Baseline

Baseline report on the KPI Speeding

January 2023

Baseline

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Any comments or feedback regarding this report should be sent to Baseline@vias.be.

Version history

Version	**Date**	**Changes**
1.0	February 17, 2020	First draft version of format
2.0	April 29, 2022	Second draft version, using data collected in 2021
2.1	July 29, 2022	Updated second draft version
2.2	August 23, 2022	Updated second draft version
2.3	September 15, 2022	Updated second draft version
2.4	October 2, 2022	Final draft
2.5	December 22, 2022	Updated final draft, including review feedback and latest data
2.6	January 23, 2023	Updated final draft, including latest feedback
2.7	January 26, 2023	Included expressways in table 5 and figures 3, 4 and 5
2.8	January 27, 2023	Included expressways in table 4 and figures 1, 6, 7 and 8

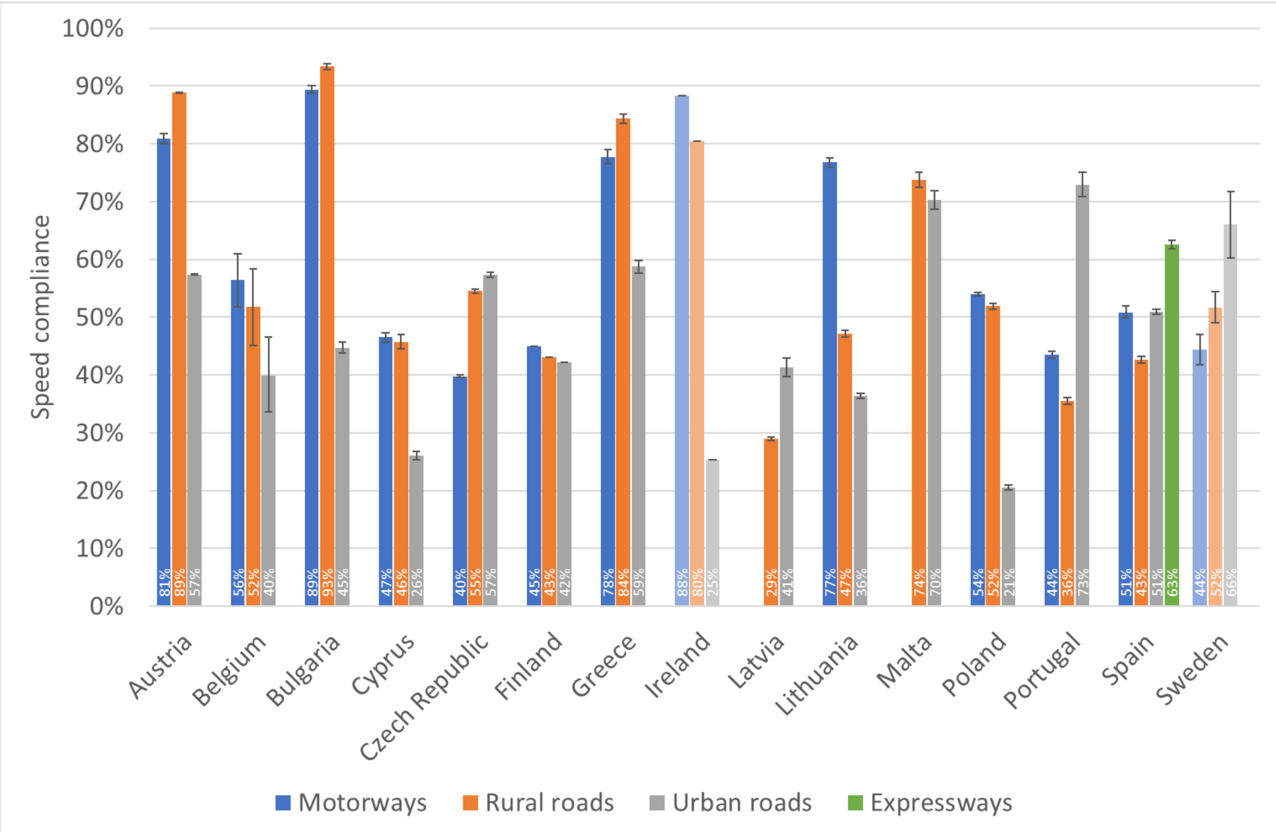
Contents

Executive summary

This document reports information on the KPI speeding, which is defined as the percentage of drivers driving within the speed limit. Speed is a risk factor that is indicative for road safety, and the speeding KPI is an indicator for this risk factor. Seventeen Member States provided data on this KPI, and the figure below provides an overview[1]: it concerns passenger cars during weekday/daytime on motorways[2], rural roads, urban roads and expressways. Denmark and the Netherlands[3] are not in the figure as they provided results on different aggregation levels. The indicators average speed and 85th percentile of speed have also been provided by some Member States, and they complement the main KPI, e.g. by telling whether exceedances of the speed limit are mainly small or large. Speed limits per road type differ between Member States, and a higher speed limit on the same road type usually means a higher share of drivers driving within the speed limit, hence for further comparison between Member States a breakdown by speed limit is also considered.

The limited available data on different time periods suggests that driving behaviour in terms of speed may differ between daytime and night-time and between weekdays and weekends, and provision of data for these different time periods by more Member States could share more light on this.

Figure 1. Speed compliance by passenger cars during weekday/daytime



[1] No information on the traffic conditions in Ireland was available at the time of writing this report, hence their results may deviate methodologically and therefore are marked differently. The results of Sweden are also marked differently as theirs are based on measurements during daytime and night-time and weekdays and weekends combined.

[2] Note that no data on motorways for Latvia and Malta is included, which is because both have no motorways.

[3] Results of the Netherlands deviated methodologically from those of the other Member States.

1 Introduction

1.1 Context

The Communication of the European Commission "Europe on the Move – Sustainable Mobility for Europe: safe, connected and clean" of the 13th of May 2018 confirmed the EU's long-term goal of moving close to zero fatalities in road transport by 2050 and added that the same should be achieved for serious injuries. It also proposed new interim 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% in the same period. To measure progress, the most basic – and important – indicators are of course the result indicators on deaths and serious injuries.

In order to gain a better understanding of the different issues that influence overall safety performance, the Commission has elaborated, in cooperation with Member State experts, a first set of key performance indicators (KPIs). The list of the KPIs is given in ***Table 1***. The minimum requirements for these KPIs are described in the *Commission Staff Working Document SWD (2019) 283*, further referred to as 'SWD'.

Table 1. List of European KPIs for road safety

KPI area	KPI definition
Speed	Percentage of vehicles travelling within the speed limit
Safety belt	Percentage of vehicle occupants using the safety belt or child restraint system correctly
Protective equipment	Percentage of riders of PTWs and bicycles wearing a protective helmet
Alcohol	Percentage of drivers driving within the legal limit for blood alcohol content (BAC)
Distraction	Percentage of drivers not using a handheld mobile device
Vehicle Safety	Percentage of passenger cars with a Euro NCAP safety rating equal or above a threshold
Infrastructure	Percentage of distance driven over roads with a rating above an agreed threshold
Post-crash care	Time elapsed between the emergency call following a collision resulting in personal injury and the arrival at the scene of the collision of the emergency services

Funding has been made available by the European Commission to support Member States in the data collection and analysis for these KPIs. Eighteen Member States participate in a common project, called "Baseline". The aim of the Baseline project, funded partially by the European Commission, is to assist participating Member States' authorities in the collection and harmonized reporting of these KPIs and to contribute to building the capacity of Member States which have not yet collected and calculated the relevant data for the KPIs. The outcomes of this project will be used to set future European targets and goals based on the KPIs.

1.2 Participation in Baseline

The following EU Member States participated in the Baseline project: Austria; Belgium; Bulgaria; Cyprus; Czech Republic; Finland; Germany; Greece; Ireland; Latvia; Lithuania; Luxembourg; Malta; The Netherlands; Poland; Portugal; Spain; Sweden. Some data regarding KPIs of EU Member States that were not participating in Baseline are also included in the deliverables.

1.3 Final deliverables of the Baseline project

The final public outcomes and deliverables of the Baseline project are:

- Eight specific reports, each on one KPI
- A website on which all public information is accessible
- A final report including the key results of the project and recommendations for next steps.

This document is the report providing information on the ***KPI Speeding***. This KPI has been defined as:

"Percentage of vehicles travelling within the speed limit"

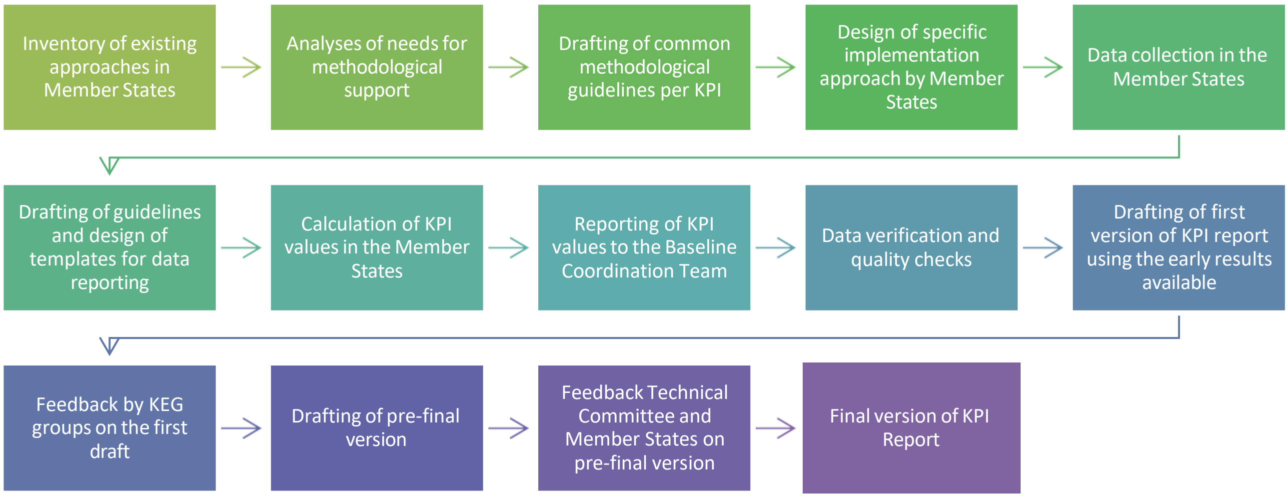
This KPI is complemented with two optionally provided indicators, the average speed and the 85th percentile of speed, to provide a more informative picture on speeding.

2 Methodology

2.1 Overall process

The process followed for arriving at this report is summarized in the following scheme:

Figure 2. Process leading to this report



For each KPI, a "KPI Expert Group" (KEG) was established, which was responsible for the design of the methodological guidelines and for the review of a draft version of this report. The KEG for the speeding indicator consisted of the following persons:

- Anna Vadeby, VTI (Sweden),
- Ingrid van Schagen, SWOV Institute for Road Safety Research (the Netherlands);
- François Riguelle, AWSR (Belgium),
- Paweł Tutka, Warsaw University of Technology (Poland).

The overall process was overseen by the Technical Committee, which focused in particular on issues that were important for several KPIs (e.g. structure and content of methodological guidelines, minimum samples, number of observations and locations, weighting of data, data reporting, etc.). The Technical Committee consisted of:

- Peter Silverans, Vias institute (Belgium) - Coordinator
- Wouter Van den Berghe, Vias institute (Belgium)
- Frits Bijleveld, SWOV (Netherlands)
- Sheila Ferrer López, DGT (Spain)
- Peter Larsson, Trafikverket (Sweden)
- Markus Schumacher, BASt (Germany)
- Veronika Valentova, CDV (Czech Republic)
- George Yannis, NTUA (Greece)

2.2 Support tools developed

For every KPI, methodological guidelines were developed, covering topics such as:

- definition of the KPI concerned, and possibly complementary or alternative KPIs
- methods to be used for data collection
- breakdowns requested of the KPI values (road category, vehicle type, day of week, …)
- minimum sample of observations/cases and observation locations
- methods for weighting and analysing the data
- nature and format of data to be reported

The methodological guidelines of the KPI Speeding (Teuchies et al., 2021) can be accessed from the Baseline website via https://www.baseline.vias.be/en/publications/methodological-guidelines-kpi/. Many elements of the Methodological Guidelines have been integrated in this report, either within the main body of the text, or as part of the Annex.

In order to streamline and harmonize the data flow, data reporting guidelines and data reporting templates were developed. The data reporting templates (in Excel) were used by the Member States for reporting their KPI values to the Baseline Coordination Team.

Time period	Road Type	Vehicle Type	Nr of Locations	N	Traffic Counts	KPI	CI (95%) - lower bound3	CI (95%) - upper bound3
weekday/daytime	motorways	passenger cars	15	7.172	179.300	0,8090	80,0%	81,8%
weekday/daytime	motorways	vans, small trucks	15		179.300			
weekday/daytime	motorways	trucks/ buses/ heavy goods vehicles	15		179.300			
weekday/daytime	motorways	motorcycles	15		179.300			
weekday/daytime	**motorways-Total**	*(All vehicles)*	**15**		**179.300**			
weekday/daytime	rural roads	passenger cars	45	726.774	2.287.930	0,8890	88,8%	89,0%
weekday/daytime	rural roads	vans, small trucks	45	103.908	2.287.930	0,8630	86,1%	86,5%
weekday/daytime	rural roads	trucks/ buses/ heavy goods vehicles	45	122.532	2.287.930	0,9880	98,7%	98,9%
weekday/daytime	rural roads	motorcycles	45	14.859	2.287.930	0,7950	78,9%	80,2%
weekday/daytime	**rural roads-Total**	*(All vehicles)*	**45**	**983.755**	**2.287.930**	**0,8970**	**89,6%**	**89,8%**
weekday/daytime	urban roads	passenger cars	61	1.368.747	3.873.309	0,5740	57,3%	57,5%
weekday/daytime	urban roads	vans, small trucks	61	167.623	3.873.309	0,5480	54,6%	55,0%
weekday/daytime	urban roads	trucks/ buses/ heavy goods vehicles	61	138.253	3.873.309	0,7040	70,2%	70,6%
weekday/daytime	urban roads	motorcycles	61	39.093	3.873.309	0,5930	58,8%	59,8%
weekday/daytime	**urban road-Total**	*(All vehicles)*	**61**	**1.752.808**	**3.873.309**	**0,5840**	**58,3%**	**58,5%**
weekday/daytime	*(All roads)*	**passenger cars-Total**	121	2.102.693	6.340.539	**0,7890**	**78,8%**	**79,0%**
weekday/daytime	*(All roads)*	**vans, small trucks-Total**	223		11.261.279			
weekday/daytime	*(All roads)*	**trucks/ buses/ heavy goods vehicles-Total**	223		11.261.279			
weekday/daytime	*(All roads)*	**motorcycles-Total**	223		11.261.279			
weekday/daytime	*(All roads)*	*(All vehicles)*	223		11.261.279			

2.3 Definition of speed and speeding

Studies have shown that with an increase in absolute speed both the crash rate and the severity of crashes increase, and that the crash rate increases with an increase in speed dispersion, i.e., spatiotemporal speed differences between vehicles; see e.g. European Commision (2021) and references therein. This makes speed a risk factor that is indicative for road safety.

A speed is considered “too high” from a road safety point of view when it is excessive or inappropriate, i.e., when it exceeds the speed limit or when it is too high for the situation taking into account circumstances such as traffic, infrastructure and the weather. Excessive or inappropriate speed is found to be the direct cause of 10 to 15% of all road crashes and of 30% of all fatal injury crashes, and when not the main cause it is often a contributing or aggravating factor (European Commission, 2021).

For the measurement of speed there exist various indicators that complement each other. The principal indicator considered here is the percentage of vehicles travelling within the speed limit. It measures excessive speed, which is directly linked to the amount of road crashes and fatal injury crashes. This presumes, however, that speed limits are set at a safe value (European Commission, 2021). Other indicators are the average speed and the V85, i.e., the speed below which 85% of vehicles are driving.

Furthermore, speed indicators can be measured in different ways. Two measurement methods relevant to the KPI speeding are that of spot speed measurements and section speed measurement. Spot speed is the speed that is measured when driving over a very short distance, such that the speed may be considered constant over this short distance. Section speed is the average speed that is measured over a road section. Along this section the speed may fluctuate.

For the KPI speeding as it is defined within Baseline, it is required that traffic is free flowing, i.e., not experiencing any speed restrictions due to external conditions such as traffic jams, infrastructure or road works. Consequently, journey speed is not suitable to measure speed in free flowing traffic as it provides no guarantee that traffic is free flowing, whereas spot speed is, and so the latter will be the concept of speed underlying the KPI speeding.

2.4 Minimum and optional requirements for the KPI Speeding within Baseline

The minimum requirements for the KPI Speeding are given in ***Table 2***. The table also includes optional supplementary approaches. Baseline partner countries had the option of either just meet the minimum requirements or to extend (part of) their methodology and include other elements.

The KPI is presented as the percentage of vehicles in free flowing traffic that are travelling within the speed limit. Free flowing traffic means that drivers are free to choose their speed and in doing so are not restricted by external conditions such as traffic jams, infrastructure or road works. This is operationalised by only including vehicles that have a headway similar to the distance travelled in 5 seconds at the current legal speed limit. Besides this indicator, it was recommended to also measure the speed below which 85% of vehicles are driving (V85), and the average speed. Standard error and standard deviation should be included if possible.

Table 2. Minimum requirements and optional additions for the KPI Speeding

	Minimum requirement	Optional additions
KPI definition	• Percentage of vehicles within speed limit	• Average speed (+ Standard Deviation and Standard Error/Confidence Interval) • V85
Method	• Should allow for the observation of momentaneous speed in free flowing traffic[4]	
Conditions	• Free-flow traffic • Good weather conditions • In spring or autumn	• Non free flow traffic • Bad weather conditions • In summer or winter
Sample size	• Min 2000 observations • Min 500 observations / road type • Min 10 locations / road type • The proportion of observations at each of the three road types should be at least 20%	*If optional vehicles are included, the minimum sample requirements are per vehicle type in order to be considered in the national KPI tables*
Locations	• Random selection • Representative of entire national road network • Measurements should not take place near speed cameras, either fixed or mobile • A minimum traffic flow of at least 10 vehicles passing per hour is required	• Stratification by Regions

4. Possible methods include:

- those based on out-of-road devices (e.g. radar systems, light detection and ranging (LIDAR) devices, active infrared devices, cameras),
- in-road devices (e.g. loop detectors, axle detectors)
- and hand-held devices (e.g. radar guns and laser guns).

Vehicle types	• Passenger cars	• Motorcycles • Vans and light trucks • Heavy trucks • Buses
Road types	• Motorways • Rural roads (defined as roads outside built-up areas, but no motorways) • Urban roads (defined as roads inside built-up areas)	• Differentiate between single and dual lane roads for rural and urban roads • Differentiate between speed limits within rural and urban roads
Time periods	• Weekdays • Daylight hours	• Weekend • Night-time hours

3 Results

3.1 Overall results

The Member States that provided data are Austria, Belgium, Bulgaria, Cyprus, the Czech Republic, Denmark, Finland, Greece, Ireland, Latvia, Lithuania, Malta, The Netherlands, Poland, Portugal, Spain and Sweden. Luxembourg only had their data for multiple days combined, no individual days, and without distinction between day and night, hence their data was not fit for inclusion.

3.1.1 Metadata

An overview per Member State of the data collection method and conditions including time of the year when data was collected is provided in Table 3. Most Member States used radar or loop detectors or both, Sweden also made use of pneumatic tubes, and the Netherlands relied on floating car data (FCD). With the exception of FCD, these are all methods that allow for the measurement of spot speeds. Since spot speed in the kind of speed considered here in this report, results by the Netherlands will be marked differently in all of the figures.

The traffic conditions under which observations were made were free-flowing traffic, or mostly free-flowing in the case of Sweden. Since traffic in Sweden is mostly free-flowing we expect their results to be comparable with those of other Member States. Ireland provided no information on the traffic conditions, hence it is difficult to say how comparable their results are to those of other Member States, and therefore we will mark their results differently.

It has been recommended to collect data during spring and autumn, as these periods are considered neutral in terms of seasonal variation in traffic and weather conditions. All Member States collected data during at least spring and/or autumn. Those that included summer collected data over a period of at least 8 months, and we expect this to be long enough for seasonal variations to have little influence and results to be comparable. Those that also collected data during winter included only results obtained under good weather conditions, and so we expect these also to be comparable. Ireland provided no information on the observation period and weather conditions.

All Member States provided as indicators the percentage of vehicles driving within the speed limit (speed compliance), all but Denmark also provided the average speed, and all but Denmark and Sweden also provided the speed below which 85% of vehicles are driving (V85). These indicators came with 95% confidence intervals, except for Finland which provided confidence intervals for the percentage driving within the speed limit at the required aggregation levels for which there was sufficient data to do so. Results on these indicators will be presented with the 95% confidence intervals, whenever these are available, except for the V85 which will be presented without confidence intervals due to the complexity of calculating the latter.

