SECUR

Safety Enhancement through Connected Users on the Road

Deliverable 1.2

Accident parameters description for the chosen scenarios

Project Name	SECUR	
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Deliverable	D1.2 - Accident parameters description for the chosen scenarios	
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EXECUTIVE SUMMARY

The SECUR project aims to study the potential of connectivity, especially of V2X technologies, to improve the safety of different road users. With the same objective in mind this project brings together diverse and complementary stakeholders: automotive OEM and Tier1 manufacturers as well as V2X-market-stakeholders and automotive test systems providers.

The first Work Package of SECUR (WP1) is dedicated to the identification of the main accident scenarios and their parameters. The geographical scope of the accident data study is Europe. Considering that the connectivity of the vehicle is relatively recent, offering a wide range of possibilities and benefits to all the road users, the following ones were considered as opponent: Passenger Car (PC), Power Two-Wheelers (PTW), Bicyclist (BC) and Pedestrian (PD). However, in this study the ego vehicle is always a Passenger Car.

Following the deliverable D1.1 which focus on the SECUR WP1 first steps and methodology, this report provides all the information gathered, analysed, and compiled during the WP1 accident data study. Each scenario studied and its parameters are detailed in a specific section, below. This deliverable establishes the accidentology basis necessary for the next steps of the project and especially for the definition of the SECUR use cases, to be done in the WP3. The selected accident scenarios have a coverage of 70,6% of the whole accidentology of the SECUR Generic Scenario Catalogue (see D1.1). The following tables show the list of the studied accident scenarios and their parameters. Not all parameters were analysed for each scenario: only the most relevant ones depending on the scenario type and the data needed for a use case definition.

Table 1: Accident scenarios studied

N°#	Name	Road user / Opponent
1	**Oncoming**	Passenger car
2	Straight Crossing Path – Right Direction (**SCP-RD**)	Cyclist
3	Straight Crossing Path – Right Direction (**SCP-RD**)	Passenger car
4	Straight Crossing Path – Right Direction (**SCP-RD**)	Pedestrian
5	Straight Crossing Path – Left Direction (**SCP-LD**)	Pedestrian
6	Loss Of Control in CUrve (**LOC-CU**)	Single (Ego = car)
7	Straight Crossing Path – Left Direction (**SCP-LD**)	Passenger car
8	Loss Of Control in Straight Line (**LOC-SL**)	Single (Ego = car)
9	Straight Crossing Path – Left Direction (**SCP-LD**)	Cyclist
10	Rear End - Following Vehicle (**RE-FV**)	Passenger car
11	Rear End - Previous Vehicle (**RE-PV**)	Passenger car
12	Left Turn Across Path – Opposite Direction (**LTAP/OD**)	Passenger car
13	Left Turn Across Path – Opposite Direction (**LTAP/OD**)	PTW
14	Left Turn Across Path – Left Direction (**LTAP/LD**)	Passenger car
15	Left Turn Across Path – Left Direction (**LTAP/LD**)	PTW

Table 2: Parameters studied for each scenario

SECUR Scenario n°	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15
SECUR Category name	Oncoming	SCP-RD	SCP-RD	SCP-RD	SCP-LD	LOC-CU	SCP-LD	LOC-SL	SCP-LD	RE-FV	RE_PV	LTAP-OD	LTAP-OD	LTAP-LD	LTAP-LD
SECUR Category n°	9	13	13	13	14	21	14	20	14	11	15	1	1	4	4
Opponent / Parameter	PC	BC	PC	PD	PD	Single	PC	Single	BC	PC	PC	PC	PTW	PC	PTW
Weather condition	x	x	x	x	x	o	x	o	x	x	x	x	x	x	x
Road surface (dry, wet, icy, ...)						o		o							
Light condition (day / night)	x	x	x	x	x		x		x	x	x	x	x	x	x
Illumination of the road		x	x	x	x		x		x			x	x	x	x
Percentage of view obstruction	x	x	x	x	x		x		x	x	x	x	x	x	x
Kind of view obstruction	x	x	x	x	x		x		x	x	x	x	x	x	x
Topology of road / intersection	x	x	x	x	x		x		x	x	x	x	x	x	x
Radius of curve (mean)						o									
Kind of traffic regulation		x	x	x	x		x		x			x	x	x	x
Traffic density	x	x	x	x	x	o	x	o	x	x	x	x	x	x	x
Accident cause	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Human failure	x					x		x							
Initial speed Ego	x	x	x	x	x	o	x	o	x	x	x	x	x	x	x
Initial speed Opponent	x	x	x				x		x	x	x	x	x	x	x
Deceleration Ego										x	x				
Deceleration Opponent										x	x				

REVISION HISTORY

Revision	Date	Description, updates and changes	Status
0.1	Jan. 2022	Creation of the report structure	Draft
1.1	31/01/2022	First version of the report	Draft
1.2	25/03/2022	First review of the report	In review
1.3	21/04/2022	Second review and final version of the report	Final version
1.3	27/04/2022	Validation of the report by the Steering Board	Approved

ABBREVIATIONS

ADAS	Advanced Driver Assistance Systems
BC	Bicyclist
C-ITS	Cooperative Intelligent Transport Systems
EU	European Union
GDV	German Insurance Association
GIDAS	German In-depth Accident Study
KTP	Kind of traffic participation
KSI	Killed and severely injured
LTA	Left Turn Assist
PC	Passenger Car
PD	Pedestrian
PTW	Powered Two-wheeler
UC	Use case
V2I	Vehicle-To-Infrastructure
V2N	Vehicle-To-Network
V2P	Vehicle-To-Pedestrian
V2V	Vehicle-To-Vehicle
V2X	Vehicle-To-Everything
VRU	Vulnerable Road User

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1. Introduction

1.1 THE SECUR PROJECT

Through its 2025 roadmap, the European New Car Assessment Programme (Euro NCAP) aims to encourage, by a consumer approach, ever more safety on the roads thanks to the use of new inter-vehicle communication solutions. In pursuit of Vision Zero, a functional validation protocol will be developed, and mass-produced vehicles' safety performance will be evaluated.

Innovative and collaborative, the SECUR project brings great importance to technological neutrality, while there was at the time a certain rivalry around the V2X (Vehicle-to-Everything) preventing a homogeneous development of connectivity solutions. This pioneering project aims to study the potential of connectivity, especially of V2X technologies, to improve the safety of different road users.

Coordinated by UTAC, the SECUR project expect to push a coherent proposal for V2X testing and assessment protocols to Euro NCAP. To this end, the industrial consortium brings together some twenty international stakeholders, from the entire automotive and V2X ecosystem – automotive OEM, Tier1 manufacturers, V2X-market-stakeholders and automotive test systems providers. They will share knowledge and collaborate through Workshops and Working Groups. First, the most common accident situations on European roads will be studied. Then, the current knowledge on V2X communication systems will be shared and studied. Thereafter, the potential of V2X systems will be studied, either alone or combined with ADAS systems. Finally, multi-technologies connected targets and protocols for evaluating these V2X systems, will be developed.

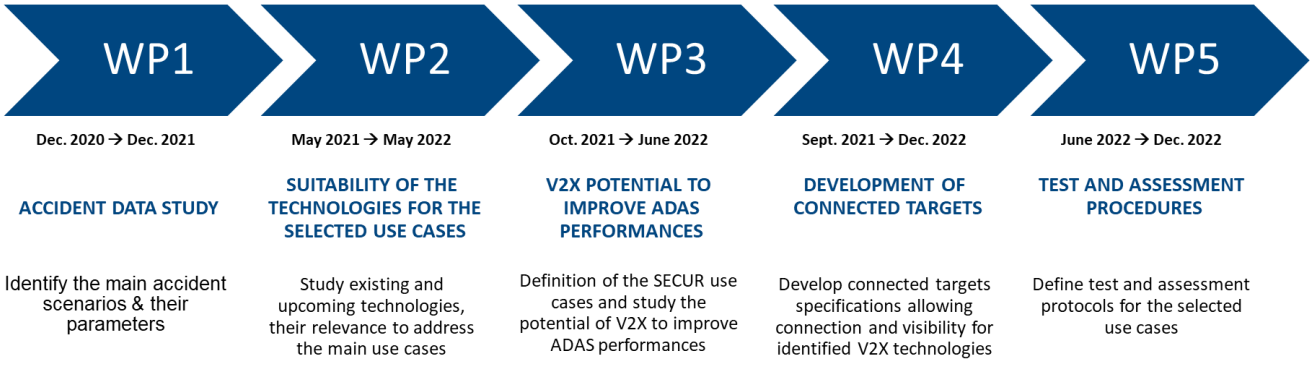


Figure 1: SECUR project Work Packages

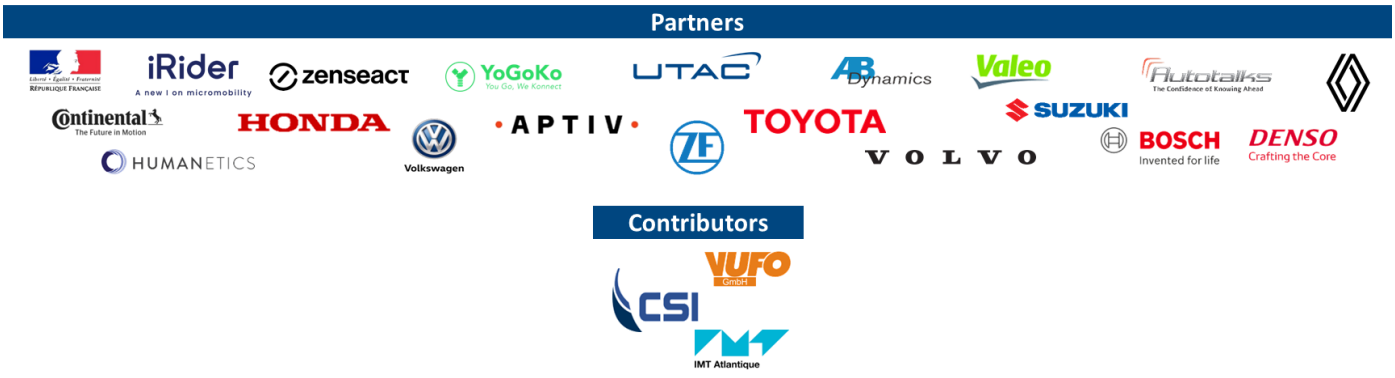


Figure 2: SECUR project partners and contributors

1.2 OBJECTIVES AND SCOPE OF THE STUDY (WP1)

The WP1 of SECUR is dedicated to the identification of the main accident scenarios and their parameters. For this, the methodology used was the following:

1) Literature review to gather and study the results of the existing V2X projects and main accident scenarios considered into previous ADAS projects.

2) High level EU accident data study on the French (BAAC), German (DESTATIS) and European (CARE) databases to complete the previous literature review.

3) SECUR Generic Scenario Catalogue: Development of a generic accident scenario catalogue for all the types of accidents and for all the main road users (passenger car, PTW, cyclist and pedestrian), for EU scope and based on GDV clustering.

4) Selection of the relevant accident scenarios and targets (pedestrian, bicyclist, passenger car, PTW…) to be considered based on the previous catalogue. The following elements were also considered for the scenario selection: V2X perspective (relevance, capability and market readiness) and ADAS perspective (limitations, effectiveness and remaining accidents in 2025).

5) In-depth EU accident data study: Deep study of a set of parameters for the selected scenarios, based of GIDAS and, with a focus on the EU potential of each scenario. The analysis outcomes is used to build SECUR use cases in the WP3.

The geographical scope of the accident data study is Europe. Considering that the connectivity of the vehicle is relatively recent, offering a wide range of possibilities and benefits to all the road users the following ones were considered as opponent: Passenger Car (PC), Power Two-Wheelers (PTW), Bicyclist (BC) and Pedestrian (PD). However, in this study the ego vehicle is always a Passenger Car.

1.3 OBJECTIVE OF THE DELIVERABLE

Following the deliverable D1.1, this report will provide all the information gathered, analysed, and compiled during the WP1. Each scenario studied and its parameters will be detailed in a specific section below. This deliverable establishes the accidentology basis necessary for the next steps of the project and especially for de definition of the SECUR use cases which will be done in the WP3.

2. Scenario selection

Analysing all the 28 categories in combination with all 4 KTP would have meant to analyse 112 combinations of categories and kinds of traffic participation (KTP). These combinations of categories and KTP are called “Scenario”. With taking the nine most relevant categories like described in chapter 4.5 of the Deliverable 1.1 (which led to 36 scenarios), only 12% of the KSI cases were lost.

In some of these nine categories, not all the KTP of the injured people are relevant. Thus, the decision was made to analyse the 15 most relevant scenarios, only. At this, the relevance is again based on the number of killed or severely injured (KSI) occupants. With these 15 scenarios, 70.6% of all the KSI accidents are covered. These scenarios were already identified by WG2 and WG3 as relevant and realistic from a Vehicle-To-Everything (V2X) and Advanced Driver Assistance Systems (ADAS) point of view. The 15 relevant scenarios are shown red marked in Table 3.

Table 3: Top 9 categories combined with kind of road usage – List of scenarios

				Total	Passenger Car	Powered Two-Wheeler	Bicycle	Pedestrian	Other kind of participation
Ranking KSI	Category			KSI	KSI	KSI	KSI	KSI	KSI
1	Category 13	SCP-RD	Straight Crossing Path - Right Direction	735	233	40	248	214	0
2	Category 14	SCP-LD	Straight Crossing Path - Left Direction	575	179	29	167	194	6
3	Category 9	Oncoming	Oncoming	377	332	24	14	4	3
4	Category 1	LTAP-OD	Left Turn Across Path - Opposite Direction	301	123	87	56	34	1
5	Category 15	RE-PV	Rear End - Previous Vehicle	201	154	39	6	0	2
6	Category 21	LOC-CU	Loss Of Control in Curve	190	190	0	0	0	0
7	Category 4	LTAP-LD	Left Turn Across Path - Left Direction	188	86	82	20	0	0
8	Category 11	RE-FV	Rear End - Following Vehicle	184	164	12	7	0	1
9	Category 20	LOC-SL	Loss Of Control in Straight Line	174	174	0	0	0	0

The following 15 scenarios will be analysed in the scope of the GIDAS in-depth analyses. Thereby, the categories “LOC-SL” (ranking number 8) and “LOC-CU” (ranking number 6) will be analysed combined (ranking number 6).

At this, the following abbreviations were used:

- BC for bicycle
- PC for passenger car
- PD for pedestrian
- PTW for powered two-wheeler

GIDAS in-depth analyses:

Scenario 1	Oncoming-PC	Oncoming – Passenger Car
Scenario 2	SCP-RD-BC	Straight Cross Path – Right Direction – Bicycle
Scenario 3	SCP-RD-PC	Straight Cross Path – Right Direction – Passenger Car
Scenario 4	SCP-RD-PD	Straight Cross Path – Right Direction – Pedestrian
Scenario 5	SCP-LD-PD	Straight Cross Path – Left Direction – Pedestrian
Scenario 6	LOC-Single	Loss Of Control – Single Vehicle
Scenario 7	SCP-LD-PC	Straight Cross Path – Left Direction – Passenger Car
Scenario 8	Combined as „Loss Of Control“ (Scenario number 6)	
Scenario 9	SCP-LD-BC	Straight Cross Path – Left Direction – Bicycle
Scenario 10	RE-FV-PC	Rear End – Following Vehicle – Passenger Car

Scenario 11	RE-PV-PC	Rear End – Previous Vehicle – Passenger Car
Scenario 12	LTAP-OD-PC	Left Turn Across Path – Other Direction – Passenger Car
Scenario 13	LTAP-OD-PTW	Left Turn Across Path – Other Direction – Powered Two-wheeler
Scenario 14	LTAP-LD-PC	Left Turn Across Path – Left Direction – Passenger Car
Scenario 15	LTAP-LD-PTW	Left Turn Across Path – Left Direction – Powered Two-wheeler

3. Results In-depth analyses

This chapter contains the description of the analysed parameters, the results of the analyses for each scenario and a conclusion of all the analyses. In the pictograms of the scenario analyses, the ego vehicle is consistently coloured in blue and the opponent vehicle in red. Please notice, that every scenario got build based on different accident types. Further information will be found in the deliverable D 1.1.

