Understanding speeding through Key Performance Indicators

Alexandra Laiou[1*][0000-0002-9975-5133], George Yannis[1][0000-0002-2196-2335],

Johannes Mesimäki[2][0000-0002-3001-4572], João L. Cardoso[3][0000-0002-2791-8888],

Stephen Kome Fondzenyuy[4][0000-0002-8207-1229],

Dagmara Jankowska-Karpa[5][0000-0001-5146-4882]

[1] National Technical University of Athens (NTUA), Athens, Greece,
[2] Technical Research Centre of Finland (VTT), Espoo, Finland
[3] National Laboratory for Civil Engineering (LNEC), Lisbon, Portugal
[4] Sapienza University of Rome Research Centre for Transport and Logistics (CTL), Rome, Italy
[5] Motor Transport Institute (ITS), Warsaw, Poland
*alaiou@central.ntua.gr

Abstract. Within Trendline, a project co-funded by the EU, a series of basic Key Performance Indicators (KPIs) are calculated including one on speed defined as the percentage of vehicles travelling within the speed limit. In order to supplement this basic KPI and provide a good further insight into overspeeding, Alternative Speeding Indicators (ASI) were suggested taking into account national facts on speed limits, distribution of vehicle types and road types. These included: a) the percentage of vehicles travelling 10km/h, 20km/h or 30km/h faster than the speed limit b) speed variation expressed by the difference between the lowest and highest 10% of speeds per road type or area type or speed limit or vehicle type. Pilot implementation of these ASI showed that the same data are needed for the development of KPI Speed and ASI but they must be differently analysed. Generally, the percentage of vehicles overspeeding decreases at higher overspeeding levels showing a restrained inclination to speeding. In most cases the higher the speed limit is, the higher the speed variation gets showing different behaviours towards speeding in different contexts. Meaningful overspeeding intervals differ among Member States implying different levels of tolerance against speeding reflected in the respective enforcement practices and sanctions.

Keywords: speeding, speed variation, KPI, Trendline, pilot

1 Introduction

Speed is a major factor in overall road safety performance. 2,100 lives could be saved each year if the average speed dropped by only 1km/h on all roads across the EU. Excessive and inappropriate speed is accountable for about one third of fatal collisions and is an aggregative factor in most collisions [1].

In addition to speed in absolute terms, the difference in speed (or variation) also has an influence on the crash rate. Speed differences result in more encounters with other road users and also in more lane-changing and overtaking manoeuvres; this increases the risk of crashes [2]. Speed variation and its effect on road safety has been investigated in several studies and the results are clear concerning crash risk. On freeways, crash rates increase as the within lane speed variations rise, especially at higher traffic volumes. Higher speeds coupled with greater volume and high between-lanes speed variation also increase crash likelihood [3]. On urban arterials, it has been found that an increase of 1% in mean speed is associated with a 0,7% increase in total crashes, and larger speed variation is also associated with increased crash frequency [4].

The EU road safety policy framework 2021-2030 includes a list of Key Performance Indicators (KPIs) to be connected to target outcomes, in close cooperation with Member States; one being related to speed (percentage of vehicles travelling within the speed limit) [5]. EU co-funded project Trendline [6] brought together 25 EU Member States (and 4 observers) for data collection, data analysis, delivery of road safety KPIs and for using these within road safety policies. In addition to the eight KPIs that had been defined by the Commission, new indicators were selected within Trendline and appropriate methodologies were developed to test these out on a limited scale.

The work on the selection of Alternative Speeding Indicators (ASI), the development of the respective methodological guidelines and the pilot testing of this KPI was undertaken by a group of seven experts – Key Expert Group (KEG) in the field of road safety and particularly speed issues. The group comprised experts from Member States with different levels of road safety performance and different national road infrastructure, policies and safety culture characteristics, thus allowing for the contribution of several different opinions and experiences on the examined subject.

The objective of this paper is to present the selection and pilot testing of ASI that can serve as complimentary indicators to the basic KPI Speed and provide a more thorough understanding of the major road safety problem of speeding.