Table 3. Data collection method, conditions and indicators

	Data collection method	Traffic conditions	Weather conditions	Observation period	Indicators
Austria	hand-held radar on motorways, automated radar on rural and urban roads	free-flow	all weather, motorways no rain	01/03/2021 - 30/11/2021	speed compliance, average speed, V85
Belgium	radar	free-flow	all weather, no storm or snow	20/09/2021 - 08/12/2021	speed compliance, average speed, V85
Bulgaria	mobile radar camera	free-flow	good weather conditions	04/10/2021 - 31/05/2022	speed compliance, average speed, V85
Cyprus	radar guns	free-flow	good weather conditions	01/09/2022 - 13/10/2022	speed compliance, average speed, V85
Czech Republic	automated radar	free-flow	sunny or cloudy weather	09/06/2021 - 30/06/2021, 03/09/2021 - 20/10/2021	speed compliance, average speed, V85
Denmark	electrical loops in the road	free-flow	all weather	03/2022 - 08/2022	speed compliance
Finland	inductive loops	free-flow	all weather	01/09/2021 - 30/09/2021	speed compliance, average speed, V85
Greece	radar guns	free-flow	good weather conditions	28/03/2022 - 25/05/2022	speed compliance, average speed, V85
Ireland	automated measurements	-	-	-	speed compliance, average speed, V85
Latvia	hand-held radar on urban roads, loop detectors on rural roads	free-flow	good weather conditions	01/09/2021 - 31/10/2021 (rural roads), 01/09/2021 - 16/11/2021 (urban roads)	speed compliance, average speed, V85
Lithuania	microwave radar, inductive loops	free-flow	good weather conditions	08/09/2020 - 26/05/2021	speed compliance, average speed, V85
Malta	radar	free-flow	sunny and hot weather	20/06/2022 - 18/08/2022	speed compliance, average speed, V85
Netherlands	floating car data	all traffic	all weather	2021	speed compliance, average speed, V85
Poland	Doppler-based microwave radar	free-flow, all traffic	good weather, no rain, no fog	01/10/2021 - 31/11/2021	speed compliance, average speed, V85
Portugal	magnetic sensors on motorways and rural roads, LIDAR speed gun on urban roads	free-flow	dry weather, occasional short showers	12/10/2021 - 18/11/2021 (urban roads), 15/02/2022 - 05/05/2022 (other)	speed compliance, average speed, V85

Spain	Doppler-based microwave radar	free-flow	excluded extreme weather conditions	24/08/2022 - 16/10/2022	speed compliance, average speed, V85
Sweden	pneumatic tubes on motorways and rural roads, radar on urban roads	mostly free-flow	all weather types, no extreme situations	09/2022 (urban roads), 04/2022 - 09/2022 (other)	speed compliance, average speed

The disaggregation of the data provided by each Member State is presented in table 4. All Member States provided data covering weekday/daytime, some also covering the weekend and/or night-time, except for Denmark, the Netherlands and Sweden which provided data for all these periods combined. Since in Sweden the daytime period was between 6 AM and 8 PM when observations were done, and experience has shown differences are minor between these daytime hours and all hours, we will compare their results with those of other Member States during weekday/daytime, though with that of Sweden marked differently in figures and tables. Data for each of the road types motorway, rural road and urban road were provided by each Member State, except for Latvia and Malta which do not have motorways and therefore could not provide data for this particular road type. Data regarding passenger cars was provided by all Member States, some also provided data on the other vehicle type categories. Portugal with respect to vehicles on motorways and urban roads classified them on the basis of their length, and included motorcycles into the category of passenger cars.

Table 4. Disaggregation

	Data collection timeslots	Road type	Vehicle types observed
Austria	weekday/daytime, weekday/night-time, weekend/daytime, weekend/night-time	motorways, rural roads, urban roads	passenger cars; vans/small trucks; trucks/buses/heavy goods vehicles; motorcycles
Belgium	weekday/daytime, weekday/night-time, weekend/daytime, weekend/night-time	motorways, rural roads, urban roads	passenger cars
Bulgaria	weekday/daytime	motorways, rural roads, urban roads	passenger cars
Cyprus	weekday/daytime, weekend/daytime	motorways, rural roads, urban roads	passenger cars; vans/small trucks; trucks/buses/heavy goods vehicles
Czech Republic	weekday/daytime, weekday/night-time, weekend/daytime, weekend/night-time	motorways, rural roads, urban roads	passenger cars; vans/small trucks; trucks/buses/heavy goods vehicles; motorcycles
Denmark	all periods combined	motorways, rural roads, urban roads	passenger cars
Finland	weekday/daytime, weekday/night-time, weekend/daytime, weekend/night-time	motorways, rural roads, urban roads	passenger cars
Greece	weekday/daytime, weekend/daytime	motorways, rural roads, urban roads	passenger cars; vans/small trucks; trucks/buses/heavy goods vehicles; motorcycles

Ireland	weekday/daytime	motorways, rural roads, urban roads	passenger cars; vans/small trucks; trucks/buses/heavy goods vehicles
Latvia	weekday/daytime	rural roads, urban roads	passenger cars
Lithuania	weekday/daytime	motorways, rural roads, urban roads	passenger cars
Malta	weekday/daytime	rural roads, urban roads	passenger cars; vans/small trucks; trucks/buses/heavy goods vehicles; motorcycles
Netherlands	all periods combined	motorways, rural roads, urban roads	all vehicles combined
Poland	weekday/daytime, weekday/night-time	motorways, rural roads, urban roads	passenger cars; vans/small trucks; trucks/buses/heavy goods vehicles; motorcycles
Portugal	weekday/daytime, weekday/night-time	motorways, rural roads, urban roads	passenger cars + motorcycles; trucks/buses/heavy goods vehicles
Spain	weekday/daytime, weekday/night-time, weekend/daytime, weekend/night-time	motorways, expressways, rural roads, urban roads	passenger cars; vans/small trucks; trucks/buses/heavy goods vehicles; motorcycles
Sweden	all periods combined	motorways, rural roads, urban roads	passenger cars; vans/small trucks; trucks/buses/heavy goods vehicles; motorcycles

The method of sampling of measurement locations, and their number, and the number of observed vehicles are presented in table 5. Measurement locations were selected through simple or stratified random sampling in all Member States except Denmark, Finland, Latvia (rural roads only) and the Netherlands. In Finland and in the case of rural roads in Latvia all locations with loop detectors were included that meet the requirements. Both Denmark and the Netherlands are not included in table 5 as they deviate methodologically and provided no numbers of observations. In Denmark permanent stations were used that are in function all year and have been located to give representative samples, with 12 to 14 stations per road type. In the Netherlands floating car data is collected over millions of road segments per road type, where each segment is of a length of 50 meters maximum. The minimum requirement of 10 locations per road type and provided vehicle type was met by all Member States, except for urban roads in Finland for which there are only 7 locations included, and which is due to there not being that many urban locations that meet all the requirements for measurement locations. The minimum requirement of 2000 observations in total and 500 observations per road type is met by all Member States. For the optional vehicle types of vans / small trucks, trucks / buses / heavy goods vehicles, and motorcycles, the recommended minimum of 10 locations is met by all Member States that provided data on these vehicle types, and the recommended minimum of 2000 observations in total and 500 observations per road type is met by most of those Member States.

Table 5. Sampling method and number of measurement locations

				Number of observations			
		Sampling	Number of locations	Passenger cars	Vans/small trucks	Trucks / buses / heavy goods vehicles	Motorcycles
Austria	**motorways**	stratified random	15	7172	-	-	-
	rural roads		45	1309142	166463	157842	28074
	urban roads		61	2353264	258609	186136	69427
Belgium	**motorways**	stratified random	27	1118237	-	-	-
	rural roads		57	1350925	-	-	-
	urban roads		88	994618	-	-	-
Bulgaria	**motorways**	simple random	10	8487	-	-	-
	rural roads		10	9252	-	-	-
	urban roads		10	10069	-	-	-
Cyprus	**motorways**	stratified random	13	15230	2513	2	-
	rural roads		13	7478	944	46	-
	urban roads		14	12900	1391	282	-
Czech Republic	**motorways**	stratified random	10	359070	94744	148241	210
	rural roads		13	131840	26736	41686	585
	urban roads		13	109677	8061	11577	318
Finland	**motorways**	all valid sites	37	13214567	-	-	-
	rural roads		268	36500560	-	-	-
	urban roads		7	1539221	-	-	-
Greece	**motorways**	stratified random	25	5108	1213	1398	95
	rural roads		47	11061	1851	561	705
	urban roads		43	10625	1730	525	1474
Ireland	**motorways**	-	10	3764	956	1648	-
	rural roads		11	2637	527	535	-
	urban roads		12	3576	406	194	-
Latvia	**motorways**	-	-	-	-	-	-
	rural roads	all valid sites	18	98161	-	-	-
	urban roads	random	19	3785	-	-	-
Lithuania	**motorways**	stratified random	10	10640	-	-	-
	rural roads		22	13820	-	-	-
	urban roads		35	25049	-	-	-
Malta	**motorways**	stratified random	-	-	-	-	-
	rural roads		13	4477	1942	582	318
	urban roads		14	3174	1119	245	973
Poland	**motorways**	stratified random	16	130579	26423	61751	725
	rural roads		42	59689	10640	15389	266
	urban roads		22	42212	7069	10895	205
Portugal	**motorways**	stratified random	10	5183	-	33325	-
	rural roads		11	29309	-	6805	-
	urban roads		20	1789	-	86	-

Spain	**motorways**	stratified random	10	213164	16966	28867	14660
	expressways		19	724687	86096	109174	30627
	rural roads		29	480457	40143	39938	17345
	urban roads		39	1037950	251957	45085	101703
Sweden	**motorways**	stratified random	277	1970000	-	128000	21000
	rural roads		990	3040000	-	198000	32000
	urban roads		67	1439000	56000	22000	51000

3.1.2 National KPIs on speeding

Previous studies on speed include that by ETSC (2019), which considers for several EU Member States the percentage of speeders and the mean speed of passenger cars, vans and heavy goods vehicles over the time period from 2007 to 2017.

Within the Baseline project Poland also provided data on non-free flowing traffic. Comparison of their free and non-free flowing data shows that on 140 km/h motorways, 120 km/h motorways (expressways), 90 km/h rural roads and 50 km/h urban roads the average speed and the 85th percentile of speed are notably higher in free flowing traffic compared to non-free flowing traffic. The share of drivers driving within the speed limit on 140 km/h motorways, 120 km/h motorways (expressways) and 90 km/h rural roads is notably lower in free flowing traffic compared to non-free flowing traffic, on 50 km/h urban roads there was no remarkable difference.

3.2 Overall speed KPI by country

Results on the main KPI, the average speed and V85 will be presented initially for the minimum required disaggregations, i.e., during weekday/daytime and for passenger cars only. This is because these were provided by most Member States that delivered data on speed, and therefore comparison on this level is possible between these Member States. Results will be presented per road type and also for the speed limits available per road type in the Member States that provided speed data.

3.2.1 Motorways and expressways

Figures 3, 4 and 5 show the percentage of vehicles driving within the speed limit, the average speed and the 85th percentile of speed for passenger cars on motorways and expressways during daytime on weekdays. Only Member States are included for which there was data, hence Latvia and Malta are not present as they have no motorways and Denmark and the Netherlands as they only provided results for all time periods combined, Sweden is not present in figure 5 as it provided no 85th percentile of speed data. The percentage of vehicles driving within the speed limit on motorways is lowest in the Czech Republic, closely followed by Cyprus, Finland, Portugal and Sweden, and highest in Bulgaria, closely followed by Ireland. Since the speed limits differ between countries it is not obvious to compare the percentage driving within the speed limit with the average speed and the 85th percentile of speed. The latter two show an almost equal pattern, i.e., the 85th percentile of speed lies between 10 to 21 km/h higher than the average speed.

Figure 3. Percentage driving within speed limit for passenger cars on motorways and expressways during weekday/daytime

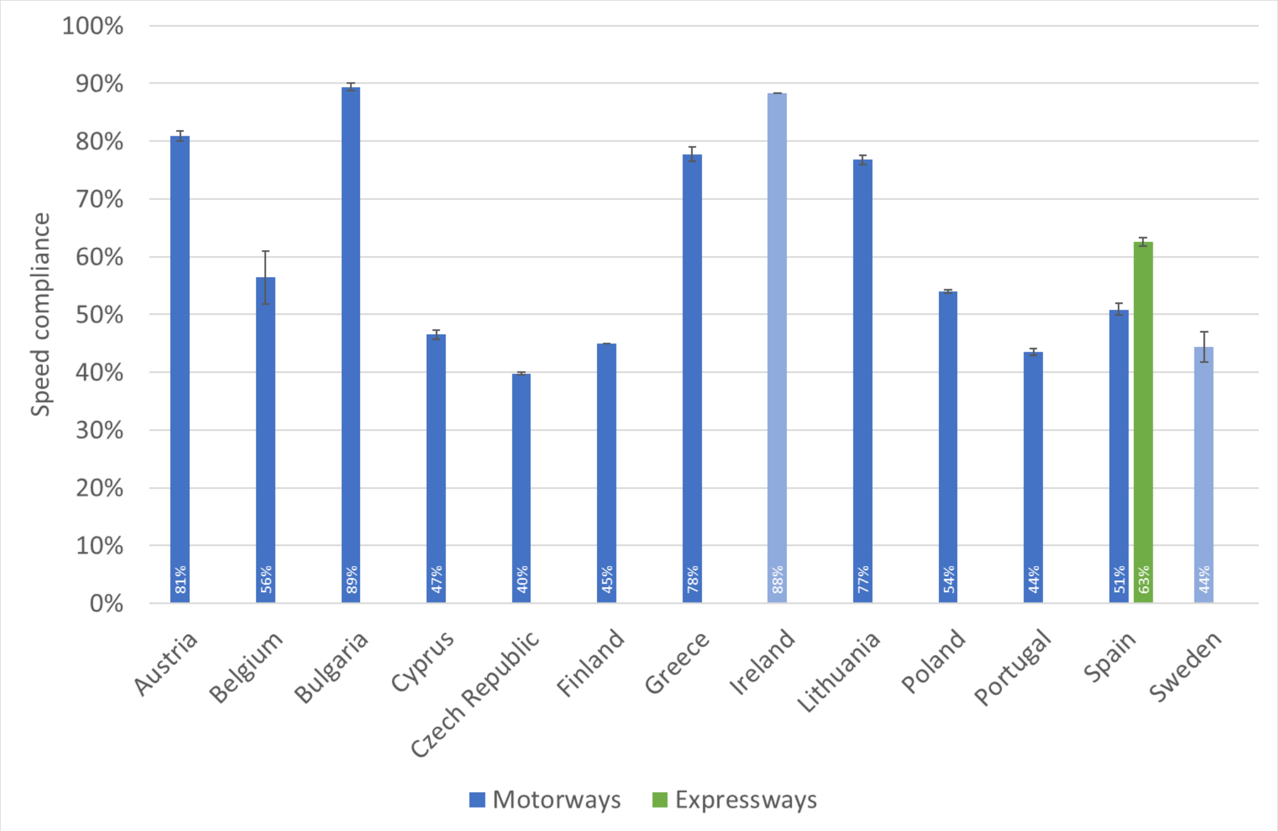


Figure 4. Average speed for passenger cars on motorways and expressways during weekday/daytime

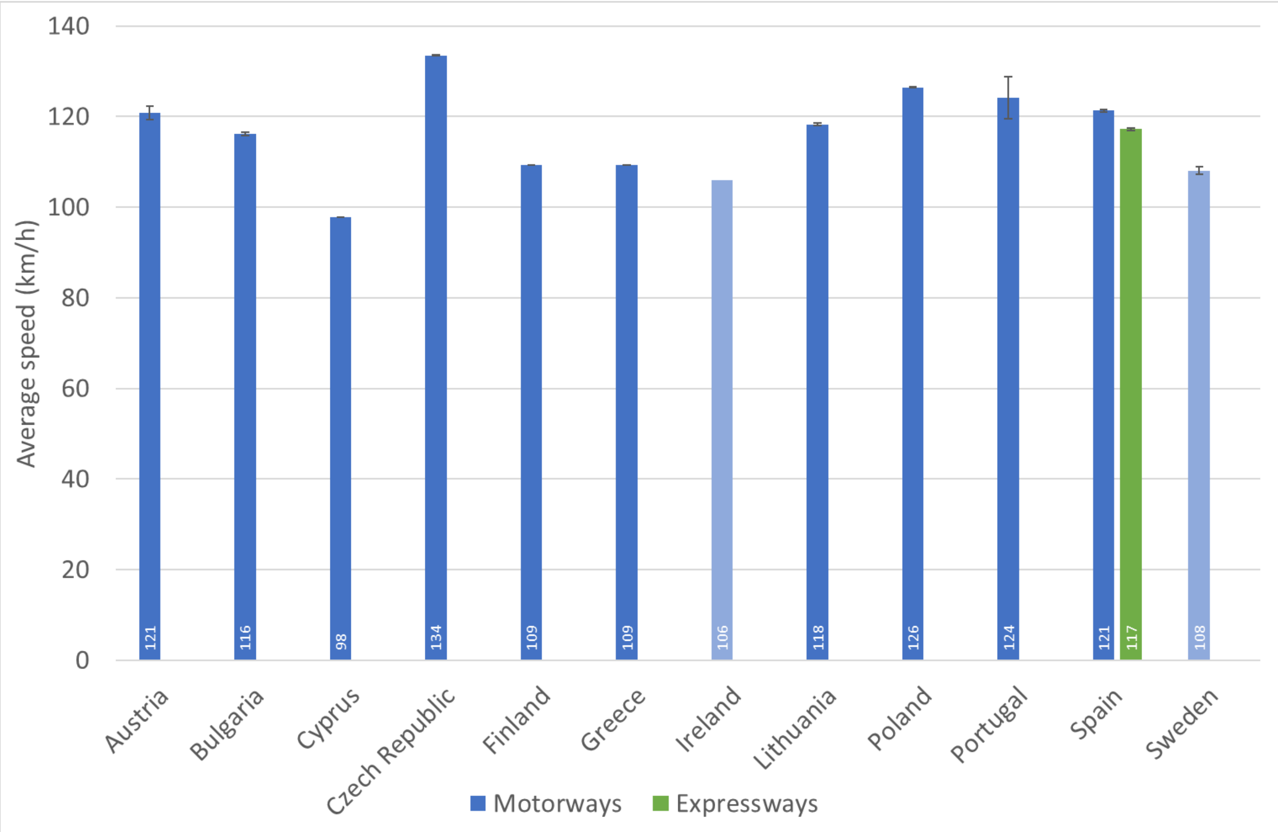
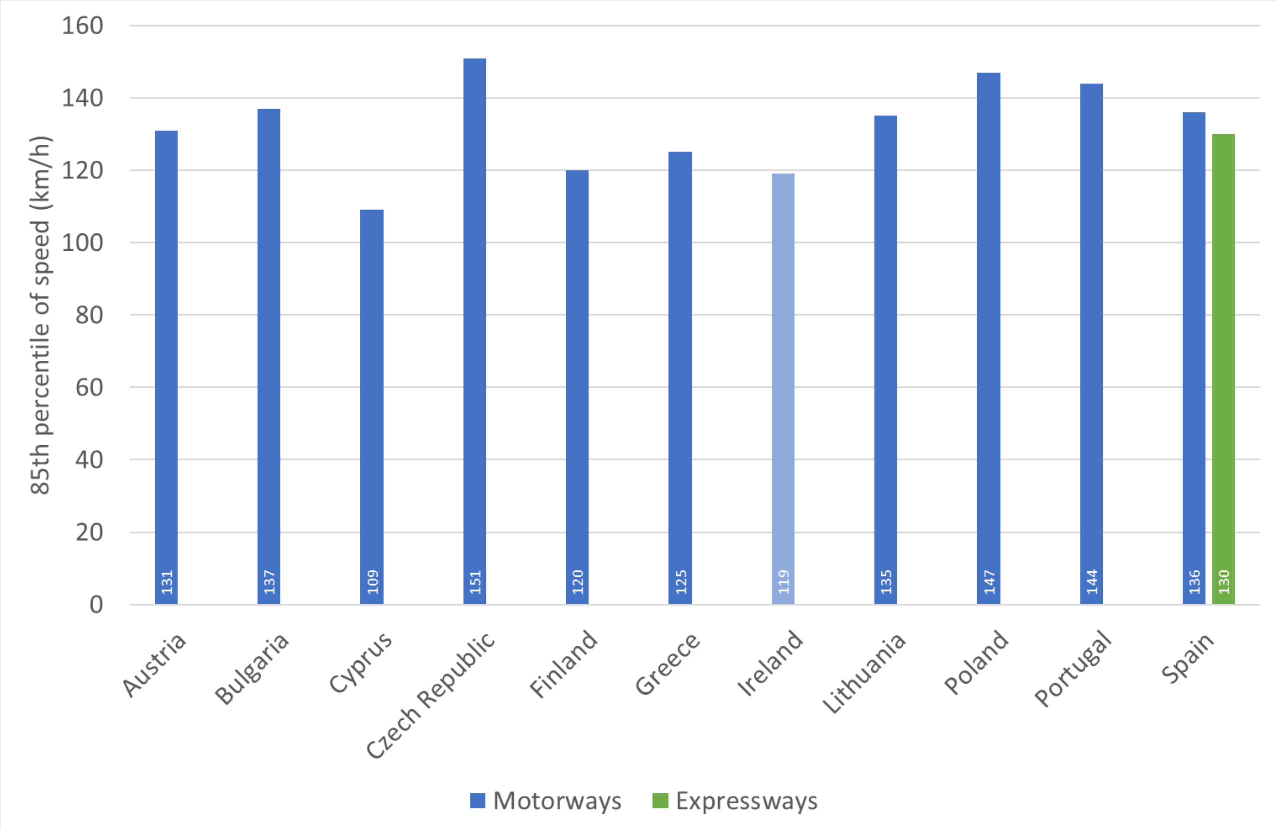


Figure 5. 85th percentile of speed for passenger cars on motorways and expressways during weekday/daytime



As a further breakdown we provide results for specific speed limits. Figures 6, 7 and 8 show the percentage of vehicles driving within the speed limit, the average speed and the 85th percentile of speed for passenger cars on motorways with a speed limit of 80, 100, 120, 130, 140 or mainly 110 and 120 km/h or expressways with a speed limit of 120 km/h for passenger cars during daytime on weekdays. This includes 120 km/h expressways in Poland, which are roads that are quite similar to motorways, except that they can be dual- or single-carriageway roads at which intersections occur exceptionally, but since the measurement locations on expressways in Poland were dual carriageways with no intersections they are included here under motorways.

