Trend line

KPI Compliance with traffic rules on signalized pedestrian crossings and intersections

Methodological guidelines

September 2025

Co-funded by the European Union

KPI Compliance with traffic rules on signalized pedestrian crossings and intersections. Methodological Guidelines

Please refer to this report as follows:
Ambros, J., Šípek, M., Ljubotina, L., Krizsik, N., Deane, P., Kreicbergs, J., Vieira, S., Karantanos, M., Mondésir, H., Folla, K. (2025). KPI Compliance with traffic rules on signalized pedestrian crossings and intersections. Methodological Guidelines. Report produced as part the Trendline project, supported by the European Union.

Project details:	
Project start date: **Duration:** **Project name:**	15/10/2022 36 months Trendline
Coordinator:	Wouter Van den Berghe & Agnieszka Stelling | SWOV Institute Research for Road Safety Henri Faasdreef 312, 2492 JP The Hague
	Co-funded by the European Union

Report details:	
Version: **Dissemination level:** **Date:**	4.1 Consortium 04/09/2025

Report Author(s):

Ambros, J., Šípek, M., Ljubotina, L., Krizsik, N., Deane, P., Kreicbergs, J., Vieira, S., Karantanos, M., Mondésir, H., Folla, K.

Revision history

Date	Version	Description
15/12/2023	1.0	Version sent for discussion after the 1st KEG meeting
08/03/2024	2.0	Version sent for discussion after the 2nd KEG meeting
31/05/2024	3.0	Version sent for discussion after the 3rd KEG meeting
08/07/2025	4.0	Final version after consultation within the KEG
04/09/2025	4.1	Final version published on the Trendline website

Legal Disclaimer

Table of contents

About Trendline

Trendline brings together 29 European countries (25 EU Member States and countries as observers) for data collection, data analysis, delivery of road safety KPIs (Key Performance Indicators) and for using these KPIs within road safety policies. Trendline is co-funded by the European Union and builds on the experience gained in the Baseline project. KPIs provide information about factors that are associated with crash and injury risks.

At the core of the Trendline project are the following eight KPIs:

Indicator	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 powered two wheelers 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 new passenger cars with a Euro NCAP safety rating equal or above a predefined threshold
Infrastructure	Percentage of distance driven over roads with a safety rating above an agreed threshold
Post-crash care	Time elapsed in minutes and seconds between the emergency call following a collision resulting in personal injury and the arrival at the scene of the collision of the emergency services

These 8 KPIs originate from the Commission Staff Working Document 'EU Road Safety Policy Framework 2021-2030 - Next steps towards "Vision Zero" SWD (2019) 283 final.' In addition, methodologies for some new experimental and complementary indicators have been developed and tested within Trendline:

- Driving under the influence of drugs
- 30km/h on urban roads
- Compliance with traffic rules on signalized pedestrian crossings and intersections
- Compliance with traffic rules on unsignalized pedestrian crossings and intersections
- Helmet wearing by PMD (Personal Mobility Device) riders
- Self-report behaviour
- Attitudes
- Light use by cyclists in the dark
- Enforcement of traffic regulations
- Alternative speeding KPIs.

For each of the original eight KPIs and the experimental KPIs, a 'KPI Expert Group' (KEG) was established, consisting of European experts. The main role of the KEGs was to draft the common methodological guidelines, to answer methodological questions, and to supervise the pilot tests of the new methodologies.

Website Trendline: https://www.trendlineproject.eu/

Terms and definitions

Vehicle type (European Commission, 2021):

- **Car or taxi**: Motor vehicle with 3 or 4 wheels, mainly used to transport people, seating for no more than 8 occupants (excluding the driver). Motor vehicles with these characteristics used as taxis as well as motor caravans are also included.
- **Light goods vehicle**: Goods vehicle under 3.5t maximum gross weight: Smaller motor vehicle used only for the transport of goods. (=also van for transport of equipment by workers such as electricians, plumbers…)
- **Heavy goods vehicle**: includes road tractors and goods vehicles over 3.5t maximum gross weight. Road tractor: road motor vehicle designed, exclusively or primarily, to haul other road vehicles that are not power-driven (mainly semi-trailers). Goods vehicle over 3.5t maximum gross weight: larger motor vehicle used only for the transport of goods.
- **Bus or coach**: Bus: passenger-carrying vehicle, most commonly used for public transport, having more than 16 seats for passengers. Coach: passenger-carrying vehicle, having more than 16 seats for passengers. Most commonly used for interurban movements and touristic trips. To differentiate from other types of buses, a coach has a luggage hold separate from the passenger cabin.