2 Methodology

The minimum requirement for KPI Speed (within Trendline) is to estimate the percentage of vehicles travelling within the speed limit. Besides this, the indicator is complemented by the measurement of the speed below which 85% of drivers are driving (V85), and the average speed (including its standard error and the standard deviation of speed).

Complementary to these KPIs for speed, Alternative Speeding Indicators were selected to be calculated within Trendline, initially at a small scale. Although variation in speeds on different types of road or areas and its effect on road safety has been the subject of several research studies, to the best of our knowledge, this (or similar) KPI definition has not been used for speeding.

Therefore, the primary Alternative Speeding Indicator was defined as the: **percentage of vehicles travelling 10km/h or 20km/h or 30km/h faster than the speed limit,** in other words, the percentage of vehicles overspeeding by less than or equal to 10km/h, 20km/h or 30km/h.

The proposed intervals of 10, 20 and 30 km/h above the speed limit were chosen to serve as a common EU-level comparative standard. Thus, it was a minimum requirement to calculate the KPI using these intervals. Still, they may not perfectly align with every Member State's legal penalty thresholds. Therefore, each Member State could additionally calculate the KPI using the intervals that are more meaningful to them taking into account national law provisions. Alternative speed thresholds mirror differences in national penalty systems towards speeding. For example, in Portugal, speeding by less than 20km/h inside urban areas corresponds to a minor violation (no penalty points); speeding by less more than 20km/h and less than 40km/h is a serious violation (2 points); and speeding by more than 40 km/h is a very serious violation (4 points). Outside urban areas, the thresholds are 30km/h and 60km/h, respectively.

Given the relevance of KPI Speed and Alternative Speeding Indicators, data necessary for their development are the same but must be analysed in different ways. Therefore, the minimum requirements set for this Alternative Speeding Indicator are those set by the EC for KPI Speed as described in the Commission Staff Working Document SWD (2019) 283 [7]. The requirements are quantified and specified for each of the parameters in the respective Methodological Guidelines for ASI [8] which are based on a review of the methodological guidelines on KPI Speed [9] that were developed within the Trendline project.

The minimum requirement for the Alternative Speeding Indicator (ASI) was to estimate the percentage of vehicles travelling 10km/h or 20km/h or 30km/h faster than the speed limit. Besides this indicator, it was suggested to also measure:

speed variation expressed by the difference between the lowest and highest 10% of speeds per road type or area type or speed limit or vehicle type.

This indicator is calculated as the difference between the 90th percentile speed and the 10th percentile speed for each road type or area type or speed limit or vehicle type. The 10th percentile speed represents the speed below which 10% of the speeds fall, and the 90th percentile speed represents the speed below which 90% of the speeds fall. The minimum requirements for the calculation of ASI are summarized in Table 1.

Table 1. Overview of minimum requirements for KPI Alternative Speeding Indicators.

	Minimum requirement	Optional
KPI	% of vehicles travelling 10km/h or 20km/h or 30km/h faster than the speed limit Speed variation i.e. difference between the lowest and highest 10% of speeds per road type or area type or speed limit or vehicle type Free flow traffic	Non-free flow traffic data Calculation of the % of vehicles overspeeding using speed intervals over the speed limit that are more meaningful to Member States based on national law provisions.
Location	Random selection Representative of entire national roadnetwork Covering the whole country Measurements should not take place near speed cameras, either fixed or mobile A minimum traffic flow of at least 10 vehicles passing per hour Locations where the speed limit was changed up to 6 months before the measurements or in between measurements -> data excluded	Stratification by Regions
Road type	Motorway Expressway including urban express roads Rural road Urban road (or road inside urban areas) Public road inside urban boundary signs	Differentiate between single and dual carriageway roads for rural and urban roads Differentiate between speed limits within rural and urban roads
Vehicle type	Passenger cars	Motorcycles Vans and light trucks Heavy trucks Buses
Time period	Weekdays Daylight hours Spring/autumn	Weekend Night-time hours
Weather	Good conditions	
Sample size	Minimum of 2000 observations Minimum of 500 observations per road type Minimum of 10 locations per road type The proportion of observations at each of the three road types should be at a minimum 20%	

3 Pilots on Alternative Speeding Indicators

Following the development of the draft methodological guidelines on KPI ASI, four Member States expressed their interest to run a pilot implementation and calculate ASI. These Member States were Finland, Italy, Poland and Portugal. Data collection and KPI calculations took place between autumn 2024 and spring 2025 in all pilot countries. ASI were calculated according to the respective methodological guidelines and adjusted

to the particular needs and interests in each pilot country, to the extent that this was allowed (e.g. overspeeding using other speed intervals). An overview of the pilot calculations of KPI ASI is presented in Table 2.