Poland and Portugal form a group with almost equal values for the three speed indicators on 120 km/h motorways, as do Austria and Lithuania on 130 km/h motorways. We observe here that the percentage of vehicles driving within the speed limit inversely relates to the average speed and the 85th percentile of speed.

Figure 6. Percentage driving within speed limit for passenger cars on 80, 100, 120, 130, 140 and mainly 110 and 120 km/h motorways during weekday/daytime

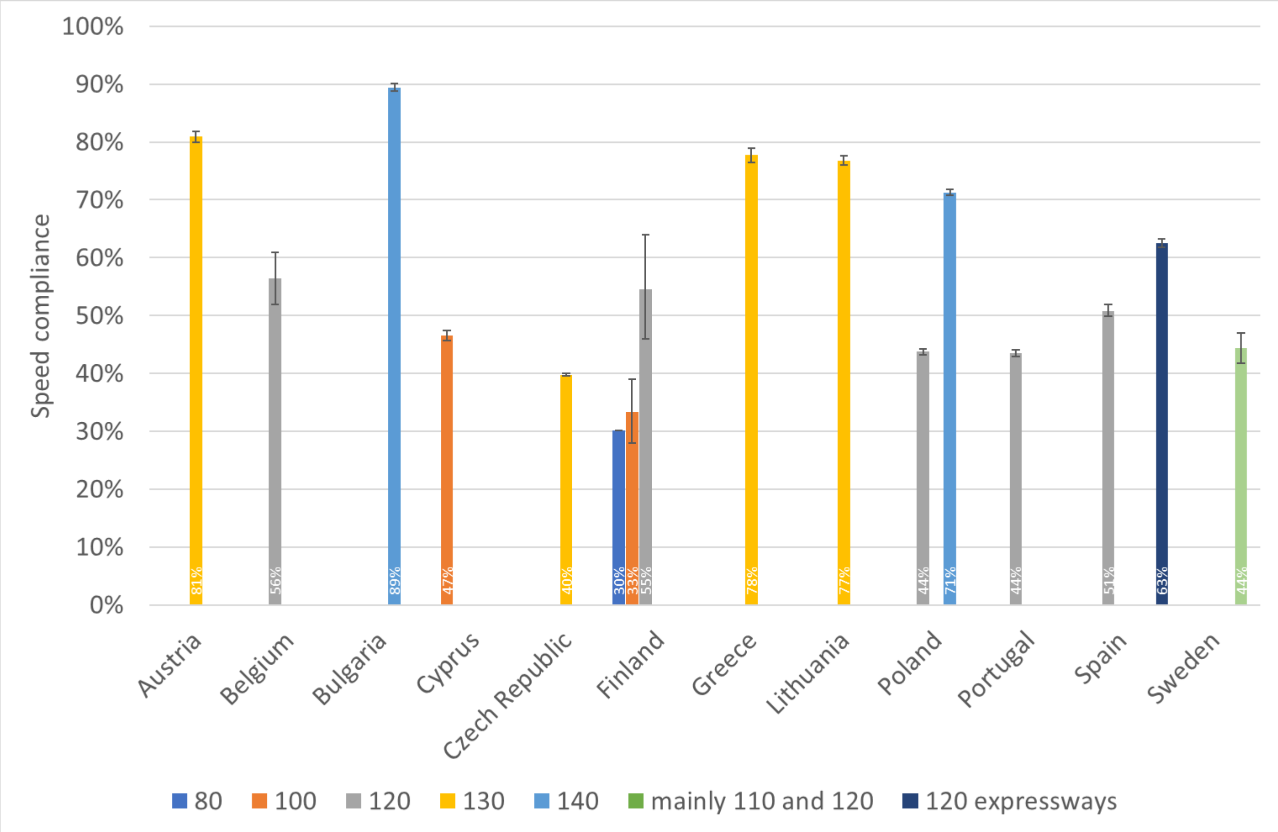


Figure 7. Average speed for passenger cars on 80, 100, 120, 130, 140 and mainly 110 and 120 km/h motorways during weekday/daytime

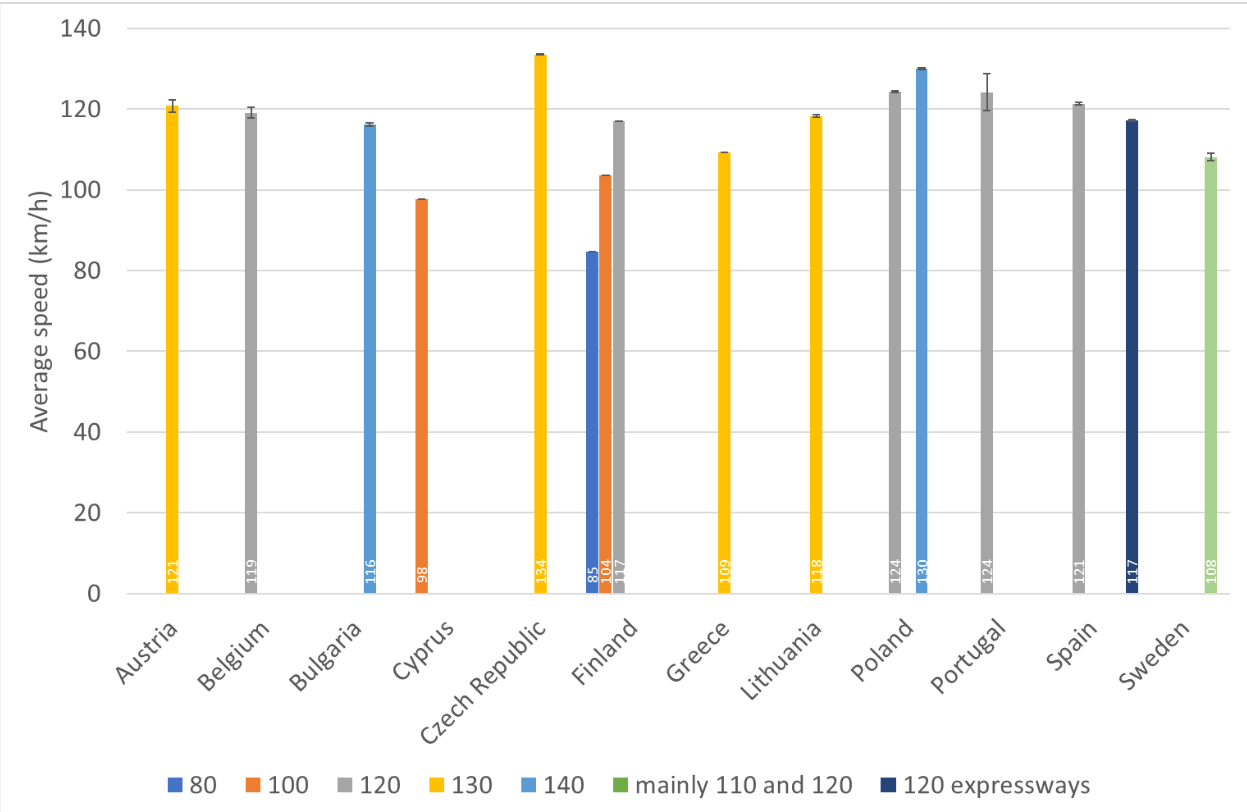
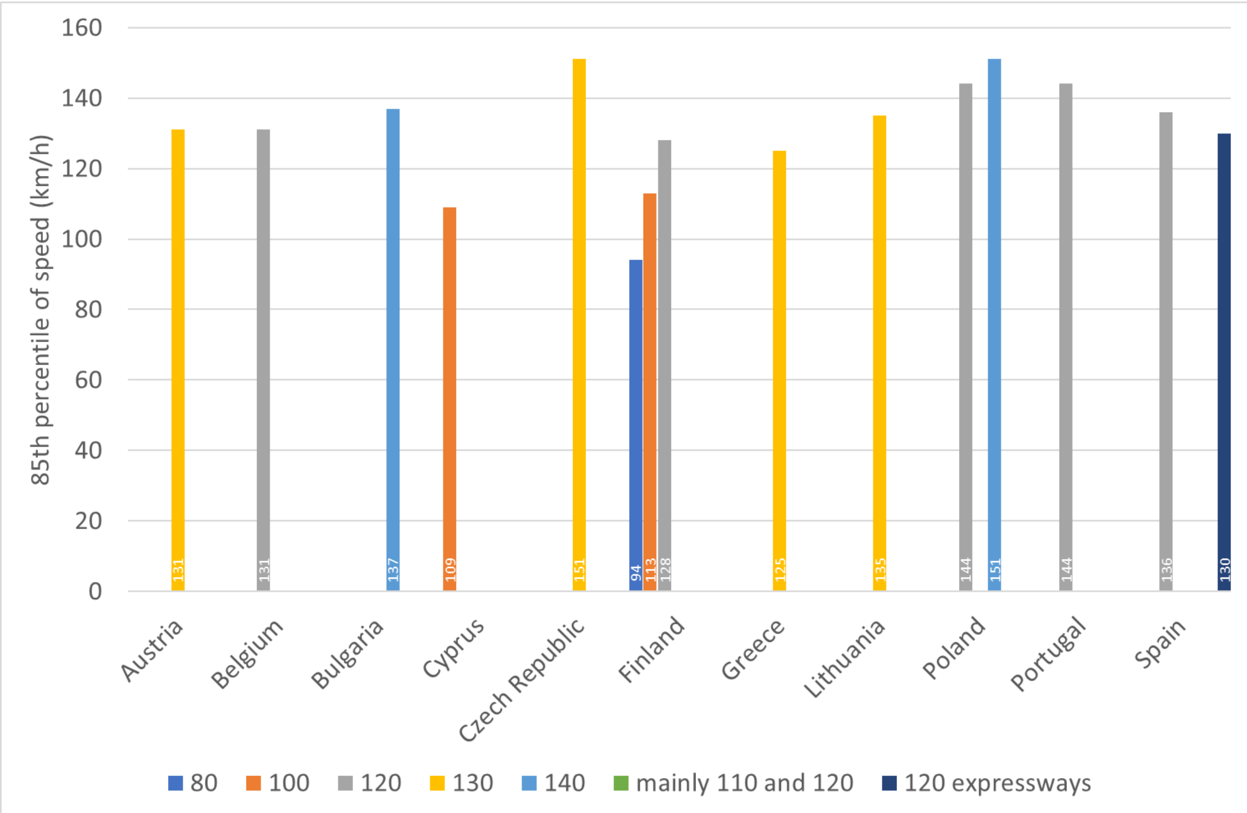


Figure 8. 85th percentile of speed for passenger cars on 80, 100, 120, 130, 140 and mainly 110 and 120 km/h motorways during weekday/daytime



Results for Denmark and The Netherlands were only provided for all periods combined. The share of drivers driving within the speed limit on 110 km/h and 130 km/h motorways in Denmark is 45.4 and 80.4 percent, respectively. This share in the Netherlands varies from 45 percent on 90 km/h motorways to 67 percent on 100 km/h motorways.

The above results based on roadside observations we can compare with those of the ESRA2 (2022) survey, which provides indicators on topics including speeding. Since ESRA2 is a survey research, it does not suffer from the typical disadvantages of roadside observations, but results are more subjective as they are based on self-reported data. We speak here only of those countries that regarding the KPI of speeding are both covered in ESRA2 and in Baseline. In ESRA2 roads are categorised into motorways or freeways, roads inside built-up areas, and roads outside built-up areas but not motorways or freeways.

According to the ESRA2 results, the percentage of drivers exceeding the speed limit on motorways or freeways at least once during the past 30 days ranges from 44.0 ± 3.8 in Bulgaria to 80.5 ± 3.1 in Sweden. This is in line with Bulgaria reporting a relatively high percentage of 89.4 ± 0.7 of driving within the speed limit, albeit on 140 km/h motorways, and Sweden reporting a relatively low percentage of driving within the speed limit on motorways. The personal acceptability to exceed the speed limit on motorways ranges from 6.6 ± 1.6 in Bulgaria to 29.0 ± 2.0 in Austria. The low personal acceptability in Bulgaria is in line with its relatively high percentage of driving within the speed limit on motorways, that in Austria however is more in contrast with its relatively high percentage of obeying the speed limit on motorways and its relatively low values for the average speed and 85th percentile of speed on motorways.

3.2.2 Rural roads

Figures 9, 10 and 11 show the percentage of vehicles driving within the speed limit, the average speed and the 85th percentile of speed for passenger cars on rural roads during daytime on weekdays. Only Member States are included for which there was data, hence Denmark and the Netherlands are not present as they only provided results for all time periods combined, Belgium is not present in figures 10 and 11 as it only provided the average speed and the 85th percentile of speed for individual speed limits, and Sweden is not present in figure 11 as it provided no 85th percentile of speed for passenger cars on rural roads. The percentage of vehicles driving within the speed limit on rural roads is lowest in Latvia and highest in Bulgaria. The 85th percentile of speed in most countries lies about 10 km/h higher than the average speed, except in Poland and Portugal where it lies about 20 km/h higher.

Figure 9. Percentage driving within speed limit for passenger cars on rural roads during weekday/daytime

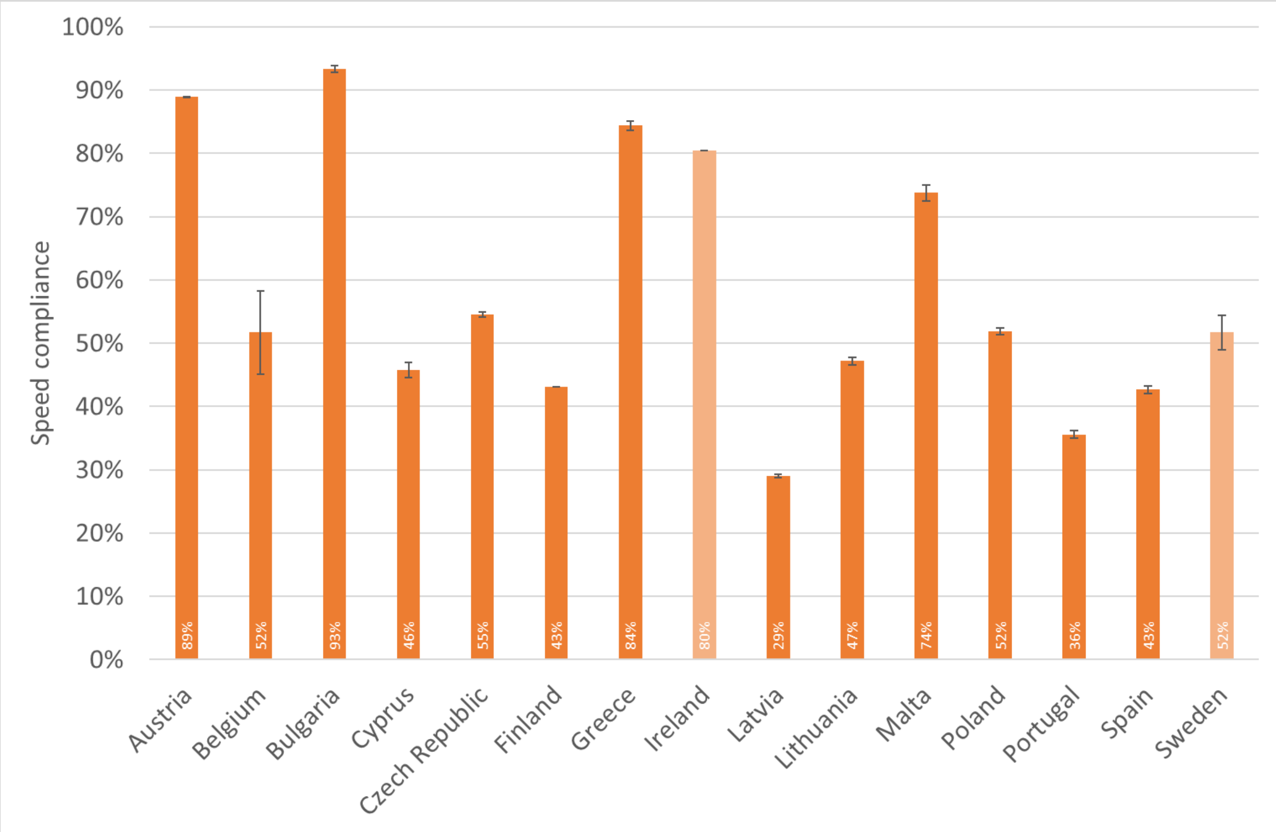


Figure 10. Average speed for passenger cars on rural roads during weekday/daytime

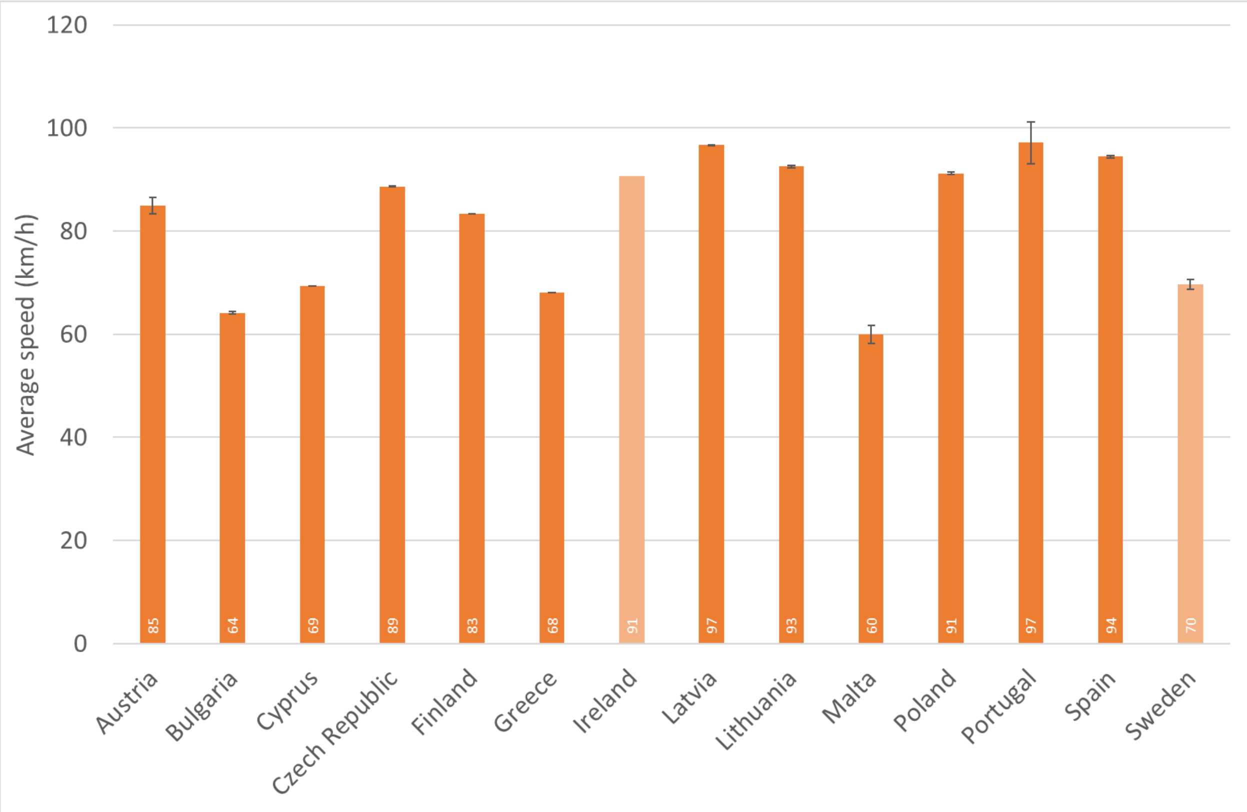
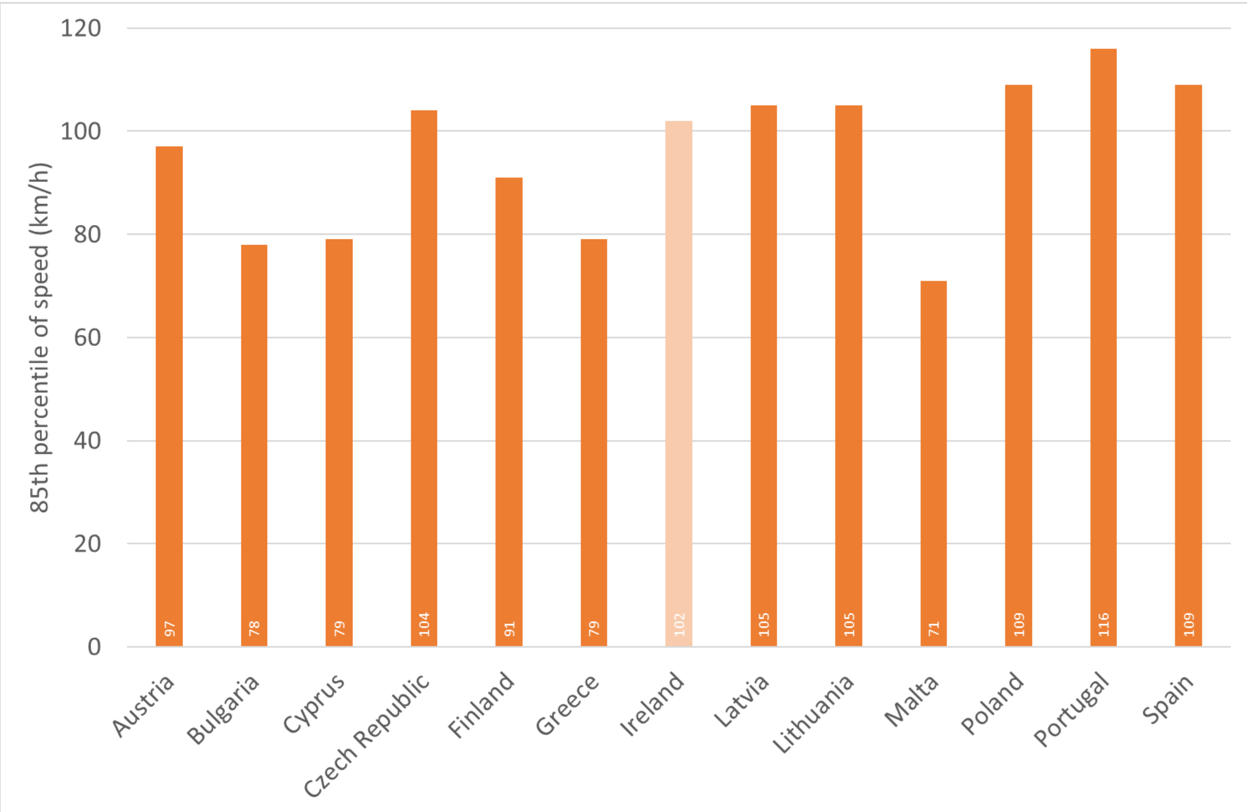


