Rethinking transport
27–30 April 2020

TRA 2020 HELSINKI

Proceedings of 8th Transport Research Arena TRA 2020, April 27-30, 2020, Helsinki, Finland

Development of a Platform for Global Road Safety Data Analysis

George Yannis [a]*, Katerina Folla [a], Dimitrios Nikolaou [a], Anastasios Dragomanovits [a], Xuesong Wang [b]

[a] *National Technical University of Athens, 5 Heroon Polytechniou str., 15773, Athens, Greece*
[b] *Tongji University, 4800 Cao'an Road, 201804, Shanghai, China*

Abstract

Road accidents constitute a major social problem in modern societies, with very high discrepancies between the different regions and countries of the world. Within the Greek-China cooperation project i-safemodels, the objective of this research is the development of a platform for global road safety data to support macroscopic analyses. A methodological framework was designed for the development of the global data platform, combining the five road safety pillars of WHO Global Plan of Action with the concept of the SUNflower pyramid, suitably adjusted in order to serve more efficiently the needs of global road safety analysis. A set of numerous indicators and data have been selected to be included in the database from various international databases. A "big data" platform is also designed, combining transport data coming from new technologies, with the traditional road safety indicators, used for monitoring road safety performance, in order to better support decision making process.

Keywords: safety, injuries, fatalities, data analysis, global database.

* Corresponding author. Tel.:+ 30-210-772-1326; fax: +30-210-772-1454;
E-mail address: geyannis@central.ntua.gr

1. Introduction

Road accidents constitute a major social problem in modern societies, accounting for more than 1 million road accidents per year in EU-28 (2.900 per day) with consequences 1,4 million injured and 26.000 fatalities (70 per day) (WHO, 2018). 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 placing heavy burden on people just entering their most productive years. Particularly in low and middle income countries, road traffic injuries rates are twice those in high income countries and still increasing. This can be partly attributed to rapid motorization in many developing countries, without road safety related investment. 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 (WHO, 2018).

In order to guide countries in taking concrete, national-level action, the United Nations drew up a Global Plan for the Decade of Action for Road Safety 2011–2020. The Plan provides a context that explains the background and reasons behind the declaration of a special decade by the General Assembly and serves as a tool to support the development of national and local plans of action. It also provides a framework to allow coordinated activities at regional and global levels. The 2030 Agenda for Sustainable Development adopted by the UN Sustainable Development Summit 2015, defined the Sustainable Development Goals (SDGs). The SDGs targets that are directly related to road safety are:

- SDG target 3.6, which aims to reduce global road traffic deaths and injuries by 50% by 2020 and
- SDG target 11.2, which aims to provide access to safe, affordable, accessible and sustainable transport systems for all by 2030.

Within this context, transport authorities and road safety related policy makers, mostly in developed countries, develop dedicated tools and statistical models in order to predict road accidents, analyse injury severity, identify hotspots and assess safety countermeasures. However, developing these tools requires a tremendous effort of data collection and data analysis, which could be potentially skipped by researchers and engineers if the already existing models were transferable to conditions different from the ones they were developed for. The issue of research findings transferability among various countries is much more complex and due to many limitations, generalization of results is not feasible. However, the development of a generic road safety management system which could be utilized worldwide and provide real-world solutions to everyday road safety problems would be beneficial for policy makers and an essential step for its achievement is the reliable transferability of road safety research findings. Thus, there is an imperative need for international scientific cooperation to identify and fully understand crash risk factors and respective measures, ultimately aiming at the development of an integrated international road safety management system.

Within the above context, the Greek-China cooperation project i-safemodels has been initiated, with main objective to propose international comparative analyses of road traffic safety statistics and safety modelling at both macroscopic and microscopic level. Comparison of differences and investigation of transferability aspects will allow for the identification of the influencing factors that lead to road safety performance differences between countries. Furthermore, the findings will provide supportive evidence worldwide - with emphasis on emerging economies, such as China - to improve national safety management strategies. In order to achieve this aim, a data platform will be established for the convenience of model development and comparative analyses. This platform will be gradually enriched with the statistical methods, models and results of the project, while the respective tools for road safety analysis and decision support at global level will also be available for the research and policy-making community.

