SafeFITS Round Table Meeting

Geneva, 30 June 2017

United Nations
Econonomic Committee for Europe

SafeFITS

A Global Road Safety Model For Future Inland Transport Systems

George Yannis
Professor

Department of Transportation Planning and Engineering
National Technical University of Athens, Athens, Greece

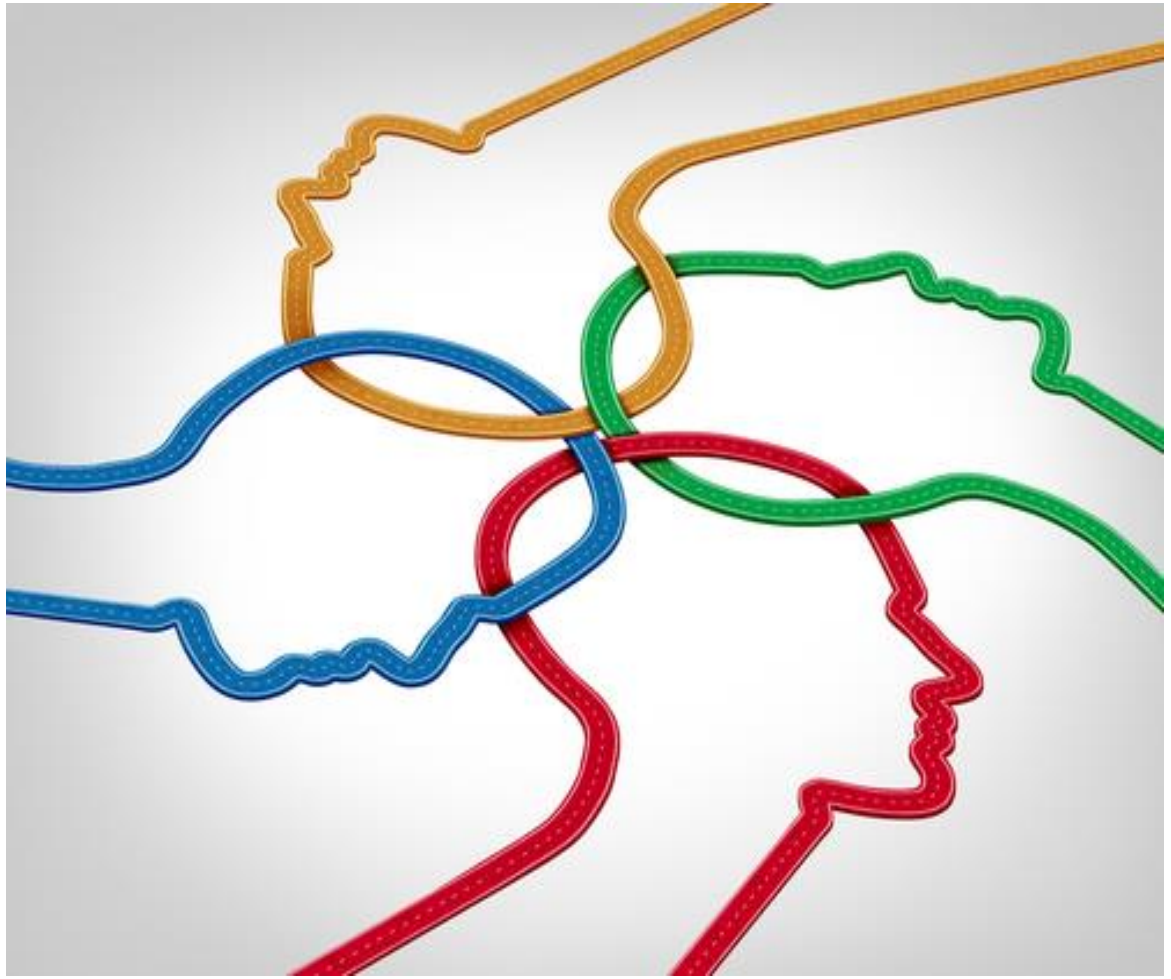
SafeFITS Objectives

- 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.

- The tool is **based on the related scientific knowledge available worldwide**, with emphasis on recent academic research and project results.

SafeFITS Report and Presentation Outline

- SafeFITS Conceptual framework
- Literature review of existing research on accident causalities
- Focused literature review on quantified accident causal relations
- SafeFITS Database development
- SafeFITS Model development
- SafeFITS Tool, including:
  - Intervention analysis module
  - Forecasting module
  - Benchmarking module



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 Deve-lopments, Strategy & Targets, Regu-latory 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 regi-stered vehicles, Vehicle age, Technical inspe-ction 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 Manage-ment, Improve-ment 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 infringe-ments, 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

Review of accident causalities

- Literature review of existing research on accident casualties was performed for **each of the pillars separately**.
- **Causal relationships** between policies or measures and road safety outcomes were summarized.

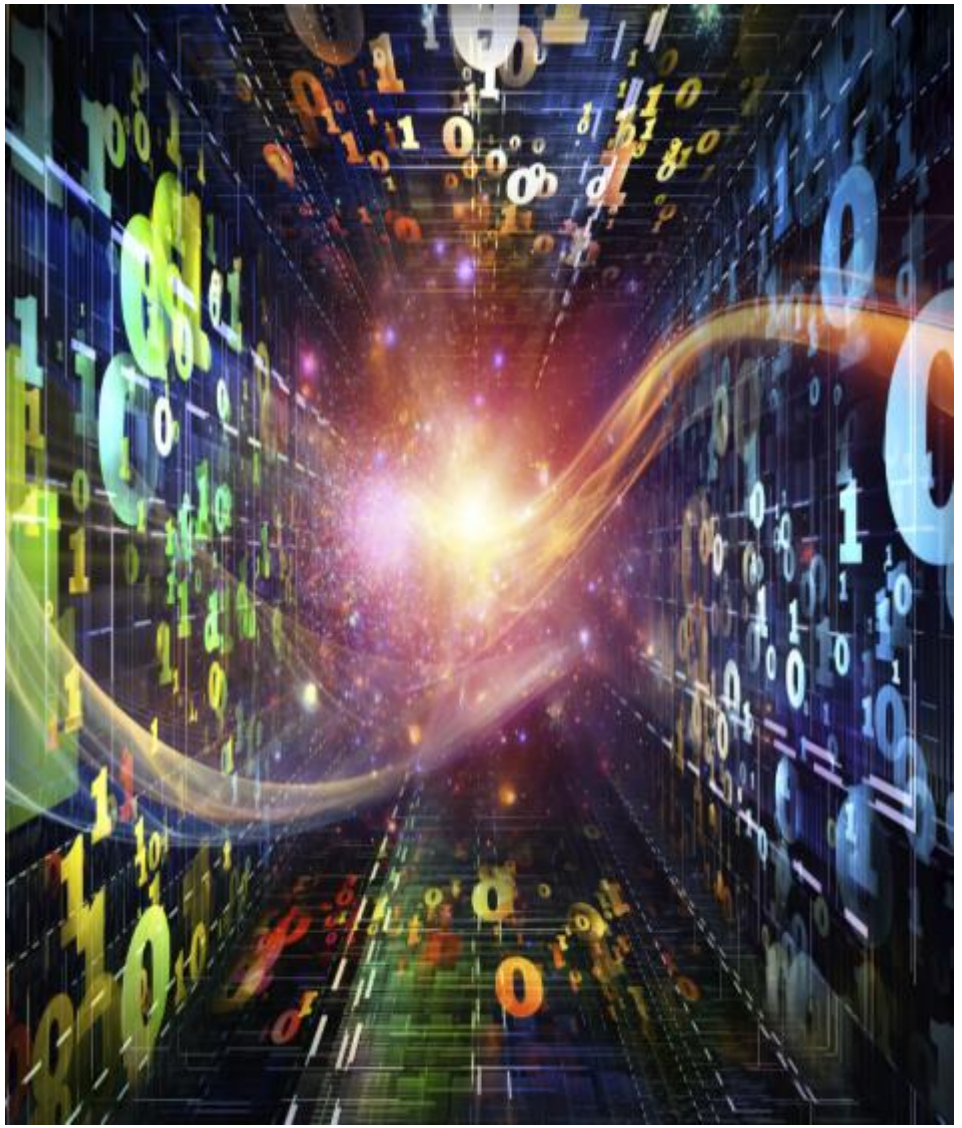
- In many cases the relationships **have not been adequately quantified**.
- Very **limited available information** from studies in middle and low-income countries.
- **Inter-correlation of road safety measures and policies** applied simultaneously may affect the safety effects.
- Some causal relationships identified in literature were found to be **incompatible** with each other.