Table 2. Overview of pilot calculations of KPI Alternative Speeding Indicators.

KPI	Finland	Italy	Poland	Portugal
% of vehicles travelling 10km/h, 20km/h or 30km/h over the speed limit	passenger car on weekday-daytime / road type weekday/daytime / road type and vehicle type (passenger car, truck/HGV) passenger car / time period and road type Free flow	passenger car on weekday-daytime / road type weekday/daytime / road type and vehicle type (passenger car, vans-buses-trucks) vehicle type / time period and road type Free flow	passenger car on weekday-daytime /road type, weekday/daytime / road type and vehicle type (passenger car, vans, buses, trucks, motorcycles) vehicle type / time period and road type Free flow Non-free flow	passenger car on weekday-daytime / road type weekday/daytime / road type and vehicle type (passenger car) vehicle type / time period and road type Free flow
speed variation per road type or area type or speed limit or vehicle type	as above	as above	as above	as above
% of vehicles overspeeding using other speed intervals	Yes (≥ 31 km/h)	Yes (≤ 5, 11-39, 40-59, ≥ 60 km/h)	No	Yes (≥ 40, ≥ 60 km/h)

4 Results

Pilot calculation of ASI was undertaken in four Member States namely Finland, Italy, Poland and Portugal. A summary of the results for the minimum requirements and per Member State are presented in Tables 3-6.

Table 3. Summary of ASI pilot results in Finland

KPI	Motorway (120 km/h)	Expressway (100 km/h)	Rural road (80 km/h)	Urban road (60 km/h)
% of vehicles travelling 10km/h, 20km/h or 30km/h over the speed limit	32,6% 7,4% 0,9%	43,3% 10,5% 2,0%	50,3% 11,7% 2,6%	55,8% 10,8% 1,1%
speed variation per road type or area type or speed limit or vehicle type	28,9	21,0	17,2	14,8
% of vehicles overspeeding using other speed intervals	0,2%	0,5%	0,6%	0,2%

Table 4. Summary of ASI pilot results in Italy

KPI	Motorway (130 km/h)	Expressway (110 km/h)	Rural road (90 km/h)	Urban road (30 km/h)	Urban road (50 km/h)
% of vehicles travelling	4,7%	8,5%	10,8%	30,3%	18,4%
10km/h, 20km/h or 30km/h	5,7%	11,9%	15,8%	46,7%	26,6%
over the speed limit	5,8%	13,0%	18,0%	53,2%	29,2%
speed variation					
per road type or area type or speed limit or vehicle type	46,0	51,0	44,0	34,0	39,0
% of vehicles overspeeding using other speed intervals	3,2%	5,0%	6,4%	15,6%	10,4%
	1,1%	4,8%	8,0%	24,2%	11,5%
	0,0%	0,1%	0,3%	0,4%	0,3%
	0,0%	0,0%	0,0%	0,0%	0,0%

Table 5. Summary of ASI pilot results in Poland

KPI	Motorway (140 km/h)	Expressway (120 km/h)	Rural road (90 km/h)	Urban road (50 km/h)
% of vehicles travelling	21,4%	42,6%	23,8%	41,4%
10km/h, 20km/h or 30km/h	9,8%	23,0%	11,5%	15,7%
over the speed limit	4,3%	12,3%	5,2%	4,9%
speed variation				
per road type or area type or speed limit or vehicle type	50,0	49,0	43,0	30,0
% of vehicles overspeeding using other speed intervals	-	-	-	-