The objective of the current research is to present the methodological approach for the development of a platform for global road safety data to support macroscopic road safety modelling and international comparative analyses. In order to develop this data platform, the necessary road safety indicators are identified, based on literature findings and previous related initiatives and projects. The optimum selected methodological framework for the purposes of this research, combines the five road safety pillars of WHO Global Plan of Action (WHO, 2011) with the concept of the SUNflower pyramid (SUNflower, 2002), which is suitably adjusted in order to serve more efficiently the needs of global road safety analysis. In order to collect the respective data for the calculation of the selected indicators, international road safety databases are initially explored, while questionnaires will also be disseminated to national representatives in order to collect more detailed data. Finally, companies using new emerging technologies are also explored as an alternative data source for the estimation of specific road safety indicators. As a first step, macroscopic behaviour and exposure data from drivers in Greece collected by a telematics company will be explored for the estimation of exposure and safety performance indicators, with aim to further extend this methodology to four more countries (i.e. Germany. UK, China and USA).

2. Needs for road safety indicators

Several projects and publications have focused on the exploration of road safety indicators, which could play a significant role in global road safety analyses and have suggested structures of road safety management. Most of these publications concern European countries, however, more recently initiatives for other regions have also been recorded. The SUNflower approach (SUNflower, 2002) uses a target hierarchy which is comprised by five layers, i.e. a) Structure and culture, b) Safety measures and programmes, c) Safety performance indicators (Intermediate outcomes), d) Number of killed and injured (Final outcomes) and e) Social costs. Each level may be influenced by external factors (e.g. demographic differences among the countries, weather conditions etc.) which should be taken into account, while under-reporting issues are considered significant, since injuries are differently under-reported and accidents are categorized in different ways. SUN flower approach recommends a three-dimensional comparison of the countries, including a comparison of the pyramidal outcome hierarchy (vertical dimension), of the components in each country (horizontal dimension) and over time (time dimension). The SUNflower approach and its subsequent developments (SUNflower+6, 2005; SUNflowerNext, 2008) concluded to the importance of exposure data, information on road safety performance indicators and on severely injured persons for monitoring and predicting road outcomes, as well as for benchmarking road safety performances.

The SUNflower approach was used within the SafetyNet (2005-2008) project which aimed to build the framework of the European Road Safety Observatory. Within this project, the framework of harmonization of data by using common definitions and common collection methods was developed for each type of the following data: road accidents, risk exposure data and safety performance indicators. Within this context, the level of detail of accident data was defined, so that accident variables combine information of the accident, road, vehicle and road user characteristics. Exposure and road safety performance indicators were also recommended to be disaggregated in such a way that they are compatible to accident data. Briefly, the exposure data discussed concern vehicle-kilometres, person-kilometres, road length, fuel consumption, population, number of trips and recommendations on methods for their collection are also given. Furthermore, the surveys and the necessary data which should be collected in order to estimate the safety performance indicators are discussed, covering the following domains: alcohol and drugs, speeds, protective systems, daytime running lights, vehicle passive safety, roads and trauma management (Hakkert & Gitelman 2007a, 2007b; Vis & Eksler 2008).

Data for 30 European countries under the SafetyNet framework were collected and analysed in the DaCoTA project (2010-2012). The DaCoTA Master Tables include data on road accidents, risk exposure, safety performance indicators, under-reporting of crashes, country characteristics, social costs and traffic laws and measures coming from several international and national databases (Dacota, 2012).

In the context of the United Nations General Assembly resolution, which proclaimed 2011-2020 the Decade of Action for Road Safety, a Global Plan of Action was developed proposing several road safety activities which are categorized in five pillars: Road Safety Management, Road Infrastructure, Vehicle, Road User and Post-Crash Services. Within this context, the World Health Organization (WHO) has published three global status reports (WHO, 2013; WHO, 2015; WHO, 2018) on road safety, which serve as a baseline for the Decade of Action for Road Safety 2011-2020. Road safety data and information were collected through questionnaires delivered to national representatives. The domains for which data were collected are: a) road traffic deaths, b) post-crash response, c) speed laws and enforcement, d) drink-driving law and enforcement, e) helmet law, enforcement and wearing rates, f) seat-belt law, enforcement and wearing rates, g) mobile phone laws, h) road safety management, strategies and targets and i) safer mobility.

