Available online at www.sciencedirect.com

ScienceDirect

Transportation Research Procedia 00 (2022) 000–000

Transportation Research Procedia

www.elsevier.com/locate/procedia

Transport Research Arena (TRA) Conference

Assessing Driver Safety Behaviour in Greece

George Yannis[a]*, Katerina Folla[a], Dimitrios Nikolaou[a], Antonis Chaziris[a], Marianthi Kallidoni[a], Stratos Georgiopoulos[b], Manos Parissis[b]

[a] National Technical University of Athens, Iroon Polytechniou 9, Zografou, Athens 157 73, Greece
[b]Ministry of Infrastructure and Transport, 2 Anastaseos str. and Tsigante, Papagos, GR-15669, Greece
[*]Corresponding author. Email: katfolla@central.ntua.gr

Abstract

The objective of this research is to assess drivers' road safety behavior in Greece in relation to speeding, seat-belt and helmet use and driver distraction and identify the characteristics that are associated with these behavioral patterns. Data were collected from roadside observations at randomly selected locations in all regions of Greece, in order to obtain a representative sample. The national Key Performance Indicators were calculated and Negative Binomial Regression models were developed for each indicator. 27% of Greek drivers were found to exceed the legal speed limits and 9% of drivers used a handheld mobile phone while driving. The use of helmet was found relatively high (88%), while the use of seat-belt was relatively low (65%). The results allow to evaluate drivers' behavior and can provide useful support to decision makers working for the improvement of safety in Greece.

Peer-review under responsibility of the scientific committee of the Transport Research Arena (TRA) Conference
Keywords: Driver Behaviour; Road Safety; Key Performance Indicators; Greece

1. Introduction

Road safety constitutes a significant public health problem, with 1,35 million people being killed in road crashes every year worldwide (WHO, 2018). While Europe is the safest continent in terms of road safety, progress in reducing EU-wide road fatality rates has stagnated in recent years (EC, 2021). For the next decade, the European Union has set new targets of reducing the number of road deaths by 50% between 2020 and 2030 as well as reducing the number of serious injuries by 50% over the same period (EC, 2019). In order to monitor closely road safety progress, the European Commission (EC) has elaborated in close cooperation with Member State experts, a set of Key Performance Indicators

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

2352-1465
Peer-review under responsibility of the scientific committee of the Transport Research Arena (TRA) Conference

- KPIs (EC, 2019), which are related to the prevention of road crash casualties, and have been collected in 2021 and 2022 under a common methodological framework by most EU Member States.

In 2020, Greece recorded 579 fatalities in road crashes, achieving a 54% reduction compared to 2010 (1.258 fatalities) (ELSTAT, 2022). Despite this significant improvement, additional efforts are required in order to further improve its road safety performance. An important step to improve road safety performance is to better understand the factors leading to road crashes and casualties. On that purpose, the new Greek Road Safety Strategic Plan for the decade 2021-2030, has harmonized its policy with the European road safety strategic plan, and set a road safety monitoring system based on the 8 KPIs, as defined by the EC, in order to better monitor road safety progress during the next decade (YME, 2022).

The objective of this research is to assess drivers' road safety behavior in Greece based on the KPIs on speeding, seat-belt use, helmet use and driver distraction and evaluate the characteristics that are associated with these behavioral patterns. On that purpose, roadside measurements and observations were carried out in order to collect data on vehicle speed, use of seat-belt by drivers, use of helmet by riders and use of hand-held mobile phone while driving. The number and spatial distribution of census points along different road categories and different regions in Greece were carefully selected in order to obtain a representative sample for the whole country and estimate valid and representative indicators. The estimation of national KPIs by road type and time period or vehicle type were calculated. Further analysis was performed in order to identify the characteristics that are associated with the observed driver behavioral patterns. Therefore, a Binary Logistic Regression model was applied in order to explore the influence of multiple factors (driver's age, gender, type of vehicle, type of road, time period) on a negative/positive outcome of each KPI. The data, on which the analysis is based, were collected in the context of the Baseline project (https://baseline.vias.be/) and will be included in the NAPCORE platform (http://napcore.eu/).