Road type (European Commission, 2021):

- **Motorway** (European Commission, 2019b): A road, specially designed and built for motor traffic, which does not serve properties bordering on it and which meets the following criteria:
  - it is provided, except at special points or temporarily, with separate carriageways for the two directions of traffic, separated from each other either by a dividing strip not intended for traffic or, exceptionally, by other means;
  - it does not cross at level with any road, railway or tramway track, bicycle path, or footpath;
  - it is specifically designated as a motorway.
- **Expressway** (European Commission, 2021): Road specially built for motor traffic, which does not serve adjacent properties, and:
  - Is accessible only from interchanges or controlled junctions;
  - Is specially sign-posted as an express road and reserved for specific categories of road motor vehicles;
  - On which stopping and parking on the running carriageway are prohibited.
  - Entry and exit lanes are included irrespective of the location of the signposts.
  - Urban express roads are also included.
- **Rural road** (European Commission, 2021): Public road outside urban boundary signs, excluding motorways and expressways.
- **Urban road** (or road inside urban areas) (European Commission, 2021): Public road inside urban boundary signs.

Time of the week / day (European Commission, 2022):

- **Week – daytime:** Monday to Friday 6.00 a.m. to 9.59 p.m.

- **Week – nighttime:** Monday 10 p.m. to Tuesday 5.59 a.m., Tuesday 10 p.m. to Wednesday 5.59 a.m., Wednesday 10 p.m. to Thursday 5.59 a.m., Thursday 10 p.m. to Friday 5.59 a.m.
- **Weekend – daytime:** Saturday to Sunday 6.00 a.m. to 9.59 p.m.
- **Weekend – nighttime:** Friday 10 p.m. to Saturday 5.59 a.m., Saturday 10 p.m. to Sunday 5.59 a.m., Sunday 10 p.m. to Monday 5.59 a.m.

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 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 much clearer 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 KPIs relate to main road safety challenges to be tackled, namely: (1) infrastructure safety, (2) vehicle safety, (3) safe road use including speed, alcohol, distraction and the use of protective equipment, and (4) emergency response. The aim of the KPIs is connected to EC target outcomes.

The Commission Implementing Decision C(2021)5763 final of 5.8.2021 concerning the adoption of the work programme for 2021-2023 and the financing decision for the implementation of the CEF foresaw a technical assistance action for the collection of Key Performance Indicators for road safety in EU Member States. The action builds on a previous CEF support action in 2020-2022 which established the Baseline project to collect 8 road safety Key Performance Indicators (KPIs) in 18 EU Member States. On the 10th of August 2022, a call was published with reference "MOVE/C2/2022-54— Technical Assistance for the development and collection of Road safety Key Performance Indicators (KPI)". A consortium of 25 EU Member States proposed the "Trendline" project to continue and elaborate the work on key performance indicators.

1.2. Purpose of this document

This document presents the methodological guidelines for an experimental KPI on Compliance with traffic rules on signalized pedestrian crossings and intersections. This indicator is of high policy relevance and has a clear link with the risk on injuries and fatalities on the road. A challenge is to identify a methodology that is cost-effective and results in indicator values that are comparable between and within countries.

1.3. Background information

1.3.1. Link with road safety

Compliance with traffic rules is frequently associated with enhanced traffic safety (Evans, 2004). Therefore, it makes sense to use compliance in the sense of an 'intermediary objective' (Laurent et al., 2021) or a safety performance indicator (SPI) / key performance indicator (KPI). In addition, the periodical road safety improvement monitoring confirmed that better compliance has a great potential for saving more lives since progress toward the EU target has been fastest in countries with a medium level of safety that have prioritized compliance with key traffic safety rules (ETSC, 2007).