The OISEVI Latin America road safety observatory collects and publishes data for several key indicators of road safety management (e.g. strategy and targets), recent road safety measures, and Road Safety Performance Indicators (e.g. share of alcohol impaired crash participants, seat belt and helmet wearing, share of distraction or fatigue impaired drivers) for 20 countries (OISEVI, 2016).

In the SafeFITS project (UNECE, 2018), a methodological framework was designed combining the five road safety pillars of WHO Global Plan of Action (WHO, 2011) with the concept of the SUNflower pyramid (SUNflower, 2002), suitably adjusted. As a result, the road safety management system within the SafeFITS project is described as a structure that includes five layers (Economy & Management, Transport demand & Exposure, Road Safety Measures, Road Safety Performance Indicators, Fatalities & Injuries) and five pillars (Road Safety Management, Road Infrastructure, Vehicle, User and Post-Crash Services), as presented at Table 1.

Additionally, the SaferAfrica research project recently assessed road safety data availability and quality in the African countries, and suggested a list of data elements that need to be available for road safety analysis to support road safety improvement in the continent (Thomas et al., 2018).

Finally, the European Commission recently published a Staff Working Document titled "EU Road Safety Policy Framework 2021-2030 – Next steps towards "Vision Zero", including details as to how it intends to put its Strategic Action Plan on Road Safety into practice. This Document includes a first list of Road Safety Key Performance Indicators (KPIs), that will be monitored across the EU to underpin the target of 50% reduction in fatalities and serious injuries by 2030. The list includes indicators like vehicle safety, seat belt and helmet wearing rate, speed compliance and post-crash care, with the first data possibly being gathered on this basis from 2020.

Table 1: Structure of the road safety management system (Source: UNECE, 2018)

		PILLARS				
		1. Road Safety Management	2. Road Infrastructure	3. Vehicle	4. User	5. Post-Crash Services
LAYERS	1. Economy & Management	Economic Developments, 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 Management, Installation of road restraint systems, Lighting, Speed limits in urban areas	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

3. Database Overview

On the basis of the above review, a list of indicators has been developed, which are considered essential for macroscopic road safety analyses and international comparisons. The methodological framework is based on the SafeFITS approach, and thus, the indicators are categorized in the following five layers: Economy and Management, Transport Demand and Exposure, Measures, Safety Performance Indicators, Fatalities and Injuries.

3.1. Economy and Management

For the layer Economy and Management, data for 28 indicators need to be collected, which are divided in the following pillars/domains: a) Demographics, b) Area & Climate, c) Economy and d) Management. More specifically, Demographics refer to the total population of each country, while the synthesis of the population by gender and age groups, as well as the distribution of population by area of residence (e.g. percentage of urban population) are also important. The Area and Climate related indicators concern data on the country characteristics, such as percentage of land covered by water or mountains, typical average temperature in winter or summer etc. Data for Economic indicators concern the Gross Domestic Product (GDP), Human Development Index (HDI) and unemployment rate by age group. The road safety management indicators concern mainly qualitative information on the existence of road safety strategy and targets, of policies and practices related to road safety infrastructure management (e.g. audits, safety impact or road assessment policies etc.), of systems to monitor road user behaviours or data systems to monitor road safety progress in achieving road safety targets etc.

The indicative method for the data collection is via the international databases, which in most cases have available time-series. Data concerning Demographics and Economy are highly available, while data for climate can be found in a few databases. Additionally, for some of the requested indicators, especially those related to Road Safety Management, data are available for a few countries (mainly the developed ones), while few indicators are available in a couple data sources for more countries (e.g. WHO).

3.2. Transport Demand and Exposure

For the layer Transport Demand and Exposure, data for at least 15 indicators are foreseen to be collected for the purposes of the statistical modelling. The pillars in which these data are divided are: a) Roads, b) Vehicles, c) Road Users. More specifically, data concern the length of road network (in total and by type of road), as well as characteristics of the road network (e.g. percentage of paved roads). As far as the vehicles are concerned, data on the number of the registered vehicles in traffic (in total and by type of vehicle) are needed. The most important indicators for the purposes of macroscopic road safety analyses are those concerning the pillar of road users. These indicators refer to the passenger kilometres and/or vehicle kilometres travelled. Besides the total national estimations of these indicators, data disaggregated by road user type and road user characteristics (age, gender), vehicle type and vehicle characteristics (e.g. vehicle age group) and road type would serve an added value in the modelling process. Most of the data can be found in the international databases, however, they are available only for a few countries.