- A model linking the two layers Economy and Management and Road Safety Measures to the road safety outcomes cannot safely be based only on the literature findings.

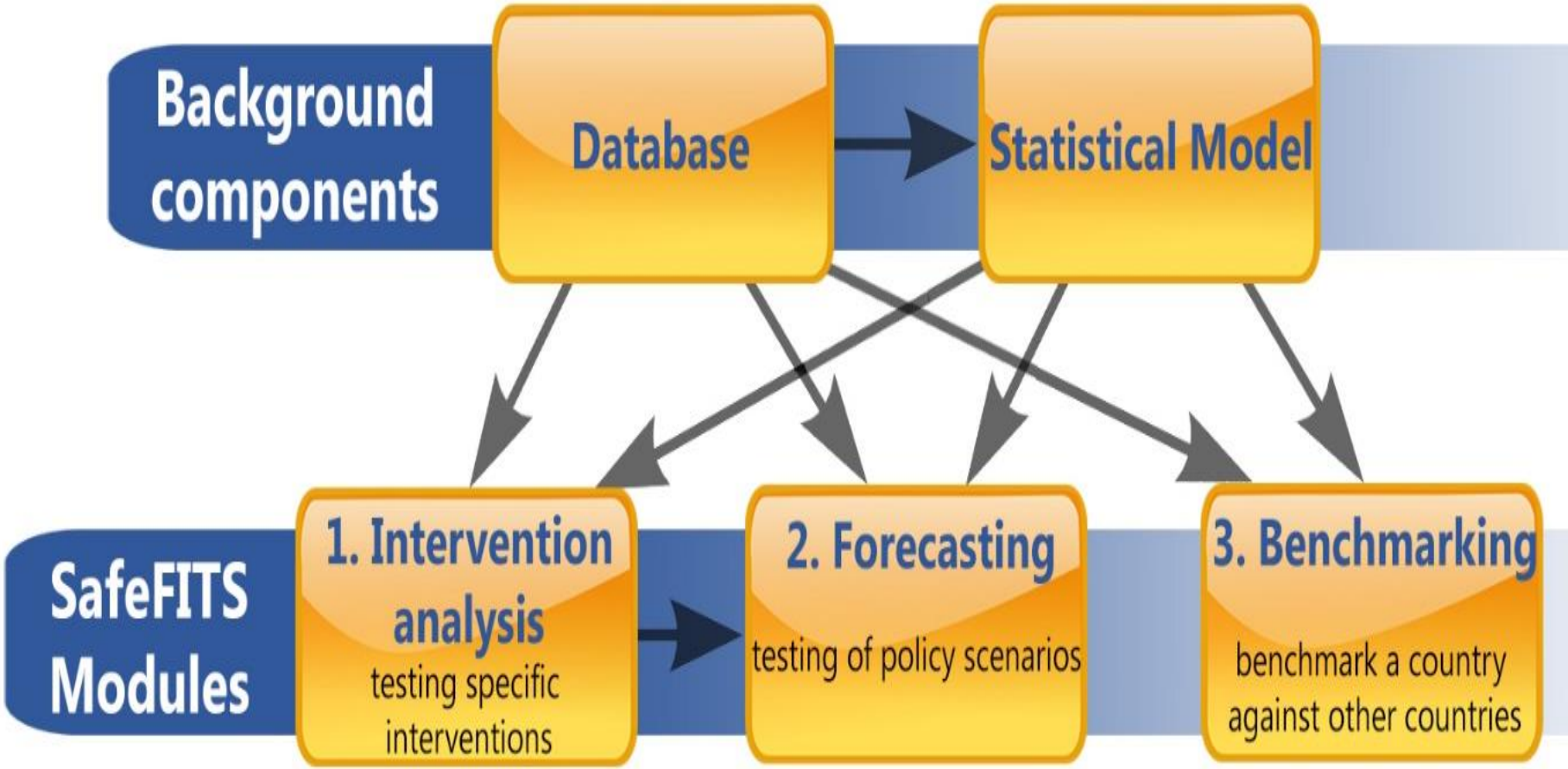
Focused review of detailed causalities

- **Priority indicators** were proposed to be included in the SafeFITS model.
- Review on **specific quantified causal relations** linking these indicators with the road safety outcomes was performed.

- Very **limited available information** from studies in middle and low-income countries.
- In some cases, a **quantitative relation** to estimate an overall accident reduction attributed to a specific indicator is not available.
- Indicators mainly from the economy and management layer are characterized by **complex objectives**.
- Some identified detailed causalities have been based on **logical assumptions**.



Overview of the SafeFITS model



The SafeFITS Database

- Architecture of the project Database

- Data indicators from the five layers:
  - Economy and Management
  - Transport Demand and Exposure
  - Road Safety Measures
  - Road Safety Performance Indicators
  - Fatalities and Injuries

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

Economy and Management

Demographic and Economic Characteristics

- **Population** (World Bank Database)
- **Area** (World Bank Database)
- **GNI per capita** in US dollars (World Bank Database)
- **Projected GDP per capita** for 2015-2030 in 2010 US dollars (ERS International Macroeconomic Data Set)

Road Safety Management Indicators (WHO)

- Existence of **RS lead agency**
- The **lead agency is funded**
- Existence of national **RS strategy**
- The **RS strategy is funded**
- Existence of **RS fatality targets**

Transport Demand and Exposure

Roads

- Road **network density** (IRF)
- Percentage of **motorways** (IRF)
- Percentage of **paved roads** (IRF, CIA)

Vehicles (IRF)

- Number of **vehicles in use** in total and by type of vehicle

Traffic (IRF)

- **Traffic Volume**
- Inland surface **passengers transport**
- Inland surface **freight transport**

Road Safety Measures (1/2)

Roads (WHO)

- Road safety **audits on new roads**
- Existence of **speed law**
- Max **speed limits on urban roads** (no speed limits; >50 km/h; ≤50 km/h)
- Max **speed limits on rural roads** (no speed limits; 100-120 km/h; 70-90 km/h; ≤70 km/h)
- Max **speed limits on motorways** (no speed limits; ≤100 km/h; 100-120 km/h; ≥120 km/h)

Vehicles

- Existence of **ADR law** (UNECE)
- **Vehicle standards** include seat-belts, electronic stability control, pedestrian protection (WHO)
- New cars subjected to **NCAP** (WHO)

Post-crash care (WHO)

- Training in emergency medicine for doctors
- Training in emergency training for nurses

Road Safety Measures (2/2)

Road User (WHO)

- Existence of **drink-driving law**
- Allowed **BAC limits** (3 separate variables for general population, young/novice drivers, commercial drivers)
- Existence of national **seat-belt law**
- The seat-belt law **applies to all occupants**
- Existence of national **child restraint law**
- Existence of national **helmet law**
- The law requires **helmet to be fastened**
- The helmet law defines specific **helmet standards**
- Existence of national law on **mobile phone use** while driving
- The law applies to **hand-held phones**
- The law applies to **hands-free phones**
- Existence of **penalty point system**

Road Safety Performance Indicators

Traffic law enforcement (WHO)

- Assessment of effectiveness of **seat-belt law** enforcement
- Assessment of effectiveness of **drink-driving law** enforcement
- Assessment of effectiveness of **speed law** enforcement
- Assessment of effectiveness of **helmet law** enforcement

Road User (WHO)

- Seat-belt wearing rates in **front seats**
- Seat-belt wearing rates in **rear seats**
- **Helmet** wearing rates – driver