3.1 Analysed Parameters

For the analyses of the scenarios, 16 relevant parameters were chosen by an expert group in the scope of SECUR.

- weather condition
- road surface
- light condition
- illumination of the road
- percentage of view obstruction
- kind of view obstruction
- topology of road / intersection
- radius of curve
- kind of traffic regulation
- traffic density
- accident cause
- human failure
- initial speed ego
- initial speed opponent
- deceleration ego
- deceleration opponent

Not all parameters had to be analysed for each scenario. In Table 4 the parameter set can be found for each scenario.

Table 4: Parameter set for each scenario

SECUR Scenario n°	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15
SECUR Category name	Oncoming	SCP-RD	SCP-RD	SCP-RD	SCP-LD	LOC-CU	SCP-LD	LOC-SL	SCP-LD	RE-FV	RE_PV	LTAP-OD	LTAP-OD	LTAP-LD	LTAP-LD
SECUR Category n°	9	13	13	13	14	21	14	20	14	11	15	1	1	4	4
Opponent / Parameter	PC	BC	PC	PD	PD	Single	PC	Single	BC	PC	PC	PC	PTW	PC	PTW
Weather condition	x	x	x	x	x	o	x	o	x	x	x	x	x	x	x
Road surface (dry, wet, icy, …)						o		o							
Light condition (day / night)	x	x	x	x	x		x		x	x	x	x	x	x	x
Illumination of the road		x	x	x	x		x		x			x	x	x	x
Percentage of view obstruction	x	x	x	x	x		x		x	x	x	x	x	x	x
Kind of view obstruction	x	x	x	x	x		x		x	x	x	x	x	x	x
Topology of road / intersection	x	x	x	x	x		x		x	x	x	x	x	x	x
Radius of curve (mean)						o									
Kind of traffic regulation		x	x	x	x		x		x			x	x	x	x
Traffic density	x	x	x	x	x	o	x	o	x	x	x	x	x	x	x
Accident cause	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Human failure	x					x		x							
Initial speed Ego	x	x	x	x	x	o	x	o	x	x	x	x	x	x	x
Initial speed Opponent	x	x	x				x		x	x	x	x	x	x	x
Deceleration Ego										x	x				
Deceleration Opponent										x	x				

Weather conditions

The first parameter, which was analysed for all scenarios, is the weather condition. It describes, if there was any precipitation during the accident and if so, the type of precipitation, for example rainfall, hail, or snow.

Road surface

The parameter for the road surface was only analysed for the loss of control scenarios. With the help of this parameter the state of the road surface at the time of the accident is characterised. Conditions like dry, damp, wet or hoarfrost are possible. The grip of the road can be estimated from this parameter.

Light condition

The light condition was examined for most of the scenarios. It describes if the accident happened during daylight, darkness, or dawn/twilight.

Illumination of the road

For the accidents that happened during the darkness or dawn/twilight, the parameter illumination of the road was also analysed. This parameter contains information whether the scene of the accident was covered by street lighting and if so, whether it was switched on or off.

Percentage of view obstruction

To quantify the number of accidents, where a view obstruction was present, the parameter percentage of view obstruction was used.

Kind of view obstruction

For the accidents where a view obstruction was present, the type of the view obstruction is described in detail. This can be other cars, structural circumstances or problems on the own vehicle like an icy windscreen. For a lot of cases the kind of view obstruction is unknown due to the fact, that this variable is only implemented in GIDAS since 2009. Additionally, the actual viewing conditions prior to the accident often cannot be traced exactly, because of the time difference between the accident and the arrival of the survey team.

Topology of the road / intersection

The topology of road / intersection describes the road or intersection, where the accident happened. This parameter shows the available driving lanes. Because of a better clarity, in the results the Top 5 of the kinds of topology are shown, only.

Radius of curve

For the loss of control scenarios, the parameter radius of curve was used to describe the mean radius of the curve. For this parameter there is a high percentage of “unknown“, because it is often not possible to realize a curve measurement (e.g. too high traffic density or too dangerous accident site). The radius is measured at the inner side of the curve.

Kind of traffic regulation

For accidents on intersections, the parameter kind of traffic regulation was used to give an information about the traffic control. This can be for example traffic lights or right has right-of-way. This variable has a high percentage of “unknown“ since it has been implemented in GIDAS only since 2005. For each type of traffic regulation, it was additionally analysed if the ego participant was the main causer of the accident.

Traffic density

The traffic density was studied for all scenarios. This can be light traffic, dense traffic or a traffic jam.

Accident cause

The parameter accident cause was also analysed for all scenarios. This parameter describes the main cause of the accident. The possible causations are clustered in groups like ability to drive, speed, or right of way priority, but are also described more detailed. Because of a better clarity, in the results the Top 5 of the accident causes are shown, only.

Human failure

For some scenarios, the human failure parameter was studied. This parameter describes if a human failure of the ego-participant influenced the accident. Thereby, a human failure is something like problems at seeing or hearing, distraction or wrong estimation of situations. It is collected during the interview and describes only the point of view of the participant. This parameter also has a high percentage of “unknown“, because the information has been implemented in the GIDAS scheme in the year 2008.

Initial speed

The initial speed is the speed driven prior to the first critical situation in the accident. It was analysed for the ego vehicle and the opponent vehicle, if the opponent was a bicycle, a powered two-wheeler or a passenger car. For accidents with pedestrians, only the speed of the ego vehicle was analysed.

Deceleration

For scenarios, where the colliding participants drove in the same direction, the deceleration of the ego and the opponent vehicle were studied. The unit of this parameter is m/s^2. It describes the mean deceleration prior to the crash and has a positive sign if the participant decelerates.

3.2 Scenario 1 – Oncoming – Passenger car

Figure 3 illustrates the participants in the scenario 1, also called the *Oncoming-PC*. Both participants in this scenario are passenger cars.

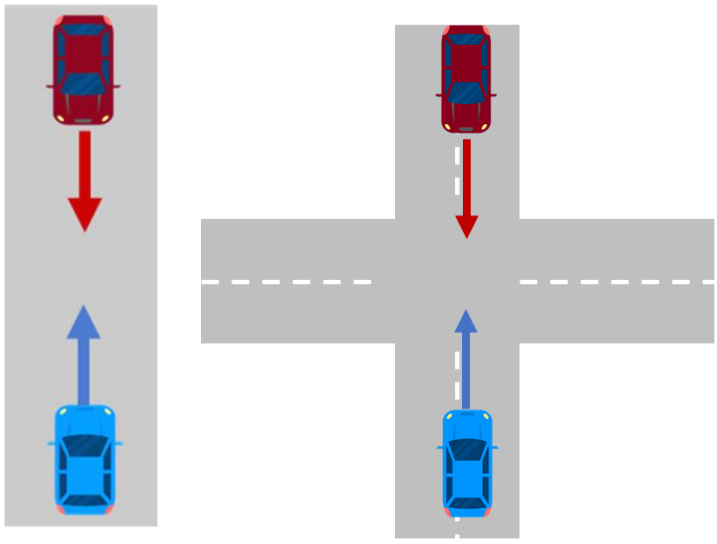


Figure 3: Pictogram Oncoming-PC

3.2.1 Safety Potential

A system addressing and preventing O*ncoming-PC* contains a big safety potential for car occupants. 5.8% of the severely injured car occupants in the EU could be saved. Furthermore, the system would prevent 4.9% of the slightly and 3.1% for the fatally injured car occupants in the EU. More information about the safety potential of this scenario can be found in deliverable D1.1.

3.2.2 Results

In Figure 4 an overview over the weather conditions during the accidents in *Oncoming-PC* is shown.

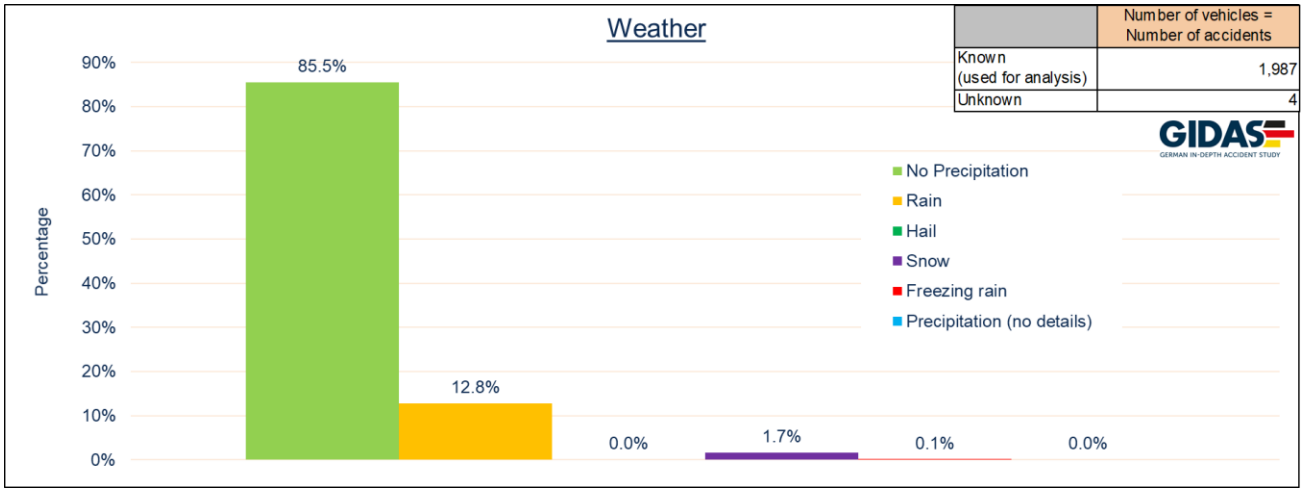


Figure 4: Weather conditions during accidents in Oncoming-PC [1]

In the majority of the cases (85.5%) there was no precipitation when the accident happened. In 12.8% of the cases, the accident happened during rainy conditions. Other forms of precipitation were relatively uncommon for this scenario. In only 1.7% of the accidents, it snowed during the time of the accident.

In Figure 5 the light conditions during the accidents are shown.

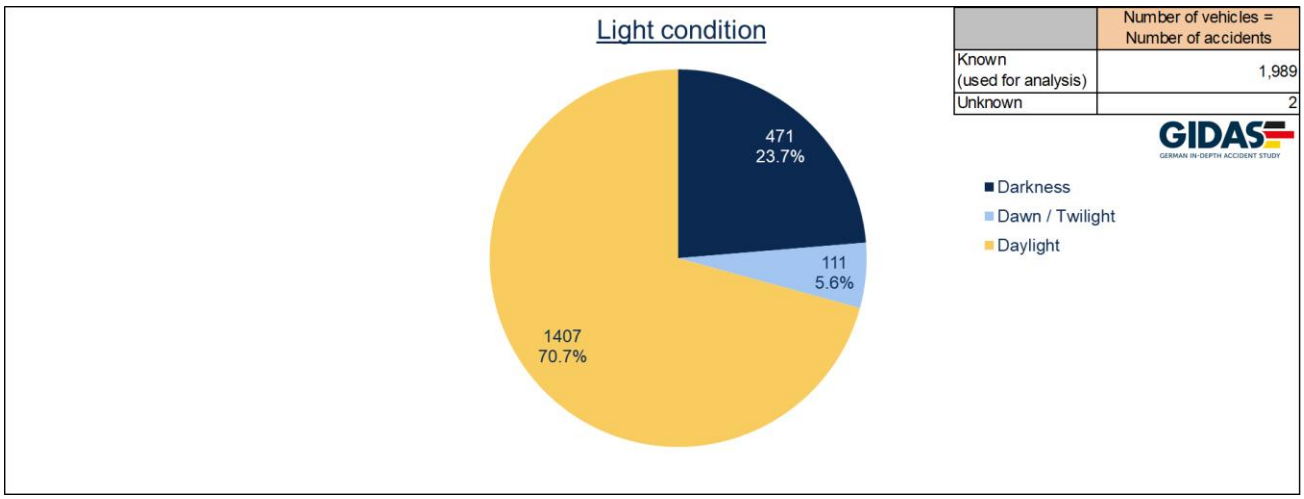


Figure 5: Light conditions during accidents in Oncoming-PC [1]

With a share of 70.7%, the biggest number of accidents happened during daylight conditions. More than a quarter of the accidents happened in the darkness or during dawn/twilight.

Figure 6 shows the percentage of view obstructions for the ego participants.

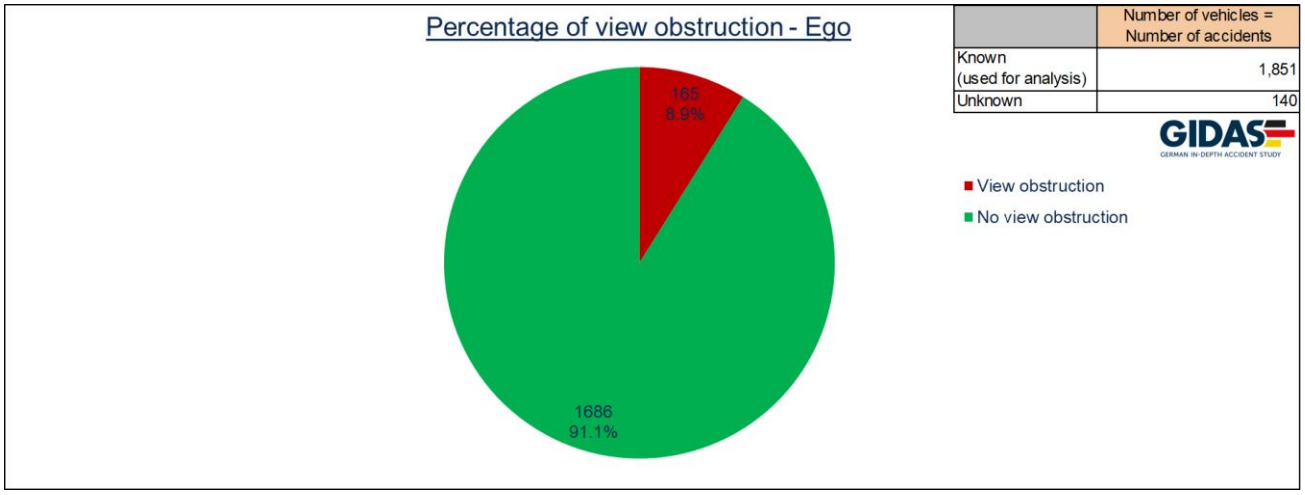


Figure 6: Percentage of view obstructions for accidents in Oncoming-PC [1]

In more than 90% of the cases, the ego had a clear view towards the opponent. In nearly every tenth accident, the view of the ego participant was influenced by a view obstruction.

Figure 7 describes the kind of the appeared view obstruction.

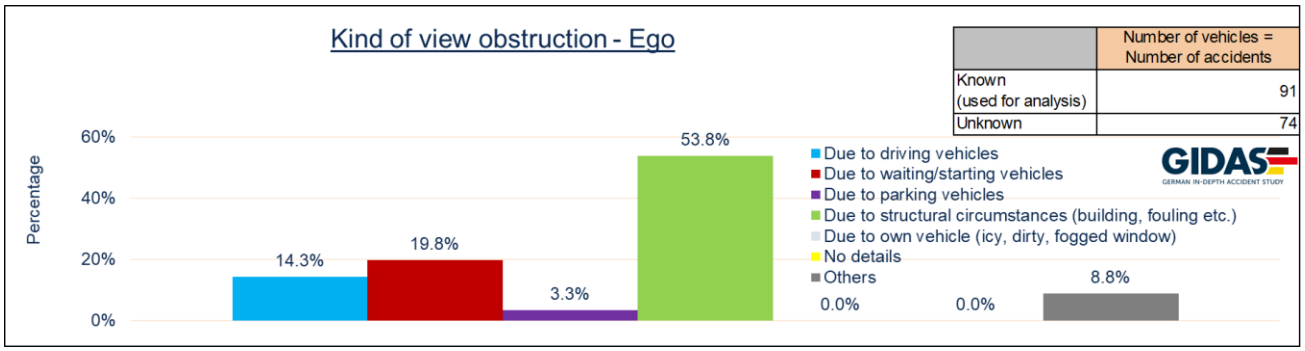


Figure 7: Kind of view obstructions for accidents in Oncoming-PC [1]

Around a half of the view obstructions were caused by structural circumstances like buildings. In more than a third of the cases, the view was obstructed due to other vehicles.