3.3. Road Safety Measures

For the layer Road Safety Measures, data for 38 indicators are to be collected. The pillars/domains in which these data are divided are: a) Vehicles (e.g. compliance with UN regulations for vehicle standards, participation in NCAP programmes, regulations for technical inspections etc.) b) Road Users (e.g. existence of traffic law related to driving under influence (DUI), use of protection systems and helmets, use of mobile phone etc., education and training of drivers, driving licences thresholds etc.), c) Roads (e.g. speed limits by type of road etc.) and d) Post Impact Care (e.g. existence of trauma cares, third-party insurance schemes for drivers etc.).

Most of the data elements of this layer can be found to a few international databases, which have collected the respective information for almost all countries through questionnaires. However, information on vehicle inspections, licenses, education and post-impact care are not highly available. It has to be noted that the values of these data are restricted to yes/no answers and consequently there is a significant lack of detail, which would highlight the differences on road safety legislation and measures among the countries.

3.4. Safety Performance Indicators

For the layer Performance Indicators, data for 35 indicators are aimed to be collected. The pillars/domains in which these data are divided are: a) Roads (length of interurban roads of 3 or more stars), b) Road Users (SPIs related to speeding, DUI, seat-belt, child restraints and helmet use, mobile phone use) c) Vehicles (e.g. NCAP score by category) and d) Post Impact Care (e.g. mean EMS response time, number of hospital beds, etc.). Data for most of these indicators are usually collected centrally at national level and can be extracted by official national databases, while several of them may be available at international databases as well.

As regards the collection of data on the length of interurban roads that are 3 star or better for all road users, this specific element should be disaggregated by road type, thus, two variables should be considered. However, this element is not available in the vast majority of countries.

Concerning the vehicle speeds, data on speeds by road type, vehicle type and time of the day would be the optimum disaggregation level. Additionally, concerning the SPI for the percentage of drivers above the legal alcohol limit, data by area type, vehicle type, driver's age group and gender and time of the day are useful to be collected. Concerning the use of protection systems, data by area type, vehicle type, road users' age group and gender are considered useful to be collected.

While most of these data are considered of high usefulness for road safety analyses, they are not available at international databases and even many countries are not expected to collect such data. A few countries, mainly the developed ones, collect data coming from roadside surveys. A main source of comparable SPIs is expected to be the European Commission, which has suggested a set of Key Performance Indicators to be collected by the EU Member States and specific guidelines for the data collection, in order to obtain comparable KPIs. It is expected that a first set of the EU KPIs will be disseminated in 2020.

3.5. Fatalities and Injuries

For the layer Fatalities and Injuries, data for 22 indicators are to be collected. The pillars in which these data are divided are: a) Fatalities (e.g. traffic fatalities, serious injuries, number of hospitalized persons, underestimate rate etc.) and b) Management (costs of road accidents and casualties). Fatality data in most countries are collected centrally by official national sources. Time-series of fatality data disaggregated by area type, road type, vehicle type, time of the day and casualty's age and gender are required. Concerning the level of under-reporting of fatalities, the hospitalization of non-fatal casualties, as well as the costs of road accidents and casualties, dedicated studies or surveys are required for the collection of the respective data.

While data on the number of fatalities may be available in several international databases for most countries, neither time-series nor disaggregated data can be found. In addition, data coming from specific studies or surveys (e.g. under-reporting study, crash costs survey) are available only for some European or OECD countries.