Figure 11. 85th percentile of speed for passenger cars on rural roads during weekday/daytime



As a further breakdown we provide results for specific speed limits. Figures 12, 13 and 14 show the percentage of vehicles driving within the speed limit, the average speed and the 85th percentile of speed for passenger cars on rural roads with a speed limit of 50, 60, 70, 80, 90, 100 and 70, 80 and 90 km/h during daytime on weekdays.

While for the Czech Republic and Latvia the percentage of vehicles driving within the speed limit inversely relates to the average speed, the 85th percentile of speed is for both countries more or less the same and relatively low compared to the other Member States, so the passenger cars exceeding the speed limit on these roads both in Latvia and the Czech Republic mostly do so only moderately, whereas in Portugal fewer vehicles exceed the speed limit but with larger exceedances when they do.

The average speed and 85th percentile of speed on 90 km/h rural roads in Bulgaria and Greece are both remarkably low as they lie below the speed limit. A possible and plausible, though not proven or exhaustive explanation for this in Bulgaria may be that it is very common among drivers in Bulgaria to share on social media the presence of radar cameras, usually associated with police enforcement, and that measurement sessions had a relatively long duration of two hours twice a day.

Figure 12. Percentage driving within speed limit for passenger cars on 50, 60, 70, 80, 90, 100 and 70, 80 and 90 km/h rural roads during weekday/daytime

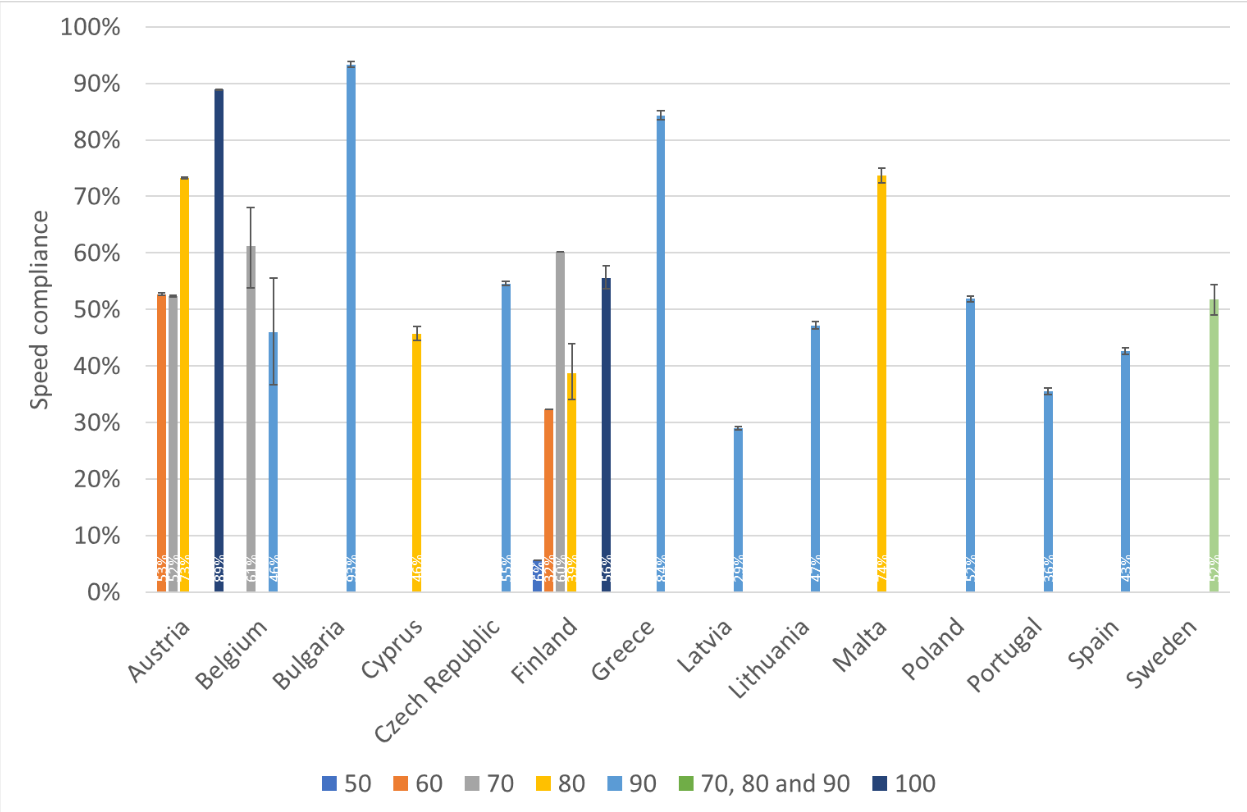


Figure 13. Average speed for passenger cars on 50, 60, 70, 80, 90, 100 and 70, 80 and 90 km/h rural roads during weekday/daytime

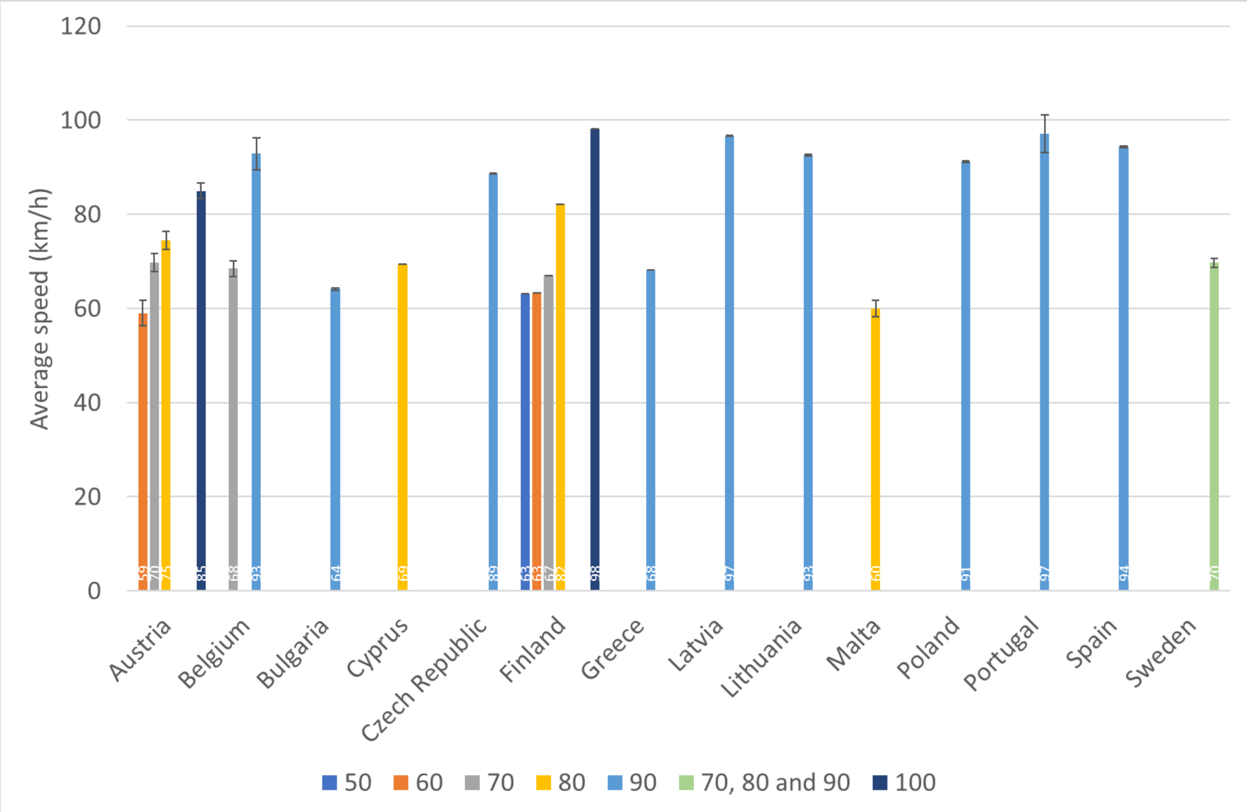
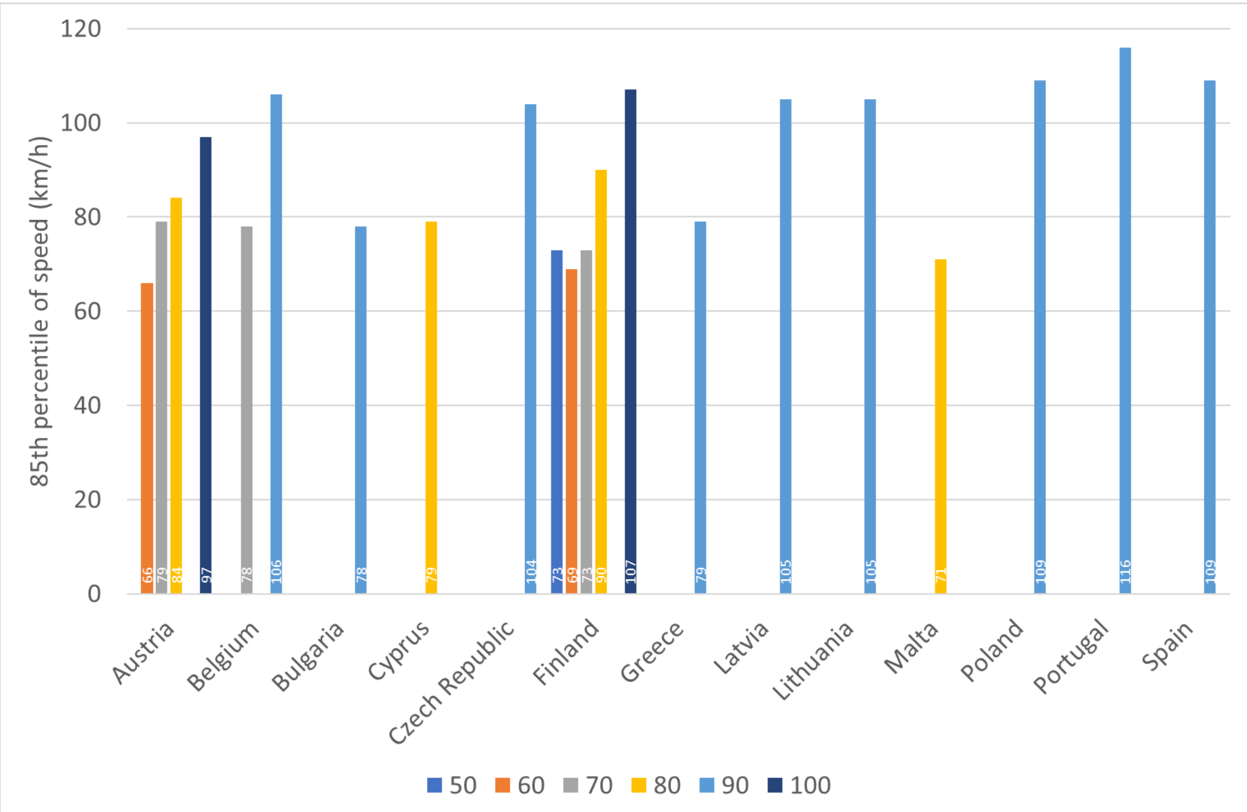


Figure 14. 85th percentile of speed for passenger cars on 50, 60, 70, 80, 90, 100 and 70, 80 and 90 km/h rural roads during weekday/daytime



Results for Denmark and The Netherlands were only provided for all periods combined. The share of drivers driving within the speed limit on 80 km/h rural roads in Denmark is 44 percent in the region Jutland and 61 percent in the Islands region. In the Netherlands this share varies from 46 percent on 90 km/h rural roads to 68 percent on 100 km/h rural roads.

As with motorways, we can compare the above results that are based on roadside observations with those of the ESRA2 (2022) survey. The percentage of drivers exceeding the speed limit outside built-up areas (but not on motorways/freeways) at least once during the past 30 days ranges from 55.2 ± 3.7 in Bulgaria to 82.5 ± 2.4 in Austria. For Bulgaria this seems to agree with the results based on roadside observations, for Austria however roadside observations say that the percentage exceeding the speed limit is relatively low, and so are the average speed and the 85th percentile of speed compared to that of other Member States. The personal acceptability and the social acceptability to exceed the speed limit outside built-up areas (but not on motorways/freeways) ranges from 5.9 ± 1.5 in Bulgaria to 22.1 ± 1.8 in Austria and from 8.6 ± 1.8 in the Czech Republic to 29.2 ± 2.0 in Austria, respectively. As on motorways, the low personal acceptability in Bulgaria is in line with its relatively high percentage of driving within the speed limit, but that in Austria is more in contrast with its relatively high share in obeying the speed limit and low values for the average speed and 85th percentile of speed. While in the Czech Republic according to roadside observations the 85th percentile of speed is relatively low, in agreement with the relatively low self-reported social acceptability, the percentage driving within the speed limit and the average speed are between that of other Member States.

3.2.3 Urban roads

Figures 15, 16 and 17 show the percentage of vehicles driving within the speed limit, the average speed and the 85th percentile of speed for passenger cars on urban roads during daytime on weekdays. Only Member States are included for which there was data, hence Denmark and the Netherlands are not present as they only provided results for all time periods combined, and Sweden is not present in figure 17 as it provided no 85th percentile of speed for passenger cars on urban roads. The percentage of vehicles driving within the speed limit on urban roads is lowest in Poland and highest in Portugal, Malta and Sweden. The 85th percentile of speed in most Member States lies about 7 km/h above the average speed, in Bulgaria, Ireland, Poland and Spain this difference is a bit larger and about 13 km/h.

Figure 15. Percentage driving within speed limit for passenger cars on urban roads during weekday/daytime

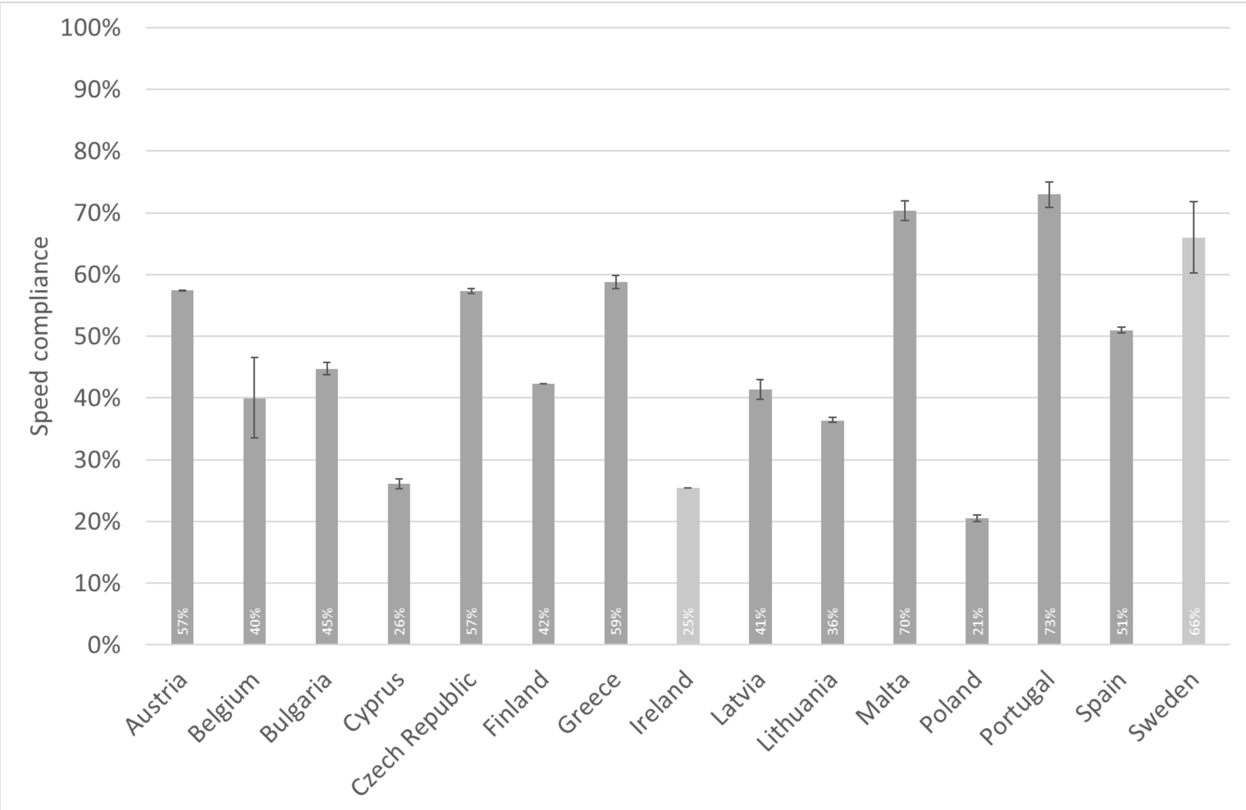


Figure 16. Average speed for passenger cars on urban roads during weekday/daytime