Compliance with traffic rules is especially relevant regarding pedestrians. According to the EU overview (Dijkstra, 2021; Slootmans, 2021), several patterns emerge regarding pedestrian crash and injury characteristics:

- Pedestrians suffer the most severe consequences in collisions with other road users because they are unprotected against the speed and mass of the crash opponent.
- Pedestrians comprise **around 20% of all road deaths** in the EU, a proportion that has remained stable over the last decade. The proportion of pedestrian fatalities is **much higher for females** compared to males. Half of all pedestrian fatalities in Europe are **aged 65 or over**.
- Most pedestrian injuries occur in **urban areas**. Cars account for over 70% of vehicles hitting pedestrians. Most crashes involving pedestrians occur while crossing the road and frequently **at pedestrian crossings**. In total, **81% of pedestrians died on a road segment and 11% at an intersection**.
- The monthly distribution is very different from other road user types, with up to two times more pedestrians getting killed on the road **in the winter months**.
- During the working week, a stronger **morning and evening peak** is observed than for all road fatalities combined.

In the context of signalized crossings and intersections, the term 'red-light negation' is used, including red-light running (by drivers/riders) and red-light violation (by pedestrians). Road safety experts agree on the risks of red-light negation since it is a causal factor in part of the crashes (Cohn et al., 2020; Xing et al., 2022).

Also, pedestrian distraction is critical. Observational studies found between 20 and 30% of pedestrians using their mobile phones while crossing the roads. These smartphone users had a significantly higher proportion of critical events compared with non-smartphone users, were less likely to wait for the crossing light, to look left and right before crossing the street or to make eye contact with approaching drivers. They also made aggressive crossing manoeuvres, darted in front of traffic or crossed illegally. (Osborne et al., 2020)

Based on several scientific studies and overviews (Martin, 2006; Goldenbeld and van Schagen, 2017; Diependaele et al., 2019), the following findings were summarized:

Red-light running (RLR)

- is associated with very severe crash outcomes (fatality or serious injury) – up to 15 times increase in fatal crashes due to RLR
- may not only endanger drivers of motor vehicles but also pedestrians or cyclists

- RLR rate per 1000 vehicles varies between 1.3 and 5.3 in the US and Australia; European figures are not available
- cyclists frequently engage in RLR in large city areas; the rates vary widely between approx. 10% and 60%

Red-light violations (RLV)

- reported rates (prevalence) are usually around 20%
- crash risk is about eight times higher for illegal crossing
- male pedestrians (especially adolescents) violate traffic rules more frequently than females
- the longer pedestrians have to wait at a crossing, the more likely RLV is
- when several people are waiting at a crossing and a few cross during the red light, other people may be likely to follow
- the more pedestrians (as well as higher traffic volumes) are around, the lower the probability of RLV
- pedestrians are more inclined to RLV when zebra markings are in bad condition

All these findings indicate that the KPI should:

- consider **both pedestrians and drivers/riders/vehicles,** including their **speed and volume**
- **not only intersections** but also road segments
- distinguish the **gender and age** of road users, as well as **groups** of pedestrians
- eliminate potentially confounding location-specific factors

1.3.2. Policy relevance

Pedestrian safety is a crucial aspect of transportation policy: governments and policymakers implement a range of measures and initiatives to enhance pedestrian safety, recognizing its importance for public health, urban development, equity, and overall transportation safety and efficiency (WHO, 2013). Specific activities include:

Improving pedestrian infrastructure: The provision of high-quality sidewalks, safe crossings, pedestrian zones, and traffic-calming measures (e.g. raised crossings, curb extensions, and pedestrian refuges) is central to enhancing pedestrian safety and comfort.

Speed management policies: Lowering speed limits in urban and residential areas, combined with enforcement and street design that promotes lower speeds, is one of the most effective ways to reduce pedestrian injury risk.

Regulation and enforcement: Policies that ensure compliance with traffic rules — such as yielding to pedestrians at crossings, prohibiting illegal parking on sidewalks or near intersections, and enforcing speed and distraction laws — are key for deterrence and behavior change.