Post-crash care

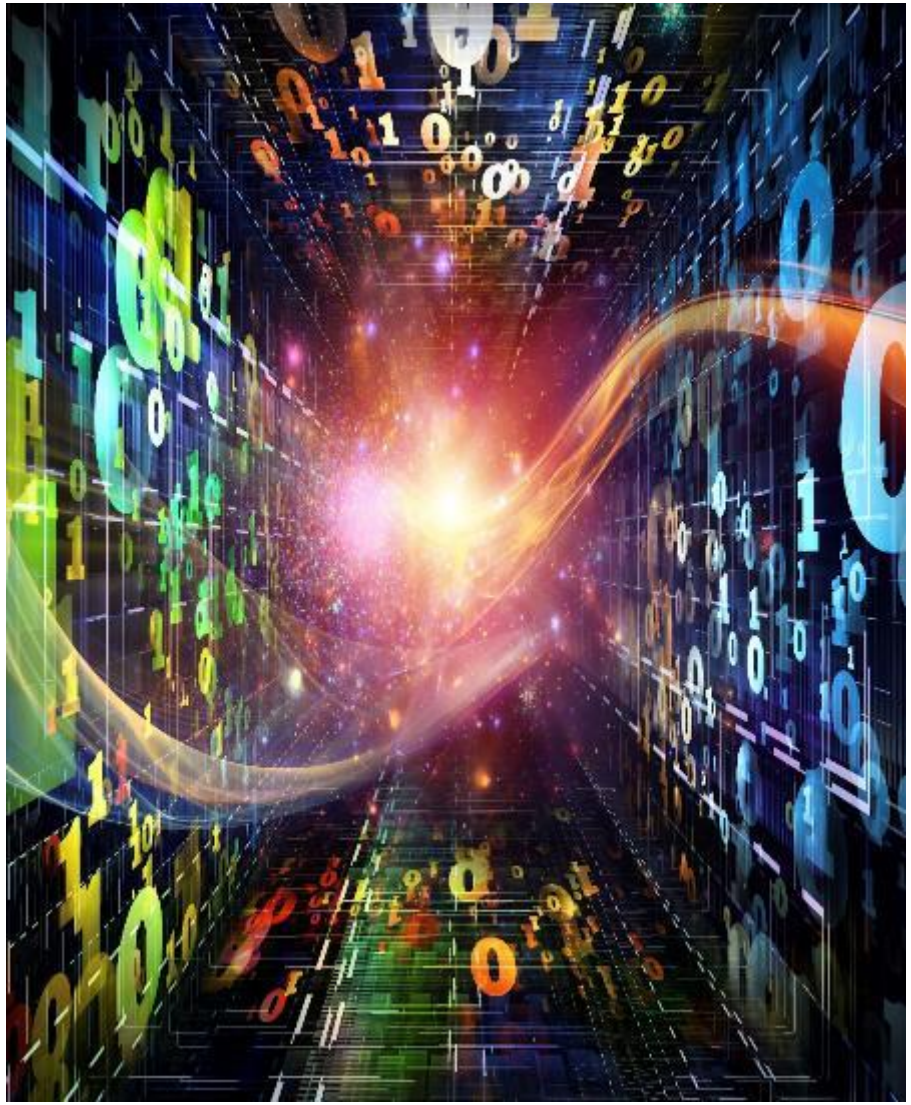
- Estimated percentage of **seriously injured patients** transported by ambulance (WHO)
- Number of **hospital beds** per population (World Bank Database)

Fatalities and Injuries

- Reported number of **road traffic fatalities** (WHO, IRF)
- **Estimated number** of **road traffic fatalities** (WHO)
- Estimated road traffic fatality **rates per 100.000 population** (WHO)
- Distribution of road traffic fatalities **by road user type** (WHO)
- Distribution of road traffic fatalities **by gender** (WHO)
- Percentage of road traffic fatalities **attributed to alcohol** (WHO)

SafeFITS Database (1/2)

- Wherever data for 2013 were not available, the **latest data available** were used.
- The missing values of each indicator of the countries were filled with **the mean value** of the indicator in their regions.
- The respective information of each variable is **properly represented** in the database for the statistical process.
- **Data for most variables were available for almost all countries.**
- **Low data availability** is observed for few variables regarding:
  - the restraint use rates
  - the percentage of fatalities attributed to alcohol
  - the distribution of fatalities by road user type
  - transport demand and exposure indicators



SafeFITS Database (2/2)

Number	Variable	Source
1	Population in thousands (2013)	World Bank Database
2	Area (sq km) (2013 or latest available year)	World Bank Database
3	Projected Gross Domestic Product per capita in 2010 US $ (2015-2030)	ERS International Macroeconomic Dataset
4	Gross national income per capita in US $ (2013 or latest available year)	World Bank Database
5	Percentage of popualtion under 15 years old (2013)	World Bank Database
6	Percentage of popualtion over 65 years old (2013)	World Bank Database
7	Percentage of urban population (2013)	World Bank Database
8	Existence of a road safety lead agency (2013)	WHO, 2015
9	The lead agency is funded (2013)	WHO, 2015
10	Existence of national road safety strategy (2013)	WHO, 2015
11	The strategy is funded (2013)	WHO, 2015
12	Existence of fatality reduction target (2013)	WHO, 2015
13	Length of total road network (km) (2013 or latest availbale year)	IRF, 2015
14	Percentage of motorways of total road network (2013 or latest available year)	IRF, 2015
15	Percentage of paved roads of total road network (2013 or latest available year)	IRF, 2015
16	Total number of vehicles in use (2013 or latest availble year)	IRF, 2015
17	Number of passenger cars in use (2013 or latest availble year)	IRF, 2015
18	Number of buses/motorcoaches in use (2013 or latest availble year)	IRF, 2015
19	Number of vans and lorries in use (2013 or latest availble year)	IRF, 2015
20	Number of powered two wheelers in use (2013 or latest availble year)	IRF, 2015
21	Total number of vehicle kilometers in millions (2013 or latest available year)	IRF, 2015
22	Total number of passenger kilometers in millions (2013 or latest available year)	IRF, 2015
23	Number of road passenger kilometers in millions (2013 or latest available year)	IRF, 2015
24	Number of rail passenger kilometers in millions (2013 or latest available year)	IRF, 2015
25	Total number of tonnes-kilometers in millions (2013 or latest available year)	IRF, 2015
26	Road Safety Audits on new roads (2013 or latest available year)	WHO, 2015
27	Existence of ADR law (2013)	UNECE
28	Existence of national speed law (2013)	WHO, 2015
29	Maximum speed limits on urban roads (2013)	WHO, 2015
30	Maximum speed limits on rural roads (2013)	WHO, 2015
31	Maximum speed limits on motorways (2013)	WHO, 2015
32	Vehicle standards-seat belts (2013)	WHO, 2015
33	Vehicle standards-seat belt anchorages (2013)	WHO, 2015
34	Vehicle standards-frontal impact (2013)	WHO, 2015
35	Vehicle standards-side impact (2013)	WHO, 2015
36	Vehicle standards-Electronic Stability Control (2013)	WHO, 2015
37	Vehicle standards-Pedestrian Protection (2013)	WHO, 2015
38	Vehicle standards-child seats (2013)	WHO, 2015
39	Existence of national drink-driving law (2013)	WHO, 2015
40	BAC limits less than or equal to 0.05 g/dl (2013)	WHO, 2015
41	BAC limits lower than or equal to 0.05g/dl for young/novice drivers (2013)	WHO, 2015
42	BAC limits lower than or equal to 0.05g/dl for commercial drivers (2013)	WHO, 2015
43	Existence of national seat-belt law (2013)	WHO, 2015
44	The law applies to all occupants (2013)	WHO, 2015
45	Existence of national child restraints law (2013)	WHO, 2015
46	Existence of national helmet law (2013)	WHO, 2015
47	Law requires helmet to be fastened (2013)	WHO, 2015
48	Law requires specific helmet standards (2013)	WHO, 2015
49	Existence of national law on mobile phone use while driving (2013)	WHO, 2015
50	The law applies to hand-held phones (2013)	WHO, 2015
51	The law applies to hands-free phones (2013)	WHO, 2015
52	Demerit/Penalty Point System in place (2010)	WHO, 2013
53	Training in emergency medicine for doctors (2013)	WHO, 2015
54	Training in emergency medicine for nurses (2013)	WHO, 2015
55	Effectiveness of seat-belt law enforcement (2013)	WHO, 2015
56	Effectiveness of drink-driving law enforcement (2013)	WHO, 2015
57	Effectiveness of speed law enforcement (2013)	WHO, 2015
58	Effectiveness of helmet law enforcement (2013)	WHO, 2015
59	Seat-Belt wearing rate-Front (2013 or latest available year)	WHO, 2015
60	Seat-Belt wearing rate-Rear (2013 or latest available year)	WHO, 2015
61	Helmet wearing rate-driver (2013 or latest available year)	WHO, 2015
62	Estimated % seriously injured patients transported by ambulance (2013)	WHO, 2015
63	Number of hospital beds per 1,000 population (2012 or latest available year)	Wold Bank Database
64	Reported number of road traffic fatalities (2013 or latest available year)	IRF, 2015
65	Estimated number of road traffic fatalities (2013 or latest available year)	WHO, 2015
66	Distribution of fatalities by road user(%)-Drivers/passengers of 4-wheeled vehicles (2013 or latest available year)	WHO, 2015
67	Distribution of fatalities by road user(%)-Drivers/passengers of motorized 2- or 3-wheelers (2013 or latest available year)	WHO, 2015
68	Distribution of fatalities by road user(%)-Cyclists (2013 or latest available year)	WHO, 2015
69	Distribution of fatalities by road user(%)-Pedestrians (2013 or latest available year)	WHO, 2015
70	Distribution of fatalities by gender(%)-male (2013 or latest available year)	WHO, 2015
71	Distribution of fatalities by gender(%)-female (2013 or latest available year)	WHO, 2015
72	Attribution of road traffic deaths to alcohol (%) (2013)	WHO, 2015