4. Data collection methodology

4.1. International Road Safety Databases

In order to collect the reliable and most recent data for each of the aforementioned layers, the international data sources with road safety related data will be initially explored. For each indicator, one data source is preferred in order to ensure that the collected data are comparable among the different countries and over time. However, in the case of combining more data sources for the collection of the necessary data, attention should be given in the definitions used for the various data elements, in order to examine whether these sources can be used in a complementary way. The most significant and complete international data sources are presented below:

4.1.1. United Nations Economic Commission for Europe (UNECE)

The UNECE Working Party on Transport Statistics undertakes dissemination of transport statistics through publications and also through the development and maintenance of the on-line UNECE Transport Statistics Database, which includes data on road safety, transport by road and rail, transport infrastructures for 55 countries, mainly European, middle-east Asian and North American. Data cover years 1993 to 2017. The road safety related data included in the UNECE Transport Statistics Database cover:

- General data (e.g. demographics, area, Gross Domestic Product etc.)
- Accidents (e.g. accidents and casualties by country, year, injury severity, accident type, area type, road user type, transport mode etc.)
- Road Traffic (e.g. freight transport, passenger transport, motor vehicle movements, vehicle fleet by vehicle type etc.)

4.1.2. World Health Organisation (WHO)

The theme pages of the Global Health Observatory (GHO) of WHO provide data and analyses on global health priorities, including road safety. Each theme page provides information on global situation and trends highlights, using core indicators, database views, major publications and links to relevant web pages on the theme. The following data are available under the "Road Safety" theme of the repository:

- Demographic and Socio-Economic Statistics (i.e. population, Gross National Income etc.)
- Number of Registered Vehicles (i.e. total number and distribution by vehicle type)
- National Legislation (i.e. drink driving law, protection systems use legislation, speed limits, etc.)
- Institutional Framework (i.e. lead road safety agency, road safety strategy etc.)
- Policy (i.e. alternative transport, safety audits etc.)
- Post-Crash Response (i.e. pre-hospital care, training in emergency medicine etc.)
- Road Traffic Deaths (i.e. number of traffic deaths, population rate, by road user type)

Many of these datasets represent the best estimates of WHO using methodologies for specific indicators that aim for comparability across countries and time; they are updated as more recent or revised data become available, or when there are changes to the methodology being used. Data are available for 182 countries worldwide. Three editions of "The Global status report on road safety" (WHO, 2013; WHO, 2015; WHO, 2018) present information on road safety from these countries, including a detailed statistical annex with country profiles.

4.1.3. International Road Federation (IRF)

The International Road Federation (IRF) is a nongovernmental, not-for-profit organisation with the mission to encourage and promote development and maintenance of better, safer and more sustainable roads and road networks. IRF Members have organized as a Road Safety Committee to address the needs of road safety around the world. IRF is key contributor when it comes to road infrastructure expertise and road statistics. Data collected concern:

- Road Networks (length of road network, road network density, percentage of paved roads etc.)
- Road Traffic (e.g. traffic volume by vehicle type, freight transport, passenger transport)
- Vehicles in Use (registered vehicles by type of vehicle)
- Road Accidents (figures and rates for accidents, injured persons, killed persons)
- Production, Imports, First Registrations and Exports of Motor Vehicles (total number and passenger cars)
- Road Expenditures (per administrative level, category, total)

Each year IRF publishes detailed statistics (IRF World Road Statistics (WRS)) about the state of road infrastructure in more than 200 countries. The IRF World Road Statistics (WRS) are the only comprehensive, universal source of statistical data on road networks, traffic and inland transport, typically obtained directly from road agencies and participating governments.

4.1.4. Organisation for Economic Co-operation and Development (OECD)

OECD has established the International Road Traffic and Accident Database (IRTAD) as a mechanism for providing an aggregated database, in which international road accident and victim as well as exposure data are collected on a continuous basis. The development and use of the IRTAD is carried out by the International Traffic Safety Data and Analysis Group (IRTAD Group). Information collected for IRTAD comes directly from relevant national data providers in member countries. The database includes more than 500 data items, aggregated by country and year (since 1970) and shows up-to-date accident and relevant exposure data, including:

- Injury Accidents and Casualties classified by Road Network, Age, Gender, Road user type, Transport mode, month

- Risk Indicators: Fatalities, Hospitalised or Injury Accidents Related to Population or Mileage figures
- 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

4.1.5. European Commission (EC)

CARE (Community database on Accidents on the Roads in Europe) is the European centralised database on road accidents which result in death or injury across the EU. The major difference between CARE and most other existing international databases is the high level of disaggregation, i.e. CARE comprises detailed data on individual accidents as collected by the Member States. The database includes data on road accidents, fatalities and injuries aggregated by country, year (since 2001) and by road user type, gender, transport mode, age and month for the 28 EU Member States, Iceland, Liechtenstein, Norway and Switzerland.