The results of the analysis allow to evaluate drivers' road safety behavior, as well as to identify the driver groups and conditions (i.e. when, where) that are most associated with traffic violations in Greece. These results can also provide useful support to decision makers working for the improvement of safety in Greece, based on which the proper and more targeted road safety measures can be taken.

2. Data Collection and Methodology

As mentioned in the previous section, the data collection process and calculation of the KPIs in Greece were performed within the Baseline project, an EC funded project, which aims to support the data collection and calculation of the KPIs under a common framework at European Union level. The KPIs included in the project concern speeding, use of seat-belts and child restraint systems, use of helmet, driving under the influence of alcohol, driver distraction, vehicle safety, road infrastructure and post-crash care. For the purposes of the present study, four road safety KPIs are considered, which were collected in Greece during the autumn 2021 based on the Baseline guidelines, with emphasis on the behavior of drivers, i.e. speeding, seat-belt use, helmet use and driver distraction.

Data collection for all KPIs was performed through roadside measurements/ observations. The number and spatial distribution of census points along different road types (urban roads, rural roads, motorways) and different regions in Greece were carefully selected in order to obtain a representative sample for the whole country and estimate valid and representative indicators. It is noted that as urban roads are considered the roads within residential areas, while rural roads are defined as roads outside residential areas, excluding motorways. In total, 30 locations were selected, 10 per road type. Additionally, the measurements/observations took place during 3 weeks in autumn 2021, during daylight hours on both weekdays (Monday-Friday) and weekends (Saturday-Sunday). The duration of each session was 3 hours for the speed measurements and 1.5h for the remaining KPIs. All vehicle types were also observed, i.e. passenger cars, motorcycles, mopeds, vans, buses, light goods vehicles (< 3.5t) and heavy goods vehicles (> 3.5t).

Concerning the speed data collection, the instantaneous speed of passing vehicles in free flowing traffic conditions was measured with the use of hand-held radar guns. The selection of the appropriate measurement locations were based on the respective Baseline guidelines, considering specific road design and surrounding environment characteristics, such as straight and uniform section of road, small gradient, away from junctions and pedestrian crossings, away from speed limit change or sign or from sections where speed is enforced etc., ensuring that they will not influence speeds at which drivers operate their vehicles and are suitable for free-flow speed measurements (Teuchies et al., 2021). Measurements were also conducted under various weather conditions (good, rain, fog) for the purposes of the current analysis, however, for the calculation of the national KPIs, only good weather conditions were considered (Teuchies et al., 2021).

The collection of data on the use of seat belt, helmet and driver distraction was made through direct observation by trained observers on the roadside, in randomly selected locations in each region of Greece (Temmerman et al., 2021; Moreau et al., 2021). Concerning the driver distraction, the use of a handheld mobile phone was directly observed and coded by the observers (Boets et. al. 2021). Additionally, only drivers who were driving were observed and not drivers who were stationary. For these KPIs, additional information, i.e. gender and age group (young: 18-24 y.o., medium: 25-65 y.o., elderly: >65 y.o.) of drivers, was also recorded during the observations.

For all KPIs presented in the following section, two levels of stratification were considered (road type and time period or vehicle type). Since no traffic volume data are available at national level, a formula suggested by the Baseline project was used for the data weighting, taking into account the probability of a particular type of location and/or moment in time is chosen (sampling at stratum level) and the number of sampled vehicles/road users in the session divided by the total number of vehicles/road users that passed during the session (sampling at session level). For more detailed explanations of the data weighting, the reader can refer to Silverans & Boets, 2021.

3. Results

3.1. Key Performance Indicators

3.1.1. KPI on Speeding

The KPI on speeding is defined as the percentage of vehicles travelling within the legal speed limits (EC, 2017). It is noted that the different legal maximum speed limits by road type and vehicle type were considered. Table 1 and Table 2 show the KPI on speeding with the corresponding 95% confidence intervals, the average speed, the standard deviation, and the 85th percentile of speed (V85) by road type and vehicle type respectively.