SafeFITS Model Development

- Data Analysis Methodology
- Estimation of Composite Variables
- Development of Statistical Model
  Correlating road safety outcomes with composite variables
- Model Validation
- Customisation for Groups of Countries

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

- For efficient forecasting, it is necessary to make **explicit consideration of time dimension**

- **Identification of groups of countries** for better description by dedicated analyses

Estimation of composite variables

- By using composite variables, **reduction of the dimensionality** of the analysis is achieved, while exploiting as many indicators as possible, allowing for a robust model.
- **Each layer** can be described by a composite variable.
- **Factor analysis** is most appropriate for the estimation of composite variables.

Calculation of composite variables

- **Factor analysis** was attempted and implemented on all layers of the road safety system.
- For the estimation of composite variables **3 approaches were tested**:
  1. General factor analysis
  2. Factor analysis per layer
  3. Factor analysis, constrained to yield one factor per layer
- Calculation of composite variables through the 3rd approach was selected for the layers:
  - **Economy and Management**
  - **Transport Demand and Exposure**
  - **Road Safety Measures**
  - **Performance Indicators**
- For fatalities and injuries indicators, the **fatality rate per population** was selected as main dependent variable.

Estimation of composite variables in SafeFITS

Estimation of "composite variables scores" through the following equations:

- [**Fatalities and Injuries**] = α_1 * (Fatalities and Injuries Indicator $_1$) + α_2 * (Fatalities and Injuries Indicator$_2$) + …+ α_i * (Fatalities and Injuries Indicator $_i$) + e
- [**RSPI**] = β_1 * (RSPI Indicator $_1$) + β_2 * (RSPI Indicator$_2$) + …+ β_k * (RSPI Indicator $_j$) + v
- [**Road Safety Measures**] = γ_1 * (Road Safety Measures Indicator $_1$) + γ_2 * (Road Safety Measures Indicator$_2$) + …+ γ_k* (Road Safety Measures Indicator $_k$) + w
- [**Transport demand & exposure**] = δ_1 * (Transport demand & exposure Indicator $_1$) + δ_2 * (Transport demand & exposure Indicator$_2$) + …+ δ_l * (Transport demand & exposure $_l$) + y
- [**Economy & Management**] = ε_1 * (Economy & Management Indicator 1) + ε_2 * (Economy & Management Indicator$_2$) + …+ ε_m * (Economy & Management Indicator $_m$)+ z

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

Statistical model formulation

Generic statistical model formulation between composite variables

- $Log[\textbf{Fatalities \& Injuries}]_i = A_i + K_i * [Economy \& Management]_i + L_i * [Transport\ demand\ \& Exposure]_i + M_i * [Road\ Safety\ Measures]_i + N_i * [RSPI]_i + \upsilon_i$

Time-dependent statistical model formulation

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

Achieving:

- **Medium-term** forecasting approach, on the basis of the developments over the last few years
- **Long-term** forecasting, by applying the same approach on the future forecasted outcomes

Final Statistical Model

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

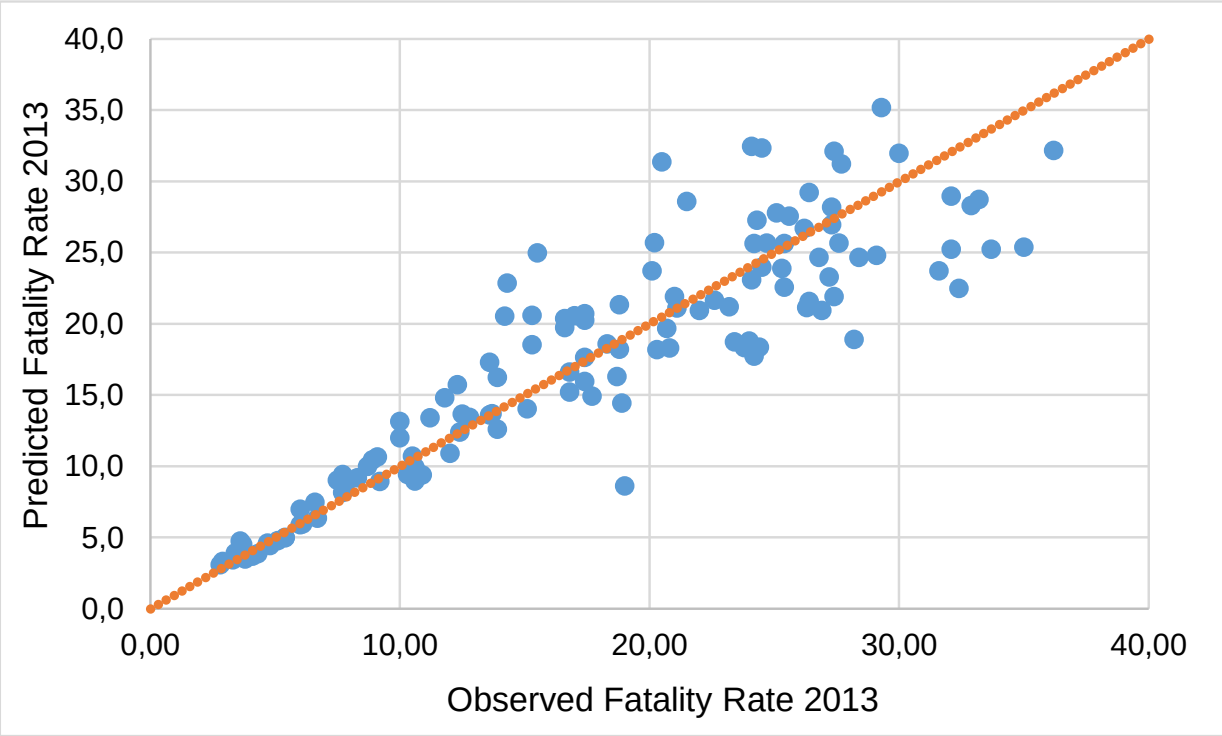
- **Dependent variable** is the logarithm of the fatality rate per population for 2013
- The main **explanatory variables** are the respective logarithm of fatality rate in 2010 and the respective logarithm of GDP per capita for 2013
- Four **composite** variables: the economy & management, the transport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

In order to **assess** the model, a comparison of the observed and the predicted values was carried out:

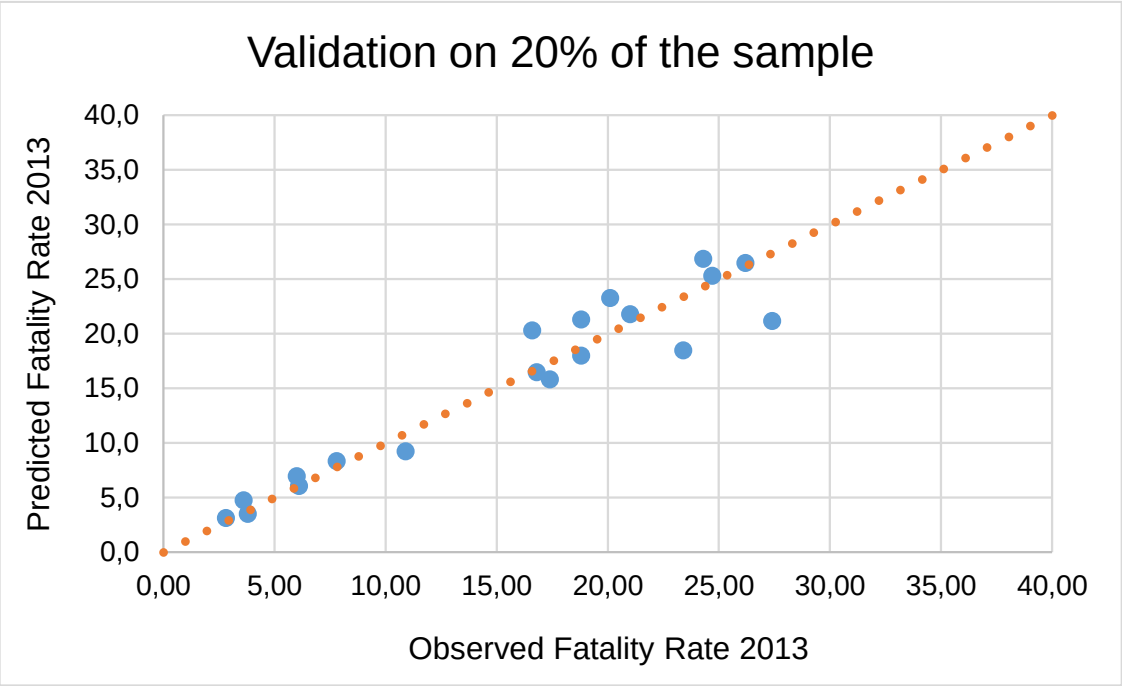
- The mean absolute prediction error is estimated at **2.7 fatalities per population**, whereas the mean percentage prediction error is estimated at **15%** of the observed value.
- The model is of **very satisfactory performance** as regards the good performing countries (low fatality rate) and of **quite satisfactory performance** as regards the medium performing countries.