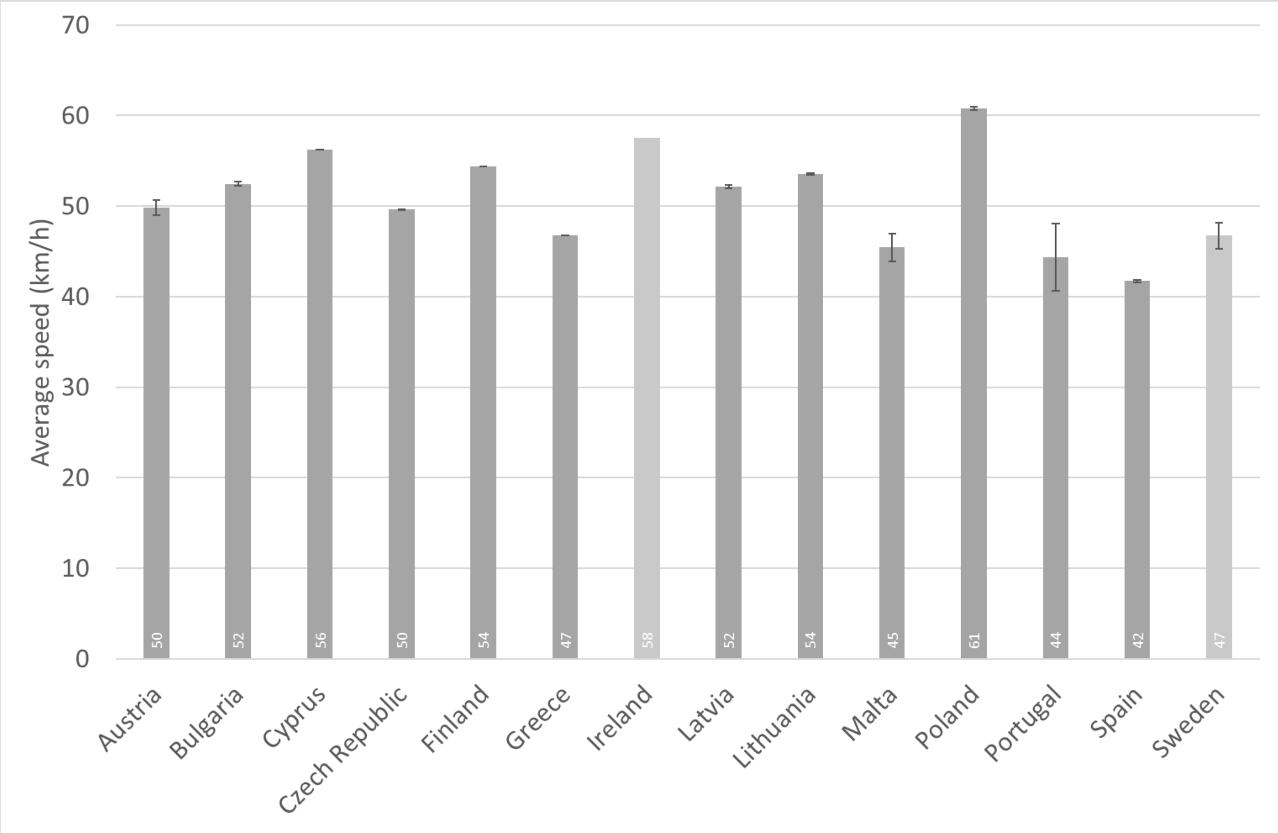
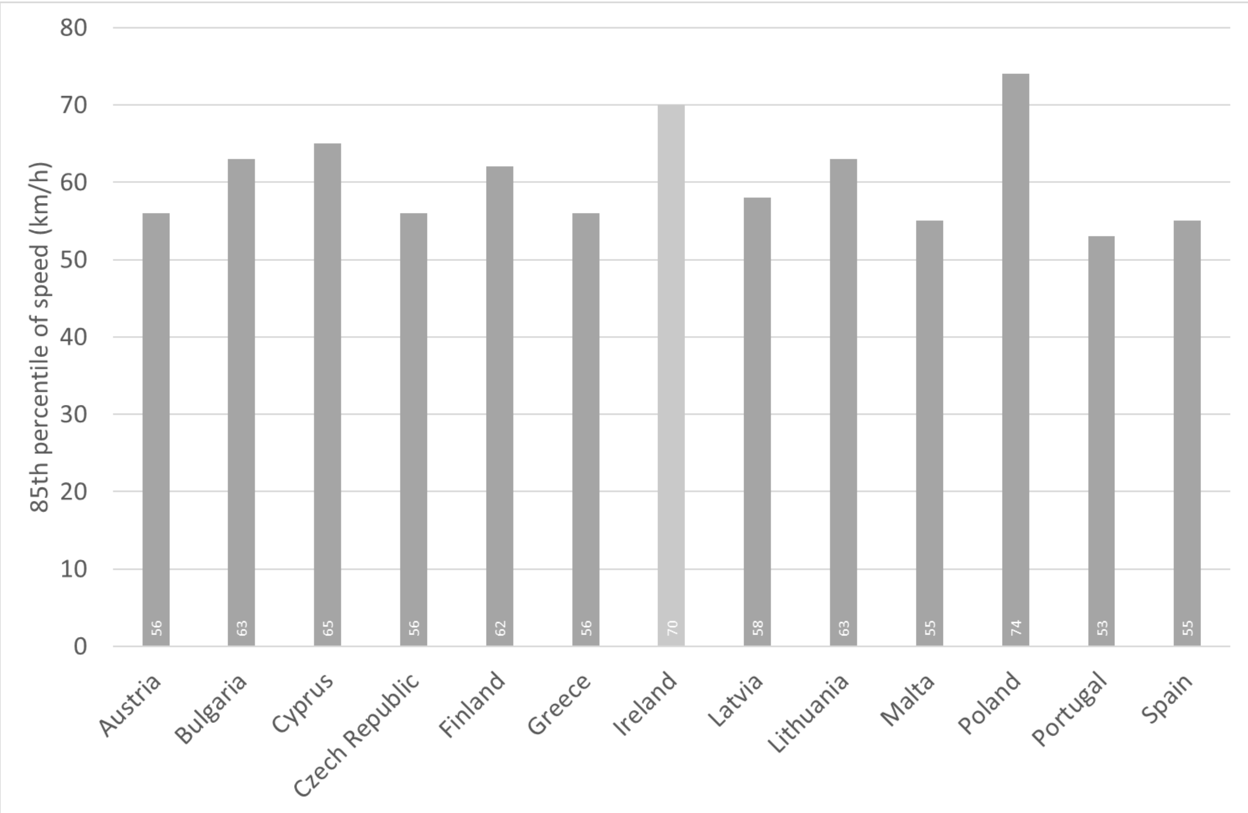


Figure 17. 85th percentile of speed for passenger cars on urban roads during weekday/daytime



As a further breakdown we provide results for specific speed limits. Figures 18, 19 and 20 show the percentage of vehicles driving within the speed limit, the average speed and the 85th percentile of speed for passenger cars on urban roads with a speed limit of 30, 50, 60 and 40, 50, 60 and 70 km/h during daytime on weekdays.

Notably, on 50 km/h urban roads, which is the most common speed limit among the Member States, the average speed varies from 44 ± 4 km/h in Portugal to 60.8 ± 0.2 km/h in Poland, and the 85th percentile of speed varies from 53 ± 5 km/h in Portugal to 74.0 ± 0.3 km/h in Poland. Finland, Latvia and Lithuania show an almost similar share in vehicles driving within the speed limit on 50 km/h urban roads, and also relatively similar values for the average speed and the 85th percentile of the speed. Although the results of Finland are based on only 7 measurement locations, they are included here because they are considered sufficiently relevant, and because in Finland it is difficult to find measurement locations for urban roads that meet all the minimum requirements. Austria and the Czech Republic also form a group with almost equal values for the three speed indicators on 50 km/h urban roads. Thus, we observe here that the percentage of vehicles driving within the speed limit inversely relates to the average speed and the 85th percentile of speed.

Figure 18. Percentage driving within speed limit for passenger cars on 30, 50, 60 and 40, 50, 60 and 70 km/h urban roads during weekday/daytime

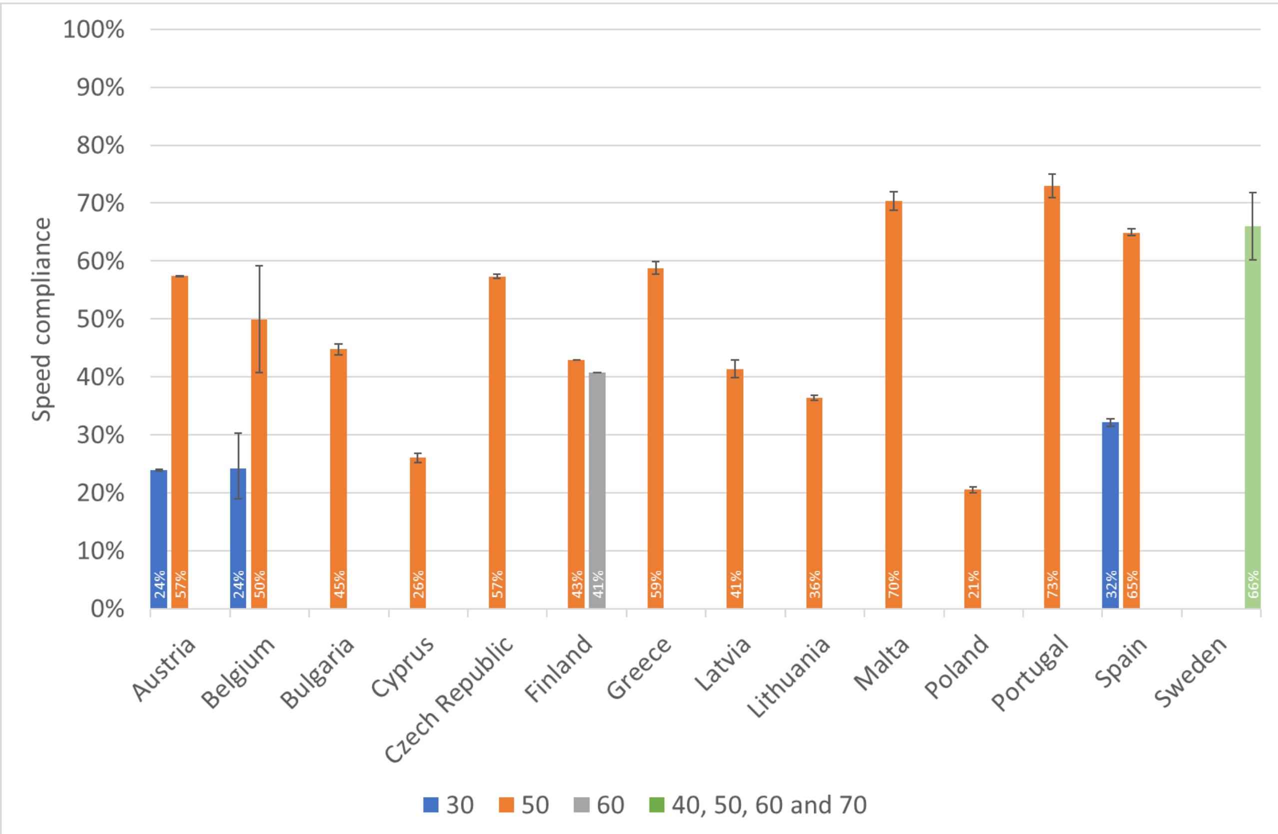


Figure 19. Average speed for passenger cars on 30, 50, 60 and 40, 50, 60 and 70 km/h urban roads during weekday/daytime

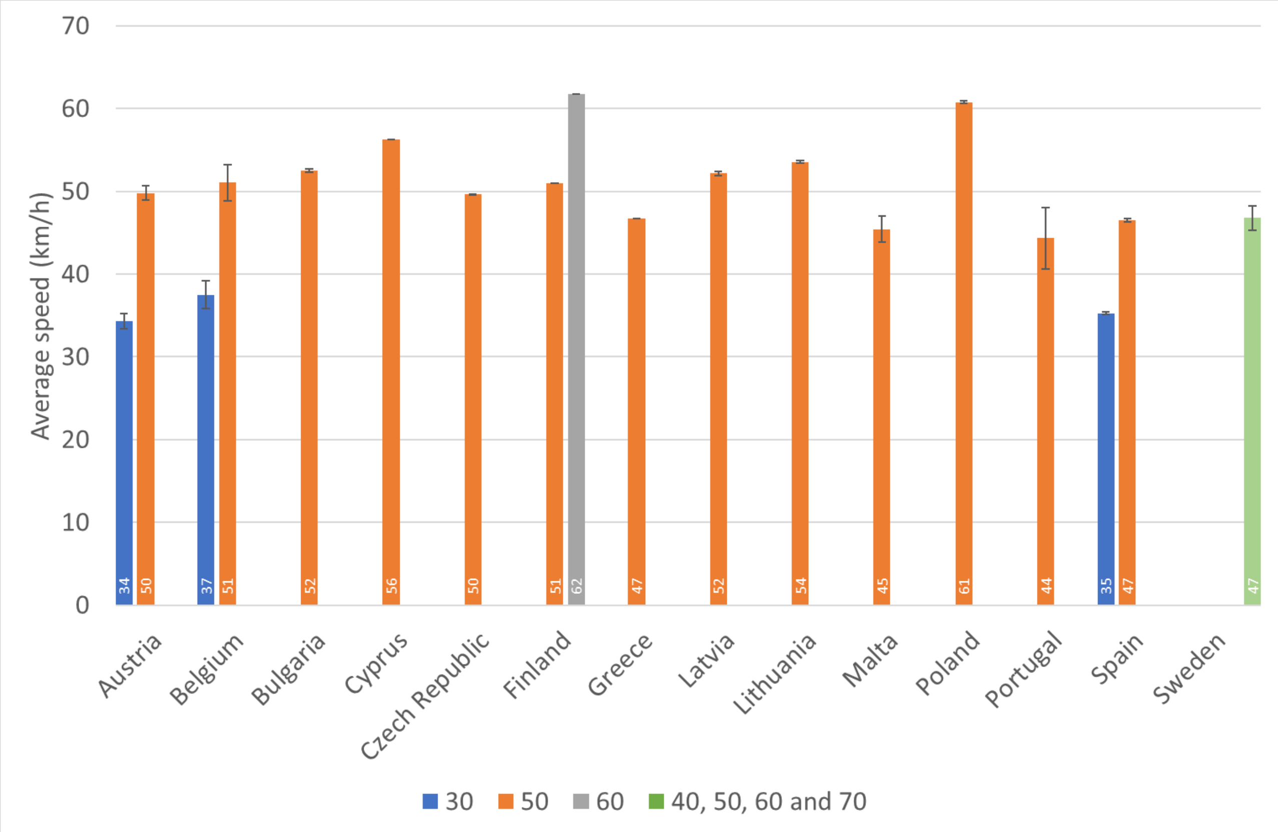
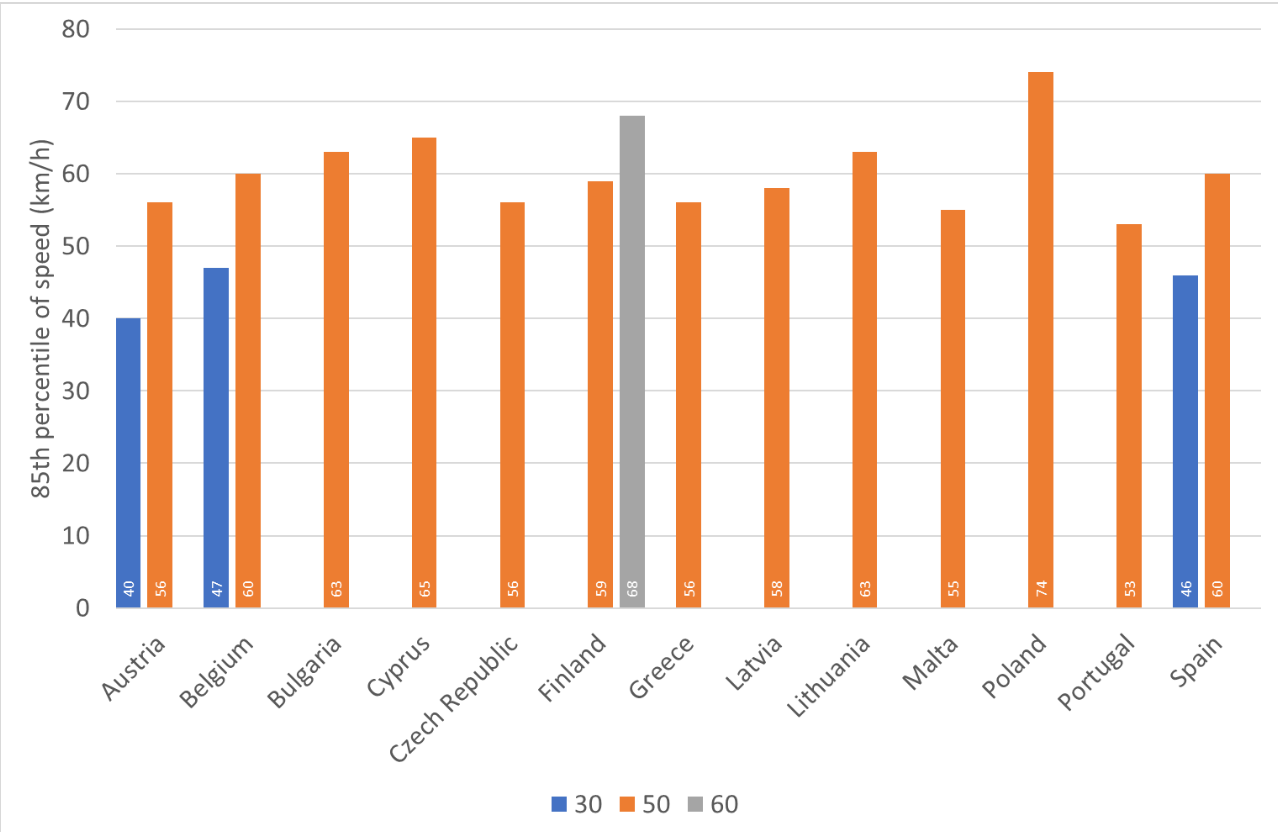


Figure 20. 85th percentile of speed for passenger cars on 50 km/h urban roads during weekday/daytime



Results for Denmark and The Netherlands were only provided for all periods combined. The share of drivers driving within the speed limit on 50 km/h urban roads in Denmark is 58 percent in larger towns and cities and 53 percent in smaller towns. In the Netherlands this share lies at around 78 percent on urban roads.

We compare the above results that are based on roadside observations with those of the ESRA2 (2022) survey. The percentage of drivers exceeding the speed limit inside built-up areas at least once during the past 30 days ranges from 49.1±3.8 in Bulgaria to 72.8±3.3 in Finland. This is in contrast with the results obtained through roadside observations, which put Bulgaria and Finland somewhere in the middle. The personal acceptability to exceed the speed limit inside built-up areas ranges from 3.1±1.2 in the Czech Republic to 10.5±1.4 in Austria. This is also in contrast with the results according to roadside observations which put the Czech Republic and Austria equally somewhere in the middle.

3.3 Breakdown by vehicle type

In addition to passenger cars some Member States also provided data on other optional vehicle categories, namely motorcycles, vans and small trucks, and trucks, buses and heavy goods vehicles. While there is less data in these categories, for some combinations of vehicle category, road type and speed limit still a comparison can be made. It should be kept in mind, however, that these results rely on the classification of vehicles. This classification is typically based on vehicle length, which in itself is not unambiguous, and furthermore devices such as radar and loop detectors are usually not that good at detecting vehicle lengths.

3.3.1 Motorcycles

Tables 6a and 6b provides the speed compliance, average speed and V85 for motorcycles during weekday/daytime per road type and speed limit. The most common speed limits for motorcycles among the Member States are 50 km/h urban roads and 90 km/h rural roads. On 50 km/h urban roads the share of drivers driving within the speed limit is highest in the Czech Republic, Malta and Spain and lowest in Greece, and the 85th percentile of speed is lowest in the Czech Republic, Malta and Spain and highest in Greece and Poland. On 90 km/h rural roads the percentage of motorcycles driving within the speed limit is highest in Greece and lowest in Spain, and the 85th percentile of speed is lowest in Greece and highest in Spain and Poland, but the average speed is notably lower in Poland than in Spain. The results for Poland on 120 km/h motorways in fact are for 120 km/h expressways, but both road types in Poland are almost equal. Not included in the table are the results for 120 km/h expressways in Spain, which are a compliance of 74.1 ± 4.2 percent, an average speed of 104.0 ± 2.0 km/h and a V85 of 126 ± 2 km/h.