The ERSO (European Road Safety Observatory) gathers harmonised specialist information on road safety practices and policy in 30 European countries. ERSO collects a range of information types. These include a series of data protocols and collection methodologies, national and in-depth accident data, exposure data and safety performance indicators. The ERSO content was developed by the SafetyNet EC co-financed project and was later updated and expanded by the DaCoTA EC co-financed project. Current updates are managed by the EU's Directorate-General for Mobility and Transport.

4.2. Collaboration with national authorities and private companies

As already mentioned, the main source for the development of the data platform is the international data sources with available comparable data for most countries worldwide. While for some indicators time series of the requested data are available for almost all countries (e.g. demographics, economic indicators), for other indicators either time series data exist for a limited number of countries (e.g. fatalities and injuries), or the disaggregation level of the available data is not sufficient for macroscopic road safety analyses (e.g. data on road safety measures and management). On that purpose, questionnaires will also be distributed to national representatives with aim to obtain data and qualitative information, that are possibly available at national statistical databases or have been collected through dedicated surveys.

The greatest lack of data, however, appears for risk exposure (person- or vehicle-kilometres travelled) and road safety performance indicators, in both international and national data sources, which creates the need to explore alternative sources of data. The rise of smartphones, sensors and connected objects over the last years is offering more and more transport data that could be used as surrogate safety data for the diagnosis of the traffic safety problems (ITF, 2019). Under this perspective, macroscopic behaviour and exposure data from drivers in Greece collected by a telematics company will be explored within the context of the project for the estimation of national exposure and safety performance indicators, with upper aim to further extend and apply this methodology to four more countries (e.g. Germany, UK, China and USA).

More specifically, OSeven Telematics (www.oseven.io) is a start-up company providing world leading solutions for insurance telematics, driving behavior analysis and fleet management, based on a smartphone-only/hardware-free and fully scalable solution. It has developed the OSeven platform in cooperation with the Department of Transportation Planning and Engineering of the National Technical University of Athens, which includes a user-friendly smartphone app, that automatically detects the start and stop of driving, without any user involvement and records data from smartphone sensors that are transmitted to the OSeven backend servers. These data are then analysed via the OSeven algorithms to produce driving metrics, scores and the overall / per trip results. The driving metrics concern harsh accelerations and harsh brakes, speeding and mileage, while phone motion is used for the determination of the mobile phone use while driving.

Therefore, historical data collected by the OSeven application will be used and through dedicated statistical analyses in combination with demographic and road related data from other data sources, the estimation of exposure and road safety performance indicators for Greece will be attempted, such as:

- total vehicle kilometres travelled (by type of vehicle and type of road)

- total person kilometres travelled (by gender, age group, type of road)
- percentage of drivers exceeding speed limits (by type of road, vehicle type, time of day)
- percentage of drivers using mobile phone while driving (by age, gender, type of road, time of day).

5. Analysis and Decision Support Tools

The data platform proposed within this research will be established for the convenience of model development and comparative analyses within the i-Safemodels project. More specifically, macroscopic analyses, providing a broader spectrum for long-term policy-based measures will be performed. Advanced statistical analyses will be conducted to identify the feasible macroscopic safety analyses unit. Then, an evaluation index will be established to identify the critical zones and the potential safety influencing factors at macroscopic level, taking into account all layers of the hierarchical structure of the road safety management systems. Statistical analyses techniques will follow to identify the relationships between influencing factors and safety index. Additionally, statistical methodologies will be adopted in order to carry out the required analyses for making country or region comparisons and test model transferability. Through the comparisons, a decision making supportive database will be formulated from all the aspects of safety management strategies, roadway infrastructure design and policy measures.

Therefore, the platform for global road safety data analysis presented within this paper will be gradually enriched with the statistical methods, models and results of the project, providing a powerful tool for road safety analysis and decision support at global level, which would make it possible to identify and quantify road safety problems throughout the world, evaluate the efficiency of road safety measures, determine the relevance of policy actions and facilitate the exchange of experience in this field. The respective tools will also be open and available for the research and policy-making community.