From the speed measurements, data were collected for 9,882 vehicles, of which the 70.9% were passenger cars, 11.3% motorcycles, 9.0% vans and 8.7% buses, light goods vehicles (LGVs) and heavy goods vehicles (HGVs). The vehicle distribution by road type was: 63.3% on urban roads, 27.8% on rural roads and 8.9% on motorways.

The lowest percentage of vehicles travelling within the legal speed limits was observed on urban roads (60.3%), where the average speed was 63.4km/h and the V85 was equal to 72.8km/h, with the respective maximum legal speed limit being 50km/h. The respective KPIs for rural roads and motorways were 82.8% and 68.7% respectively. Concerning vehicle types, the 82.9% of buses, HGVs and LGVs travel within the legal speed limits in the entire road network. The respective KPIs for passenger cars and motorcycles are 72.5% and 68.8% respectively.

Table 1. KPIs on speeding by road type

	KPI	CI (95%)		Average Speed	Std. Deviation	V85
		Lower Bound	Upper Bound	(km/h)	(km/h)	(km/h)
Motorways	68.7%	65.7%	71.8%	105.7	12.3	117.0
Rural Roads	82.8%	81.4%	84.2%	71.4	10.3	81.1
Urban Roads	60.3%	58.8%	61.8%	50.8	9.0	59.6
All roads	73.4%	72.4%	74.3%	63.4	9.8	72.8

Table 2. KPIs on speeding by vehicle type

	KPI	CI (95%)		Average Speed	Std. Deviation	V85
		Lower Bound	Upper Bound	(km/h)	(km/h)	(km/h)
Bus / LGV / HGV	82.9%	80.3%	85.5%	60.0	9.2	68.0
Passenger Car	72.5%	71.4%	73.7%	63.9	9.7	73.4
Motorcycle	68.8%	65.1%	72.5%	58.4	11.3	67.7
Van	78.7%	75.8%	81.7%	66.7	9.1	75.9
All vehicles	73.4%	72.4%	74.3%	63.4	9.8	72.8

3.1.2. KPI on Seat-belt use

The Key Performance Indicator for seat-belt use is defined as the percentage of drivers using the safety belt correctly. Table 3 and Table 4 present the national KPIs on seat belt use for passenger car drivers alongside with the respective 95% confidence intervals by road type and time period respectively.

During the roadside observations, seat-belt use data were collected for 8,577 drivers, of which the 53.1% was observed on urban roads, 22.5% on rural roads and 24.4% on motorways. The 90% of drivers was measured during weekdays and 10% during weekends. Additionally, 79.6% of the observed drivers were males and 20.4% were females, while by age group the young drivers constitute the 23.4% of the sample, 74.1% belong to the medium age group and 2.5% were elderly.

At national level, only 65.3% of drivers of passenger cars were using a seat-belt. This varies by road type, with the respective KPIs being 74.8% for motorways, 64.2% for rural roads and 66.1% for urban roads. A slight different behavior of passenger car drivers is observed by time period, with the KPI being 65.4% for weekdays and 60.9% for weekends. It is noted, however, that the sample collected at weekends was quite low, affecting the final results.

Table 3. KPIs for driver seat-belt by road type

Road Type	KPI	CI (95%)	
		Lower Bound	Upper Bound
Motorways	74.8%	72.5%	77.1%
Rural Roads	64.2%	61.7%	66.6%
Urban Roads	66.1%	64.2%	67.9%
All roads	65.3%	64.0%	66.6%

Table 4. KPIs for driver seat-belt by time period

Time Period	KPI	CI (95%)	
		Lower Bound	Upper Bound
Weekdays	65.4%	64.1%	66.7%
Weekends	60.9%	56.1%	65.7%
All periods	65.3%	64.0%	66.6%

3.1.3. KPI on Helmet use

The KPI on helmet use among powered two wheelers is defined as the percentage of riders wearing a protective helmet. Table 5 and Table 6 show the national KPIs alongside with the respective 95% confidence intervals on helmet use among motorcycle riders by road type and time period respectively.