Table 6a. Speed compliance, average speed and V85 for motorcycles during weekday/daytime

		Urban roads			Rural roads		
		30	40, 50, 60, 70	50	60	70	70, 80, 90
Austria	**Compliance (%)**	21.4 ± 0.5		59.3 ± 0.5	56.0 ± 1.1	62.1 ± 0.9	
	Average (km/h)	34.8 ± 1.3		48.1 ± 1.0	58.1 ± 2.0	62.3 ± 4.1	
	V85 (km/h)	43.0 ± 1.1		56.0 ± 1.0	71.0 ± 3.0	79.0 ± 3.4	
Czech Republic	**Compliance (%)**			76.2 ± 5.8			
	Average (km/h)			45.3 ± 1.2			
	V85 (km/h)			53.0 ± 7.2			
Greece	**Compliance (%)**			48.2 ± 2.8			
	Average (km/h)			50.3			
	V85 (km/h)			58.5			
Malta	**Compliance (%)**			77.5 ± 2.6			
	Average (km/h)			43.8 ± 2.7			
	V85 (km/h)			52.2 ± 3.2			
Poland	**Compliance (%)**			60.6 ± 8.3			
	Average (km/h)			45.5 ± 3.3			
	V85 (km/h)			62.0 ± 3.9			

Spain	Compliance (%)	52.9 ± 2.8		75.4 ± 1.8			
	Average (km/h)	31.3 ± 0.5		43.4 ± 0.4			
	V85 (km/h)	42.0 ± 1.0		55.0 ± 1.0			
Sweden	Compliance (%)						41.2 ± 3.2
	Average (km/h)		39.7 ± 1.9				72.0 ± 1.2
	V85 (km/h)						

Table 6b. Speed compliance, average speed and V85 for motorcycles during weekday/daytime

		Rural roads			Motorways			
		80	90	100	110, 120	120	130	140
Austria	Compliance (%)	62.6 ± 0.9		79.5 ± 0.7				
	Average (km/h)	70.0 ± 3.4		81.4 ± 2.5				
	V85 (km/h)	89.0 ± 3.0		105.0 ± 2.0				
Czech Republic	Compliance (%)		73.2 ± 4.6				56.4 ± 9.3	
	Average (km/h)		81.1 ± 1.8				119.7 ± 4.5	
	V85 (km/h)		99.0 ± 10.3				144.0 ± 26.9	
Greece	Compliance (%)		80.6 ± 3.5				81.1 ± 8.1	
	Average (km/h)		68.6				107.1	
	V85 (km/h)		82.3				118.5	
Malta	Compliance (%)	73.5 ± 5.4						
	Average (km/h)	60.2 ± 7.3						
	V85 (km/h)	68.9 ± 8.3						
Poland	Compliance (%)		63.7 ± 7.3			62.2 ± 8.7		40.2 ± 4.8
	Average (km/h)		72.1 ± 5.0			114.6 ± 4.3		146.6 ± 2.2
	V85 (km/h)		110.0 ± 5.6			138.0 ± 7.9		171.0 ± 4.1
Spain	Compliance (%)		54.2 ± 3.7			64.2 ± 5.1		
	Average (km/h)		90.7 ± 1.3			113.3 ± 2.1		
	V85 (km/h)		107.0 ± 2.0			132.0 ± 3.0		
Sweden	Compliance (%)				49.2 ± 3.8			
	Average (km/h)				103.5 ± 1.7			
	V85 (km/h)							

3.3.2 Vans and small trucks

Tables 7a and 7b provide the speed compliance, average speed and V85 for vans and small trucks during weekday/daytime. The most common speed limits for vans and small trucks among the Member States are 50 km/h urban roads and 80 and 90 km/h rural roads. On 50 km/h urban roads the share of drivers driving within the speed limit is highest in Greece and lowest in Poland, the average speed and the 85th percentile of speed are quite similar in Austria, Cyprus and the Czech Republic but much higher in Poland. On 80 km/h rural roads the percentage of vans and small trucks driving within the speed limit is higher in Austria than it is in Cyprus or the Czech Republic, however the average speed and the 85th percentile of speed are both much lower in Cyprus than in Austria and the Czech Republic and in fact below the speed limit. On 90 km/h rural roads in Greece the average speed and 85th percentile of speed also lie below the speed limit, in Poland and Spain both are notably higher. The results for Poland on 120 km/h motorways in fact are for 120 km/h expressways, but both road types in Poland are almost equal. Not included in the table are the results for 120 km/h expressways in Spain, which are a compliance of 46.7 ± 2.4 percent, an average speed of 103.5 ± 0.7 km/h and a V85 of 119 ± 1 km/h.

Table 7a. Speed compliance, average speed and V85 for vans and small trucks during weekday/daytime

		Urban roads			Rural roads		
		30	40, 50, 60, 70	50	60	70	80
Austria	Compliance (%)	24.1 ± 0.3		54.8 ± 0.2	49.7 ± 0.8	49.4 ± 0.4	71.2 ± 0.4
	Average (km/h)	34.6 ± 1.0		49.9 ± 1.0	58.3 ± 3.5	69.8 ± 2.2	74.4 ± 2.3
	V85 (km/h)	41.0 ± 1.1		56.0 ± 1.0	66.0 ± 3.3	80.0 ± 2.4	84.0 ± 2.8
Cyprus	Compliance (%)			48.6 ± 2.7			63.5 ± 3.1
	Average (km/h)			50.1			63.9
	V85 (km/h)			57.1			70.9
Czech Republic	Compliance (%)			61.9 ± 1.3			56.7 ± 0.9
	Average (km/h)			48.4 ± 0.2			88.1 ± 0.2
	V85 (km/h)			55.0 ± 1.5			102.0 ± 1.8
Greece	Compliance (%)			70.6 ± 2.4			
	Average (km/h)			42.7			
	V85 (km/h)			50.7			
Malta	Compliance (%)				49.7 ± 2.2		
	Average (km/h)				59.8 ± 2.6		
	V85 (km/h)				71.9 ± 3.2		
Poland	Compliance (%)			18.2 ± 1.1			
	Average (km/h)			61.2 ± 0.4			
	V85 (km/h)			74.0 ± 0.9			
Spain	Compliance (%)	29.0 ± 1.6		58.0 ± 1.2			
	Average (km/h)	35.8 ± 0.3		48.4 ± 0.4			
	V85 (km/h)	46.0 ± 1.0		62.0 ± 1.0			
Sweden	Compliance (%)		72.1 ± 6.1				
	Average (km/h)		44.7 ± 1.8				
	V85 (km/h)						

Table 7b. Speed compliance, average speed and V85 for vans and small trucks during weekday/daytime

		Rural roads		Motorways				
		90	100	80	100	120	130	140
Austria	Compliance (%)		86.3 ± 0.2					
	Average (km/h)		84.1 ± 1.8					
	V85 (km/h)		96.0 ± 2.0					
Cyprus	Compliance (%)				76.0 ± 1.7			
	Average (km/h)				90.9			
	V85 (km/h)				99.5			
Czech Republic	Compliance (%)			67.6 ± 0.4				
	Average (km/h)			119.1 ± 0.2				
	V85 (km/h)			142.0 ± 1.2				
Greece	Compliance (%)	88.3 ± 1.6					90.5 ± 1.7	
	Average (km/h)	63.3					91.1	
	V85 (km/h)	73.2					106.6	
Malta	Compliance (%)							

	Average (km/h)							
	V85 (km/h)							
Poland	Compliance (%)	61.1 ± 1.2				77.8 ± 0.9		94.0 ± 0.6
	Average (km/h)	87.3 ± 0.4				106.0 ± 0.4		108.5 ± 0.5
	V85 (km/h)	102.0 ± 1.5				127.0 ± 1.3		130.0 ± 1.3
Spain	Compliance (%)	68.5 ± 1.6				39.3 ± 4.9		
	Average (km/h)	86.6 ± 0.5				106.0 ± 1.5		
	V85 (km/h)	94.0 ± 1.0				122.0 ± 2.0		
Sweden	Compliance (%)							
	Average (km/h)							
	V85 (km/h)							

3.3.3 Trucks, buses and heavy goods vehicles

Tables 8a, 8b and 8c provide the speed compliance, average speed and V85 for trucks, buses and heavy goods vehicles during weekday/daytime. The most common speed limits for these vehicles among the Member States are 50 km/h urban roads and 80 km/h rural roads. On motorways in Greece the speed limit is 85 or 100 km/h for these vehicles. The speed limit in Poland on motorways and expressways is 80 km/h for heavy goods vehicles and 100 km/h for buses. For trucks, buses and heavy goods vehicles, on 50 km/h urban roads the share of drivers driving within the speed is with 15.4 ± 0.9 percent at its lowest in Poland and with a share around 80% at its highest in Greece, Portugal and Spain. The data in Portugal, however, is based on 86 observations, which is rather few. The average speed is not very different in Greece, Portugal and Spain, in Poland it is about 10 km/h above the speed limit. In Austria, Cyprus and the Czech Republic the average speed and the 85th percentile of speed are also not that different, but the speed compliance in Cyprus is notably lower. The 85th percentile of speed is notably higher in Poland compared to Austria and the Czech Republic. On 80 km/h rural roads the percentage driving within the speed limit is lowest in Portugal and the Czech Republic and highest in Austria. Not included in the table are the results for 120 km/h expressways in Spain, which are a compliance of 93.6 ± 0.8 percent, an average speed of 91.8 ± 0.2 km/h and a V85 of 95 ± 1 km/h.

Table 8a. Speed compliance, average speed and V85 for trucks, buses and heavy goods vehicles during weekday/daytime

		Urban roads			Rural roads	
		30	40, 50, 60, 70	50	60	70
Austria	Compliance (%)	48.3 ± 0.6		70.4 ± 0.2	77.6 ± 0.7	71.6 ± 0.4
	Average (km/h)	29.6 ± 1.4		46.1 ± 1.2	51.5 ± 3.9	62.7 ± 2.1
	V85 (km/h)	36.0 ± 1.5		52.0 ± 1.1	58.0 ± 4.0	71.0 ± 1.8
Cyprus	Compliance (%)			41.4 ± 5.9		
	Average (km/h)			43.9		
	V85 (km/h)			47.0		
Czech Republic	Compliance (%)			72.5 ± 1.0		
	Average (km/h)			47.2 ± 0.1		
	V85 (km/h)			53.0 ± 1.2		
Greece	Compliance (%)			81.6 ± 3.6		
	Average (km/h)			39.7		
	V85 (km/h)			45.5		
Malta	Compliance (%)				68.3 ± 3.8	
	Average (km/h)				55.4 ± 4.5	
	V85 (km/h)				66.6 ± 5.4	

Poland	**Compliance (%)**			15.4 ± 0.9		15.4 ± 0.7
	Average (km/h)			60.0 ± 0.3		79.1 ± 0.2
	V85 (km/h)			71.0 ± 0.7		88.0 ± 0.0
Portugal	**Compliance (%)**			83.0 ± 7.9		
	Average (km/h)			33.0 ± 3.2		
	V85 (km/h)			47.9 ± 19.7		
Spain	**Compliance (%)**	49.4 ± 3.1		78.1 ± 2.1		
	Average (km/h)	30.6 ± 0.6		40.3 ± 0.8		
	V85 (km/h)	41.0 ± 1.0		54.0 ± 1.0		
Sweden	**Compliance (%)**		81.5 ± 7.3			
	Average (km/h)		43.0 ± 3.0			
	V85 (km/h)					

Table 8b. Speed compliance, average speed and V85 for trucks, buses and heavy goods vehicles during weekday/daytime

		Rural roads				Motorways
		70, 80	80	90	100	80
Austria	**Compliance (%)**		94.5 ± 0.2		98.8 ± 0.1	
	Average (km/h)		65.4 ± 2.1		71.6 ± 1.4	
	V85 (km/h)		74.0 ± 2.4		80.0 ± 1.6	
Cyprus	**Compliance (%)**					
	Average (km/h)					
	V85 (km/h)					
Czech Republic	**Compliance (%)**		40.9 ± 0.6			1.4 ± 0.1
	Average (km/h)		81.6 ± 0.1			94.3 ± 0.1
	V85 (km/h)		90.0 ± 1.1			98.0 ± 0.7
Greece	**Compliance (%)**		69.5 ± 4.1			
	Average (km/h)		59.7			
	V85 (km/h)		65.9			
Malta	**Compliance (%)**					
	Average (km/h)					
	V85 (km/h)					
Poland	**Compliance (%)**					
	Average (km/h)					
	V85 (km/h)					
Portugal	**Compliance (%)**		37.0 ± 1.2			
	Average (km/h)		83.7 ± 2.5			
	V85 (km/h)		95.5 ± 3.1			
Spain	**Compliance (%)**			68.5 ± 1.7		
	Average (km/h)			86.6 ± 0.3		
	V85 (km/h)			92.0 ± 1.0		
Sweden	**Compliance (%)**	44.9 ± 3.0				
	Average (km/h)	72.7 ± 0.6				
	V85 (km/h)					

Table 8c. Speed compliance, average speed and V85 for trucks, buses and heavy goods vehicles during weekday/daytime

		Motorways				Expressways
		80/85 (100)	80, 90	90	120	80 (100)
Austria	**Compliance (%)**					
	Average (km/h)					
	V85 (km/h)					
Cyprus	**Compliance (%)**					
	Average (km/h)					
	V85 (km/h)					
Czech Republic	**Compliance (%)**					
	Average (km/h)					
	V85 (km/h)					
Greece	**Compliance (%)**	68.8 ± 2.5				
	Average (km/h)	80.1				
	V85 (km/h)	87.6				
Malta	**Compliance (%)**					
	Average (km/h)					
	V85 (km/h)					
Poland	**Compliance (%)**	2.3 ± 0.2				5.5 ± 0.4
	Average (km/h)	91.2 ± 0.1				90.1 ± 0.1
	V85 (km/h)	95.0 ± 0.0				94.0 ± 0.2
Portugal	**Compliance (%)**			43.4 ± 1.5		
	Average (km/h)			96.2 ± 4.9		
	V85 (km/h)			110.6 ± 9.7		
Spain	**Compliance (%)**				90.5 ± 1.5	
	Average (km/h)				92.0 ± 0.4	
	V85 (km/h)				96.0 ± 1.0	
Sweden	**Compliance (%)**		15.0 ± 2.0			
	Average (km/h)		84.2 ± 0.4			
	V85 (km/h)					

3.4 Breakdown by time period

As a final breakdown, we compare indicator values at different time periods. The minimum required time period was weekday/daytime, but some Member States also provided data on weekday/night-time, weekend/daytime and weekend/night-time. We compare these for passenger cars and the most common speed limits and road types, as for these categories there was the most data to compare. The most common speed limits and road types in the Member States that provided data on several time periods are 120 km/h motorways, 90 km/h rural roads and 50 km/h urban roads. Only Member States are included that provided data for more than one time period.

Table 9 presents the percentage of drivers driving within the speed limit, the average speed and the 85th percentile of speed for passenger cars on 120 km/h motorways in Belgium, Finland, Poland, Portugal and Spain, the Member States that provided data for this category. The values for Poland more precisely are for expressways, but measured at locations that are similar to motorways, hence they are considered comparable and included here. In each of these Member States the share of drivers driving within the speed limit is higher during night-time than during daytime, both on weekdays and in the weekend, though not always notably so. The average speed is a bit lower during night-time, as for the 85th percentile of speed there is not much difference during daytime and night-time.

Table 9. Speed compliance, average speed and V85 for passenger cars on 120 km/h motorways

		weekday/daytime	weekday/night-time	weekend/daytime	weekend/night-time
Belgium	**Compliance (%)**	56.4 ± 4.6	59.2 ± 3.7	53.4 ± 3.8	59.8 ± 5.5
	Average (km/h)	119.1 ± 1.3	117.8 ± 1.0	120.0 ± 1.2	118.1 ± 1.7
	V85 (km/h)	130.8 ± 1.8	131.1 ± 1.8	131.0 ± 1.8	131.0 ± 1.8
Finland	**Compliance (%)**	54.5 ± 9.5	60.1	53.3	58.1
	Average (km/h)	116.9	115.0	117.3	115.7
	V85 (km/h)	128.2 ± 2.1	127.7	128.4	127.8
Poland	**Compliance (%)**	43.7 ± 0.4	52.7 ± 0.6		
	Average (km/h)	124.4 ± 0.2	120.2 ± 0.2		
	V85 (km/h)	144.0 ± 0.2	140.0 ± 0.4		
Portugal	**Compliance (%)**	43.6 ± 0.6	45.6 ± 1.3		
	Average (km/h)	124.2 ± 4.6	123.5 ± 5.2		
	V85 (km/h)	144.0 ± 5.7	144.5 ± 6.6		
Spain	**Compliance (%)**	50.8 ± 1.2	58.2 ± 1.9	48.8 ± 1.8	56.4 ± 2.6
	Average (km/h)	121.3 ± 0.3	118.4 ± 0.7	122.1 ± 0.6	119.1 ± 1.0
	V85 (km/h)	136.0 ± 1.0	135.0 ± 1.0	137.0 ± 1.0	136.0 ± 2.0

Table 10 presents the percentage of drivers driving within the speed limit, the average speed and the 85th percentile of speed for passenger cars on 90 km/h rural roads in the Member States that provided data for this category. In Poland the share of drivers driving within the speed limit is higher during night-time than daytime on weekdays, in the other Member States there is not much difference. The average speed and the 85th percentile of speed during night-time compared to daytime on weekdays are lower in Poland, and not much different in the other Member States. The share of drivers driving within the speed limit during the weekend both during daytime and night-time in the Czech Republic is lower than during weekdays, and the average speed is a bit higher, between daytime and night-time during the weekend there appears to be little difference. In Belgium and Spain there shows to be little difference between daytime and night-time and between weekdays and weekend days.

Table 10. Speed compliance, average speed and V85 for passenger cars on 90 km/h rural roads

		weekday/daytime	weekday/night-time	weekend/daytime	weekend/night-time
Belgium	**Compliance (%)**	46.0 ± 9.5	41.5 ± 9.8	45.9 ± 9.7	47.4 ± 10.5
	Average (km/h)	92.9 ± 3.5	95.8 ± 3.9	93.3 ± 3.4	93.4 ± 4.1
	V85 (km/h)	106.1 ± 3.7	106.9 ± 3.5	105.9 ± 3.5	106.1 ± 3.6
Czech Republic	**Compliance (%)**	54.5 ± 0.4	53.4 ± 0.6	43.9 ± 0.6	43.7 ± 1.2
	Average (km/h)	88.7 ± 0.1	89.4 ± 0.2	93.3 ± 0.2	93.6 ± 0.3
	V85 (km/h)	104.0 ± 0.8	107.0 ± 1.4	107.0 ± 1.3	110.0 ± 2.6
Greece	**Compliance (%)**	84.4 ± 0.8		85.3 ± 1.3	
	Average (km/h)	68.1		67.4	
	V85 (km/h)	78.9		76.8	
Poland	**Compliance (%)**	51.9 ± 0.5	62.0 ± 0.6		
	Average (km/h)	91.2 ± 0.2	87.0 ± 0.2		
	V85 (km/h)	109.0 ± 1.5	103.0 ± 1.3		
Portugal	**Compliance (%)**	35.5 ± 0.6	34.7 ± 1.3		
	Average (km/h)	97.1 ± 4.0	97.7 ± 5.9		

	V85 (km/h)	115.9 ± 4.6	117.9 ± 6.1		
Spain	**Compliance (%)**	42.6 ± 0.6	39.3 ± 1.1	42.2 ± 0.9	42.0 ± 1.9
	Average (km/h)	94.4 ± 0.2	96.0 ± 0.4	94.8 ± 0.3	95.3 ± 0.6
	V85 (km/h)	109.0 ± 1.0	112.0 ± 1.0	111.0 ± 1.0	112.0 ± 1.0

Table 11 presents the percentage of drivers driving within the speed limit, the average speed and the 85th percentile of speed for passenger cars on 50 km/h urban roads in the Member States that provided data for this category. In most Member States that provided results on daytime and night-time the share of drivers driving within the speed limit is lower during night-time than daytime, and the average speed and 85th percentile of speed are higher, though not much. The share of drivers driving within the speed limit during weekend/daytime is lower than during weekday/daytime both all the Member States that provided results on these time periods, although there is not much difference in the average speed and 85th percentile of speed. During weekend/night-time the share of drivers driving within the speed limit compared to weekday/night-time is higher in some Member States but lower in some other Member States, though not by much.

Table 11. Speed compliance, average speed and V85 for passenger cars on 50 km/h urban roads

		weekday/daytime	weekday/night-time	weekend/daytime	weekend/night-time
Austria	**Compliance (%)**	57.4 ± 0.1	46.5 ± 0.2	54.9 ± 0.1	50.7 ± 0.3
	Average (km/h)	49.8 ± 0.9	52.5 ± 0.9	50.2 ± 0.9	52.1 ± 1.0
	V85 (km/h)	56.0 ± 0.9	59.0 ± 1.0	56.0 ± 0.9	59.0 ± 1.2
Belgium	**Compliance (%)**	49.9 ± 9.3	40.6 ± 7.9	46.7 ± 9.8	38.5 ± 8.1
	Average (km/h)	51.0 ± 2.2	54.7 ± 2.8	52.2 ± 2.3	55.6 ± 3.1
	V85 (km/h)	59.8 ± 2.6	57.8 ± 2.6	59.9 ± 2.8	59.1 ± 2.8
Cyprus	**Compliance (%)**	26.1 ± 0.8		20.8 ± 2.9	
	Average (km/h)	56.2		56.9	
	V85 (km/h)	65.1		65.7	
Czech Republic	**Compliance (%)**	57.3 ± 0.4	43.3 ± 0.7	47.9 ± 0.7	42.9 ± 1.3
	Average (km/h)	49.6 ± 0.1	51.8 ± 0.1	51.0 ± 0.1	52.0 ± 0.2
	V85 (km/h)	56.0 ± 0.4	59.0 ± 0.8	57.0 ± 0.7	59.0 ± 1.5
Finland	**Compliance (%)**	43.0	37.3	39.2	36.6
	Average (km/h)	50.9	52.6	51.8	52.9
	V85 (km/h)	59.0	59.0	59.0	60.0
Greece	**Compliance (%)**	58.8 ± 1.1		42.9 ± 1.9	
	Average (km/h)	46.7		55.6	
	V85 (km/h)	55.6		64.0	
Poland	**Compliance (%)**	20.5 ± 0.5	19.7 ± 0.6		
	Average (km/h)	60.8 ± 0.2	62.2 ± 0.2		
	V85 (km/h)	74.0 ± 0.3	77.0 ± 0.4		
Spain	**Compliance (%)**	64.9 ± 0.6	60.1 ± 1.0	61.8 ± 0.9	63.3 ± 1.4
	Average (km/h)	46.5 ± 0.2	48.6 ± 0.2	47.9 ± 0.3	47.6 ± 0.5
	V85 (km/h)	60.0 ± 0.0	62.0 ± 1.0	62.0 ± 1.0	61.0 ± 1.0

4 Initial analyses

Between the percentage of drivers driving within the speed limit and the average speed and the 85th percentile of speed we frequently observe an inverse relationship: a lower percentage of drivers driving within the speed limit often corresponds to a higher average speed or a higher 85th percentile of speed, or both. As we observed with the data on rural roads, the indicators complement one another. An increase in the share of drivers exceeding the speed limit may be only a moderate increase in the average speed and no notable increase in the 85th percentile, or it may be that only few drivers exceed the speed limit but with large exceedances when they do, which is shown by a relatively high 85th percentile of speed. Both the share of drivers exceeding the speed limit and the amount with which they do negatively impact road safety.