The roads where the ego participants were driving during the accidents are shown in Figure 8.

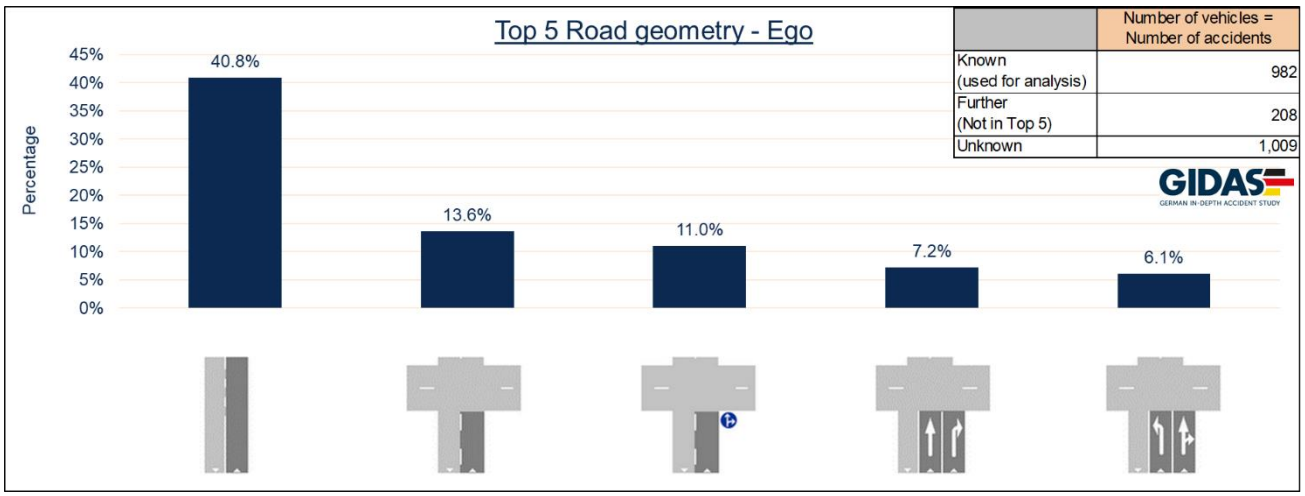


Figure 8: Top 5 Road geometry for the ego participant in accidents in Oncoming-PC [1]

In around 40% of the cases in scenario 1 the ego vehicle drove prior to the accident on a road with a single lane. In roughly every fourth accident the ego participant drove towards an intersection on a single lane, either for all directions or for right or straight driving only. The Top 5 covers nearly 80% of the known ego vehicles.

The kind of traffic regulation during the accident for the ego participant is shown in Figure 9.

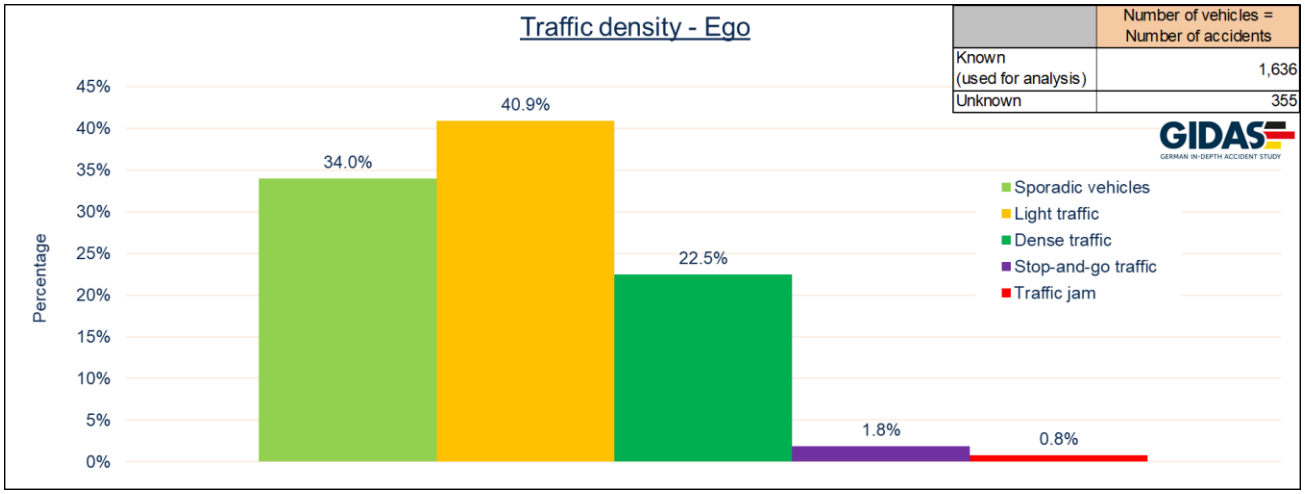


Figure 9: Traffic density for accidents in Oncoming-PC [1]

During most of the accidents the traffic density was either light or only sporadic vehicles. Around every fifth ego had an accident during dense traffic. Stop-and-go traffic or traffic jams were uncommon for this scenario.

In Figure 10 the most frequent main accident causations in *Oncoming-PC* are shown.

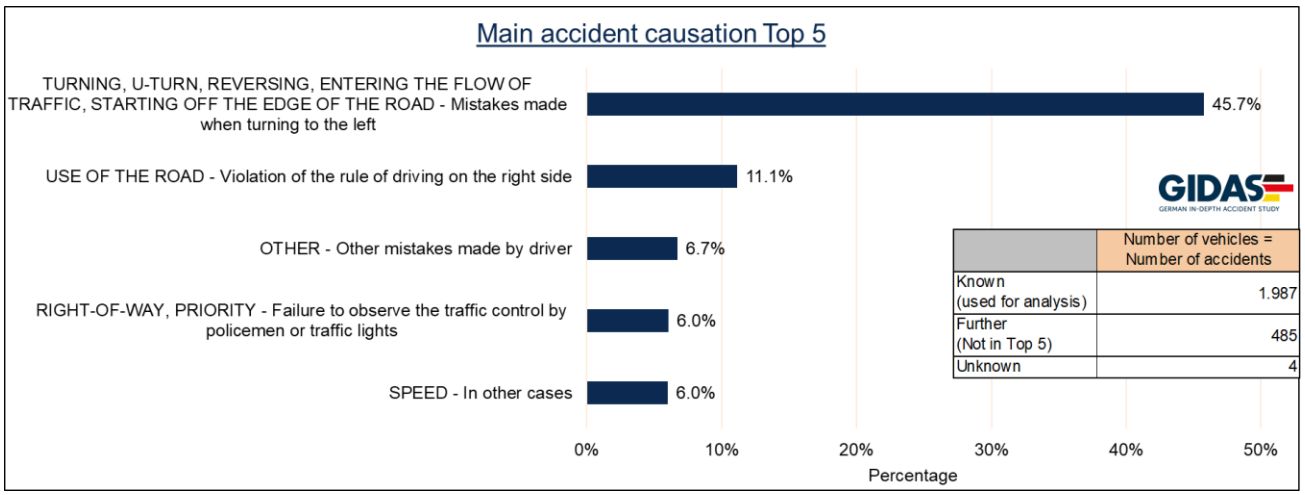


Figure 10: Top 5 main accident causation for accidents in Oncoming-PC [1]

In nearly half of the cases, the accident was mainly caused by mistakes when turning to the left. More than every tenth of the accidents was caused by a violation of the rule of driving on the right side of the road. Other causations that often occurred were mistakes made by the driver, failures to observe the traffic control by policemen or traffic lights, or speeding, with each caused around 6% of the accidents.

Figure 11 depicts the number of accidents, which were influenced by human failures.

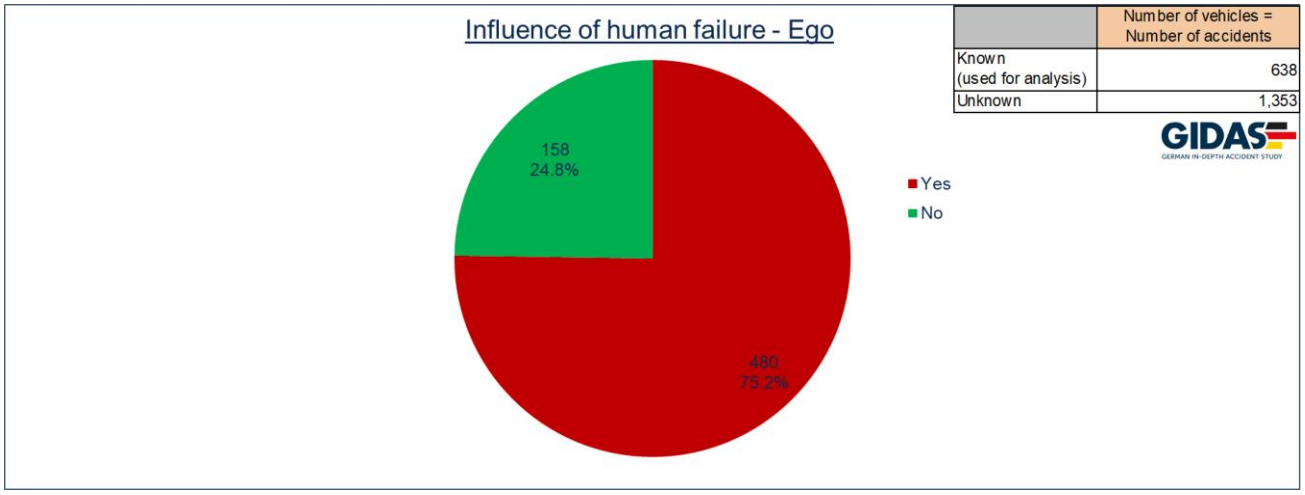
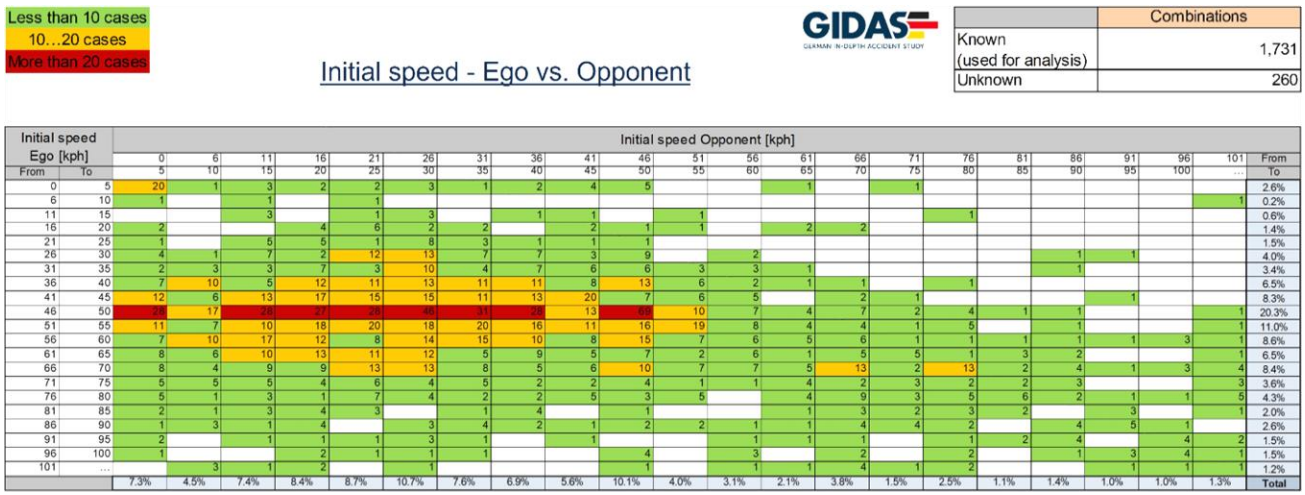


Figure 11: Influence of human failure from the ego participant in accidents in Oncoming-PC [1]

With a share of three quarters, most of the accidents were influenced by a human failure of the driver of the ego vehicle.

The following figure shows the initial speeds of the ego vehicle and the opponent vehicle (Figure 12).



Initial speed Ego [kph] From	To	0 5	6 10	11 15	16 20	21 25	26 30	31 35	36 40	41 45	46 50	51 55	56 60	61 65	66 70	71 75	76 80	81 85	86 90	91 95	96 100	101 …	From To
0	5	20	1	3	2	2	3	1	2	4	5			1		1							2.6%
6	10	1		1		1																1	0.2%
11	15			3		1	3		1	1		1					1						0.6%
16	20	2			4	6	2	2		2	1	1		2	2								1.4%
21	25	1		5	5	1	8	3	1	1	1												1.5%
26	30	4	1	7	2	12	13	7	7	3	9		2						1	1			4.0%
31	35	2	3	3	7	3	10	4	7	6	6	3	3	1					1				3.4%
36	40	7	10	5	12	11	13	11	11	8	13	6	2	1	1		1						6.5%
41	45	12	6	13	17	15	15	11	13	20	7	6	5		2	1				1			8.3%
46	50	28	17	26	27	28	48	31	25	13	59	10	7	4	7	2	4	1	1			1	20.3%
51	55	11	7	10	18	20	18	20	16	11	16	19	8	4	4	1	5		1			1	11.0%
56	60	7	10	17	12	8	14	15	10	8	15	7	6	5	6	1	1	1	1	1	3	1	8.6%
61	65	8	6	10	13	11	12	5	9	5	7	2	6	1	5	5	1	3	2			1	6.5%
66	70	8	4	9	9	13	13	8	5	6	10	7	7	5	13	2	13	2	4	1	3	4	8.4%
71	75	5	5	5	4	6	4	5	2	2	4	1	1	4	2	3	2	2	3			3	3.6%
76	80	5	1	3	1	7	4	2	2	5	3	5		4	9	3	5	6	2	1	1	5	4.3%
81	85	2	1	3	4	3		1	4		1			1	3	2	3	2		3		1	2.0%
86	90	1	3	1	4		3	4	2	1	2	2	1	1	4	4	2		4	5	1		2.6%
91	95	2		1	1	1	3	1		1			1	1	1		1	2	4		4	2	1.5%
96	100	1			2	1	1	1			4		3		2		2		1	3	4	1	1.5%
101	…		3	1	2		1				1		1	1	4	1	2			1	1	1	1.2%
		7.3%	4.5%	7.4%	8.4%	8.7%	10.7%	7.6%	6.9%	5.6%	10.1%	4.0%	3.1%	2.1%	3.8%	1.5%	2.5%	1.1%	1.4%	1.0%	1.0%	1.3%	Total

Figure 12: Initial speed of ego and opponent during accidents in Oncoming-PC [1]

In 77.0% of the cases, the ego vehicles had an initial speed between 26 kph and 70 kph. The speed range of the opponent vehicle was lower compared to the ego vehicle. 81.3% of the opponent vehicles drove with less than 56 kph initially.

3.2.3 SCENARIO CONCLUSION

A noticeable characteristic in *Oncoming-PC* is the relatively low amount of daylight during the accidents compared to other scenarios. Also unusual is the relatively low number of accidents happening at intersections. Human failures often influenced the accidents. Apart from that, *Oncoming-PC* is defined through weather conditions without rain, low view obstructions, and light traffic. Mistakes

when turning to the left were the most common main accident causations. Initial speeds of the ego were with mostly 36 kph to 60 kph often higher than the speeds of the opponents.

3.3 SCENARIO 2 - SCP-RD – BICYCLE

Figure 13 illustrates the participants in scenario 2, also called the *SCP-RD-BC* scenario. The ego participant in this scenario is a passenger car. The opponent is a bicycle coming from the right direction.