From the roadside observations, helmet use data were collected for 5,844 motorcycle drivers, of which the 88.6% were observed on urban roads, 2.3% on rural roads and 9.1% on motorways. Concerning the stratum of time period, 87.9% of motorcyclists were observed on weekdays and 12.1% motorcyclists during weekends. Additionally, 96% of observed riders were males and 4% of riders were females.

The national KPI on helmet use by motorcycle riders was is 87.6%. The highest use of helmet by motorcyclists is observed on motorways (97.4%), with the respective KPIs on urban and rural roads being 88.6% and 83.7% respectively. Also, a difference on helmet use between weekdays and weekends is observed (88.5% vs. 81.4%).

Table 5. KPIs on helmet use among motorcycle riders by road type

Road Type	KPI	CI (95%)	
		Lower Bound	Upper Bound
Motorways	97.4%	96.0%	98.7%
Rural Roads	83.7%	76.9%	90.4%
Urban Roads	88.6%	87.7%	89.4%
All roads	87.6%	86.7%	88.4%

Table 6. KPIs on helmet use among motorcycle riders by time period

Road Type	KPI	CI (95%)	
		Lower Bound	Upper Bound
Weekdays	88.5%	87.6%	89.4%

Weekends	81.4%	78.5%	84.3%
All periods	87.6%	86.7%	88.4%

3.1.4. KPI on Distraction

The KPI on driver distraction is defined as the percentage of drivers not using a handheld mobile phone while driving. Table 7 and Table 8 show the national KPIs on driver distraction alongside with the respective confidence intervals by road type and vehicle type respectively.

During roadside observations, 7,457 drivers were observed in total, of which the 56.1% of drivers were observed on urban roads, 22.3% on rural roads and 21.6% on motorways. Concerning the vehicle types, 92% of the sample were passenger cars, 6% were LGVs and 2% were buses.

The national KPI on driver distraction 90.6%, meaning that about 10% of drivers use a handheld mobile phone while driving. Drivers' behavior concerning the mobile phone use does not differentiate significantly when travelling on rural and urban roads, while the KPI on motorways is much lower (81%). A different behavior among drivers of different vehicle types is also observed, however, with the low sample of LGVs and buses, conclusions cannot be safely deduced.

Table 7. KPIs on driver distraction by road type

Road Type	KPI	CI (95%)	
		Lower Bound	Lower Bound
Motorways	81.2%	79.3%	83.1%
Rural Roads	91.3%	89.9%	92.6%
Urban Roads	91.1%	90.0%	92.3%
All roads	90.6%	89.8%	91.4%

Table 8. KPIs on driver distraction by vehicle type

Road Type	KPI	CI (95%)	
		Lower Bound	Lower Bound
Passenger Car	90.6%	89.8%	91.4%
Bus	81.1%	74.0%	88.2%
LGV	94.9%	92.8%	97.0%
All vehicles	90.6%	89.8%	91.4%

3.2. Binary Logistic Regression

Binary Logistic Regression models are well established statistical functional-based methods, widely applied in order to model two discrete outcomes. The best fitting model which describes the linear relationship between a dichotomous dependent variable and a number of independent variables is pursued. If the utility function is given by Equation (1), then the probability P that the dependent variable belongs in a specific class is given by Equation (2):

$$U = \beta_0 + \beta_i * X_i \quad (1)$$

$$P = e^U / (e^U + 1) \quad (2)$$

Model selection process between models including different independent variables is conducted by the Akaike Information Criterion (AIC). The majority of the tests for goodness of fit of a model are carried out by analyzing residuals. However, a similar approach is not feasible for a binary outcome variable. In this case, the Hosmer & Lemeshow Test can be used for the assessment of the model’s goodness of fit. This test evaluates whether observed event rates match the expected once in subgroups of the model population. The test’s output is a chi-squared and a p-value; a p-value higher than 0.05 indicates a good fit (Hosmer & Lemeshow, 2000). For more in-depth explanations of the statistical background, the reader can refer to Washington et al. (2020).