When comparing the results with mortality rates (European Commission, 2022), that is, the number of road crash fatalities per one million inhabitants, there does not appear to be a clear relationship. For some Member States, such as Bulgaria, Latvia and Poland, the mortality rate is relatively high, yet the share of drivers driving within the speed limit is relatively high in Bulgaria but low in Latvia and Poland, and in other Member States, such as Austria, the mortality rate is not particularly high or low, yet the share of drivers driving within the speed limit is relatively high.

Comparison of the results obtained through roadside observations with those of the ESRA2 survey shows that they in some instances agree but not always. On motorways the Member States with the lowest and highest share of drivers driving within the speed limit according to roadside observations are also the Member States with the lowest and highest share of self-reported speeding, but on rural roads and urban roads this agreement no longer appears to hold. The Member States with the lowest and highest share of personal acceptability and social acceptability to speed also not quite match with those with the lowest and highest share of drivers driving within the speed limit according to roadside observations. While it is difficult to say where these disagreements come from, there is a clear methodological difference between self-reported data and roadside observation. The former concerns behaviour observed at least once during a 30 day period whereas the latter concerns behaviour observed at a certain instant, and the latter does not suffer from the subjectivity inherent to self-reporting. The difference in methodology and outcomes supports the added value of roadside observation to gather data on speeding.

5 Conclusions on data quality and recommendations for the future

5.1 Data quality

The data reported on here was collected by different methods, mostly radar and loop detectors, but all allowed for the measurement of spot speeds, except in the Netherlands where results were based on floating car data. The traffic conditions under which observations were made were free-flowing traffic, only in Sweden the conditions were mostly free-flowing and in the Netherlands where traffic was not free-flowing. All Member States collected data during at least spring or autumn, and under good weather conditions. Those that included summer collected data over a period of at least 8 months, and we expect this to be long enough for seasonal variations to have little influence and results to be comparable. Those that also collected data during winter included only results obtained under good weather conditions, and so we expect these also to be comparable. Ireland provided no information on the observation period and weather conditions.

Most Member States provided as indicators the percentage of drivers driving within the speed limit, the average speed and the 85th percentile of speed. These indicators were most of the times provided with confidence intervals.

Portugal with respect to vehicles on motorways and urban roads classified them on the basis of their length, and included motorcycles into the category of passenger cars. In general the classification of vehicles on the basis of their length, which is common for automated measurements, is not unambiguous, and devices such as radars and loop detectors are not very good at it.

Measurement locations were mostly selected through simple or stratified random sampling. The minimum requirement of 10 locations per road type and provided vehicle type was met in all cases, except urban roads in Finland for which there are only 7 locations included, and which is due to there not being that many urban locations that meet all the requirements for measurement locations. The minimum requirement of 2000 observations in total and 500 observations per road type is met by all Member States. For the optional vehicle types of vans / small trucks, trucks / buses / heavy goods vehicles, and motorcycles, the recommended minimum of 10 locations is met by all countries that provided data on these vehicle types, and the recommended minimum of 2000 observations in total and 500 observations per road type is met by most of those Member States.

There is quite some variation in the size of confidence intervals between the Member States, which may be due to various causes. One reason may be a variation between measurement locations, which may be larger in some Member States and smaller in others. A selection of measurement locations based on stratified sampling compared to simple random sampling typically yields smaller confidence intervals if the strata are relatively homogeneous. There may also be differences in the way the confidence intervals were calculated. Some Member States calculated them based on the average value per measurement location, which results in relatively large confidence intervals. Very small confidence intervals may be the result of calculating them based on individual observations rather than averages per measurement location.

5.2 Comparability of data

All Member States that provided data did so on passenger cars during weekday/daytime on motorways, rural roads and urban roads, except Latvia which did has no motorways and hence could not provide data on this kind of roads. Some Member States also provided data on weekends or night-time or both, and on other vehicles types, and comparisons there could also be made for the most common combinations of time period and vehicle type but not for other combinations as they were only provided by a single Member State. Several Member states have more than one speed limit per road type, and provided results per road type and speed limit. Though perhaps not easy, it allows for valuable comparisons.

5.3 Recommendations

Speed is a risk factor that is indicative for road safety, as is supported by studies that show that the crash rate and the severity of crashes both increase with an increase in absolute speed (European Commission, 2021). The share of drivers driving within the speed limit is an indicator for how many drivers conform to a speed that is considered acceptable from a road safety point of view, a decrease in this share indicates a higher risk for road crashes when other factors such as the speed limit remain the same. The average speed and the 85th percentile of speed are indicators for the absolute speed and as such also work as indicators for the crash rate and the severity of crashes. They have added value as they complement the percentage of drivers driving within the speed limit.

In order to compare Member States, breakdowns by road type and speed limit should remain. Ideally, in order to compare different roads with the same speed limit, the speed limits should fit the road design. Verifying this, however, may in practice be difficult. It appears that a higher speed limit on the same road type usually results in a higher share of drivers driving within the speed limit. Since speed limits differ per vehicle type, distinction between vehicle types should also be kept. The available data on different time periods, although limited, suggests that driving behaviour in terms of speed may differ between daytime and night-time and between weekdays and weekends, and provision of data for these different time periods by more Member States could share more light on this.

Several Member States asked questions about the data collection process, regarding details that often could not be found in the guidelines. For future collection of data by Member States it is recommended to update the guidelines based on these questions, or to centrally make available a list of answers to frequently asked questions.

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7 Annex 1. Results by speed limit for passenger cars during weekday/daytime

Tables 12a, 12b and 12c present the percentage of passenger cars driving within the speed limit (KPI), the average speed, and the speed below which 85% of the drivers are driving (V85), on urban roads, rural roads and motorways with different speed limits, during weekday/daytime. The values for Poland on 120 km/h motorways more precisely are for expressways, which are quite similar to motorways, except that they can be dual- or single-carriageway roads at which intersections occur exceptionally, but since the measurement locations on expressways were dual carriageways with no intersections they are put here under motorways. Sweden reported a 66.0 ± 5.8 percentage driving within the speed limit and an average speed of 46.8 ± 1.5 km/h on 40, 50, 60 and 70 km/h urban roads combined, a KPI value of 51.7 ± 2.7 percent and an average speed of 69.7 ± 1.0 on 70, 80 and 90 km/h rural roads, and a KPI value of 44.4 ± 2.6 percent and an average speed of 108.1 ± 0.9 km/h on mainly 110 and 120 km/h motorways. Not included in the table are the results for 120 km/h expressways in Spain, which are a compliance of 62.5 ± 0.8 percent, an average speed of 117.2 ± 0.3 km/h and a V85 of 130 ± 1 km/h.

Table 12a. Speed compliance, average speed and V85 for passenger cars during weekday/daytime on urban and rural roads and motorways

		Urban roads				Rural roads	
		30	40, 50, 60, 70	50	60	50	60
Austria	Compliance (%)	23.9 ± 0.1		57.4 ± 0.1			52.7 ± 0.3
	Average (km/h)	34.3 ± 1.0		49.8 ± 0.9			59.0 ± 2.8
	V85 (km/h)	40.0 ± 1.0		56.0 ± 0.9			66.0 ± 2.7
Belgium	Compliance (%)	24.1 ± 6.1		49.9 ± 9.3			
	Average (km/h)	37.5 ± 1.7		51.0 ± 2.2			
	V85 (km/h)	47.2 ± 2.1		59.8 ± 2.6			
Bulgaria	Compliance (%)			44.7 ± 1.0			
	Average (km/h)			52.5 ± 0.2			
	V85 (km/h)			63.3 ± 0.4			
Cyprus	Compliance (%)			26.1 ± 0.8			
	Average (km/h)			56.2			
	V85 (km/h)			65.1			
Czech Republic	Compliance (%)			57.3 ± 0.4			
	Average (km/h)			49.6 ± 0.1			
	V85 (km/h)			56.0 ± 0.4			
Finland	Compliance (%)			43.0	40.7	5.7	32.3
	Average (km/h)			50.9	61.7	63.2	63.3
	V85 (km/h)			59.0	67.5	73.0	69.0
Greece	Compliance (%)			58.8 ± 1.1			
	Average (km/h)			46.7			
	V85 (km/h)			55.6			
Latvia	Compliance (%)			41.4 ± 1.6			
	Average (km/h)			52.1 ± 0.2			
	V85 (km/h)			58.0			
Lithuania	Compliance (%)			36.4 ± 0.4			
	Average (km/h)			53.6 ± 0.1			
	V85 (km/h)			63.0 ± 1.0			
Malta	Compliance (%)			70.3 ± 1.6			
	Average (km/h)			45.4 ± 1.6			

	V85 (km/h)			54.9 ± 1.9			
Poland	Compliance (%)			20.5 ± 0.5			
	Average (km/h)			60.8 ± 0.2			
	V85 (km/h)			74.0 ± 0.3			
Portugal	Compliance (%)			73.0 ± 2.1			
	Average (km/h)			44.3 ± 3.7			
	V85 (km/h)			52.7 ± 4.3			
Spain	Compliance (%)	32.1 ± 0.7		64.9 ± 0.6			
	Average (km/h)	35.3 ± 0.1		46.5 ± 0.2			
	V85 (km/h)	46.0 ± 0.0		60.0 ± 0.0			
Sweden	Compliance (%)		66.0 ± 5.8				
	Average (km/h)		46.8 ± 1.5				
	V85 (km/h)						

Table 12b. Speed compliance, average speed and V85 for passenger cars during weekday/daytime on urban and rural roads and motorways

		Rural roads					Motorways
		70	70, 80, 90	80	90	100	80
Austria	Compliance (%)	52.4 ± 0.1		73.3 ± 0.1		88.9 ± 0.1	
	Average (km/h)	69.8 ± 1.9		74.5 ± 2.0		85.0 ± 1.6	
	V85 (km/h)	79.0 ± 2.2		84.0 ± 2.3		97.0 ± 1.7	
Belgium	Compliance (%)	61.2 ± 7.4			46.0 ± 9.5		
	Average (km/h)	68.5 ± 1.7			92.9 ± 3.5		
	V85 (km/h)	78.0 ± 1.9			106.1 ± 3.7		
Bulgaria	Compliance (%)				93.4 ± 0.5		
	Average (km/h)				64.2 ± 0.3		
	V85 (km/h)				77.7 ± 0.7		
Cyprus	Compliance (%)			45.7 ± 1.2			
	Average (km/h)			69.4			
	V85 (km/h)			79.2			
Czech Republic	Compliance (%)				54.5 ± 0.4		
	Average (km/h)				88.7 ± 0.1		
	V85 (km/h)				104.0 ± 0.8		
Finland	Compliance (%)	60.1		38.7 ± 5.3		55.6 ± 2.1	30.1
	Average (km/h)	66.9		82.2		98.2	84.7
	V85 (km/h)	73.3		90.1 ± 1.3		107.1 ± 0.6	93.6
Greece	Compliance (%)				84.4 ± 0.8		
	Average (km/h)				68.1		
	V85 (km/h)				78.9		
Latvia	Compliance (%)				29.0 ± 0.3		
	Average (km/h)				96.6 ± 0.1		
	V85 (km/h)				105.0		
Lithuania	Compliance (%)				47.2 ± 0.6		
	Average (km/h)				92.6 ± 0.2		

	V85 (km/h)				104.6 ± 0.8		
Malta	Compliance (%)			73.7 ± 1.3			
	Average (km/h)			60.0 ± 1.7			
	V85 (km/h)			70.9 ± 2.1			
Poland	Compliance (%)				51.9 ± 0.5		
	Average (km/h)				91.2 ± 0.2		
	V85 (km/h)				109.0 ± 1.5		
Portugal	Compliance (%)				35.5 ± 0.6		
	Average (km/h)				97.1 ± 4.0		
	V85 (km/h)				115.9 ± 4.6		
Spain	Compliance (%)				42.6 ± 0.6		
	Average (km/h)				94.4 ± 0.2		
	V85 (km/h)				109.0 ± 1.0		
Sweden	Compliance (%)		51.7 ± 2.7				
	Average (km/h)		69.7 ± 1.0				
	V85 (km/h)						

Table 12c. Speed compliance, average speed and V85 for passenger cars during weekday/daytime on urban and rural roads and motorways

		Motorways				
		100	110, 120	120	130	140
Austria	Compliance (%)				80.9 ± 0.9	
	Average (km/h)				120.8 ± 1.5	
	V85 (km/h)				131.0 ± 1.5	
Belgium	Compliance (%)			56.4 ± 4.6		
	Average (km/h)			119.1 ± 1.3		
	V85 (km/h)			130.8 ± 1.8		
Bulgaria	Compliance (%)					89.4 ± 0.7
	Average (km/h)					116.2 ± 0.4
	V85 (km/h)					136.8 ± 0.7
Cyprus	Compliance (%)	46.5 ± 0.8				
	Average (km/h)	97.7				
	V85 (km/h)	108.9				
Czech Republic	Compliance (%)				39.8 ± 0.2	
	Average (km/h)				133.5 ± 0.1	
	V85 (km/h)				151.0 ± 0.7	
Finland	Compliance (%)	33.4 ± 5.6		54.5 ± 9.5		
	Average (km/h)	103.5		116.9		
	V85 (km/h)	112.7 ± 1.2		128.2 ± 2.1		
Greece	Compliance (%)				77.7 ± 1.2	
	Average (km/h)				109.2	
	V85 (km/h)				124.8	
Latvia	Compliance (%)					
	Average (km/h)					

	V85 (km/h)					
Lithuania	**Compliance (%)**				76.8 ± 0.8	
	Average (km/h)				118.3 ± 0.3	
	V85 (km/h)				135.0 ± 0.3	
Malta	**Compliance (%)**					
	Average (km/h)					
	V85 (km/h)					
Poland	**Compliance (%)**			43.7 ± 0.4		71.3 ± 0.5
	Average (km/h)			124.4 ± 0.2		130.0 ± 0.2
	V85 (km/h)			144.0 ± 0.2		151.0 ± 0.1
Portugal	**Compliance (%)**			43.6 ± 0.6		
	Average (km/h)			124.2 ± 4.6		
	V85 (km/h)			144.0 ± 5.7		
Spain	**Compliance (%)**			50.8 ± 1.2		
	Average (km/h)			121.3 ± 0.3		
	V85 (km/h)			136.0 ± 1.0		
Sweden	**Compliance (%)**		44.4 ± 2.6			
	Average (km/h)		108.1 ± 0.9			
	V85 (km/h)					

8 Annex 2. Requirements for representative speed measurements

8.1 Free flowing traffic

The minimum requirement for the KPI on speeding is to only look at **free flowing traffic**. This means traffic conditions in which drivers can freely choose the speed they drive and are not restricted by traffic jams, infrastructure (e.g., speed bumps) or road works. To guarantee the observation of free-flowing traffic strict inclusion criteria are used for the measurement locations (see section 7.3.1). Next to selecting observation locations that allow free flowing traffic, there should also be enough headway between the vehicles of interest included in the analysis and the vehicle driving in front of it. Practically this means only including vehicles that have a headway similar to the distance travelled in 5 seconds at the current legal speed limit. This would for instance be 42, 69, and 167 meters for 30 km/h, 50 km/h, and 120 km/h respectively (Riguelle, 2008). It was found that using this 5 second headway is enough to guarantee free-flowing traffic (Global Road Safety Partnership, 2008).

8.2 Adequate observation equipment

8.2.1 Choice of measurement method

The SWD does not specify a required measurement method. However, the chosen method should allow the observation of **momentaneous speed in free flowing traffic** situations. The focus in these guidelines will be solely on tools that measure the momentaneous (or instantaneous) speed, thus producing spot speed data. Hakkert and Gitelman (2007) describe several methods to collect speed data, which will be explained in more detail in sections 7.2.5 through 7.2.7 of these guidelines.

Speed can also be measured over certain lengths of the road (e.g. with ANPR - Automatic Number Plate Recognition - systems), but this method is outside the scope of these guidelines, since for the KPI on speeding the requirement is to consider free flow traffic only and looking at speeds over certain lengths of road does not allow the analysis of free flow traffic. Similarly, floating car data can only be considered as a data source when it can be guaranteed that free flowing traffic can be analyzed and that the sample of drivers from which the data are obtained is representative of the broader population (e.g. are users of the smartphone application used to obtain the data representative of the Member State population).

8.2.2 Requirements for equipment

As mentioned above, the scope of these guidelines is limited to devices that measure instantaneous speed, or spot speed at a particular location. The SWD does not specify the required equipment to do this. Because the speed measurement will usually be carried out over a short period of time (e.g. a couple of weeks) and ideally at a large number of locations, it is recommended to use equipment which can be installed quickly and flexibly. That is why portable systems such as radars or cameras that can be mounted quickly are preferred. It is possible to use permanent or semi-permanent systems such as loops as well, and therefore these are included in this section for the sake of completeness.

In general, three types of devices for collecting spot speed data can be distinguished (Knodler et al., 2005): out-of-road devices, in-road devices, and hand-held devices (although hand-held devices are not recommended they are included for the sake of completeness). In this section, a basic overview of each of these devices is provided. Note that only the most commonly used devices are described.

8.2.3 Minimum requirements

Regardless of the device used, the equipment used should at least meet the **following minimum requirements**:

- be able to measure, store and deliver the instantaneous speed of individual vehicles;
- be able to measure the number of vehicles (traffic count);
- be able to measure the length of vehicles (in meters to one decimal place). The main reason to include length is that this variable is the most common means to determine vehicle type. When other means are available to determine vehicle type they can be used instead of length;
- be able to record the pass-by time of each vehicle (accurate to the second);
- be able to work uninterruptedly and store data for at least seven days;
- be able to collect data on at least 250,000 vehicles (either by internally storing the data in the device or by sending the data in real-time to an external server);
- be reasonably unobtrusive (not look like speed cameras);
- have a solid, stable installation. Also, the equipment should be calibrated and checked after installation to ensure correct data collection;
- be protected against theft and vandalism (optionally a small disclaimer can be added to the device explaining that the data are not used for law enforcement).

8.2.4 Unobtrusiveness of the equipment

Although this is not required by the SWD, to ensure the measurement of free flow traffic it is highly recommended that the equipment is as unobtrusive as possible. When drivers notice their speed is being measured, it will influence the speed they are driving, rendering the data less meaningful or unreliable. For this reason, hand-held devices are not recommended as it is hard to use these devices inconspicuously. Moreover, using hand-held devices limits the time window for the measurement, as drivers can report the measurement and warn other road users via various websites or smartphone applications.

8.2.5 Out-of-road devices

Doppler-based microwave radars are probably the most recommended method for speed measurements. These radars send a constant wave (24.5 GHz) which rebounds off the surface of the vehicle. From the modified frequency a number of variables can be deduced, typically including vehicle type (based on length), pas-by time, instantaneous speed, and vehicle count. They are placed along the roadway using existing poles such as traffic signs or street lights. Microwave radars are relatively unaffected by weather conditions and are thus often preferred to other types of radars. Another similar technique is frequency modulated carrier wave radar (FMCW): however, the cost of these radars is higher than Doppler radar but the performance is similar.

An advantage of radar systems is that they are relatively non-intrusive and there is usually no need to interrupt traffic to install them, although sometimes a road lane might have to be closed for a short amount of time to install the radar. It must be noted that to ensure the safety of the people installing the radar equipment, this should be done by trained and experienced personnel in accordance with the safety regulations and traffic laws of the Member State. Both radar systems can be flexibly used and installed on a wide variety of locations ranging from city centers to highways provided that poles or lampposts are available to install the radar equipment. This also offers flexibility in selecting locations, allowing a high-quality random locations sample.

A disadvantage is that with these devices, one can only obtain a coarse classification of vehicle types based on their dimensions. Additionally, it is very important that this type of equipment is installed by experienced and trained personnel since poor installation can prejudice the data quality enormously. Also, the devices should be properly calibrated and checked after installation using another type of device (e.g. a speedgun) to ensure the installation is successful. This requirement for experience with the installation should be listed in the proposal if the installation of the equipment is subcontracted.

LIDAR devices (light detection and ranging) work similarly to radars but they use a different wavelength and a different type of wave. LIDARs use a laser wave and gather the reflected wave to obtain information on the detected objects. Their main field of application is enforcement because of their very high accuracy. The cost is significantly higher compared to Doppler-based radars.