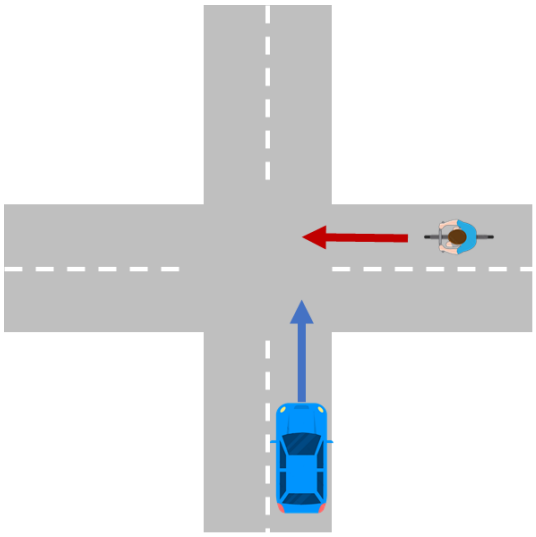


Figure 13: Pictogram SCP-RD-BC

3.3.1 SAFETY POTENTIAL

A system addressing and preventing the *SCP-RD-BC* contains a big safety potential for cyclists, with the possibility to save 10.6% of the fatally injured cyclists in the EU. In addition, the system would prevent 9.2% of the slightly and 7.7% of the severely injured cyclists. More information about the safety potential of this scenario can be found in deliverable D1.1.

3.3.2 RESULTS

In Figure 14 the distribution of precipitation during the accidents is shown.

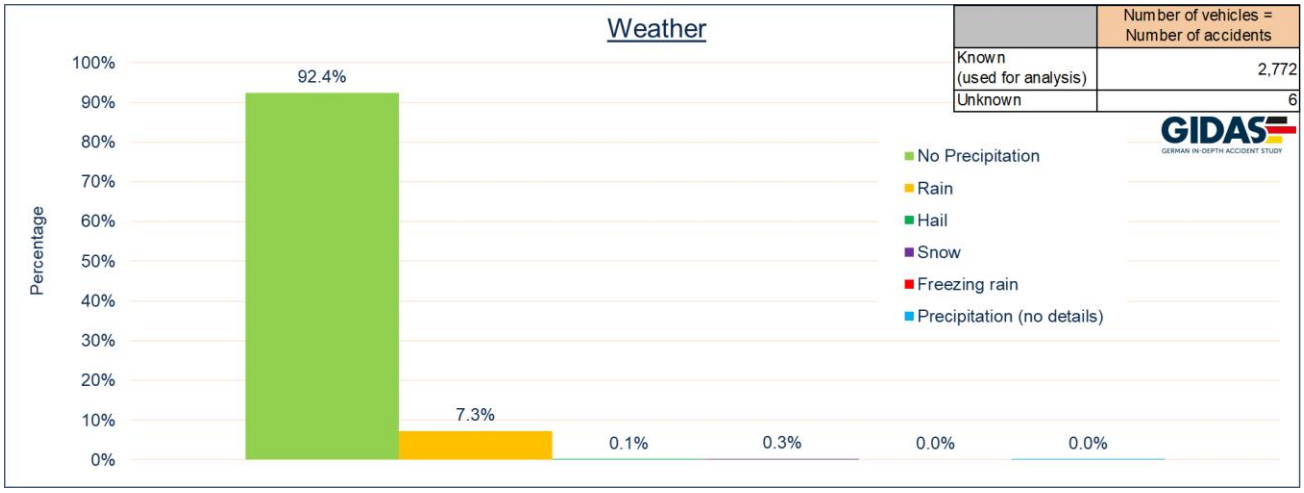


Figure 14: Weather conditions during accidents with cyclists in SCP-RD-BC [1]

In the majority of the cases (92.4%) there was no precipitation when the accident happened. In only 7.3% of the cases, the accident happened during rainy conditions. Other forms of precipitation were rather unusual for this type of accident. The reason can be by the smaller number of cyclists during bad weather conditions like rain or snow.
Figure 15 gives an overview over the light conditions during the accidents in *SCP-RD-BC*.

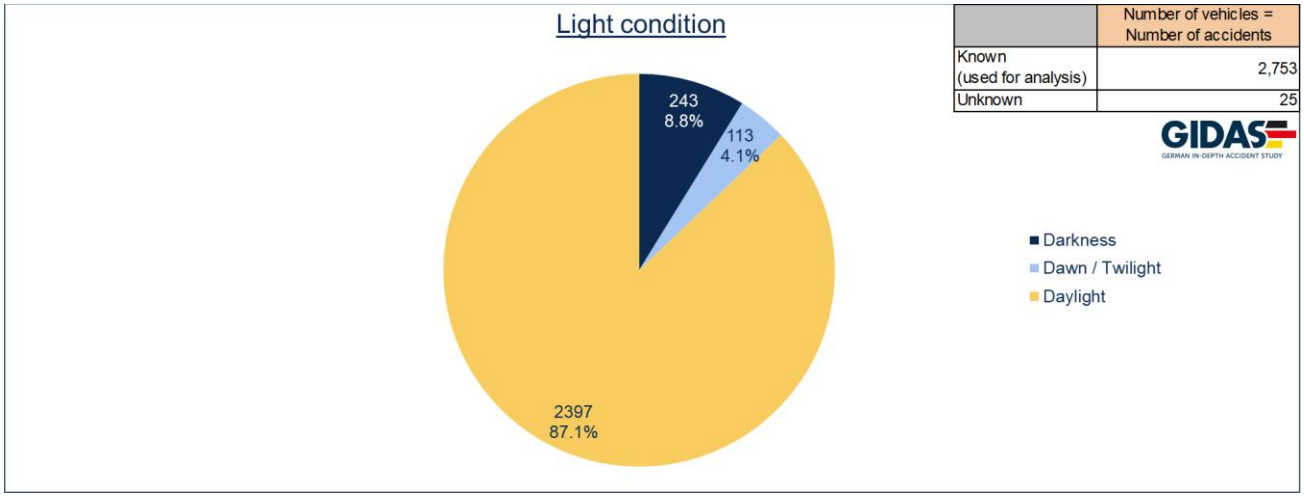


Figure 15: Light conditions during accidents with cyclists in SCP-RD-BC [1]

With a share of 87.1%, the majority of accidents happened during daylight conditions. Only 12.9% of the accidents happened in the darkness or during dawn/twilight.

Figure 16 shows the illumination of the road in those accidents, which happened in darkness or dawn/twilight.

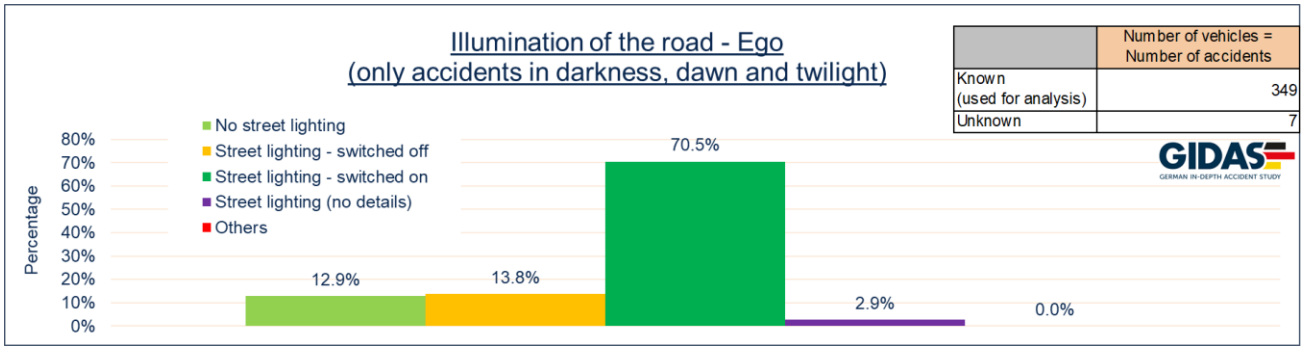


Figure 16: Illumination of the road during accidents with cyclists in SCP-RD-BC in darkness or dawn/twilight [1]

In 70.5% of the named group of cases, the road was illuminated with street lighting. In roughly one quarter of the cases, there was no illumination of the accident site, either due to no street lighting being available or due to switched off street lighting.

In Figure 17 the percentage of view obstruction for ego participants is shown.

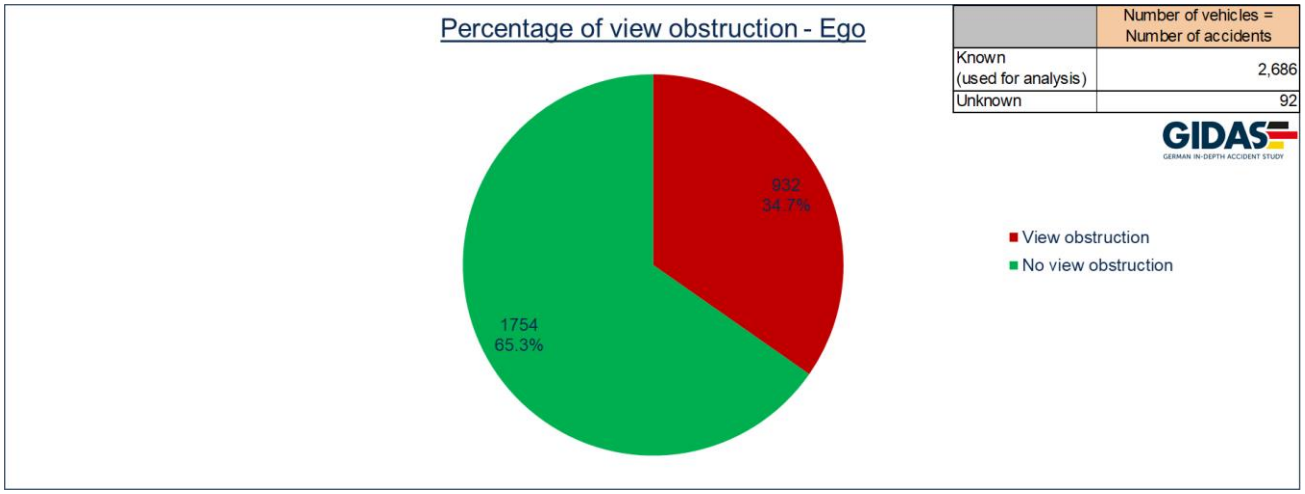


Figure 17: Percentage of view obstructions during accidents with cyclists in SCP-RD-BC [1]

In over a third of the accidents with cyclists in *SCP-RD-BC* there was a view obstruction for the ego participant at the time of the accident.

In the following figure (Figure 18) the kind of view obstruction in those cases, where a view obstruction existed, is shown.

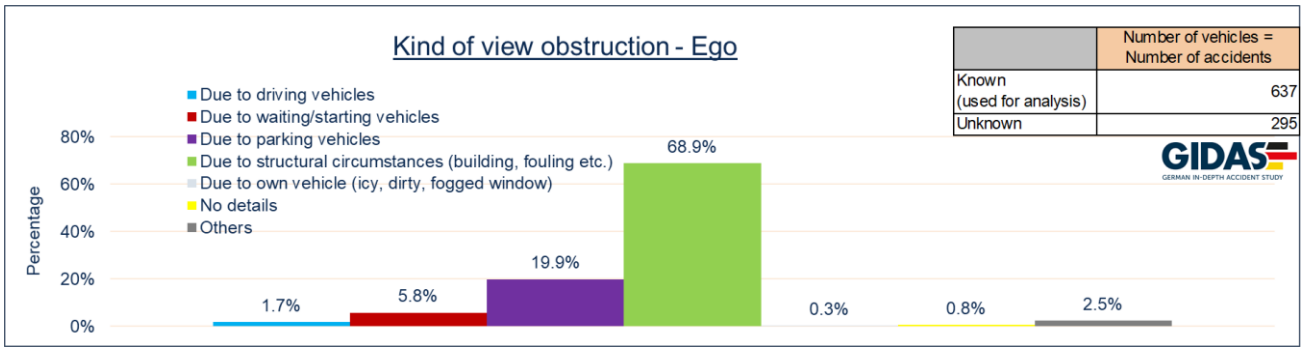


Figure 18: Kind of view obstructions during accidents with cyclists in SCP-RD-BC [1]

The view obstruction was due to structural circumstances in roughly two out of three cases. In almost 20% of the cases the view obstruction was due to parking vehicles.

In Figure 19 the road geometry where the ego participant was driving during the accident is shown.

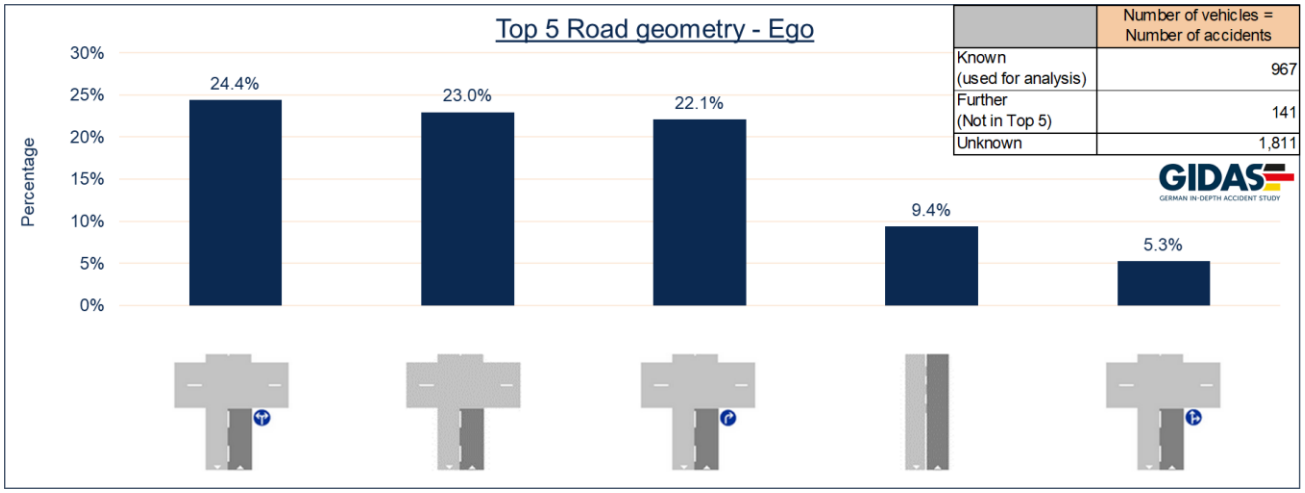


Figure 19: Top 5 Road geometry for the ego participant in accidents with cyclists in SCP-RD-BC [1]

In most of the cases, the ego participant was driving towards an intersection on a single lane for either left or right direction only (24.4%), all directions (23%), right direction only (22.1%) or right or straight only (5.3%). In about every tenth case the ego participant drove on a road with a single lane prior to the accident.

Figure 20 shows the kind of traffic regulation for the ego participant.

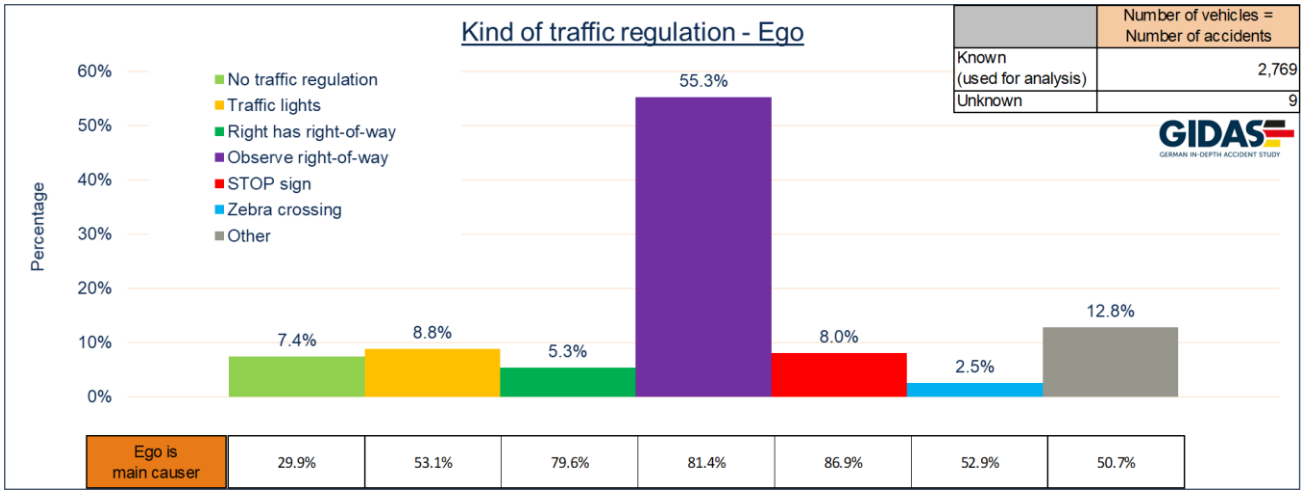


Figure 20: Kind of traffic regulation for the ego participant in accidents with cyclists in SCP-RD-BC [1]

In more than half of the accidents one of the participants had to observe the right-of-way. In 81.4% of these cases, the accident was mainly caused by the ego. The highest percentage of main causing ego participants can be found on accident scenes, where one of the participants had to observe a STOP sign. The least percentage of main causing ego participants (29.9%) can be found when the traffic scene was not traffic regulated.