Integration with land use planning: Coordinating transportation and urban planning to prioritize walkability — such as mixed-use development, compact neighborhoods, and proximity to services — contributes to both pedestrian safety and modal shift.

Public awareness and education: Campaigns that promote respectful behavior between road users and increase awareness about pedestrian rights and vulnerabilities support the effectiveness of infrastructure and enforcement measures.

Monitoring and data-driven interventions: Investing in pedestrian exposure data, crash analysis, and compliance studies allows for evidence-based policymaking and prioritization of high-risk locations and behaviors.

2. Definitions, data sources and methods

2.1. Introduction

The most general KPI definition is the **share of compliant road users**, which can be further detailed based on various characteristics. After considering the real-life presence of available configurations, while aiming to obtain representative and non-overlapping combinations, which will be feasible for observation, we received the following list of factors:

- road users
  - pedestrians
  - drivers
- on pedestrian crossings
  - on intersections
  - on road segments

On signalized intersections and crossings, in principle, interactions between pedestrians and drivers are minimized – therefore we prefer observing each road user category separately.

From these combinations, we selected:

- **pedestrian compliance with traffic light priority**
- **driver compliance with traffic light priority**

(both independently of crossing location on an intersection or a road segment)

This selection translates into two KPI definitions in the further text.

2.2. Coverage of the road network

According to the crash and injury statistics (section 1.3.1), the pedestrian risk is concentrated most in urban areas. Therefore, it may not be necessary to include rural areas, considering also lower pedestrian volumes.

On the other hand, traffic volume and speed were mentioned as critical factors – and they are also likely to influence the feasibility of observations. In these regards, it is proposed to consider locations with **different speed limits and different traffic volumes.**

In practice, there may be a multitude of combinations of number of lanes, cycle lanes, central islands, geometric characteristics, etc. However, to make the definitions and conditions comparable, we recommend selecting **"simplified" locations** (see example characteristics in Table 1).

Table 1. Reference characteristics of observation locations

	Recommended	To avoid
General conditions	Free-flow traffic Two-lane and two-way Sufficient signing/marking	Frequent congestions One-way, four lanes, etc. Insufficient signing/marking
Signalized crossing characteristics	No pedestrian countdown No push button	Pedestrian countdown Push button
Intersection characteristics	3 or 4 legs Protected turn phase	4+ legs or roundabouts Permissive turn phase

Note that the characteristics in Table 1 served as reference criteria and were applied in most cases, except where local constraints required adaptation. The objective is to focus on the locations which will be typical (representative) and at the same time simple enough to allow feasible real-time observations.

2.3. Definition 1: Pedestrian compliance

Working definition:

share of pedestrians complying with the traffic light priority

In practice, registering all the pedestrians (of which most come in groups and are usually complying with the traffic light priority) is usually not feasible. Thus, only the non-compliant pedestrians are registered; and in parallel the number of all pedestrians is counted to enable calculating the number of compliant ones.

Since traffic light systems and priority rules may be different across the countries, the definition is open for adaptation to the national conditions.

2.4. Definition 2: Driver compliance

Working definition:

share of drivers complying with the traffic light priority

In practice, registering all vehicles (of which most come in groups and are usually complying with the traffic light priority) is usually not feasible. Thus, only the non-compliant drivers are registered; and in parallel the number of all vehicles is counted to enable calculating the number of compliant drivers.

Since traffic light systems and priority rules may be different across the countries, the definition is open for adaptation to the national conditions.

2.5. Data sources

In principle, both pedestrian and driver behaviour data may be collected using human observers or through video-based methods. Each approach has its pros and cons, including the following:

- **Human observers** have good insight into the observed events and may change their position and perspective according to the situation. However, they need to be sufficiently trained and collect data reliably in real-time.
- **Video cameras** enable collecting longer time periods and using the record for following retrospective analyses in detail. On the other hand, the record may be influenced by obstacles, sun glare, weather conditions, etc. In addition, GDPR needs to be considered, and road users are often sensitive to having their data collected by a video camera.