6. Discussion

Despite the efforts of transportation researchers and practitioners in order to improve road safety, road crashes remain a major global societal problem. The development of an integrated international road safety management system could be beneficial to policy makers by providing solutions for road safety issues with much less effort and cost. This could be achieved if research results and road safety models were transferable among the different countries and regions.

The present research presents the methodological approach for the development of a platform for global road safety data to support macroscopic road safety modelling and international comparative analyses. Based on previous publications and initiatives, a database is considered with numerous indicators and data dealing with the following five layers of the road safety management system: Economy and Management, Transport Demand and Exposure, Road Safety Measures, Safety Performance Indicators and Fatalities and Injuries. For each layer, a set of road safety indicators is suggested to be collected, with the appropriate level of disaggregation for global road safety analyses. Data for the calculation of these indicators will be collected by international road safety databases, while more detailed data and road safety related information will be sought from national sources. Finally, telematics data on driver behaviour and exposure will also be explored as an alternative source of data for the estimation of national exposure and safety performance indicators for five countries.

This proposed data platform, including as many road safety indicators as possible, aims to contribute to international road safety knowledge and road safety management. The existence of all these data will support more sophisticated macroscopic road safety analyses, which will allow for the identification of the leading factors affecting the road safety performances of the countries, the most reliable forecasting of road safety outcomes and thus, the better monitoring of road safety progress and finally the better assessment of various policy scenarios at both global and country level, which is expected to bridge the road safety gap between the various regions of the world. Finally, the "big data" platform, as designed within this research, aims to combine the transport related data as collected through new technologies, such as smartphones, with the traditional road safety indicators, used for monitoring road safety performance, in order to better support decision making process.

References

Dacota, 2012. Road Safety Knowledge System - Safety Performance Indicators. http://safetyknowsys.swov.nl/Statistics/Performance-information.html

Hakkert, A.S and V. Gitelman (Eds.), 2007a. Road Safety Performance Indicators: Manual. Deliverable D3.8 of the EU FP6 project SafetyNet.

Hakkert, A.S, Gitelman, V. and Vis, M.A. (Eds.), 2007b. Road Safety Performance Indicators: Theory. Deliverable D3.6 of the EU FP6 project SafetyNet.

ITF, 2019. New Directions for Data-Driven Transport Safety. International Transport Forum - OECD, Paris.

OISEVI - El Observatorio Iberoamericano de Seguridad Vial, 2016. VIII Informe Iberoamericano de Seguridad Vial. http://www.oisevi.org/a/images/files/informes/info-7.pdf

SUNflower, 2002. A comparative study of the development of road safety in Sweden, the United Kingdom, and the Netherlands. Final report. SWOV Institute for Road Safety Research. Koornstra M., Lynam D., Nilsson G., Noordzij P., Pettersson H. E., Wegman F., Wouters P.

SUNflower+6, 2005. A comparative study of the development of road safety in the SUNflower+6 countries: Final report. SWOV Institute for Road Safety Research. Wegman F., Eksler V., Hayes S., Lynam D., Morsink P., Oppe S.

SUNflowerNext, 2008. Towards a composite road safety performance index. SWOV Institute for Road Safety Research. Wegman F., Commandeur J., Doveh E., Eksler V. Gitelman V., Hakkert S., Lynam D., Oppe S.

Thomas P., Welsh R., Folla K., Laiou A., Mavromatis S., Yannis G., Usami D., Meta E., 2018. Recommendations for a common data collection system and definitions. SaferAfrica project Deliverable 4.2.

UNECE, 2018. SafeFITS Safe Future Inland Transport Systems, United Nations Economic Commission for Europe, Geneva.

Vis, M.A. and Eksler, V. (Eds.), 2008. Road Safety Performance Indicators: Updated Country Comparisons. Deliverable D3.11a of the EU FP6 project SafetyNet

WHO, 2011. Global Plan for the Decade of Action for Road Safety 2011–2020. World Health Organization, Geneva. (http://www.who.int/roadsafety/decade_of_action/plan/plan_english.pdf)

WHO, 2013. Global Status report on road safety 2013. World Health Organization, Geneva.

WHO, 2015. Global Status report on road safety 2015. World Health Organization, Geneva.

WHO, 2018. Global status report on road safety 2018. World Health Organization, Geneva.