The traffic density during the accidents for the ego participant is shown in Figure 21.

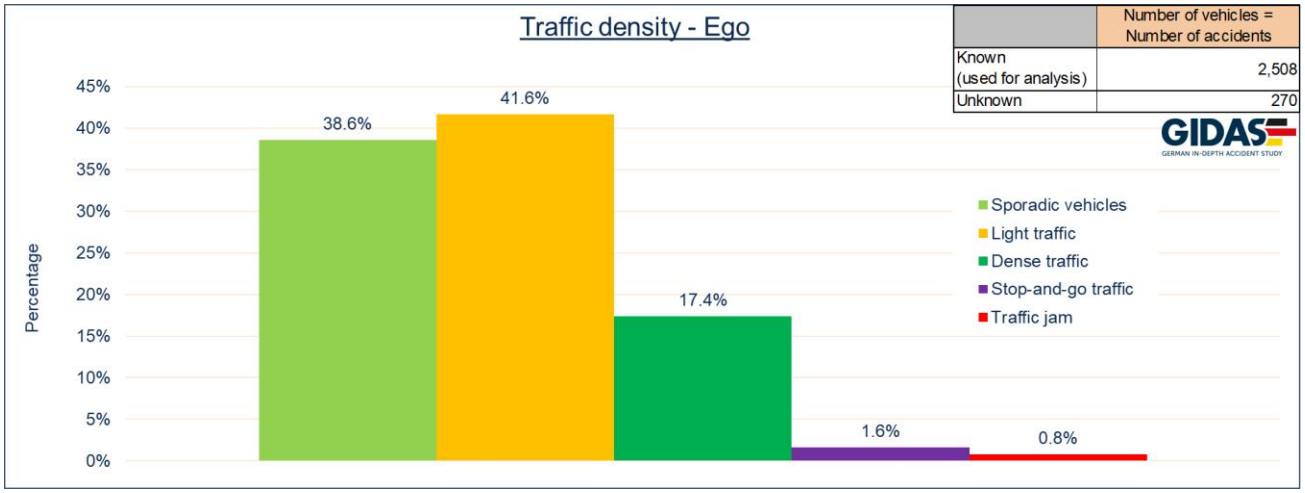


Figure 21: Traffic density during accidents with cyclists in SCP-RD-BC [1]

During four out of five accidents the traffic density was either light, or only sporadic vehicles. Around every fifth ego had an accident during dense traffic. Stop-and-go traffic or traffic jams are very uncommon for this type of accidents.

In Figure 22 an overview of the main accident causations is given.

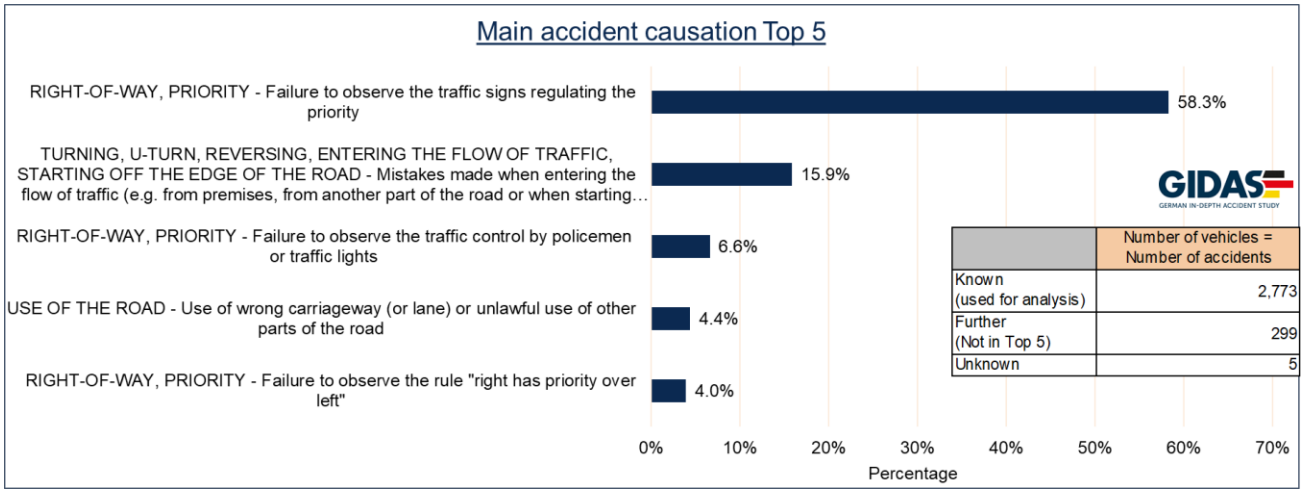


Figure 22: Top 5 main accident causation for accidents with cyclists in SCP-RD-BC [1]

Nearly 60% of the accidents happened mainly, because one participant made a failure at observing the traffic signs regulating the priority. The second big type of main accident causation were mistakes at entering the flow of traffic.

Figure 23 shows the initial speeds of the ego vehicle and the opponent.

Less than 10 cases
10…20 cases
More than 20 cases

GIDAS GERMAN IN-DEPTH ACCIDENT STUDY

	Combinations
Known (used for analysis)	2,328
Unknown	450

Initial speed - Ego vs. Opponent

Initial speed Ego [kph] From	To	Initial speed Opponent [kph] 0	6	11	16	21	26	31	36	41	46	51	56	61	66	71	76	81	86	91	96	101	From
		5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	..	To
0	5	37	143	223	178	71	22	4	1	3													29.3%
6	10	7	90	119	55	16	5	3	1														13.0%
11	15	5	59	99	53	31	11	1	1														11.2%
16	20	3	54	74	58	17	5	1	1														9.1%
21	25	5	37	48	43	17	3	2	1														6.7%
26	30	6	35	66	45	14	1																7.2%
31	35	7	12	28	26	8	2			1													3.6%
36	40	7	31	43	28	11	1																5.2%
41	45	14	19	23	22	6	2																3.7%
46	50	19	37	51	23	11	5																6.3%
51	55	7	13	10	7	5																	1.8%
56	60	6	14	5	3	1																	1.2%
61	65	2	7	2																			0.5%
66	70		7	7	2	1																	0.7%
71	75	2	2																				0.2%
76	80		3																				0.1%
81	85	1	1	1																			0.1%
86	90																						0.0%
91	95																						0.0%
96	100	1																					0.0%
101	..				1																		0.0%
		5.5%	24.5%	34.3%	23.4%	9.0%	2.4%	0.5%	0.2%	0.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	Total

Figure 23: Initial speed of ego and opponent during accidents with cyclists in SCP-RD-BC [1]

In the majority of the cases (62.6%), the initial speed of the ego vehicle was less than 21 kph. The initial speed of the opponent was most frequently (82.2%) between 6 kph and 20 kph, which are typical speeds for cyclists.

3.3.3 Scenario conclusion

Special for *SCP-RD-BC* is the high amount of view obstruction for the ego participant with the majority of the view obstructions caused by structural circumstances. Initial speeds of the ego were with mostly 0 kph to 55 kph usually higher than the speeds of the opponents. Accidents in *SCP-RD-BC* happened mostly at intersections, where the ego participant was required to observe the right of way. A failure in doing this was the most frequent main accident causation. Apart from that, *SCP-RD-BC* is defined through weather conditions without rain, often daylight and light traffic.

3.4 Scenario 3 - SCP-RD – Passenger car

Figure 24 illustrates the participants in scenario 3, also called the *SCP-RD-PC*. The ego participant in this scenario is a passenger car. The opponent is also a passenger car coming from the right direction.

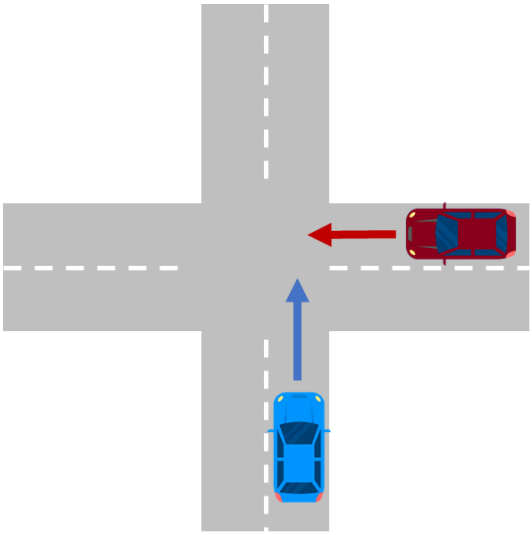


Figure 24: Pictogram SCP-RD-PC

3.4.1 Safety Potential

A system addressing and preventing *SCP-RD-PC* contains a big safety potential for car occupants, with the possibility to save 6.7% slightly injured, 4.2% severely injured and 0.2% fatally injured car occupants in the EU. More information about the safety potential of this scenario can be found in deliverable D1.1.

3.4.2 Results

Figure 25 shows the distribution of precipitation during the accidents.

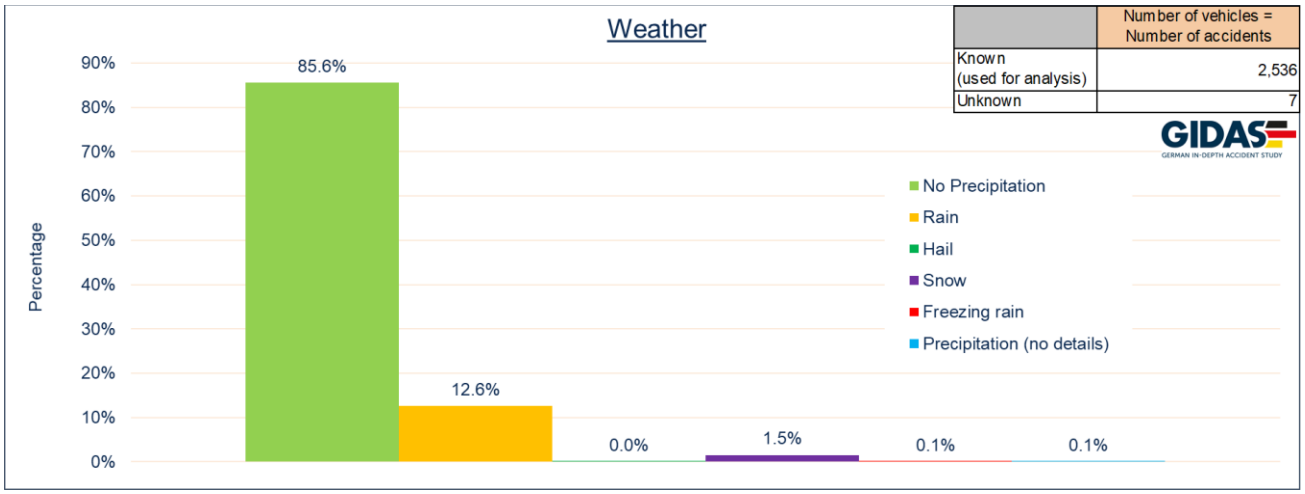


Figure 25: Weather conditions during accidents with passenger cars in SCP-RD-PC [1]

In the majority of the cases (85.6%) there was no precipitation when the accident happened. In 12.6% of the cases, the accident happened during rainy conditions. The percentage of accidents with passenger cars happening during rain and snow in *SCP-RD-PC* is higher than the percentage of these accidents in *SCP-RD-BC*, the same scenario but with a cyclist as opponent (Figure 14).
In Figure 26 an overview of the light conditions during the accidents in *SCP-RD-PC* is shown.

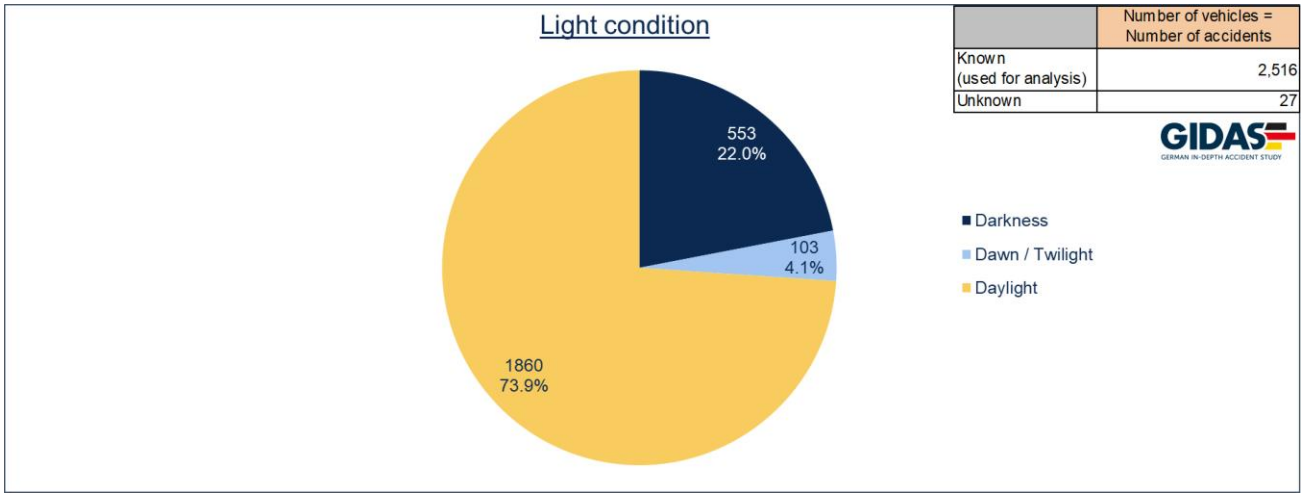


Figure 26: Light conditions during accidents with passenger cars in SCP-RD-PC [1]

Nearly three quarters of the accidents happened during daylight conditions. More than one out of four accidents happened in the darkness or during dawn/twilight.

Figure 27 shows the illumination of the road in accidents, which happened in darkness or dawn/twilight.

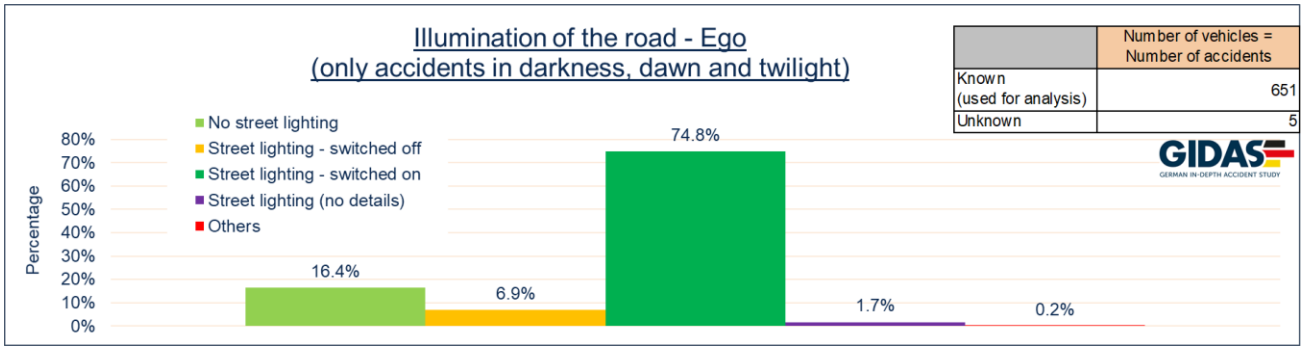


Figure 27: Illumination of the road during accidents with passenger cars in SCP-RD-PC in darkness or dawn/twilight [1]

In those cases, 74.8% of the roads were illuminated with street lighting. In nearly one quarter of the cases, there was no illumination of the accident site, either due to no street lighting being available or due to switched off street lighting.