Table 6. Summary of ASI pilot results in Portugal

KPI	Motorway (120 km/h)	Rural road (90 km/h)	Urban road (50 km/h)
% of vehicles travelling 10km/h,	17,0%	27,0%	7,6%
20km/h or 30km/h	1,3%	4,4%	2,4%
over the speed limit	0,0%	0,0%	0,1%
speed variation			
per road type or area type or speed limit or vehicle type	38,4	38,7	20,7
% of vehicles overspeeding using	0,0%	0,0%	0,0%
other speed intervals	0,0%	0,0%	0,0%
(40+, 60+km/h)			

5 Discussion

The minimum requirements set for ASI are those established by the EC for KPI Speed as described in the Commission Staff Working Document SWD (2019) 283 [7]. The developed methodological guidelines (Laiou et al, 2024) include the minimum requirements to deliver the ASI and recommendations for optional additional speeding measurements. Member States can decide to extend or not their methodology, depending on

available means and their own research questions. Data needed for the development of KPI ASI are the same data as for KPI Speed but analysed in a different way.

The implemented pilots did not reveal any methodological issues concerning the calculation of the proposed ASI. Generally, the percentage of vehicles overspeeding decreases at higher overspeeding levels (i.e. 10, 20, 30 km/h over the speed limit) showing a restrained inclination to speeding. In most cases the higher the speed limit is, the higher the speed variation (difference between the lowest and highest 10% of speeds) gets, showing different behaviours towards speeding in different contexts. This result in combination with findings of previous studies [3], [4] on the association of high speed variation with increased crash likelihood and increased crash frequency suggests that speed variation is more critical on high-speed roads. Meaningful overspeeding intervals differ among Member States implying different levels of tolerance against speeding reflected in the respective enforcement practices and sanctions. Overall, the suggested ASI provides a good further insight into overspeeding taking into account national facts on speed limits, distribution of vehicle types and road types.

Based on the pilot calculation of ASI it is suggested that in cases where different speed limits exist for the same road type (e.g. rural roads with 70km/h, 80km/h or 90km/h speed limit), the prevailing speed limit is considered. Given the transition phase of urban speed limits from 50 to 30km/h, it is suggested that two different categories are considered for urban roads based on speed limit and are compared to each other.

In conclusion, the examined ASI are not the most common or expected KPI regarding speed. However, they allow for a more profound understanding of the actual situation on the road in terms of speed. Thus, it may help to better understand existing problems and select the most appropriate measures.

References

1. ETSC: Reducing speeding in Europe. ETSC PIN Flash Report 36. European Transport Safety Council, Brussels (2019).
2. European Commission: Road safety thematic report – Speeding. European Road Safety Observatory. Brussels, European Commission, Directorate General for Transport (2021).
3. Choudhary P., Imprialou M., Velaga N.R., Choudhary A.: Impacts of speed variations on freeway crashes by severity and vehicle type. Accident Analysis and Prevention, Vol.121, pp.213–222 (2018), doi: 10.1016/j.aap.2018.09.015
4. Wang X., Zhou Q., Quddus M., Fan T., Fang S.: Speed, speed variation and crash relationships for urban arterials. Accident Analysis & Prevention, Vol. 113, pp.236-243 (2018), doi: 10.1016/j.aap.2018.01.032
5. European Commission: EU road safety policy framework 2021-2030 – Next steps towards 'Vision Zero'. Brussels, European Commission, Directorate General for Transport (2020).
6. Trendline project https://trendlineproject.eu/ (2025).
7. European Commission: COMMISSION STAFF WORKING DOCUMENT - EU Road Safety Policy Framework 2021-2030 - Next steps towards "Vision Zero, SWD (2019) 238, Brussels, European Commission, Directorate General for Transport (2019).
8. Laiou, A., Mondésir, H., Mesimäki, J., Deane, P., Kome, S., Cardoso, J., Vadeby, A.: Alternative Speeding Indicators. Methodological Guidelines. Report produced as part of the Trendline project, supported by the Union (2024).

9. Laiou, A., Vadeby, A., Riguelle, F., Van Schagen, I., Cardoso, J., Tutka, P., Usami, DS., Wardenier, N.: KPI Speed. Methodological Guidelines. Report produced as part of the Trendline project, supported by the European Union (2023).