A handbook by Polders and Brijs (2018) notes that "gender, age, and communication between road users (e.g. informal signals, eye contact) cannot be obtained easily from video data". It was also noted that with cameras one lacks information on road users outside of the study area and is not able to evaluate the events from the driver's perspective (Sheykhfard et al., 2021).

Video analysis may be to some extent automated to provide spatio-temporal risk characteristics, known as surrogate measures of safety (SMoS), e.g., time-to-collision (TTC) or post-encroachment time (PET). However, each indicator measures different dimensions: various indicators and their combinations can reflect different aspects of any traffic event and no existing indicator seems to capture all aspects (Johnsson et al., 2018).

For red-light running, an alternative would be using data from fixed enforcement cameras, known as 'red light cameras' in the US, 'safety cameras' in the UK, or 'red-light speed cameras' in Australia. These cameras are often used jointly for speeding and RLR enforcement.

Another consideration is practical feasibility: for an operational KPI, it is necessary to develop a cost-effective methodology that may be applied in varying conditions in a series of locations, ideally with low-cost requirements. While there are lots of SMoS-related research studies, they have been usually applied only selectively; in contrast, human observers were used for KPI monitoring for example in Finland (Pöysti, 2015).

The duration of the observation session is related to a selected location: for example, the school zone pedestrian activity may be quite short-term. Since in the morning and evening peaks high pedestrian volumes may lead to large groups, which cannot be simply observed and categorized, off-peak hours are recommended for observation.

As previously mentioned, in parallel to the observation, traffic (vehicles) and pedestrians need to be counted. This can be done on-site (using an additional person) or from the video record. During counting, raw numbers (without further categorization) of vehicles and pedestrians are registered.

In general, the further text mentions the required minimum data collection; the users are free to collect any additional data based on their local knowledge and specifics.

2.6. Method 1: pedestrian compliance

Pedestrian compliance may be observed on selected pedestrian crossings, which are located either at an intersection or a road segment. An observer needs to see the traffic light from the pedestrian's perspective – therefore, only the part of the crossing, which is closer to the observer, is observed (see Fig. 1).

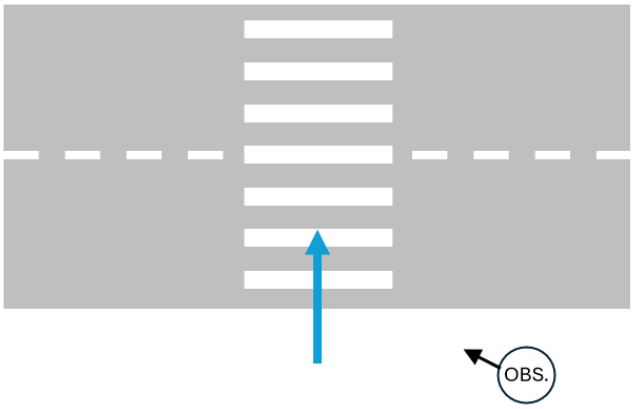

Fig. 1 Scheme of the observed part of the crossing

To enable collecting the data by human observers, the paper form was proposed (see Fig. 2), containing the following pedestrian characteristics:

- gender (male / female) or group
- age (<14, 15–60, 60+)
- distraction by using the phone, headphones or earphones
- crossing before or after the green signal

	M	F	Group	–14	15–60	60+	(Head)phone	before green	after green
1									
2									
3									

Fig. 2 Pedestrian compliance paper form (template)

Pedestrian group is defined as a cluster of two or more pedestrians, which may be either related (e.g., a family or a group of pupils) or unrelated (i.e., random pedestrians). While the former has a kind of group leader (e.g., a parent or a teacher), the latter may not have one. To register both kinds of groups consistently, in the case of a pedestrian group, no gender, age and distraction is registered. It is recommended to register a number (or at least its estimate) of pedestrians in the group.

Alternatively, video recording and subsequent analysis may be used. The camera needs to be positioned so that it records all the required characteristics.

2.7. Method 2: driver compliance

Driver compliance may be observed at the same locations as pedestrian compliance, only from a different spot so that the observer sees the traffic light from a driver's perspective (see Fig. 3).