Figure 28 visualizes the percentage of view obstruction for ego participants.

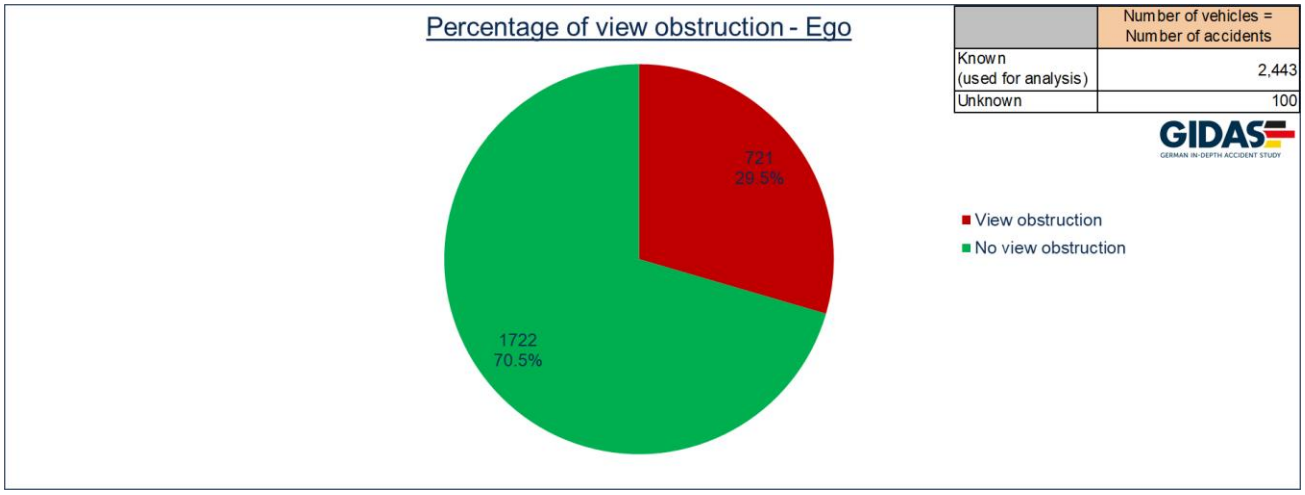


Figure 28: Percentage of view obstructions during accidents with passenger cars in SCP-RD-PC [1]

In more than a quarter of the accidents with passenger cars in *SCP-RD-PC* there was a view obstruction for the ego participant at the time of the accident.

In the following figure (Figure 29) the kind of view obstruction in the cases, where a view obstruction existed, is shown.

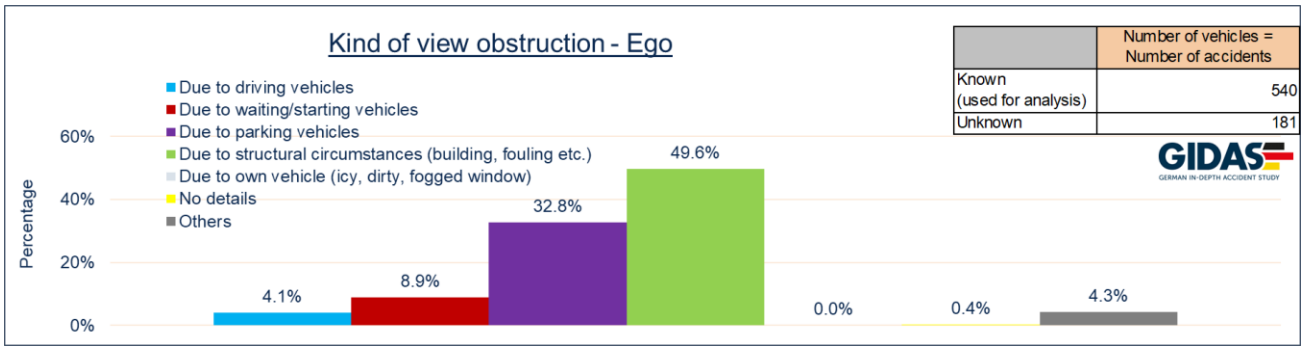


Figure 29: Kind of view obstructions during accidents with passenger cars in SCP-RD-PC [1]

In the cases with an existing view obstruction, it was due to structural circumstances in nearly half of the cases. In 45.8% of the cases the view obstruction was due to vehicles. Most of them were parking during the time of the accident.

The roads where the ego participant was driving during the accidents are shown in Figure 30.

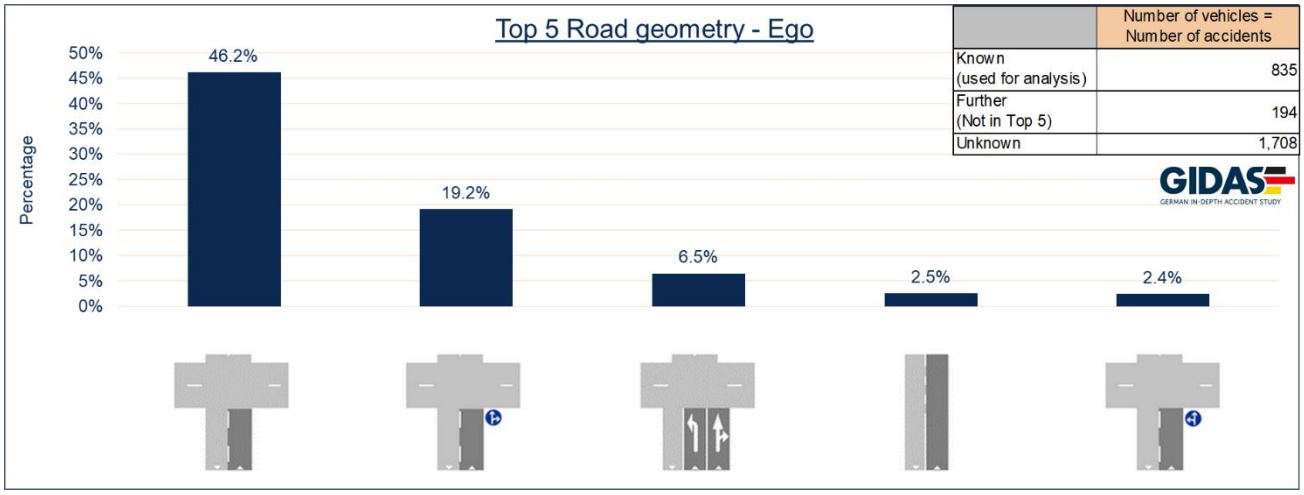


Figure 30: Top 5 Road geometry for the ego participant in accidents with passenger cars in SCP-RD-PC [1]

In the majority of the cases, the ego vehicle drove on a road towards an intersection, which had one lane for all directions (46.2%). In nearly every fifth accident the lane was for straight and right direction only.

Figure 31 shows the kind of traffic regulation for the ego participant.

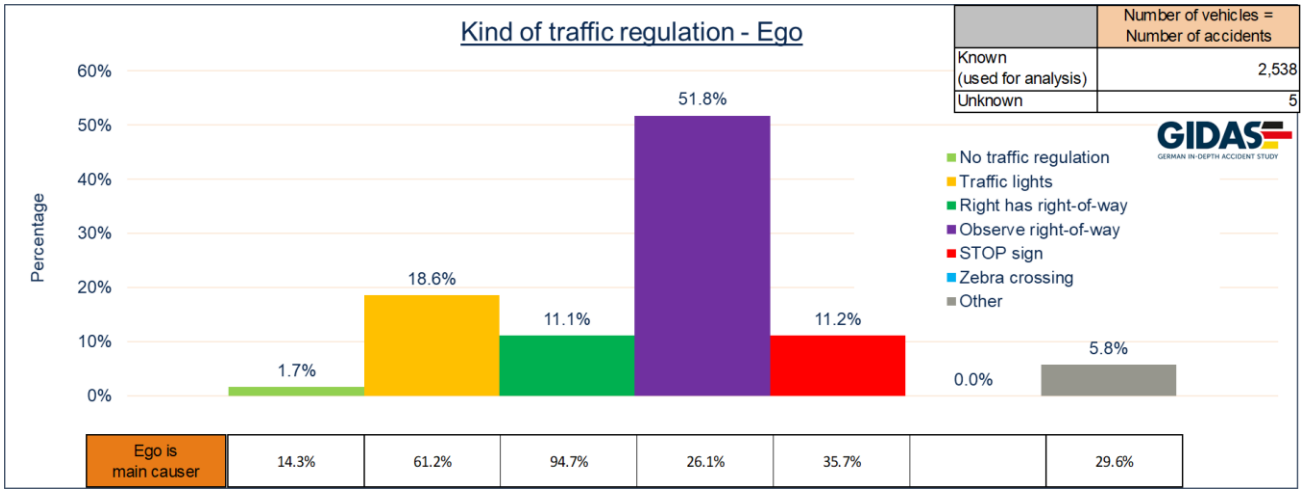


Figure 31: Kind of traffic regulation for the ego participant in accidents with passenger cars in SCP-RD-PC [1]

In more than half of the accidents, one of the participants had to observe the right-of-way. But in only about one quarter of these cases, the ego participant was the main causer of the accident. The highest percentage of main causing ego participants can be found at accident scenes, where one participant as vehicle from right had the right of way.

In Figure 32 the traffic density during the accident for the ego participant is shown.

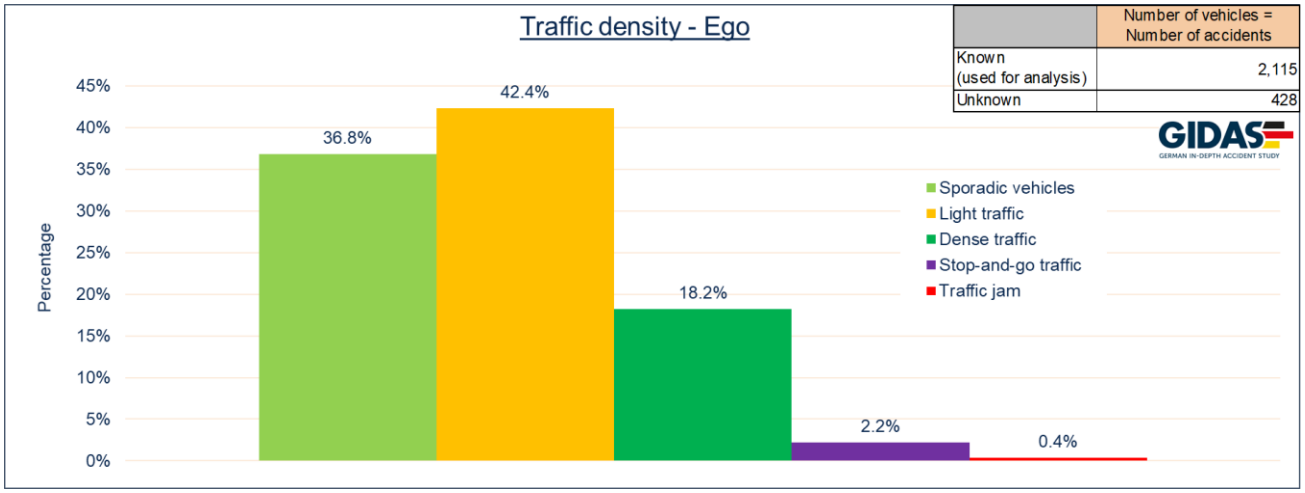


Figure 32: Traffic density during accidents with passenger cars in SCP-RD-PC [1]

During nearly four out of five accidents the traffic density was either light or only sporadic vehicles. Around every fifth ego had an accident during dense traffic. Stop-and-go traffic or traffic jams are very uncommon for this type of accidents.

In Figure 33 an overview of the main accident causations is given.

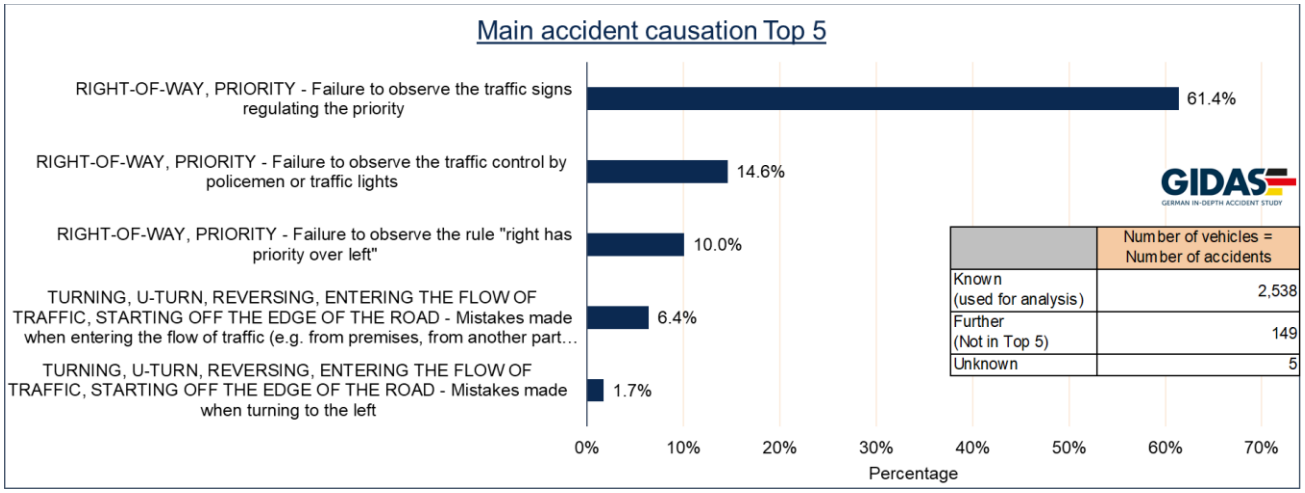


Figure 33: Top 5 main accident causation for accidents with passenger cars in SCP-RD-PC [1]

More than 60% of the accidents happened mainly, because one participant made a failure at observing the traffic signs regulating the priority. The second big type of main accident causation were failures to observe the traffic controlled by policemen or traffic lights.

Figure 34 shows the initial speeds of the ego vehicle and the opponent.

Less than 10 cases
10…20 cases
More than 20 cases

GIDAS GERMAN IN-DEPTH ACCIDENT STUDY

	Combinations
Known (used for analysis)	2,279
Unknown	264

Initial speed - Ego vs. Opponent

Initial speed Ego [kph]		Initial speed Opponent [kph]																					
From	To	0 5	6 10	11 15	16 20	21 25	26 30	31 35	36 40	41 45	46 50	51 55	56 60	61 65	66 70	71 75	76 80	81 85	86 90	91 95	96 100	101 ...	From To
0	5	16	1	1	3	2	2	6	11	11	28	13	8	5	3	2	1		1		1		5.0%
6	10	3			2	1	3	1	3	6	3	4	2	1	1								1.3%
11	15	1	2	1	3	2	1	3	7	4	9	5	2	2	1	2		1	1			1	2.1%
16	20	2	2	4	3	2	8	6	9	7	15	9	5	1	2	1	2	3	1			3	3.7%
21	25	4	1	4	5	9	11	14	5	11	15	4	8	3	3		2	1	1				4.4%
26	30	19	9	12	10	9	19	16	22	11	20	12	9	5	5	1	4	2	1	1	1		8.2%
31	35	11	16	11	8	11	20	16	15	18	22	10	6	3	3		1			1			7.5%
36	40	28	18	10	14	19	24	22	26	16	17	12	11	1	5	2	3				1		10.0%
41	45	50	24	28	22	12	32	21	10	24	27	13	2	2	4	4	1						12.1%
46	50	86	51	42	32	26	32	33	23	18	47	13	6	3	4	2	1	1					18.4%
51	55	38	14	26	8	16	15	6	12	5	9	7	6	5	2	1			1				7.5%
56	60	33	11	17	8	8	8	10	2	6	7	5	2		4	1	2						5.4%
61	65	23	12	6	10	8	8	5	7	5	7	2	3	1	1			1					4.3%
66	70	14	6	10	8	9	7	5	4	1	3		2	1		1							3.1%
71	75	16	6	5	6	1	2	3		1	1	2			1		1						2.0%
76	80	5	8	4	4	2	2	2	4		4	1	1	1	1								1.7%
81	85	2	2	5	1	3	2	1	1		2	1	1										0.9%
86	90	3	4	4	2		3	2															0.8%
91	95	2	1	2	1		1			1				1									0.4%
96	100	3		1	1	2			1		3												0.5%
101	...	2	1		1	1	3									1							0.4%
		15.9%	8.3%	8.5%	6.7%	6.3%	8.9%	7.5%	7.1%	6.4%	10.4%	5.0%	3.2%	1.5%	1.8%	0.8%	0.8%	0.4%	0.3%	0.1%	0.1%	0.2%	Total

Figure 34: Initial speed of ego and opponent during accidents with passenger cars in SCP-RD-PC [1]

In the majority of the cases (57.9%), the initial speed of the ego vehicle was between 36 kph and 65 kph. The initial speed of the opponent vehicle was most frequently between 0 kph and 50 kph (85.9%). The ego vehicle was most of the times faster than the opponent before a critical situation was recognised.