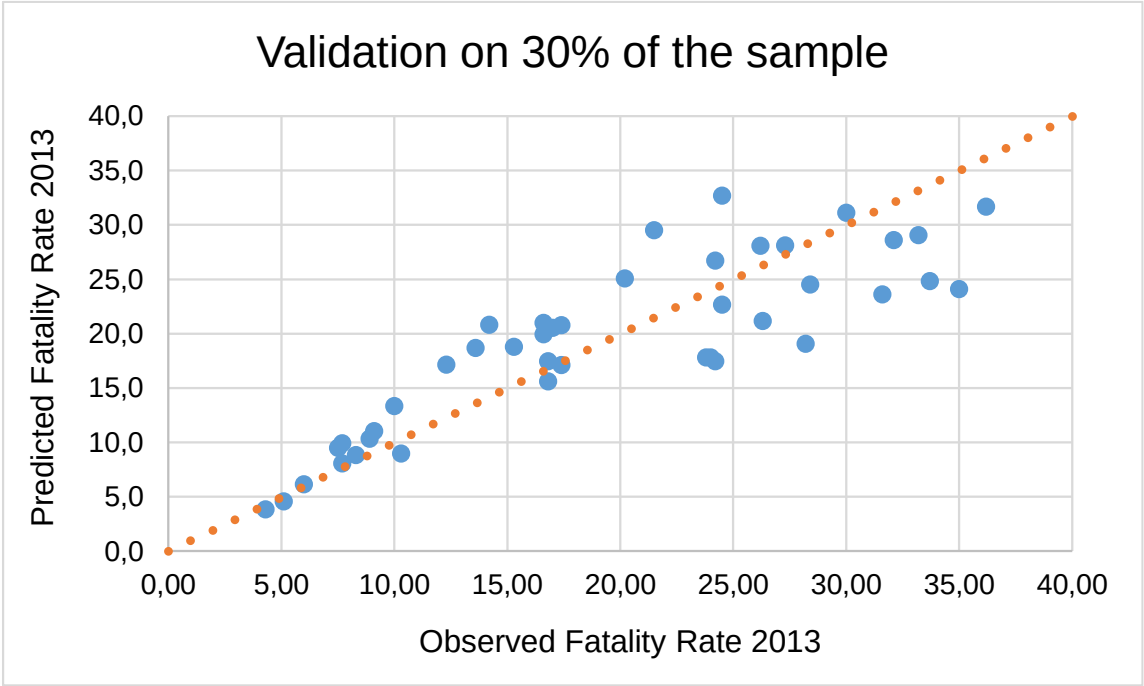


Statistical Model Validation

In order to **validate** the model, a cross-validation was carried out with two subsets:

- **80%** of the sample was used to develop (fit) the model, and then the model was implemented to predict the fatality rate for 2013 of the 20% of the sample not used
- **70%** of the sample was used to develop (fit) the model, and then the model was implemented to predict the fatality rate for 2013 of the 30% of the sample not used

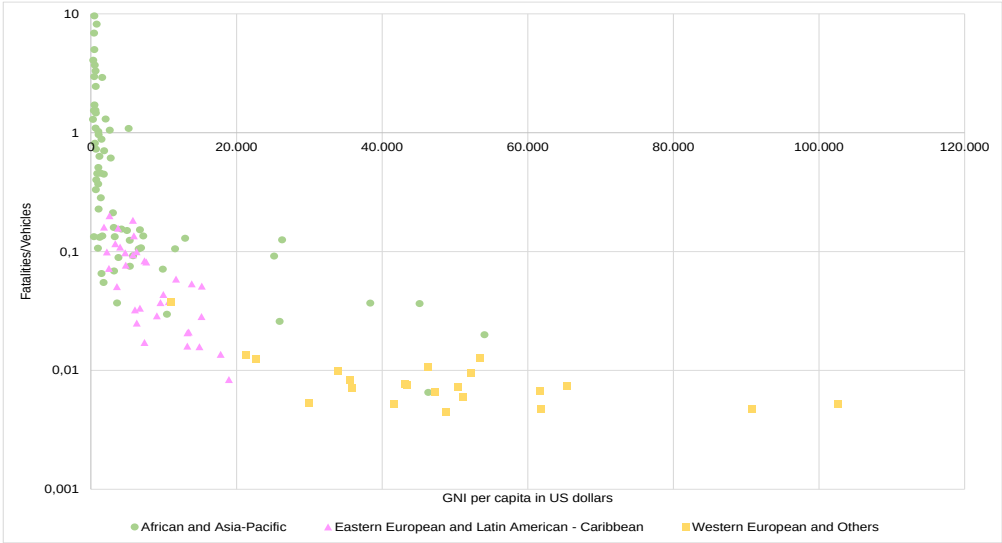




Customisation for Groups of Countries

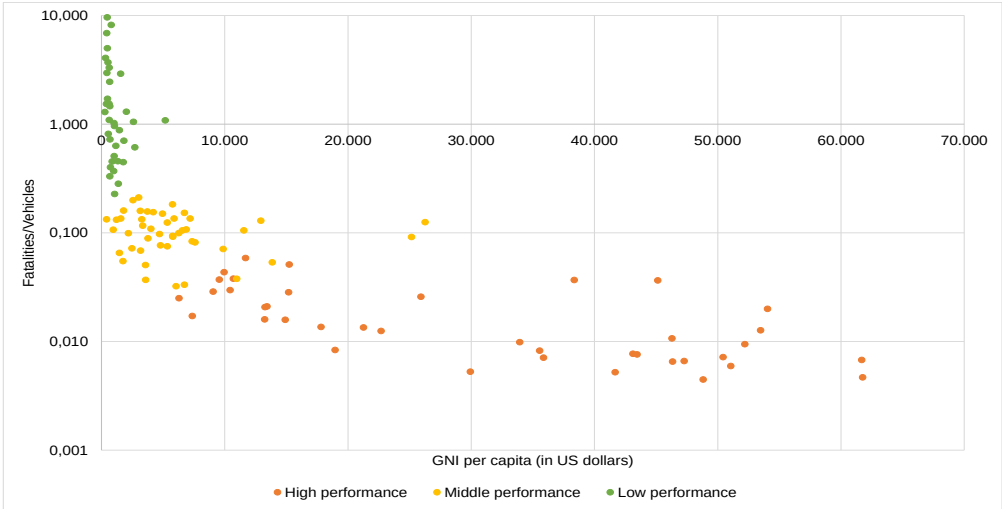
Classification based on **geopolitical criteria**:

- Region 1: African and Asia-Pacific countries
- Region 2: Eastern European and Latin American & Caribbean countries
- Region 3: Western European and developed countries



Classification based on **economic** and **road safety performance** criteria:

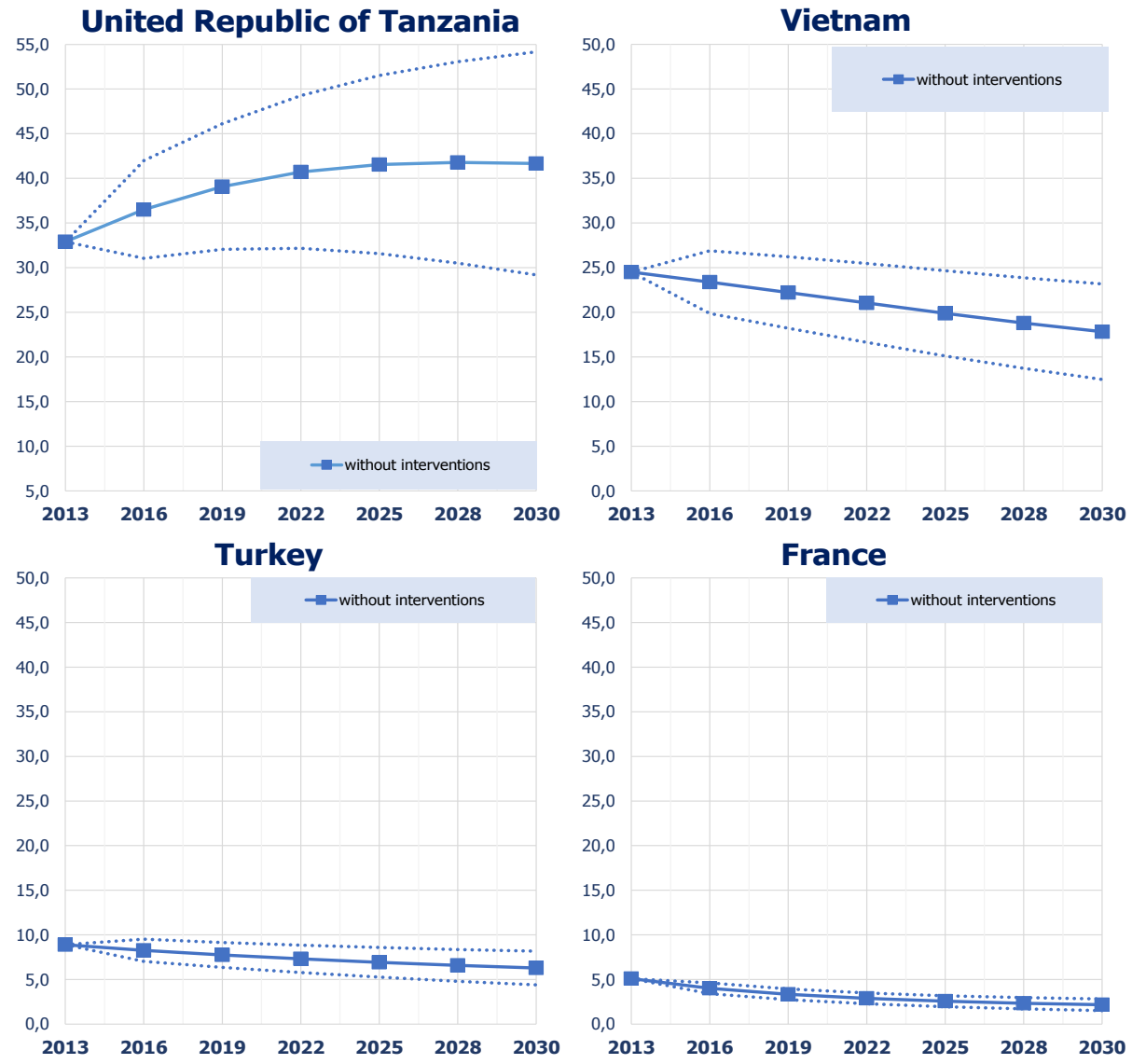
- Region 1: Low performance countries
- Region 2: Middle performance countries
- Region 3: High performance countries



Model Application

Examples of statistical model application:

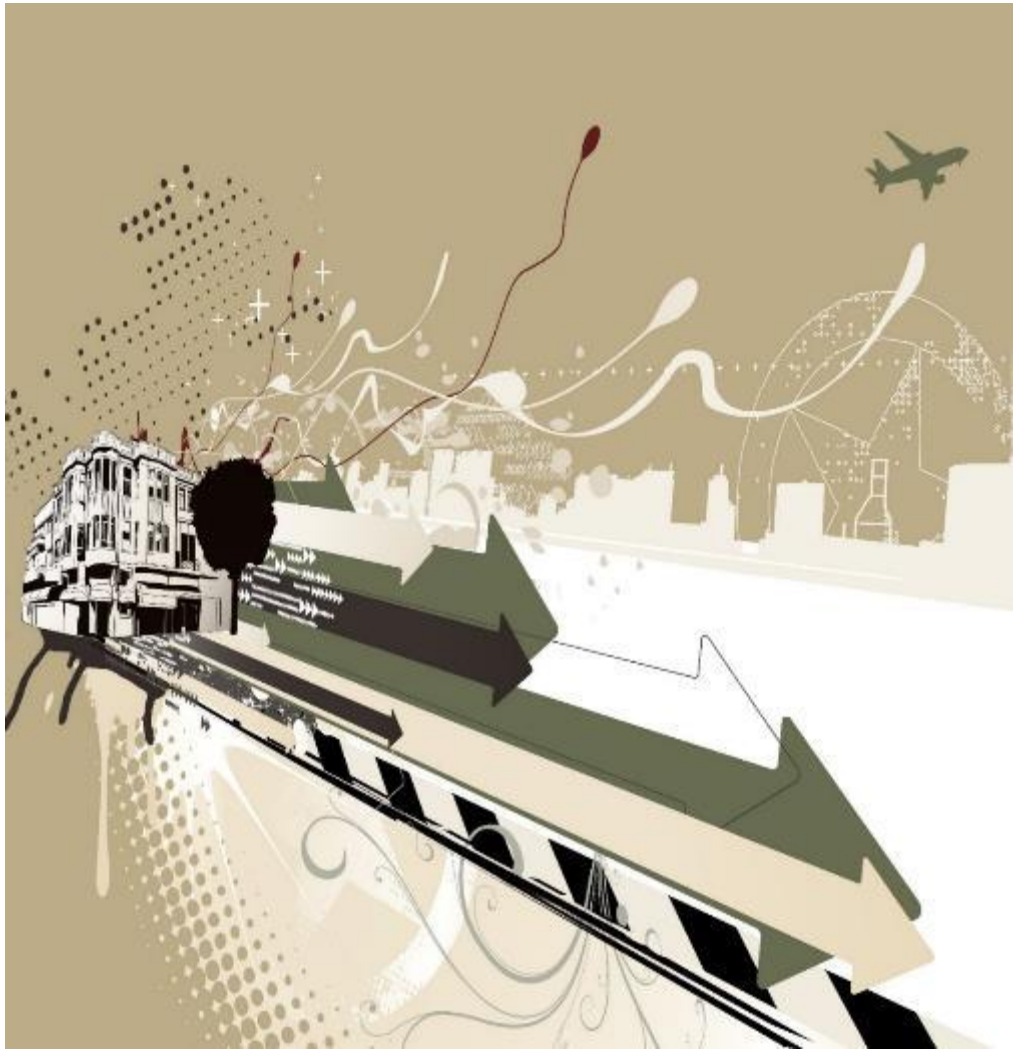
- one **low performance** country
- two **middle performance** countries
- one **high performance** country



SafeFITS Model Demonstration

The overall model implementation includes 3 distinct steps:

- Step 1 – **Countries Benchmark**
- Step 2 - **Forecast**
- Step 3 – **Report Generation**



Things to know when using the SafeFITS model

- Data and analysis methods have some **limitations**:
  - Fatality data are in some cases estimated numbers, corrected for **under-reporting**.
  - **Missing values** were addressed by imputation.
  - The available data for several indicators were **not detailed**.

- The **optimal use** of the model depends on a number of recommendations and rules:
  - The model provides overall forecasts of **short-term developments**, which might be extrapolated in the future.
  - The model includes many indicators which are correlated, thus testing **combinations of "similar" interventions** is recommended.
  - The model may not fully capture the effects on countries with very **particular characteristics**.
  - **Developing countries** are expected to be more sensitive in the testing of interventions than developed ones.