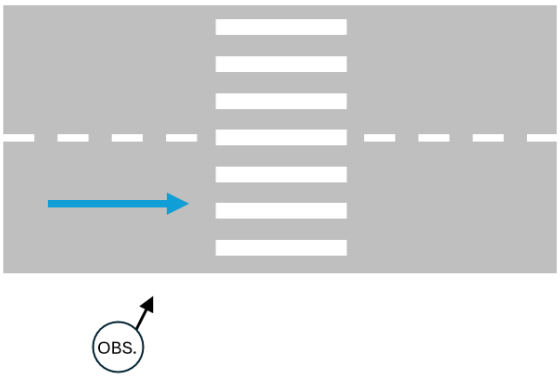

Fig. 3 Scheme of the observed part of the crossing

To enable collecting the data by human observers, the paper form was proposed (see Fig. 4), containing the following characteristics:

- vehicle type (registered by the first letter, e.g., as **P**ersonal, **T**ruck, **M**otorcycle, etc.)
- stopped
- didn't stop (on yellow or red)
- started (on yellow or red)

	Veh. type	Stopped	Didn't stop		Started	
1						
2						
3						

Fig. 4 Driver compliance paper form (template)

Note that the description may change based on different signalling designs across countries.

While waiting for the green signal, queues are typically formed. In this case, only the first (uninfluenced) vehicle is observed. The "didn't stop" category should not include the vehicles that arrived when the green signal has just ended but clearly had no chance to stop due to their arrival speed and distance from the traffic light.

Alternatively, video recording and subsequent analysis may be used. The camera needs to be positioned so that it records all the required characteristics, including the brake lights and traffic lights.

In addition, video records from red light cameras could be used. However, it is likely that these systems only record the non-compliant users – therefore, the user needs to additionally count all passing vehicles to provide the exposure required for the KPI calculation.

3. Specifications for calculating the KPI at national scale

3.1. Scope

The selection of locations may include locations with:

- various speed limits (e.g., 30 km/h, 50 km/h, 90 km/h)
- various traffic volumes (e.g., low, medium, high)
- week period (weekday, weekend)
- location of the crossing on an intersection or on a segment

In parallel to the observation, both pedestrians and vehicles (stopping on red lights as well as running the red lights) need to be counted during the observation session. For this reason, two observers per location are needed: one for behaviour observation and one for counting relevant pedestrians and vehicles.

3.2. Timing and duration

The observations should take place in the period of the year when pedestrian activity is typically highest. Conditions with adverse weather or insufficient visibility should be avoided.

Duration should be at least one hour to obtain a minimum of 100 observations.

3.3. Other operational specifications

In the case of using video cameras, records may be subsequently analyzed using dedicated software – examples may be found at https://www.ictct.net/smos/software/

The following metadata should be stored for each observation and location:

- Location, day and time
- Speed limit
- Pedestrian crossing or intersection type
- Road marking/signing and pedestrian crossing characteristics (like crossing length), including green time

3.4. Method for calculating the KPI value

In principle, the number of compliant events is related to the exposure, i.e., divided by traffic and pedestrian counts.

To enable comparison across different strata, weighting will be applied following the general Trendline recommendations.

3.5. Breakdowns

Given on the amount of collected data, it may be possible to break down the values based on the characteristics indicated in section 3.1:

- location characteristics (e.g., different speed limits, different traffic volumes)
- weekday/weekend

4. Sampling methodology

4.1. Population to be considered

A country or region may be considered.

4.2. Minimum total sample size

Following the general recommendation from the Baseline behavioural KPIs, the minimum total sample size is 2000 observations.

4.3. Selection of locations

The selection should reflect the national/regional specificities so that the final sample will allow representative results.