3.4.3 SCENARIO CONCLUSION

Special for *SCP-RD-PC* is the high percentage of view obstruction for the ego participant with the majority of the view obstructions caused by structural circumstances and vehicles. Accidents in *SCP-RD-PC* happened mostly at intersections with one lane, where one participant is required to observe the right of way. A failure doing this was the most frequent main accident causation. The initial speed of the ego vehicle was mostly higher than the ones of the opponent. Apart from that, *SCP-RD-PC* is defined through weather conditions without rain, often daylight and light traffic.

3.5 SCENARIO 4 - SCP-RD – PEDESTRIAN

Figure 35 illustrates the participants in scenario 4, also called the SCP-RD-PD. The ego participant in this scenario is a passenger car. The opponent is a pedestrian coming from the right direction.

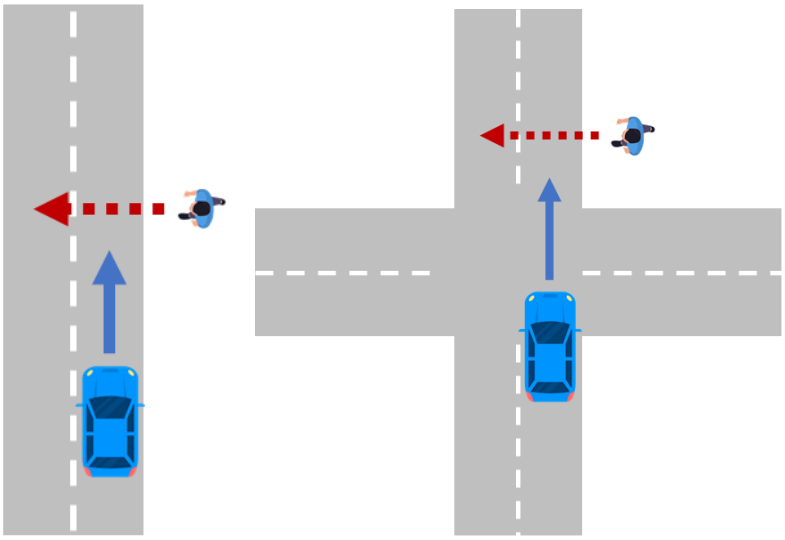


Figure 35: Pictogram SCP-RD-PD

3.5.1 SAFETY POTENTIAL

A system addressing and preventing the straight crossing path from the right direction scenarios contains a big safety potential for pedestrians, with the possibility to save 9.8% slightly injured, 9.6% severely injured and 7.1% fatally injured pedestrians in the EU. More information about the safety potential of this scenario can be found in deliverable D1.1

3.5.2 RESULTS

In Figure 36 the distribution of precipitation during the accidents is shown.

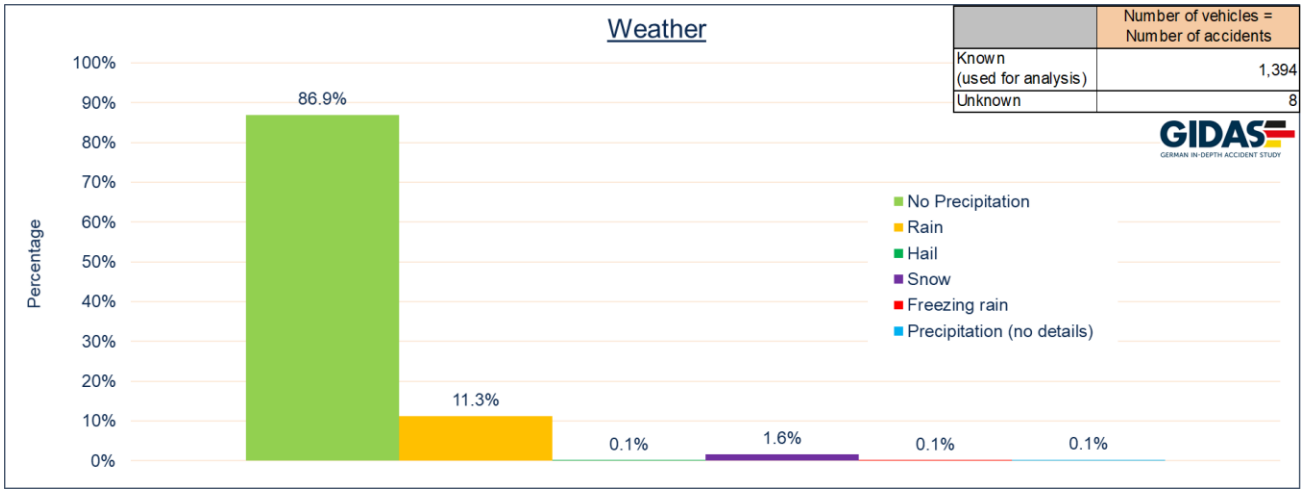


Figure 36: Weather conditions during accidents with pedestrians in SCP-RD-PD [1]

In the majority of the cases (86.9%) there was no precipitation when the accident happened. In 11.3% of the cases, the accident happened during rainy conditions. The percentage of accidents, which happened during rain and snow, is higher than the percentage of those accidents in the comparable scenario 2 (Figure 12).

In Figure 37 an overview of the light conditions during the accidents in *SCP-RD-PD* is shown.

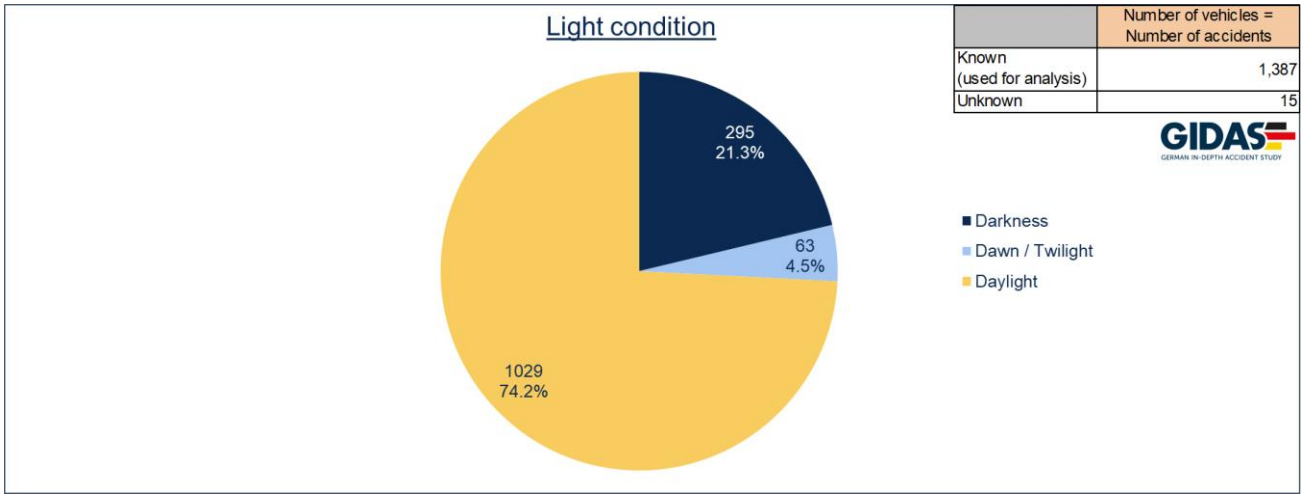


Figure 37: Light conditions during accidents with pedestrians in SCP-RD-PD [1]

With a share of 74.2%, nearly three quarters of the accidents happened during daylight conditions. Only 12.9% of the accidents happened in the darkness or during dawn/twilight.

The illumination of the road in accidents, which happened in darkness or dawn/twilight, is shown in Figure 38.

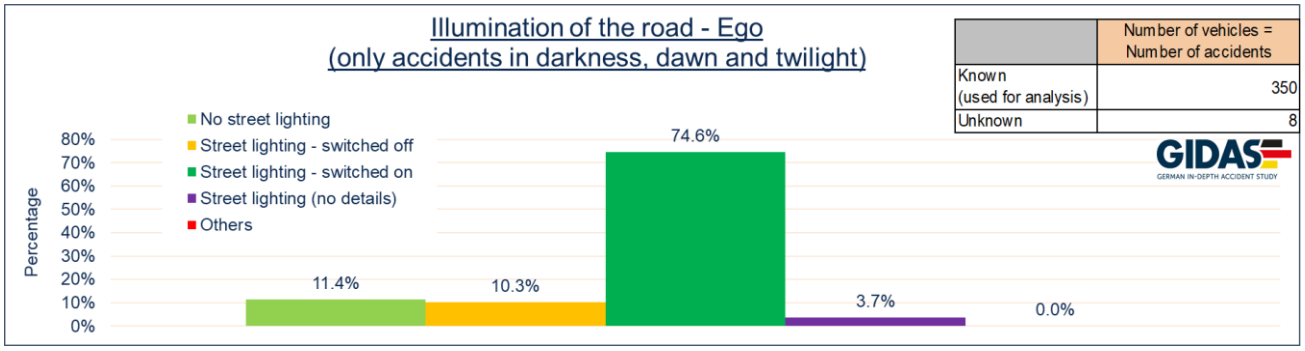


Figure 38: Illumination of the road during accidents with pedestrians in SCP-RD-PD in darkness or dawn/twilight [1]

In nearly three quarters of the accidents, which happened in darkness or dawn/twilight, the road was illuminated with street lighting. In roughly one fifth of the cases, there was no illumination of the accident site, either due to no street lighting existing or due to switched off street lighting.

The percentage of view obstruction for the ego participant is shown in Figure 39.

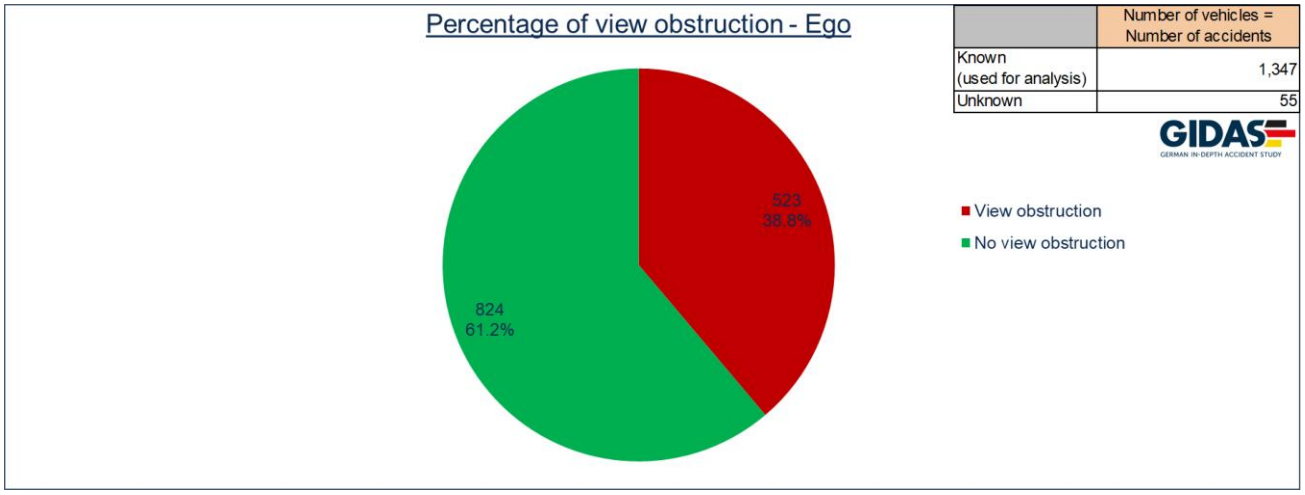


Figure 39: Percentage of view obstructions during accidents with pedestrians in SCP-RD-PD [1]

In more than a third of the accidents, the driver of the ego vehicle was influenced by a view obstruction.

In the following figure (Figure 40) the kind of view obstruction is shown in the cases, where a view obstruction existed.

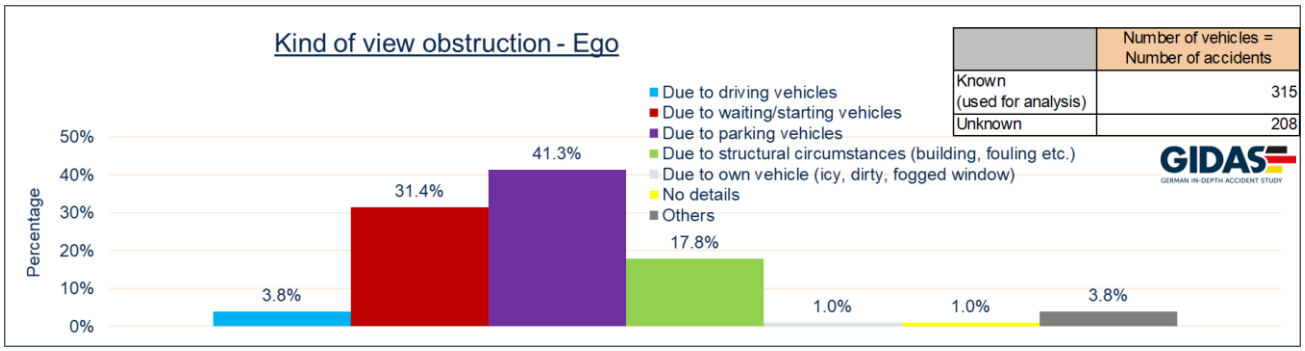


Figure 40: Kind of view obstructions during accidents with pedestrians in SCP-RD-PD [1]

In nearly three quarters of the cases, where the ego participant was view obstructed, the view obstruction was due other vehicles. Often, they were parking or waiting/starting.

An overview of the roads, where the ego participant was driving during the accident, is shown in Figure 41.