As per standard good practice, the binary logistic regression models developed within the framework of this study, were trained in a subset of the entire dataset, while their predictions were tested in completely new data for the model. Specifically, the chosen ratio was 75% for the train subset and 25% respectively for the test subset. Confusion matrixes were also created in order to inspect the accuracy of the model (true positives and true negatives compared to the total sample). All analyses are conducted using R-studio (R Core Team, 2019) and a number of packages.

All the variables that were included in the binary logistic regression models of the present study and their codification are presented at Table 9.

Table 9. Considered variables from the roadside measurements and codification

Variable	Values
Driver_seatbelt	0: No, 1: Yes
Driver_distraction	0: No, 1: Yes
Driver_helmet	0: No, 1: Yes
Speeding	0: No, 1: Yes
Driver_gender	0: Male, 1:Female
Driver_age	1: Young, 2: Middle, 3:Elderly
Road_type	1: Motorway, 2: Rural, 3: Urban
Weather_conditions	1: Good, 2: Adverse
Time_period	1: Weekday, 2: Weekend
Vehicle_type	1: Passenger Car, 2: Van, 3: Other
Vehicle_type_helmet	1: Motorcycle, 2: Other
Vehicle_type_speeding	1: Passenger Car, 2: Powered Two-Wheeler, All-Terrain Vehicle, 3: Bus, Light Truck, Heavy Truck, 4: Van

In total, four binary logistic regression models were developed and the dependent variables of the models are “Driver_seatbelt”, “Driver_helmet”, “Driver_distraction” and “Speeding”. The results of the four statistical models are demonstrated at Tables 10-12, with statistically significant variables being shown in bold.

Table 10. Binary Logistic Regression Models’ Results for seatbelt use and distraction

	Driver_seatbelt				Driver_distraction			
Independent Variable	Beta Estimate	Std. Error	z value	p-value	Beta Estimate	Std. Error	z value	p-value
(Intercept)	1.307	0.087	14.986	**<0.001**	-1.404	0.106	-13.234	**<0.001**
Driver_gender1	0.943	0.076	12.365	**<0.001**	-	-	-	-
Driver_age2	-0.534	0.068	-7.817	**<0.001**	-0.621	0.091	-6.757	**<0.001**
Driver_age3	-0.487	0.178	-2.729	**0.006**	-0.845	0.321	-2.631	**0.009**
Vehicle_type2	-1.308	0.096	-13.503	**<0.001**	0.527	0.127	4.137	**<0.001**
Vehicle_type3	-2.631	0.129	-20.363	**<0.001**	0.249	0.134	1.850	0.064
Road_type2	-0.615	0.086	-7.142	**<0.001**	-0.534	0.122	-4.371	**<0.001**
Road_type3	-0.719	0.074	-9.679	**<0.001**	-0.588	0.102	-5.756	**<0.001**
Weather_conditions2	-	-	-	-	-0.240	0.115	-2.080	**0.038**
AIC	7610.5				4045.3			
Hosmer & Lemeshow	0.475				0.938			
Accuracy (test data)	0.661				0.901			

Table 11. Binary Logistic Regression Models’ Results for helmet use

	Driver_helmet			
Independent Variable	Beta Estimate	Std. Error	z value	p-value
(Intercept)	3.431	0.285	12.029	**<0.001**
Driver_age2	0.132	0.081	1.629	**0.103**
Driver_age3	-1.256	0.498	-2.520	**0.012**
Vehicle_type_helmet2	-2.056	0.201	-10.218	**<0.001**
Road_type2	-1.470	0.404	-3.634	**<0.001**
Road_type3	-1.658	0.285	-5.804	**<0.001**
Weather_conditions2	-0.564	0.098	-5.720	**<0.001**
Time_period2	0.261	0.115	2.268	**0.023**
AIC	4132.1			
Hosmer & Lemeshow	0.932			
Accuracy (test data)	0.859			

