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Safe Future Inland Transport Systems

Note by the secretariat

I. Background

1. Road accidents are a major problem in modern societies: annually almost 1.25 million people are killed and 50 million injured globally.[1] Road traffic injuries are estimated to be the eighth leading cause of death globally, and more than half the people killed in traffic accidents are young adults aged between 15 and 44 years, thus heavily implicating people who are entering their most productive years. Approximately 90 per cent of those killed in road crashes are from low- and middle-income countries; yet they own around 54 per cent of the world's motor vehicles. Current trends suggest that, unless action is taken, traffic injuries will become the fifth leading cause of death by 2030, with the disparity between high- and low-income countries further increased.[2] These losses are largely preventable and they underscore the urgent need for action to improve road safety globally.

2. In 2010, the United Nations General Assembly proclaimed the decade 2011-2020 as the United Nations Decade of Action for Road Safety, and set a goal to stabilize and reduce the level of global road traffic fatalities by increasing safety programmes at the national, regional and global levels. General Assembly resolution A/70/L.44, adopted in April 2016, reaffirms the targets of road safety in the 2030 Agenda for Sustainable Development:

- SDG target 3.6 aims to reduce global road traffic deaths and injuries by 50 per cent by 2020, and

[1] World Health Organization, 2015
[2] Ibid.

- SDG target 11.2 aims to provide access to safe, affordable, accessible and sustainable transport systems for all by 2030.

3. UNECE Sustainable Transport Division developed a concept note for the Safe Future Inland Transport Systems (SafeFITS) project taking into account: (a) requirements of the 2030 Agenda for Sustainable Development and the Decade of Action for Road Safety and (b) findings of the UNDA financed project Improving Global Road Safety: setting regional and national road traffic casualty reduction targets, led by UNECE Sustainable Transport Division, which was finalized in 2010. The project resulted in a set of road safety measures that are focused on specific targets with proven results in improving road safety. The International Road Transport Union (IRU) has agreed to finance the development of the SafeFITS tool.

4. The road safety model "Safe Future Inland Transport Systems (SafeFITS)" aims to facilitate knowledge based transport policy decision making related to road casualty reduction. The primary objective is to assist governments and decision makers to decide on the most appropriate road safety policies and measures in order to achieve tangible results in improving road safety, in both developed and developing countries. The model is based on historical road safety data and relations between several road safety parameters and it is expected to provide information on results of different road safety scenarios based on the chosen policies and measures.

II. Development of SafeFITS

5. The research and development nature of SafeFITS and the relative rarity of global research projects dealing with predictions of the outcomes of road safety strategies imposed the necessity for project implementation in phases. Each phase consisted of a separate research and development project and only after completion of the given phase — based on that phase's deliverables — was the Project Steering Committee able to decide on the direction of the continuation of the project implementation.

6. The project development is divided into four phases: Phase I explored and analysed existing road safety modelling and causalities; Phase II developed a draft model framework and described road safety causalities to be used for developing policy scenarios for road safety; Phase III developed a draft model and application/user interface; and Phase IV will test the model and verify it through pilot tests.

7. Phase I resulted in a literature review of road safety studies and projects, a list of statistical requirements and a draft conceptual framework for the model. Phase II resulted in a conceptual framework (of three SafeFITS modules), data requirements and a list of the most relevant relations/causalities to be included in SafeFITS. Phase II concluded that deterministic models were unsuitable and that statistical models based on a robust database of road safety indicators could be the most appropriate solution. Phase III resulted in a database on road safety indicators, SafeFITS statistical model and initial version of SafefITS web-application. Phases I to III were finalized in July 2017.

8. The initial development of the SafeFITS model and the existing experience on road safety analysis and forecasting led to the identification of several challenges:

- The relationships between indicators and road safety outcomes are complex and not deterministic. Literature suggests that an indicator (economy, transport demand, measure or intervention, etc.) may vary considerably in different countries and at different time periods, and there may be several conditions that affect and modify the magnitude and type of the relationship between indicator and road safety

outcome. The problem is multidimensional, and the transfer of known national causalities to a global context is not recommended.

- Existing knowledge on causalities is incomplete: very few results are available for several key indicators. Most of the existing causalities identified from literature are from developed countries, and it is 'highly unlikely' that these estimates can be transferred to developing or low-income countries.
- There is lack of data on several indicators and road safety outcomes at global level. There are very few databases, with related global road safety data and performance indicators, and these databases show limitations due to lack of data for several countries, i.e. developing countries.