Step 1 (Benchmark) – Input

Objective:

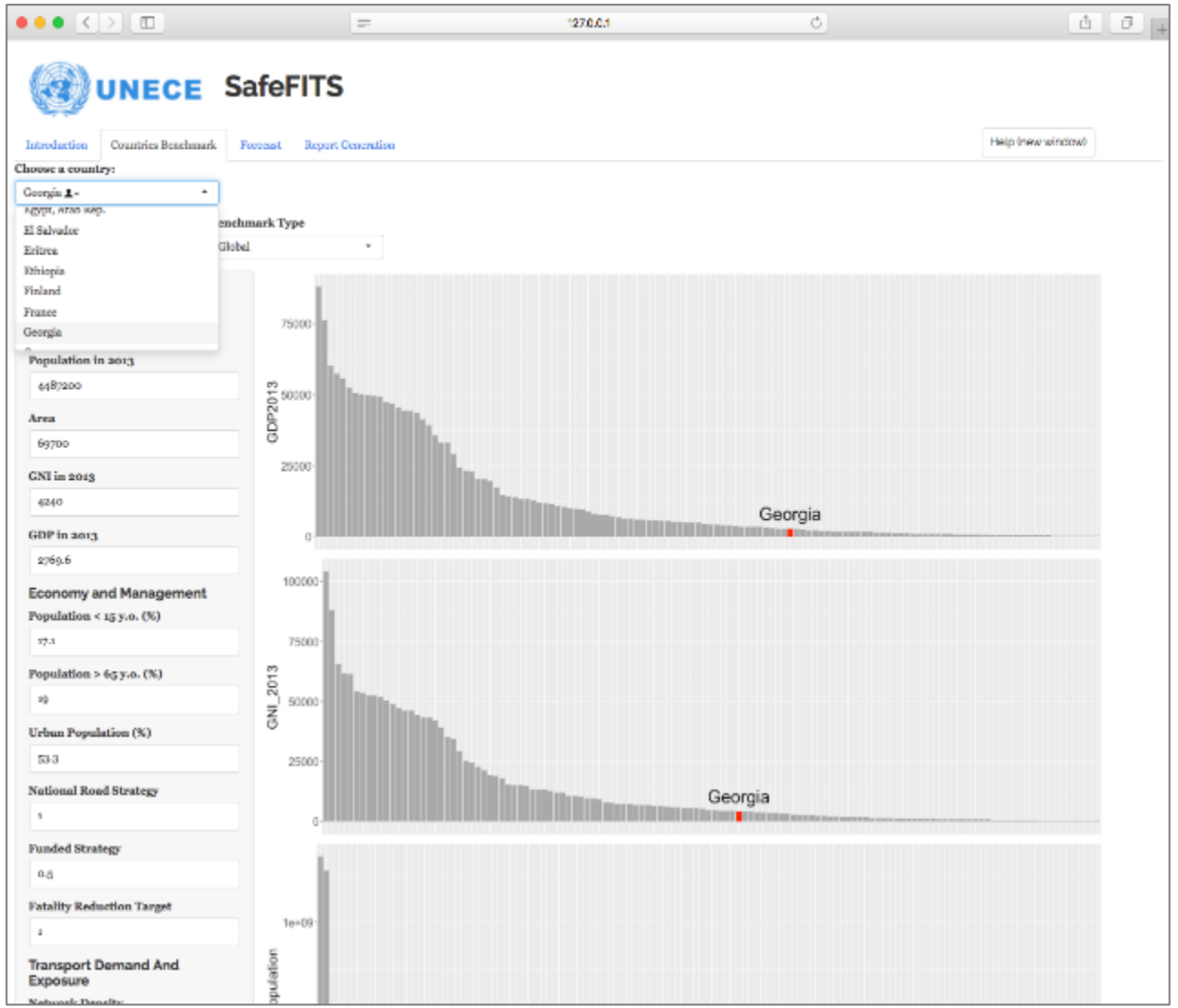
To provide the user general information concerning the country for the base year.

User input:

The user has the option to select a country

Analysis:

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

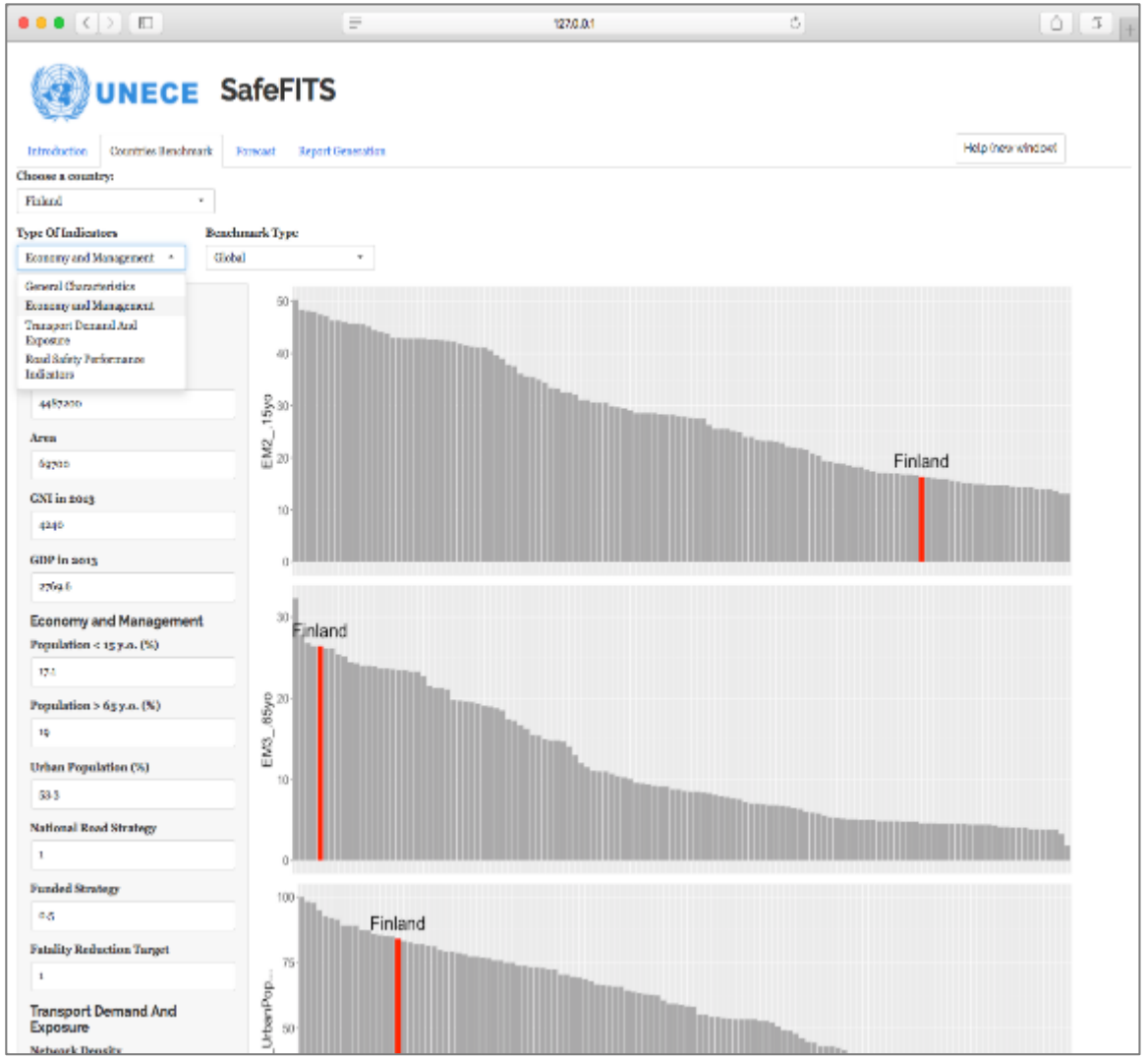


Step 1 (Benchmark) - Output

- Values of all indicators for the requested country and year
- Indicators are divided in categories

- Road safety performance results including:
  - Fatalities per population
  - General rank - the overall ranking of the selected country
  - Region rank - the regional ranking of the selected country

- Benchmarking results including:
  - Reactive diagrams presenting a benchmark of the base year situation for a selected category
  - Benchmarking will take place on a global and regional scale



Step 2 (Forecast) - Input

Objective:

To forecast the road safety performance of a country based on a series of intervention scenarios that the user can implement