Table 12. Binary Logistic Regression Models' Results for speeding

	Speeding			
Independent Variable	Beta Estimate	Std. Error	z value	p-value
(Intercept)	-0.697	0.082	-8.436	**<0.001**
Vehicle_type_speeding2	-0.063	0.076	-0.834	0.404
Vehicle_type_speeding3	-0.664	0.095	-6.960	**<0.001**
Vehicle_type_speeding4	0.025	0.083	0.305	0.761
Road_type2	-0.449	0.090	-4.941	**<0.001**
Road_type3	0.566	0.083	6.758	**<0.001**
Weather_conditions2	-1.073	0.089	-12.016	**<0.001**
Time_period2	-0.090	0.060	-1.496	0.135
AIC	10651.7			
Hosmer & Lemeshow	<0.001			
Accuracy (test data)	0.668			

Based on the beta coefficients of the four developed models, the influence of multiple factors on each KPI is identified. More specifically, results indicate the following:

- Female drivers are more likely to use their seat-belt compared to males.
- Middle-aged and elderly drivers present lower probabilities of using a seat-belt and a handheld mobile phone while driving, compared to young drivers.
- The probability of using a helmet is lower for elderly drivers compared to young drivers.
- Compared to motorways, the probability of using a seatbelt, a helmet and a handheld mobile phone while driving on rural and urban roads is lower.
- The probability of using a seatbelt in a van and other vehicle types is lower than passenger cars. The opposite is the case for the use of handheld mobile phone.
- Buses and trucks present lower probability of exceeding the speed limit compared to passenger cars.
- The probability of speeding on urban roads is higher than on motorways, while the opposite is the case for rural roads.
- In adverse weather conditions the probability of using a helmet, a handheld mobile phone while driving and exceeding the speed limit is lower in comparison with good weather conditions.
- On weekends, the probability of wearing a protective helmet increases.

The p-values of Hosmer & Lemeshow Test for goodness of fit of the seatbelt use, distraction and helmet use models are higher than 0.05 meaning that one cannot reject the null hypothesis of the test for these two models, which suggests they can be considered as acceptable. However, when examining the speeding models, and despite an adequate accuracy, the p-values of the Hosmer & Lemeshow Test was statistically significant, which may indicate a poor model fit for some of the strata of the sample.

4. Conclusions

The present study aims to assess drivers' road safety behavior in Greece in relation to speeding, seat-belt use, helmet use and driver distraction and to evaluate the characteristics that are more associated with these behavioral patterns. Data were collected through roadside measurements / observations at randomly selected locations in almost all regions of Greece, in order to obtain a representative sample. The related KPIs were calculated based on the EC definitions and the common European methodological protocol, while further information was also recorded, which was utilized for further analysis of Greek drivers' behavior. Thus, Negative Binomial Regression models were developed for each indicator, in order to associate drivers' behavior with driver, road, vehicle, time and weather related characteristics.

Concerning the national indicators, about 27% of Greek drivers were found to exceed the maximum legal speed limits on all roads, with higher percentages of drivers exceeding the speed limits being observed on urban roads (about 40%) and motorways (about 31%). Additionally, motorcyclists tend to observe the speed limits less often than the drivers of the remaining vehicle types, followed by passenger car drivers. Greek passenger car drivers tend to use the seat-belt more often when travelling on motorways in comparison with the remaining road types and during weekdays, which is also the case for the use of helmet among motorcyclists. It is noted, however, that the use of helmet is relatively high at national level (87.6%), while the use of seat-belt is relatively low (about 65%). Moreover, high rates of handheld mobile phone use were observed at national level (about 9%), with the highest percentages of using a mobile phone while driving being recorded on motorways.

Concerning drivers' gender, female drivers present a safer behavior compared to male drivers, with higher percentages of seat-belt use and lower percentages of use of a mobile phone while driving. Drivers of the medium age group tend to use less often a seat-belt or a helmet, while young drivers use more often handheld mobile phone while driving. Finally, adverse weather conditions (e.g. rain, fog) seem to affect positively drivers' behavior, with the rates of drivers exceeding speed limits and using a handheld mobile phone being lower compared to good weather conditions, however, this is not the case for the helmet and seat-belt use.

