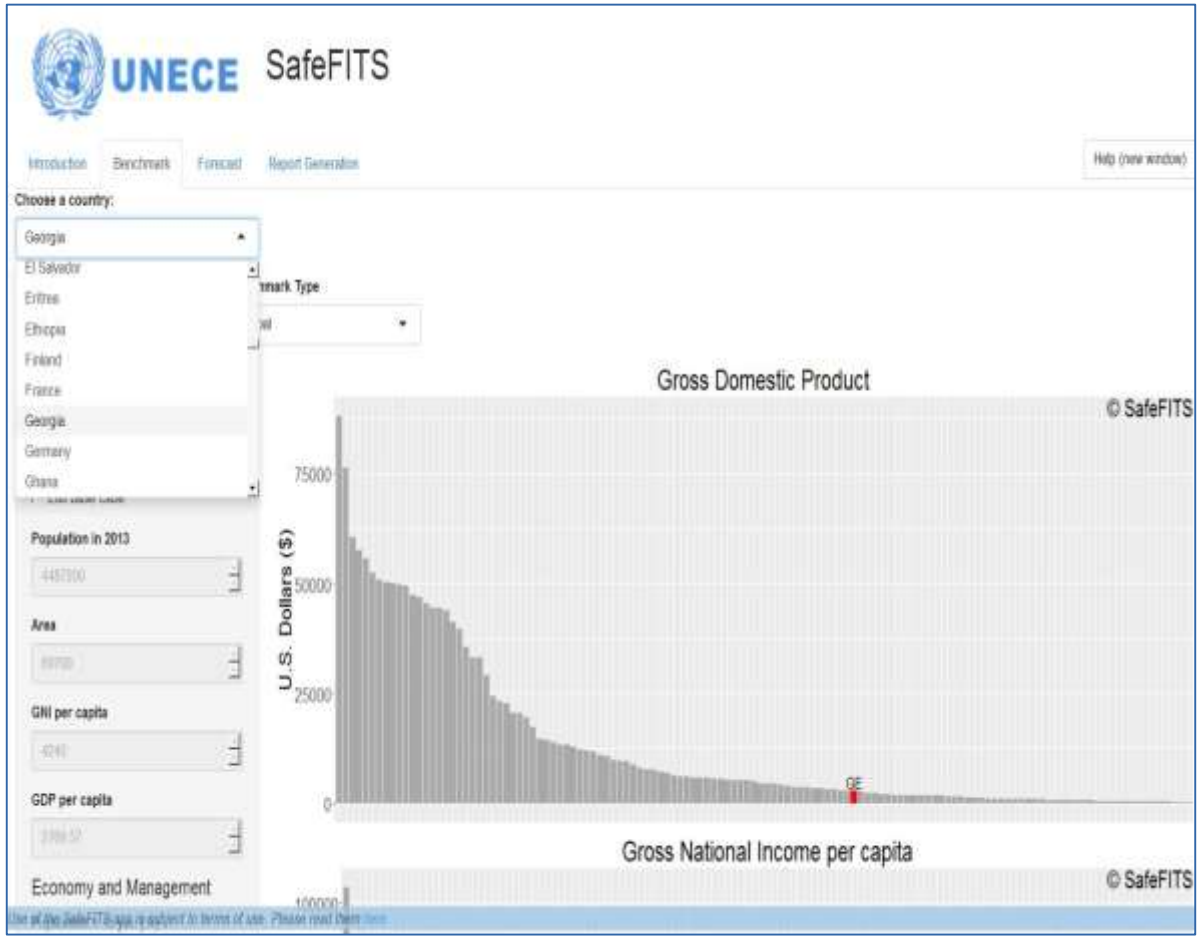
Step 1: Benchmark

User input:
The user has the option to select a country, the category of indicators to be displayed and benchmark type.

Analysis:
The outputs are based only on the database and no statistical modeling implementation is taking place.

Benchmarking results:

- Reactive diagrams presenting a benchmark of the base year situation for a selected category
- Benchmarking takes place on a global and regional scale



Step 2: Forecast with no new interventions

User input:

The user selects the intervention year and the benchmark type

Analysis:

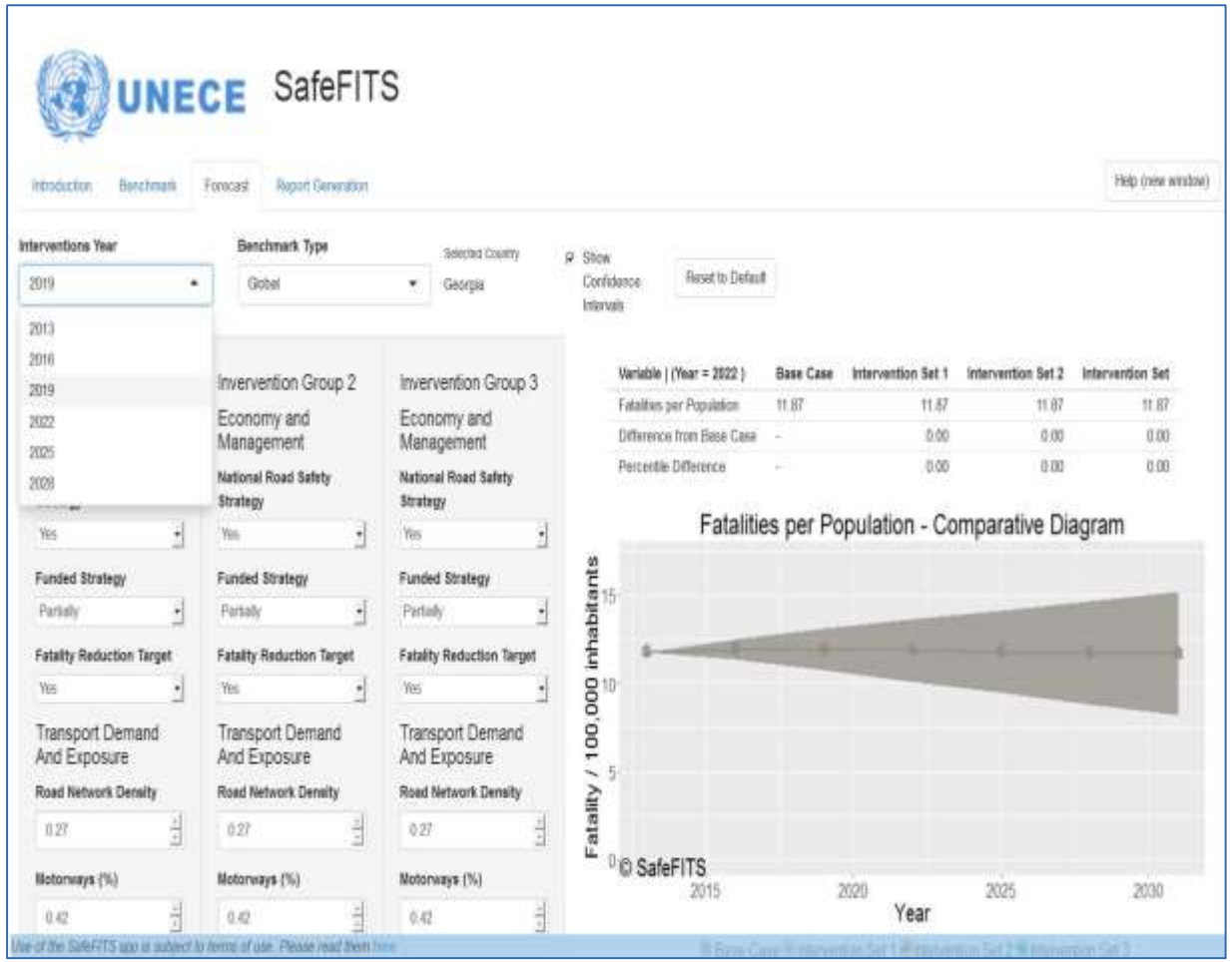
The SafeFITS model is implemented for the year of reference on the basis of GNI and demographic indicators projection

Forecasting results:

The trend for the variable fatalities per population through the years (2013-2031), alongside with the confidence intervals

Benchmarking results:

- Overall ranking
- Regional ranking



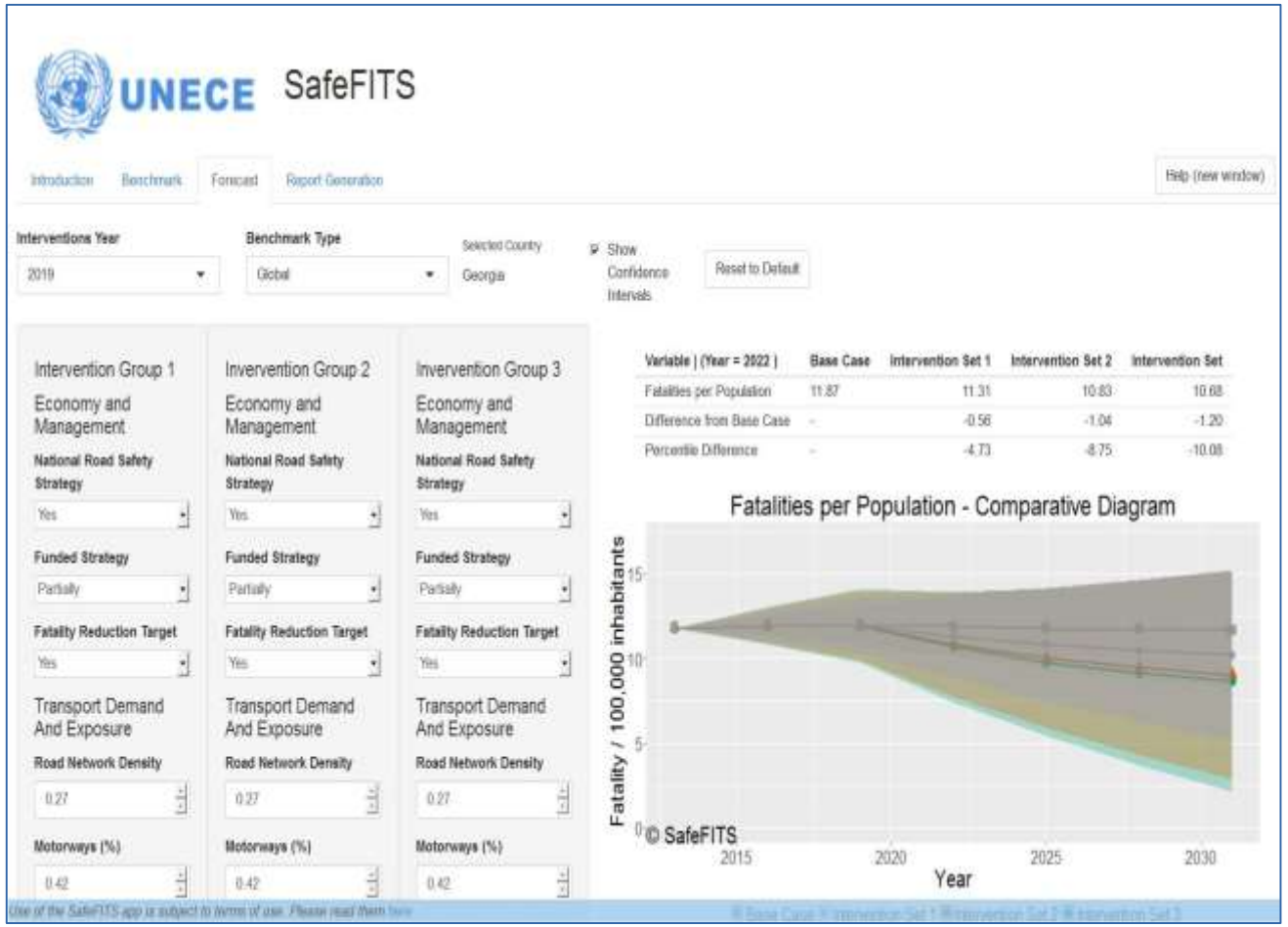
Step 3: Forecast with interventions

User input:
The user selects the intervention year and then 3 different sets of interventions

Analysis:
The SafeFITS model is implemented for the forecasting year on the basis of the intervention set selected

Forecasting results:
The trend for the variable fatalities per population through the years (2013-2031), on which the forecast for the intervention year is also identifiable.

Benchmarking results:
- Overall ranking
- Regional ranking



Model limitations and future improvements

- The SafeFITS model was developed on the basis of **the most recent and good quality data available internationally**, and by means of rigorous statistical methods. However, data and analysis methods always have some limitations.
- Data are primarily **directed at vehicle occupants** and thus, effects on road safety outcomes of VRUs may not be captured.
- The effects of interventions may not reflect the unique contribution of each separate intervention. It is strongly recommended to **test combinations of "similar" interventions** (e.g. several vehicle standards, several types of enforcement or safety equipment use rates etc.)
- The factor analysis procedure **does not assume or indicate that a direct causal relationship exists**.
- The **calibration with new data** will be the ultimate way to fully assess the performance of the model.

Benefits for the Policy Makers

- The first global road safety model to be used for policy support
  - Global assessments (i.e. monitoring the global progress towards the UN road safety targets)
  - Individual country assessments of various policy scenarios
- A framework which **enhances the understanding of road safety causalities**, as well as of the related difficulties.
- Full exploitation of the currently available global data, and use of rigorous analysis techniques, to **serve key purposes in road safety policy analysis**: benchmarking, forecasting.
- An important step for **monitoring, evidence-base and systems approach** to be integrated in decision-making.

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