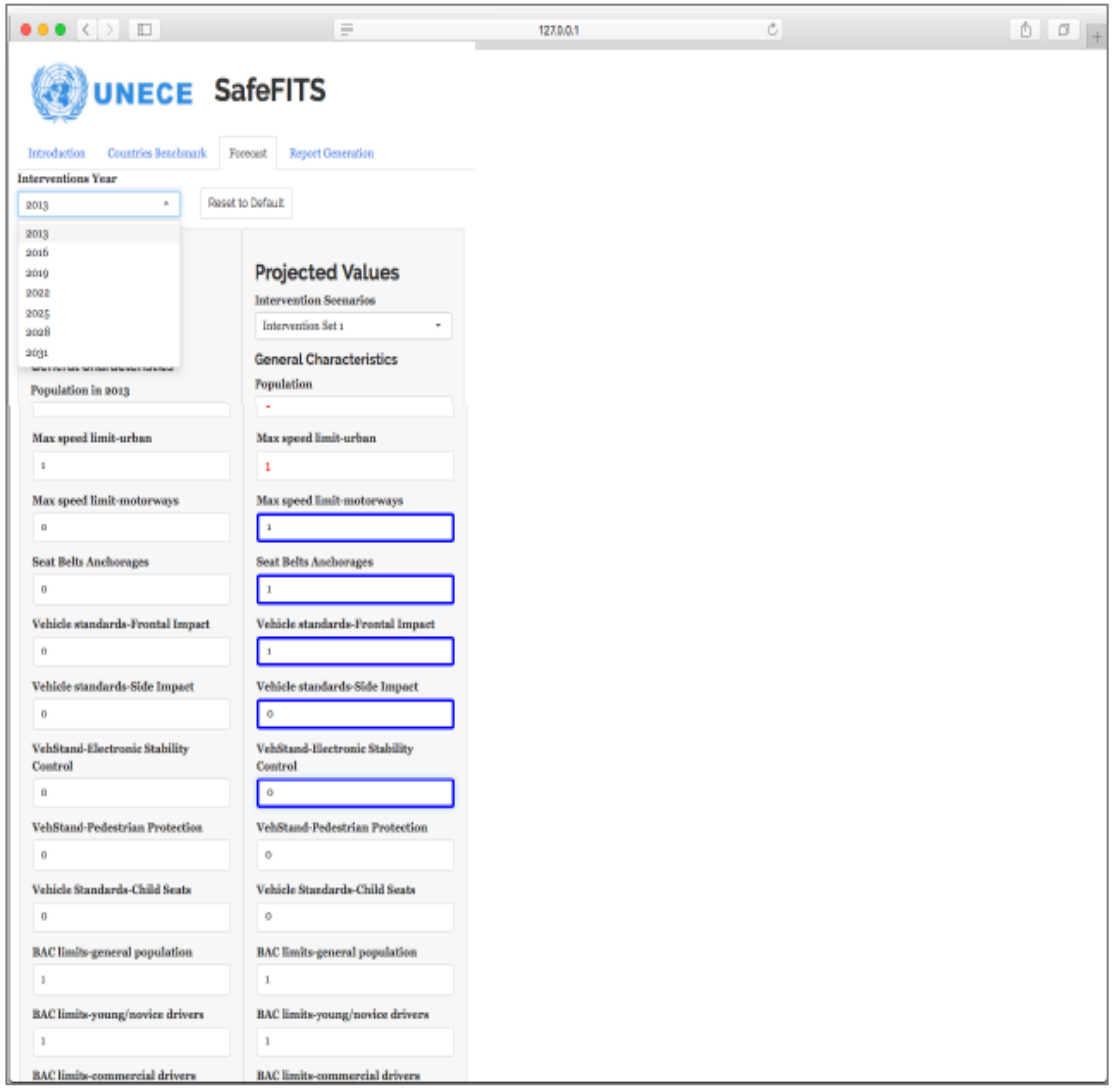
User input:

The user selects the reference year of the forecast and then different sets of interventions:

- no interventions set
- 3 different sets of interventions

Analysis:

The SafeFITS model is implemented for the year of reference on the basis of the intervention set selected



Step 2 (Forecast) - Output

Road safety results

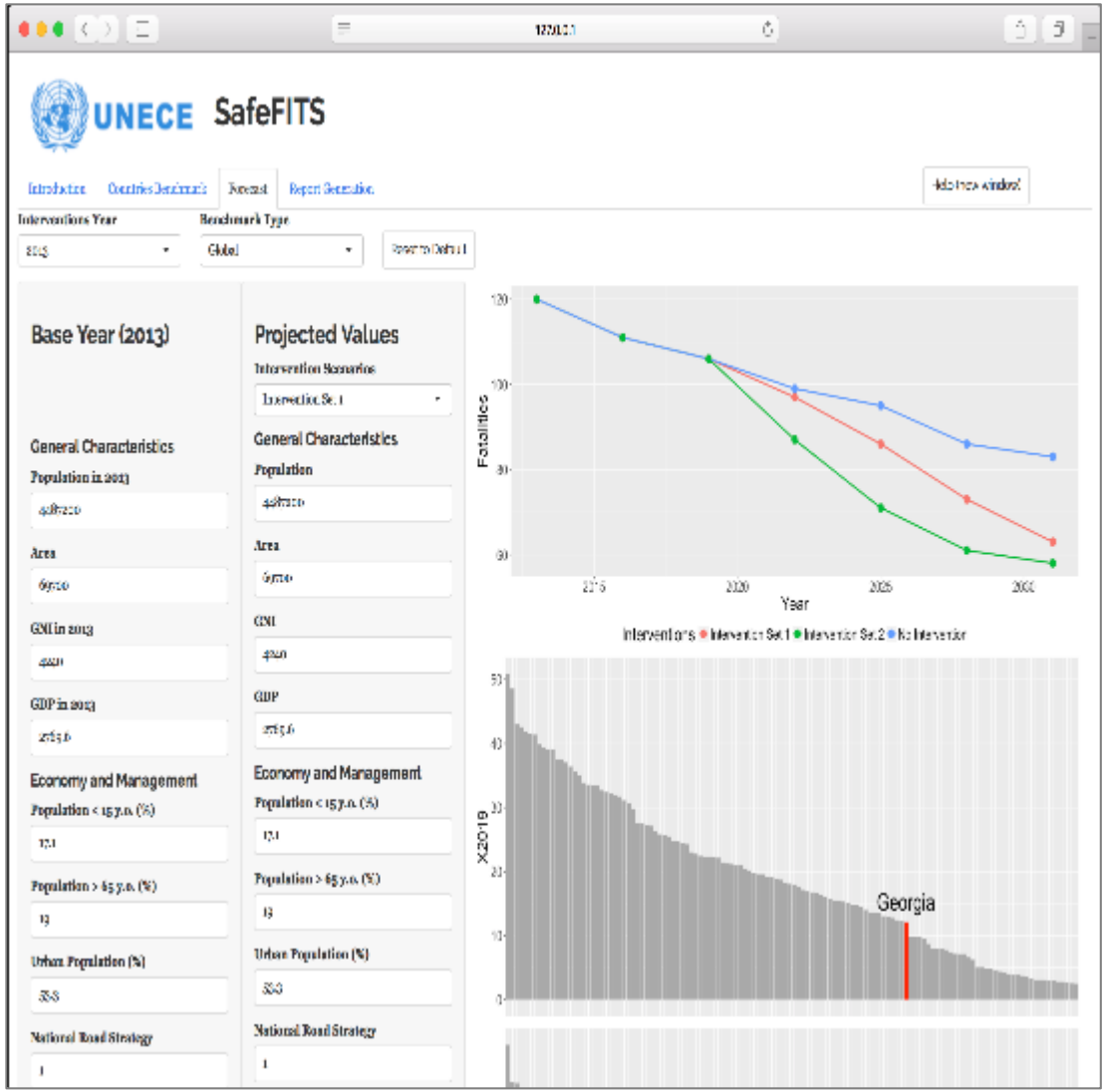
- Fatalities per population on the year of reference
- Change of fatalities per population on the year of reference compared to 2013
- General ranking of the country on the year of reference
- Regional rank on the year of reference

Forecasting

The trend for the variable fatalities per population through the years (2013-2030), alongside with the confidence intervals.

Benchmarking

- Overall ranking
- Regional ranking



Step 3 (Report Generation)

Objective:
The optional development of reports that can be downloaded for follow-up/offline use

User input:
The user selects which parts of the analysis she/he wants to have exported, as well as the file format in which the report will be generated

Output:
Reports in PDF, html, MS Word format with the analyses selected.

Next Steps

- **Pilot operation phase**: Model tested by selected users and revised at the end of the first year
- **Annual or bi-annual revisions** of all SafeFITS components (knowledge base, database and statistical models)
- Monitor **global developments in data availability and accuracy**, so that the SafeFITS database is updated regularly and continuously.
- SafeFITS tool will be further enhanced by continuously taking into account **users' feedback**.

SafeFITS Round Table Meeting

Geneva, 30 June 2017

United Nations
Econonomic Committee for Europe

SafeFITS

A Global Road Safety Model For Future Inland Transport Systems

George Yannis
Professor

Department of Transportation Planning and Engineering
National Technical University of Athens, Athens, Greece