Active infrared devices use the same principle as microwave radars but with infrared wavelengths. Smaller wavelengths make them more accurate than microwaves, which is especially helpful in distinguishing between vehicle types. This system too is more expensive compared to Doppler-based radars and is subject to errors in bad weather conditions.

Cameras can also be used when they are placed at a certain height above the roadway to film the passing vehicles. For a correct image setting two points of reference are used with a known distance between them. The device measures the time in which a vehicle drives from the first to the second point. The speed of the vehicle is calculated by means of this time and the known distance. The vehicle length can be deduced as well using this method.

8.2.6 In-road devices

Some roads contain embedded devices that are capable of detecting vehicle speeds. These devices, such as loop detectors, are widely used for traffic surveillance purposes. They generally include a set of wires embedded into the roadway in a rectangular formation. Via the wires an electromagnetic field is created which can detect any vehicle that passes over the loop. Using these loops, data on traffic volumes can be derived directly. The main advantage is that they are already in place, so data can be collected relatively easily.

An alternative in-road technology is the use of axle detectors. These detectors may be of different types: pneumatic, piezo-electric or quartz-electric. A rough classification of the vehicle can be detected provided that the headways between vehicles are not too small. As these devices do not count vehicles directly but count axles, a correction factor must be applied in order to establish correct traffic information. These correction factors are based on knowledge of the typical traffic characteristics of different road types but they must be adjusted depending on the specificity of the road where measurements are carried out.

8.2.7 Hand-held devices

Radar guns and laser guns are portable instruments that are manually operated. The main advantage is their flexibility since they do not require any installation. The use of radar and laser guns would only be recommended on less-trafficked roads, as it is hard for the observer to monitor vehicle speed on roads with high traffic volumes. An advantage is that they can be used to distinguish particular types of vehicles which are not automatically detected by other systems such as vans, motorcycles, buses, … .

A major disadvantage of using radar or laser guns is their obtrusiveness, thereby possibly influencing the behaviour of the drivers. Another issue is that the overall cost of surveys with radar/laser guns is relatively high due to labour costs of the operators.

8.3 Appropriate observation locations

8.3.1 Choice of locations

Ideally the locations that are selected to obtain speed data should be representative for the whole network of roads in a Member State. Road design characteristics and the surrounding environment influence speeds at which drivers operate their vehicles, so not every location is suitable for free-flow speed measurements. Roads should meet some specific road design criteria in order to be suitable for free flowing traffic speed measurements. These specific requirements are described below.

The SWD specifies **the following minimum requirements for the observation locations**:

- The selection of the locations should be as random as possible with the objective of ensuring a representative sample for the national road network. However, roads where there are known or perceived speed problems are best omitted as these are not representative of the larger road network. The methodology for random sampling is not specified and is for the Member States to decide, but the method used for location selection should be described in the meta-data (sampling will be discussed in more detail in section 7.3.2).
- Measurements should not take place near speed cameras, neither fixed nor mobile.
- A minimum traffic flow of at least 10 vehicles passing per hour is required.

In order to ensure reliability and comparability of speed data, the locations at which speed measurements are carried out must be chosen carefully. All places where vehicles are likely to stop, accelerate or brake should be avoided, since at these locations free flowing traffic cannot be guaranteed. Each location should meet the following criteria as closely as possible:

- straight and uniform section of road (ideally there are no curves nearby that might influence the speed at the point of the measurement)
- section of road where it is possible to drive at a higher speed than the speed limit
- section with a small gradient (<5% on at least 500 meters preceding)
- away from junctions (>500 meters)
- away from any traffic calming device such as speed bumps or narrowing traffic lanes (> 500 meters)
- away from road works (> 500 meters)
- away from pedestrian crossings (> 500 meters)
- away from any speed limit change or sign (> 500 meters)
- away from sections where speed is enforced (e.g. traffic enforcement cameras).

If a location does not meet all the criteria listed above, it is recommended to mention this in the meta-data. It has to be noted that in all likelihood it will be hard to meet all of the above mentioned criteria, especially in built-up areas. As such, the criteria can be relaxed for locations in built-up areas. Still, it is recommended to select locations that meet these criteria as closely as possible under the circumstances.

8.3.2 Sampling of locations

The SWD does not specify a required sampling method. Member States can define their own sampling methodology. It is important that the locations are representative for the national road network and ideally cover the entire geographical area of the country. Ideally, over time it would be helpful for Member States to work together with the European Commission to come up with common bases for sampling. In the meantime, sampling should be based on well-established statistical techniques aimed at achieving a properly representative result.

Selection of locations should be as random as possible, covering the geographical area of the country. There are different options for random location selections: e.g. simple random, stratified random (e.g. random sampling in different regions). The basic process consists of three steps:

(1) First the required number of locations is determined for the entire country or per region.

(2) Next, these locations are randomly selected on a map using the entire area under consideration (e.g. country or region), taking a sufficient geographical spread into account. The specific requirements for each location (e.g. road type or speed limit) do not have to be taken into account at this point. This step is just to ensure a reasonable geographical spread of the randomly selected locations.

(3) Finally, the exact locations that will be used for the observations are manually chosen in the area surrounding the locations randomly selected in step two. At this point, the final selection must be based on the location requirements (different road types), inclusion/exclusion criteria (see section 7.3.1) and practical considerations. This final selection can be done using Google Street View for instance to search for observation locations near the randomly selected locations from step one that meet all the necessary criteria. The selected locations can then also be visited in real life for a final check if needed. Pragmatic considerations related to the observation locations can be taken into account (e.g. safety of observers or people installing measurement equipment should be guaranteed). Care should be taken to ensure that the different road types are also sufficiently geographically spread.

A convenient way of selecting locations randomly (step 2) is to use a GIS system (e.g. cartographic software like ARCView/ARCGIS) as such software can automatically randomly select location points within pre-defined areas. If Member States have no GIS software, step 2 can also be done manually using a national geographic map, e.g. Google maps/Google earth.

The sampled locations should be representative of the entire national territory. When stratification is used, results should be weighted according to traffic volumes by region. It is allowed to re-use the same sampled location for different times of day or days of week. In case such a crossed design is used, this should be indicated in the meta-data. The method used and rationale for choosing the locations of the measurements should be described in the method section of the study.

Ideally, the sampling procedure should comprise a selection from a database consisting of a list of uniform road segments, including their geographic coordinates and their characteristics such as:

- Road type (e.g. motorway, rural road, urban road...)
- Speed limit
- AADT (Annual Average Daily Traffic)
- Number of lanes (not including additional lanes at intersections)
- Length

Additional useful information is:

- Type of median provisions (median divided, flush median, no median)
- Surrounding environment (inner city, outer suburbs, extended shopping area)
- Road design characteristics (slope, curvature, etc.)

The basic characteristics of the locations should be recorded at the start of each observation: GPS coordinates, address or other geographical information, target lane or path and direction which is to be observed, traffic flow (should be free: no traffic jams, no road works). A code for the sampled location should be included in the database (at least as a qualitative code referring to the location).

In several countries, traffic counters have been placed on major roads with the general purpose of monitoring traffic flows on major roads of the road network. Since these counters can also produce speed data, the speed measurements in several countries are based on these traffic counters. In such cases, speed measurements are not based on a random sampling technique and will not be representative of the road network. For countries that already have permanent counters installed, it may be not feasible to change the system completely. If counters are installed only on main roads, an option would be to randomly sample fewer sites but to sample all of them on “non-main” roads. In this case a specific weighting procedure would be needed when calculating the speed indicators in order to take into account the respective share of main and “non-main” roads.

8.3.3 Minimum sample size

In order to ensure representative results for the entire road network**, the minimum required number of locations is 10 locations for each of the three road types** (urban, rural, motorway; see also section 7.4.1 on road types). The total minimum required number of **observed vehicles is 2000.** However, **for the first stratification level, a minimum of 500 observations per stratum is required** (for the speeding KPI that means 500 observations per road type). Another minimum requirement is that **the proportion of observations at each of the three road types should be a minimum of 20%** (except if a certain road type, like motorways, is non-existent in a Member State).

Defining a minimum required sample size is by definition arbitrary since it depends on the level of accuracy that is considered adequate. With typical overall prevalence percentages in the range of 5 percent, accuracy in the order of range of 1 percent can be considered acceptable.

Accuracy for specific subgroups will by definition be lower. If higher accuracy levels are expected for particular subgroups (e.g. according to region), it is strongly recommended to increase the total sample size.

Since separate samples are taken for each road type and only straight segments of roads that fulfill certain requirements are considered (see section 7.3.1), the variance between locations should be quite small. If large variances are observed on a particular location in the sample, it is recommended to check whether that location fulfils all the requirements to be a good measuring location. If the location does not meet enough requirements, it is recommended to replace that location. If the location does meet enough requirements, it is recommended to increase the number of observations at that location.

Assuming a simple random sampling, the 95% confidence intervals for n=2000 and n=500 are, depending on prevalence (% of drivers within the speed limit) levels:

Prevalence	Lower bound, n=2000	Upper bound, n=2000	Lower bound, n=500	Upper bound, n=500
50%	47,8%	52,2%	45,5%	54,5%
75%	73,0%	76,9%	71,0%	78,7%
90%	88,6%	91,3%	87,0%	92,5%

To summarize, the minimum required sample sizes to provide the speeding KPI are:

- **min. 10 locations per road type = min. 30 locations in total**
- **min. 500 observations per road type**
- **min. 2000 observations in total**
- **the proportion of observations at each of the three road types should be at a minimum 20%**

For more information on random sampling of locations and for determining the minimum sample size, please refer to the SafetyNet general recommendations for SPI (safety performance indicators): http://www.dacota-project.eu/Links/erso/safetynet/fixed/WP3/sn_wp3_d3p8_spi_manual.pdf

8.3.4 Rationale behind the minimum sample requirements

The methodological guidelines for all KPIs are designed to ensure international comparability between KPI values while taking into account feasibility and affordability. To that end the methodological guidelines have been defined in such a way that accurate and representative results can be obtained for all parameters of interest at a reasonable cost.

Obviously, the larger the sample of observations and locations for observation, the more accurate the KPI estimates for the different strata will be (e.g. a KPI value for a particular type of road, or a particular part of the week). Increasing the number of observations and locations however implies increasing field work costs. Statistically, the required minimum sample size depends mainly on the desired accuracy of the final estimates, for which no absolute value can be determined *a priori*. Therefore, for the main KPI estimates a pragmatic evaluation was made of the expected confidence intervals at different sample sizes and population parameters. Giving priority to feasibility and affordability, as a rule of thumb the minimum total number of observations was set at 2,000, the minimum number of observations for different strata at 500. It was agreed that this should allow to identify statistically meaningful differences between countries at an affordable price. For some countries, this will imply disproportionate sampling of certain strata compared to the distribution of traffic volumes over different strata. This is however required to allow statistically meaningful international comparisons at the level of each of the strata at interest.

The same pragmatic logic was followed for determining the minimum number of 10 locations for observation for each of the required road types of interest. Once again, there is no statistical rationale for determining the required minimum number of locations to ensure representativeness of the observations for the entire country. This mainly depends on the amount of variance between locations and within a country. Giving priority to affordability, a rule of thumb was also used to define the minimum number of locations at 10 per stratum. In order to ensure representativeness for the entire country larger numbers of locations might be required for larger countries. Taking field work costs into account, it was however decided to only identify the minimum requirements and leave decisions on the final number of locations to the discretion of the Member States. Equally importantly, in order to ensure representativeness of the measurement locations these should be randomly selected as far as possible.

The main objective in defining the minimum methodological requirements is to keep a balance between affordability of the field work and the requirements to make meaningful international and historical comparisons. Therefore, the emphasis is placed on the minimum requirements that can also be taken into account by smaller countries. It is however of interest to any Member State to increase the accuracy of the KPI estimates by boosting the number of locations and the number of observations.

8.4 Stratifications and subpopulations

For speed measurements, **the minimum requirements** determined by the SWD should take into account **road type** (at a minimum urban, rural and motorways), **type of vehicle** (only cars are required, other types are optional), **time of day** (day is required, nights are optional), **day of the week** (weekdays are required, weekends are optional), and **the weather** (weather conditions must be good during the observations). In the sections below these minimum requirements will be discussed in more detail.

8.4.1 Road types

The SWD requires that the indicator should at a minimum cover **motorways, rural non-motorway roads (defined as roads outside built-up areas), and urban roads (defined as roads inside built-up areas)**. Ideally the locations that are selected to obtain speed data should be representative of the whole network of roads in a Member State.

In reality, road characteristics will vary between these different road types and therefore speed indicators should be computed separately for these three different road types. For countries where there is more than one speed limit per road type (for instance, rural roads with speed limits of 70 km/h and 90 km/h), it is recommended to compute the indicator either for each speed limit separately or for the most prevalent speed limit (it is not meaningful to aggregate data from roads with different speed limits).

For any given speed limit, it is not a minimum requirement to observe speed at both single and dual lane roads (if both exist). In Belgium, for instance, for most speed limits (50 km/h, 70/km/h and 90 km/h) there are both single and dual lane roads. It is, however, highly recommended to observe single and dual lane roads separately. Aggregating data from single and dual lane roads with the same speed limit is not meaningful and is therefore not recommended. Should a Member State decide to look only at single lane roads or only at dual lane roads, it is recommended to choose the most prevalent type, thereby being more representative of the whole road network.

When communicating about the speeding indicators, some details should be provided about the design of the roads included in the sample (e.g. number of lanes, type of division between opposite lanes, speed limit, …).

8.4.2 Vehicle types

According to the SWD the **minimum requirement for the KPI is to observe the speed of passenger vehicles (cars)**. According to EuroStat, a passenger car is a road motor vehicle, other than a moped or a motorcycle, intended for the carriage of passengers and designed to seat no more than nine persons (including the driver). The term passenger car also covers microcars (small cars which, depending on individual Member State legislation, may need no permit to be driven and/ or benefit from lower vehicle taxation), taxis and other hired passenger cars, provided that they have fewer than 10 seats in total. This category may also include vans designed and used primarily for transport of passengers, as well as ambulances and motor homes. Excluded are light goods road vehicles, as well as motor coaches and buses and mini-buses/mini-coaches (https://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:Passenger_car). This definition of a passenger car is similar to the UNECE definition of M1 vehicles: Vehicles used for carriage of passengers, comprising not more than eight seats in addition to the driver's = 9 seats total.

Optionally, motorcycles, vans, small trucks (between 6.00 meters – 12.00 meters) and trucks/ heavy goods vehicles (> 12 meters) can also be measured. When more vehicle types are considered, using the UNECE vehicle classification scheme is recommended.

Results should clearly define vehicle types included in the observations and should be presented separately for different vehicle types. Small vans might be hard to distinguish from person cars, and therefore a certain percentage of the sample might contain small vans as well. This is hard to avoid and is acceptable, since in any event small vans are not that different from person cars in size and driving characteristics.

The way to distinguish between vehicle types depends on the measuring technique. With radar/laser guns, a human observer is present, allowing a more accurate categorization of vehicles. (It is recommended that an observer receives training to ensure that the classification is as accurate as possible). Most widespread automatic speed monitoring techniques (loops, tubes, radar classifiers) require that the classification of vehicles is obtained by indirect measurements:

- Roadside radars determine the lengths of vehicles on the basis of the time they stay in the beam of radar.

- Pneumatic tubes give information on vehicle lengths, number of axles and sometimes axle loads (based on the pressure on the strips).
- Inductive loops use algorithms based on the expected vehicle distribution, the computed speeds and the occupancy rate of the loops to classify the vehicles. The determination of vehicle types becomes coarse when the traffic flow is heavy, usually resulting in an overestimation of the proportion of long vehicles.

Fortunately, even the coarser classifications (by inductive loops or roadside radars) are satisfactory to distinguish light vehicles (such as passenger cars) from other vehicles, at least when the traffic flow is not too heavy.

A specific problem with heavy vehicles is that these often have different speed limits compared with cars or light duty vehicles. Furthermore, different types of vehicles are similar in length (buses, coaches, trucks) and may also have different speed limits. Devices that determine the vehicle type on the basis of vehicle length may thus classify vehicles with different speed limits within the same category. Based on the national situation, computation of indicators for 'long vehicles' on the basis of this kind of equipment may thus be less meaningful.

8.4.3 Time period (time of day, day of the week, month)

The SWD requires at a minimum Member States to carry out speed measurements **during daylight hours on weekdays**. Measurements at night and in the weekends are optional but highly recommended. Comparisons between day and night are especially recommended due to the difference in traffic conditions and in the composition of the population of drivers between the two periods. The results should be shown separately for day and night and weekdays and weekend days.

Ideally, measurements should be carried out in a month that is "neutral" as far as seasonal variation in traffic is concerned. This means avoiding both school and bank holiday periods (especially summer, as it has the longest holiday period) and the winter period (due to a risk of bad weather). It is thus recommended to carry out the measurements during late Spring or early Autumn.

The number of periods of measurement and the length of time during which it is possible to measure might vary depending on the measuring technique that is used and on the available resources (e.g. handheld devices operated by people versus roadside radars that can measure 24/7). The exact time periods covered by the measurements should be indicated in the meta-data.

8.4.4 Region

The SWD states that the indicator should be representative of the whole Member State territory. To obtain speed indicators at regional level, a stratified random sample of locations according to region (e.g. NUTS1 regions) can be considered. If there are exceptions (e.g. for islands), they should be precisely defined and communicated.

If Member States want to obtain meaningful speed indicators at regional level it is highly recommended to apply all the minimum requirements defined for the national level to the regional level. So, for instance, one should cover the three minimum required road types per region as well as the minimum required sample size (e.g. the 2000 observations and 10 locations per road type required at national level would then be recommended for the regional level).

When stratification by region is used, results should be weighted according to traffic volumes by region in order to compute the KPI at national level (see also section 7.5.1 on Post stratification weights and statistical analysis).

8.4.5 Weather

Measurements should not be carried out in bad weather conditions (e.g. heavy rain, snow, ice, strong winds or fog). Member States are free to define the exclusion criteria and report them together with the data. The main reasons for wanting to avoid bad weather conditions such as heavy rain are that these conditions can affect both speed and radar measurements. It is recommended to consult the people installing the radar equipment on what amount of rain will have a negative impact on the data quality.

8.5 Data analysis

8.5.1 Post stratification weights and statistical analysis

The KPI (percentage of vehicles driving within the speed limit) must be provided separately by road type, vehicle type (if more vehicle types are included beyond passenger cars), and time period (if more time periods are included beyond daytime on weekdays).

For each level of stratification, results should be weighted according to traffic volumes (or mileage data per vehicle type if available) by level of stratification. It is recommended to use the exact values for each combination of stratification levels considered (e.g. traffic volume for highways on weekend nights for personal cars in a certain region).

As indicated above, traffic volumes can either be inferred from existing national mobility (survey) data or estimated by using traffic counts during the measurement sessions or period. When counting during the measurement sessions or periods it is highly recommended to use an automatic counter. Most automated equipment such as radar can also collect traffic count data. Counting should be done at the same location and direction as the measurements and separately for different vehicle categories and time periods (day, night, week, weekend). Optionally, counting can be carried out by human observers. In that case, the counting of all relevant vehicle categories should last at least 10 minutes at each location during each time period included in the speed measurement.

8.5.2 Expected results, data delivery and methodological report

The **minimum required speeding indicator is the percentage of vehicles driving within the speed limit** (at national level).

In addition to this indicator, it is highly recommended to also report the following speed indicators:

- average speed (including the standard deviation and standard error)
- V85 (the speed below which 85% of drivers are driving, i.e. the 85th percentile of speed)

Results should also include the number of locations and the unweighted number of drivers the results are based on.

National speeding indicators should be reported separately according to the following minimum required parameters:

- Vehicle type (personal cars)
- Road type (motorways*, rural roads*, urban roads*)
- Time period (daytime on weekdays)

* It is recommended to also provide results separately for different speed limits. Aggregating data from roads with different speed limits is not meaningful.

Optionally, data from non-free flow traffic can be analyzed and reported besides the required speeding indicators for free flow traffic.

Together with the above estimates, a report should be submitted that describes the methodology of the field work and the statistical techniques used to weight and analyze the results. Member States are free to determine the statistical analysis techniques and tools.

In addition to this, all Member States are expected to provide **metadata** on the applied regulations and procedures related to this KPI (e.g. legislation on speeding).

For the **data delivery** to the Baseline consortium (inclusion in the Baseline database), three possible levels of aggregation are possible (further instructions on dataset structure and variables will be provided later):

1) **Minimum level requirement: point estimates for all the minimum required observation categories (speeding indicator for cars on 3 road types during daylight hours on weekdays)**.
2) Medium level: crossed-level matrix of all considered levels of disaggregation (crossed point estimates) + confidence intervals.
3) Ideal level: also, delivery of the raw cleaned data (not pure raw data). Data cleaning is the process of preparing data for analysis by removing or modifying data that is incorrect, incomplete (only if the minimally required data is missing), irrelevant, duplicated, or improperly formatted. This data is usually not necessary or helpful when it comes to analyzing data because it may hinder the process or provide inaccurate results.