Table 2. Example structure of collected data

	Condition 1	Condition 2	Total
Locations	**5** locations	**5** locations	
Observations	**100** pedestrians **100** vehicles	**100** pedestrians **100** vehicles	
Total	**500** pedestrians **500** vehicles	**500** pedestrians **500** vehicles	**2000** observations

Conditions may be defined, e.g., as follows:

- based on traffic volume (group 1: busy roads; group 2: less busy roads)
- based on location (group 1: intersections; group 2: segments)
- based on week periods (group 1: weekdays; group 2: weekends)
- based on speed limits

4.4. Aggregation and weighting

Aggregation may reflect the available breakdowns, as indicated in section 3.5.

Weighting will be applied following the general Trendline recommendations.

References

Cohn, E. G., Kakar, S., Perkins, C., Steinbach, R., Edwards, P. (2020). Red light camera interventions for reducing traffic violations and traffic crashes: A systematic review. *Campbell Systematic Reviews*, Vol. 16, e1091. https://doi.org/10.1002/cl2.1091

Diependaele, K. (2019). Non-compliance with pedestrian traffic lights in Belgian cities. *Transportation Research Part F: Traffic Psychology and Behaviour*, Vol. 67, pp. 230–241. https://doi.org/10.1016/j.trf.2016.11.017

Dijkstra, A. (2021). *Road Safety Thematic Report – Pedestrians*. https://road-safety.transport.ec.europa.eu/system/files/2021-07/road_safety_thematic_report_pedestrians_tc_final.pdf

ETSC (2007). *Raising Compliance with Road Safety Law*. 1st Road Safety PIN Report. https://etsc.eu/wp-content/uploads/PIN_Report.pdf

European Commission (2019). *Commission staff working document EU road Safety Policy Framework 2021–2030: Next steps towards "Vision Zero"*. SWD (2019) 283 final. https://transport.ec.europa.eu/system/files/2021-10/SWD2190283.pdf

Evans, L. (2004). *Traffic Safety*. Science Serving Society, Bloomfield Hills.

Goldenbeld, C., van Schagen, I. (2017). *Traffic rule violations – Red Light Running*. https://www.roadsafety-dss.eu/assets/data/pdf/synopses/Traffic_rule_violations_Red_Light_Running_08122016.pdf

Johnsson, C., Laureshyn, A., De Ceunynck, T. (2018). In search of surrogate safety indicators for vulnerable road users: a review of surrogate safety indicators. *Transport Reviews*, Vol. 38, pp. 765–785. https://doi.org/10.1080/01441647.2018.1442888

Laurent, H., Sangnier, M., Treibich, C. (2021). *Traffic safety and norms of compliance with rules: An exploratory study*. https://defipp.unamur.be/wp/defipp_wp_2021_3.pdf

Martin, A. (2006). *Factors influencing pedestrian safety: a literature review*. Published project report PPR241. https://www.trl.co.uk/publications/ppr241

Polders, E., Brijs, T. (2018). *How to analyse accident causation? A handbook with focus on vulnerable road users*. https://www.bast.de/InDeV/EN/Handbook/Handbook-InDeV.html

Pöysti, L. (2015). *Monitoring of Traffic Behaviour in Finland*. Liikenneturva, Helsinki.

Sheykhfard, A., Haghighi, F., Papadimitriou, E., Van Gelder, P. (2021). Review and assessment of different perspectives of vehicle-pedestrian conflicts and crashes: Passive and active analysis approaches. *Journal of Traffic and Transportation Engineering (English Edition)*, Vol. 8, pp. 681–702. https://doi.org/10.1016/j.jtte.2021.08.001

Slootmans, F. (2021). *Facts and Figures – Pedestrians*. https://road-safety.transport.ec.europa.eu/system/files/2022-03/FF_pedestrians_20220209.pdf

WHO (2013). *Pedestrian safety: a road safety manual for decision-makers and practitioners*. https://www.who.int/publications/i/item/pedestrian-safety-a-road-safety-manual-for-decision-makers-and-practitioners

Xing, J., Zhang, Q., Cheng, Q., Zu, Z. (2022). A Geographical and Temporal Risk Evaluation Method for Red-Light Violations by Pedestrians at Signalized Intersections: Analysis and Results of

Suzhou, China. International Journal of Environmental Research and Public Health, Vol. 19, No. 14420. https://doi.org/10.3390/ijerph192114420