9. In order to meet the objectives of the project, an appropriate analysis methodology was required to address the main challenges of the project. The main approaches adopted in the SafeFITS were:

- A methodology is developed to take into account as many dimensions of the problem (road safety outcomes and indicators) as possible,
- The SafeFITS model will estimate future causalities, based on original statistical data analyses, taking into account existing data for all United Nations countries,
- For that purpose, an original database was created, with data from different international sources for 129 countries,
- The model would be applicable in developing and developed countries.

III. SafeFITS Model

10. The SafeFITS model includes two background components, namely (see Figure 1):

- A **database** with data on indicators from all layers of the road safety management system,
- A **set of statistical models** fitted on the database indicators to produce the SafeFITS outputs.

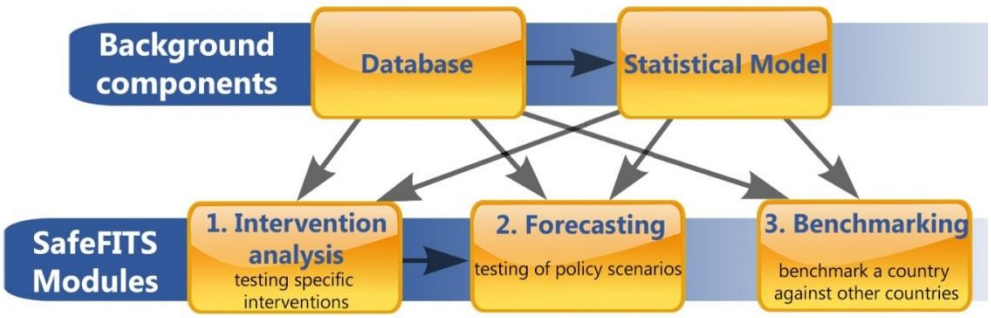

Figure 1. Overview of background components and modules of SafeFITS

11. The SafeFITS model is composed of three modules as follows:

- **Intervention analysis**: allows the user to examine the effects of single interventions at national or regional level,
- **Forecasting analysis**: allows the user to define own scenarios (i.e. combinations) of measures in a country and obtain medium/long term road safety forecasts for each scenario,
- **Benchmarking analysis**: allows the user to benchmark a country against a group of countries (e.g. all countries, geographical regions, countries of similar economic or road safety performance etc.).

12. The developed **database** consists of indicators for 129 countries, grouped into the five layers:

- Economy and Management (12 indicators, e.g. GNI per capita in US dollars, Percentage of urban population, Existence of road safety lead agency etc.),
- Transport Demand and Exposure (13 indicators, e.g. Road network density, Number of vehicles in use per population, Traffic volume etc.),
- Road Safety Measures (29 indicators, e.g. Existence of ADR law, Existence of national drink-driving law, Training in emergency medicine for doctors etc.),
- Road Safety Performance Indicators (RSPI) (9 indicators, e.g. Effectiveness of seat-belt law enforcement, Helmet wearing rates for drivers, Number of hospital beds per population etc.),
- Fatalities and Injuries (9 indicators, e.g. Estimated number of road traffic fatalities, Distribution of fatalities by road user type-pedestrians, Attribution of road traffic deaths to alcohol etc.).

Within each layer, the available indicators included all five pillars of the UN Global Plan for Action: Road Safety Management, Road Infrastructure, Vehicle, User and Post-Crash Services. Data were collected from various sources: WHO Global Status Reports on road safety, UNECE, OECD, IRF, etc. and carefully cross-checked and processed.

13. The SafeFITS model methodology was developed based on the use of composite variables, in order to take into account as many indicators as possible, and develop regression models to describe the relationships between these composite variables. A two-step approach was implemented:

- In the first step, factor analysis techniques were implemented on the indicators of all road safety system layers for the estimation of composite variables,
- In the second step, the development of a model linking road safety outcomes with the estimated composite variables was pursued.

This methodology allowed simultaneous and efficient prediction of the effects of numerous indicators on road safety outcomes.

14. Consequently, the relationship between the composite variables was described by the following equations (in the simple case of a linear or logarithmic model):

$$[\text{Fatalities \& Injuries}]i = Ai + Ki * [\text{Economy \& Management}]i + Li * [\text{Transport demand \& Exposure}] + Mi * [\text{Road Safety Measures}]i + Ni * [\text{RSPI}]i + \varepsilon i \quad (1a)$$

or

*Log[Fatalities & Injuries]i = Ai + Ki * [Economy & Management]i + Li * [Transport demand & Exposure] + Mi * [Road Safety Measures]i + Ni * [RSPI]i + υi (1b)*

with *(i)* countries, **A**, K, **L**, **M, N** parameters to be estimated, and **ε, υ** error terms expressing the uncertainty in the estimation of the relationship.