In conclusion, the results of the present analysis allow to evaluate drivers' road safety behavior, as well as to identify the driver groups and conditions that are most associated with traffic violations in Greece. Further analysis of these results, alongside with the related exposure and road crash data could reveal the real dimension and main causes of the road safety problem in Greece, providing, thus, useful support to the related decision makers in order to take proper and more targeted road safety measures.

Acknowledgements

This paper is based on data collected within the Baseline project, co-financed by the European Union and the Hellenic Ministry of Infrastructure and Transport under the CEF-PSA "Collection of Key Performance Indicators (KPIs) for road safety" (Grant Agreement No: MOVE/C2/SUB/2019-558/CEF/PSA/SI2.835753) and on work carried out within the NAPCORE project, co-financed by the European Union and the Hellenic Ministry of Infrastructure and Transport under the CEF-PSA "NAPCORE" (Grant Agreement No: MOVE/B4/SUB/2020-123/ SI2.852232).

References

Boets, S. et al. (2021). Methodological guidelines – KPI Distraction. Baseline project, Brussels: Vias institute, online available: https://baseline.vias.be/storage/minisites/methodological-guidelines-kpi-distraction.pdf

ELSTAT (2022). Press Release - Road Accidents: Year 2020. Hellenic Statistical Authority, Piraeus. Available online at: https://www.statistics.gr/documents/20181/17776954/NWS_SDT04DTAN2020_30032022_EN.pdf/99191f4c-a499-de81-b8ea-2828a34b40da?t=1648627187519

European Commission (2017) Monitoring Road Safety in the EU: towards a comprehensive set of Safety Performance Indicators. European Commission, Directorate General for Transport https://ec.europa.eu/transport/road_safety/sites/roadsafety/files/pdf/ersosynthesis2017-detail-performanceindicators15_en.pdf.

European Commission (2019). Commission staff working document EU road Safety Policy Framework 2021-2030 - Next steps towards "Vision Zero". SWD (2019) 283 final. Retrieved from https://ec.europa.eu/transport/sites/transport/files/legislation/swd20190283-roadsafety-vision-zero.pdf

European Commission (2021). Press release Road safety: 4,000 fewer people lost their lives on EU roads in 2020 as death rate falls to all-time low, Brussels.

Hosmer D W, Lemeshow S 2000. Applied Logistic Regression. New York, USA: John Wiley and Sons.

Moreau, N. et al. (2021). Methodological guidelines – KPI Helmet use of Cyclists and Powered Two-wheelers (PTWs). Baseline project, Brussels: Vias institute, online available: https://baseline.vias.be/storage/minisites/methodological-guidelines-kpi-helmet-use-of-cyclists-and-ptws.pdf

R Core Team (2019). R: A Language and Environment for Statistical Computing. R Foundation for Statistical Computing, Vienna, Austria.

Silverans, P., & Boets, S. (2021). Considerations for sampling weights. Baseline project, Brussels: Vias institute, online available: https://baseline.vias.be/storage/minisites/baseline-considerations-for-sampling-weights.pdf

Temmerman, P. et al. (2021). Methodological guidelines – KPI safety belts and child restraint systems. Baseline project, Brussels: Vias institute, online available: https://baseline.vias.be/storage/minisites/methodological-guidelines-kpi-safety-belts-crs.pdf

Teuchies, M. et al. (2021). Methodological guidelines – KPI speeding. Baseline project, Brussels: Vias institute, online available: https://baseline.vias.be/storage/minisites/methodological-guidelines-kpi-speeding.pdf

Washington, S., Karlaftis, M., Mannering, F., & Anastasopoulos, P. (2020). Statistical and econometric methods for transportation data analysis. Chapman and Hall/CRC.

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

YME (2022). National Road Safety Strategy of Greece 2021-2030. Hellenic Ministry of Infrastructure and Transport, available at: https://www.nrso.ntua.gr/nrss2030/strategy/?lang=en