15. In SafeFITS the time dimension was taken into account by implementing a medium-term forecasting approach. The developments over the last few years, for which data is available, are taken into account to forecast future developments over the next few years, taking into account the recent road safety trends which are likely to continue in the near future. By applying the same approach on the medium-term forecasted outcomes, long-term forecasts may be obtained.

16. Accordingly, equation (1b) can be expressed as follows, in case the fatality rate per population is used as "Fatalities & Injuries" indicator, and the difference between τ years is considered:

*Log(Fatalities per Population)ti = Ai + Log(Fatalities per Population) (t-τ)+ Bi * GDPti + Ki * [Economy & Management] + Li * [Transport demand & Exposure] ti + Mi * [Road Safety Measures]ti + Ni * [RSPI]ti + εi* (2)

17. For the calculation of the composite variables several approaches were tested, however, factor analysis constrained to yield one factor per layer was selected (confirmatory factor analysis). As a result, four composite variables were estimated on the basis of 43 collected indicators:

- Comp_EM: the composite variable on economy and management, including 6 related indicators,
- Comp_TE: the composite variable on transport demand and exposure including 7 related indicators,
- Comp_ME: the composite variable on measures, including 21 related indicators,
- Comp_PI: the composite variable on safety performance indicators including 9 related indicators.

18. Several alternative model specifications were tested for the selection of the final model. The best performing model was a model whose explanatory variable is the logarithm of the fatality rate per population for 2010, GDP per capita for 2013, together with the four composite variables: economy and management, transport demand and exposure, measures, and safety performance indicators.

The SafeFITS model is based on the three-year development of fatality rate and GDP, together with the various composite variables, as shown below:

Log(Fatalities per Population)ti = Ai + Log(Fatalities per Population) (t-3)+ Ki * LogGDPti + Li * [Comp_EM] + Mi * [Comp_TE]i + Ni * [Comp_ME]i + Pi * [Comp_PI]i + εi

19. The developed model is robust, with satisfactory performance and acceptable prediction errors. 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. A cross-validation of the Model was undertaken with satisfactory results. However, it has to be stated that the Model has some limitations which should be taken into account, and specific recommendations are made for optimal use of the model (e.g. combinations of policy scenarios).

20. The draft SafeFITS model is prepared to yield forecasting and benchmarking estimates for two types of scenarios:

- For "no new interventions" scenario, solely on the basis of GDP projections (either official projections, or user-defined); this scenario serves as a reference case for assessing the effects of interventions,
- Policy scenarios with interventions, in addition to GDP developments; this allows to assess the cumulative impact of these interventions on the forecasted road safety outcomes, and the country's position globally or regionally.

21. Overall, the following steps and recommendations for the testing of policy scenarios are made:

- Step 1: Analysis should start by testing the base scenario and the values of the indicators for the base scenario should be carefully examined,
- Step 2: A forecast without any new intervention, based on the GDP projections available for the period of interest. This will allow obtaining of the forecasted road safety performance in a "no new interventions" scenario, before testing interventions,
- Step 3: A forecast with the interventions. This will allow testing of a first intervention for an indicator of interest and to examination of the model results. Then introduction of a second intervention and comparison of the results, introduction of a third intervention, etc.,
- Step 4: To obtain the most realistic results, for each intervention introduced, adding all the correlated interventions that would be expected to take place at the same time (e.g. changes in several vehicle standards, improvement in several areas of enforcement, introduction of a group of measures, demographic changes affecting several indicators in the database etc.) should be considered.

IV. Current situation and the next steps

22. During the summer 2017 finalization of the initial version of web-based application took place and initial version is ready for testing. Testing and fine-tuning (before publishing on UNECE web-site) will be done through two pilot-tests in Albania and Georgia. In that sense, SafeFITS will test recommendations defined through "Strengthening the national road safety management capacities of selected developing countries and countries with economies in transition" Project, reaching synergy between two UNECE-led projects.

23. To provide a feedback on SafeFITS model and discus road safety statistics and modelling, UNECE, in cooperation with IRU, organized the SafeFITS Round Table in Geneva on 30 June 2017 for the prominent representatives of the road safety scientific community (international organizations, academia, international financial institutions, etc.). During the Round Table, SafeFITS peer review reports prepared by two renowned road safety experts were presented. The Round Table resulted in a conclusion that much better global road safety data collection and dissemination is warranted and recommendation for draft SafeFITS model updates.

24. After the pilot tests and adjustments, the full operation phase would start and the SafeFITS model would be available to the public. Annual or bi-annual revisions of all SafeFITS components (database and statistical models) should take place, in order to incorporate any new developments in the road safety field.