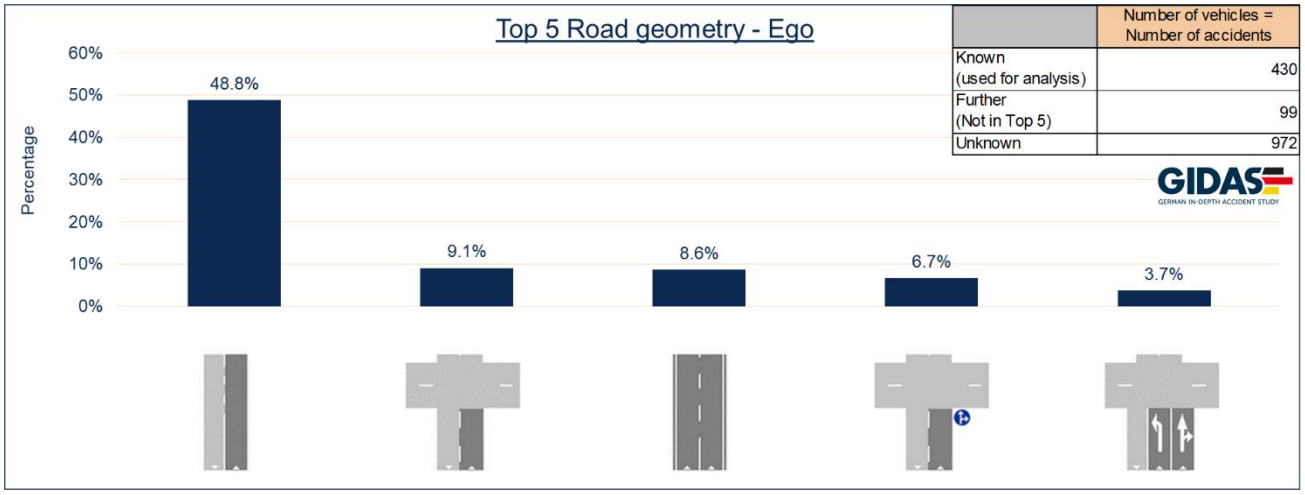


Figure 41: Top 5 Road geometry for the ego participant in accidents with pedestrians in SCP-RD-PD [1]

In nearly half of the cases, the ego participant was driving on a single lane. In about every tenth case the ego participant drove on an intersectional road with a single lane prior to the accident. Accidents at junctions were not as often in this scenario.

The kind of traffic regulation during the accident for the ego participant is shown in Figure 42.

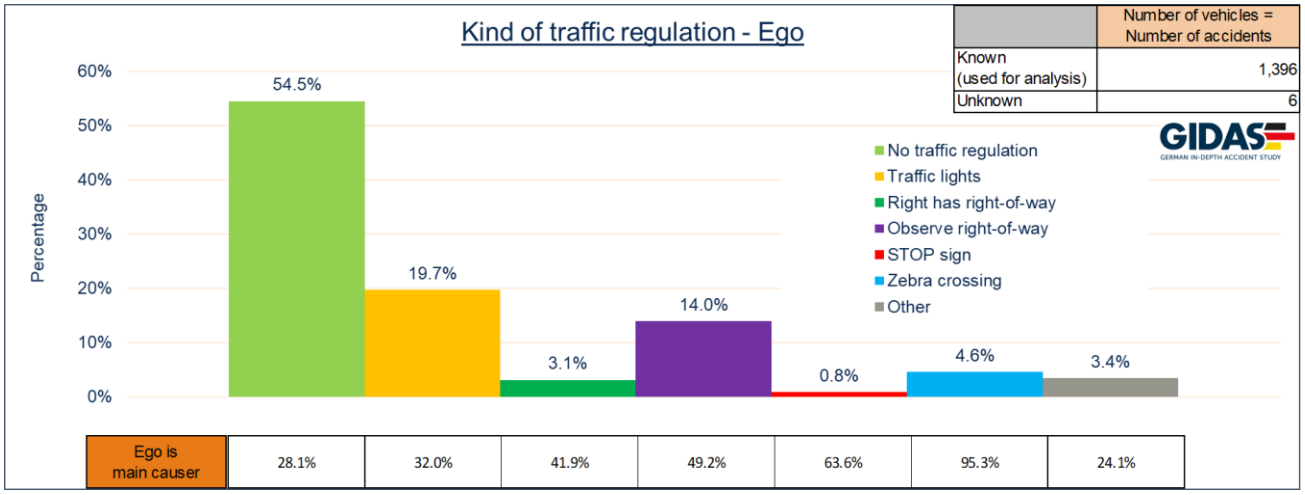


Figure 42: Kind of traffic regulation for the ego participant in accidents with pedestrians in SCP-RD-PD [1]

In more than half of the accidents there was no traffic regulation. In only roughly a quarter of them, the accident was mainly caused by the ego participant. The highest percentage of main causing ego participants can be found at zebra crossings.

In Figure 43 the traffic density during the accident for the ego participant is shown.

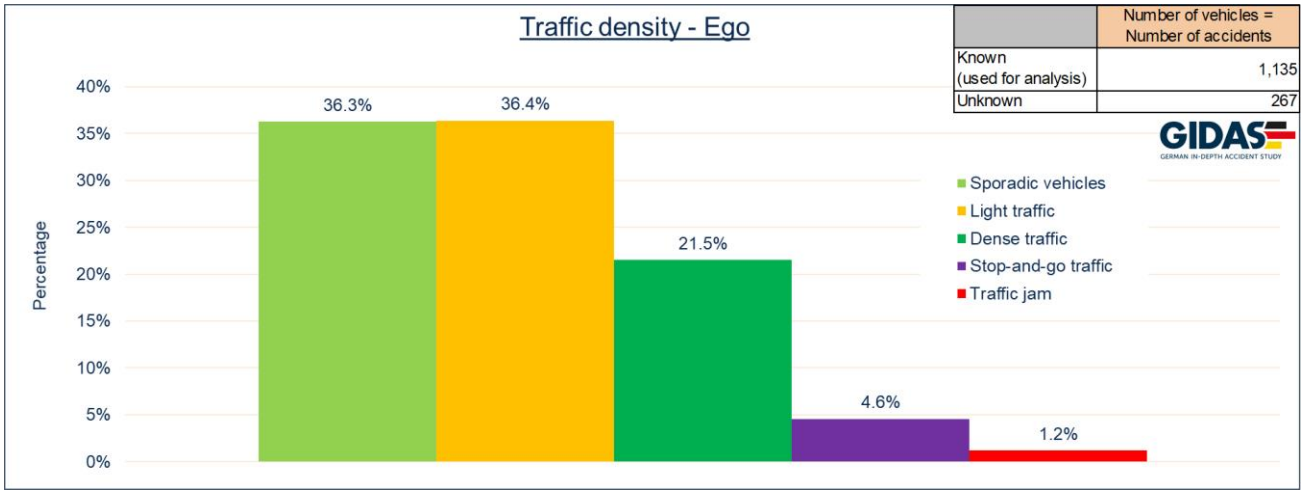


Figure 43: Traffic density during accidents with pedestrians in SCP-RD-PD [1]

During nearly three quarters of the accidents the traffic density was either light or only sporadic vehicles. Around every fifth ego participant had an accident during dense traffic. Stop-and-go traffic or traffic jams were more common for this type of accidents than for accidents with cyclists or passenger cars in scenario 2 and 3.

The most frequent main accident causations in *SCP-RD-PD* are shown in Figure 44.

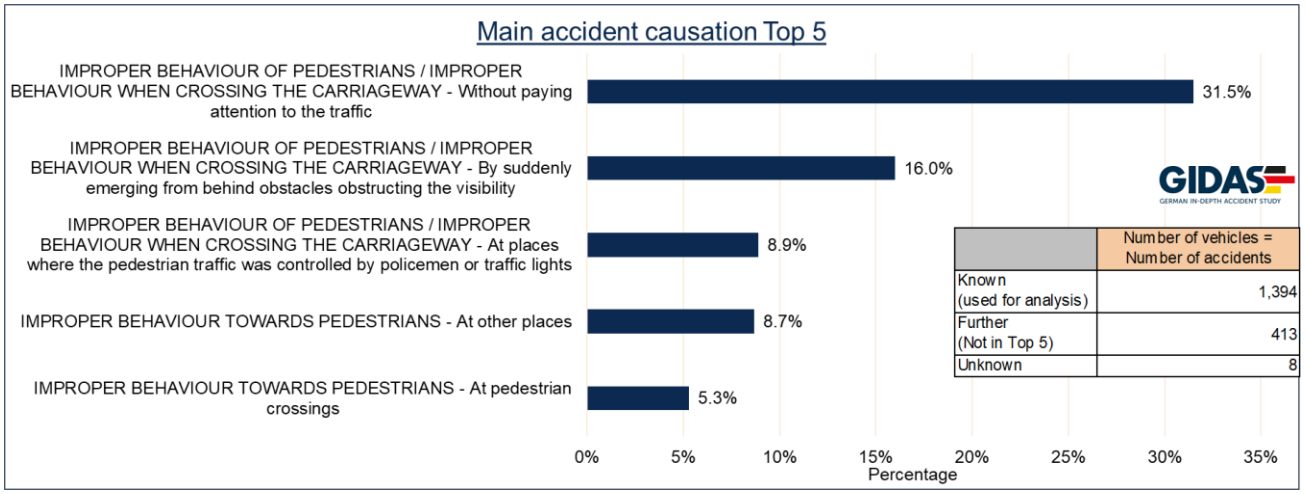


Figure 44: Top 5 main accident causation for accidents with pedestrians in SCP-RD-PD [1]

In 56.4% of the cases, the accident happened mainly because of improper behaviour of the pedestrian. In most of them, the pedestrian paid no attention to the traffic.

The initial speeds of the ego participant *SCP-RD-PD* is shown in Figure 45.

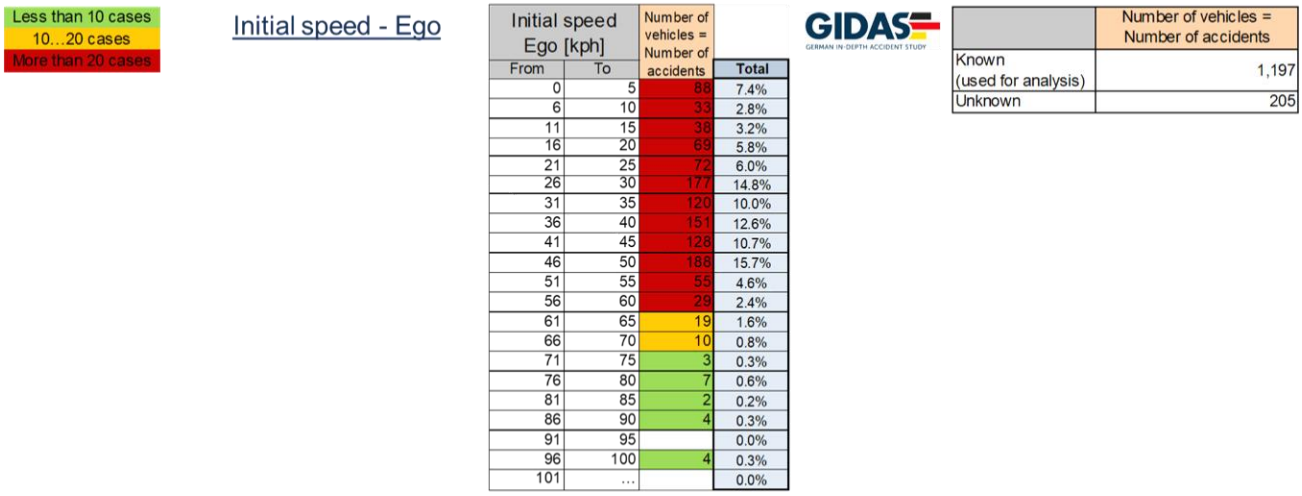


Figure 45: Initial speed of ego during accidents with pedestrians in SCP-RD-PD [1]

In nearly three quarters of the accidents, the initial speed of the ego vehicle was between 21 kph and 55 kph. Only about 6.5% of the ego vehicles drove faster than 55 kph.

3.5.3 Scenario conclusion

Special for *SCP-RD-PD* is the relatively high number of view obstruction for the ego participant with the majority of the view obstructions caused by vehicles. Accidents in *SCP-RD-PD* happened not so often at intersections. In most of the accident scenes there was no traffic regulation. Improper behaviour of the pedestrians was the most frequent main accident causation. The initial speeds of the ego were mostly between 21 kph and 55 kph. Apart from that, *SCP-RD-PD* is defined through weather conditions without rain, often daylight and light traffic.

3.6 Scenario 5 - SCP-LD – Pedestrian

Figure 46 illustrates the participants in scenario 5, also called the *SCP-LD-PD*. The ego participant in this scenario is a passenger car. The opponent is a pedestrian coming from the left direction.

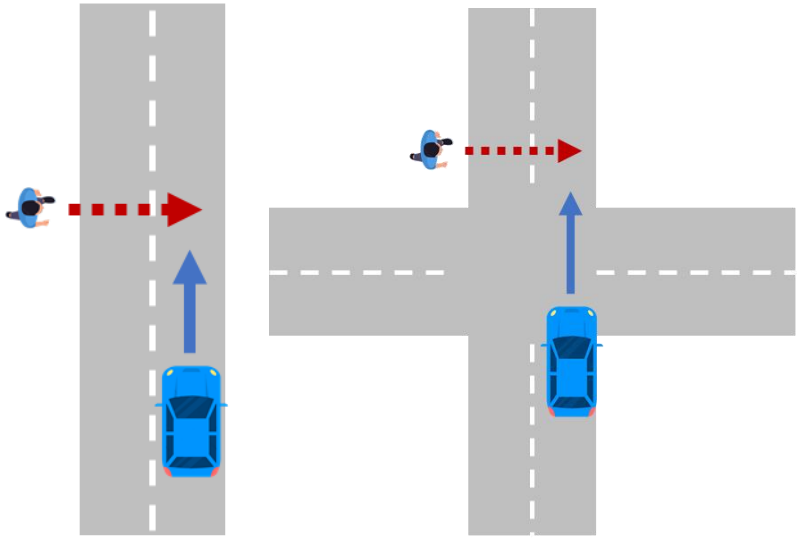


Figure 46: Pictogram SCP-LD-PD

3.6.1 SAFETY POTENTIAL

A system addressing and preventing *SCP-LD-PD* contains a big safety potential for pedestrians, with the possibility to save 5.8% slightly injured, 8.5% severely injured and 8.2% fatally injured pedestrians in the EU. More information about the safety potential of this scenario can be found in deliverable D1.1.

3.6.2 RESULTS

In Figure 47 the distribution of precipitation during the accidents is shown.

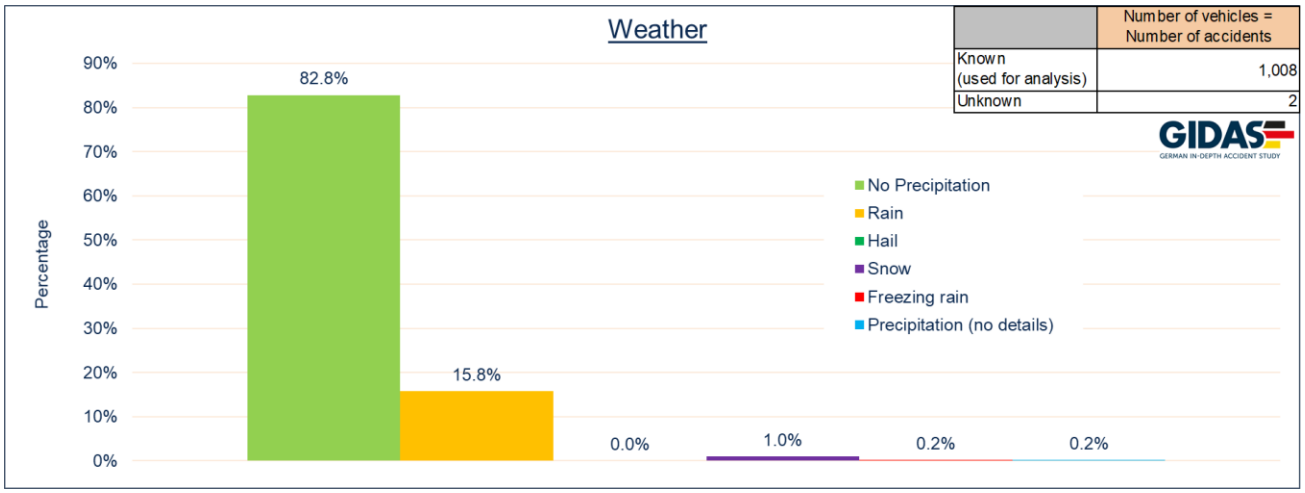


Figure 47: Weather conditions during accidents in SCP-LD-PD [1]

More than four out of five accidents happened on dry weather conditions. Only 15.8% happened in rainy situations. Other forms of precipitation were relatively uncommon for this scenario.

Figure 48 gives an overview of the light conditions during the accidents in *SCP-LD-PD*.

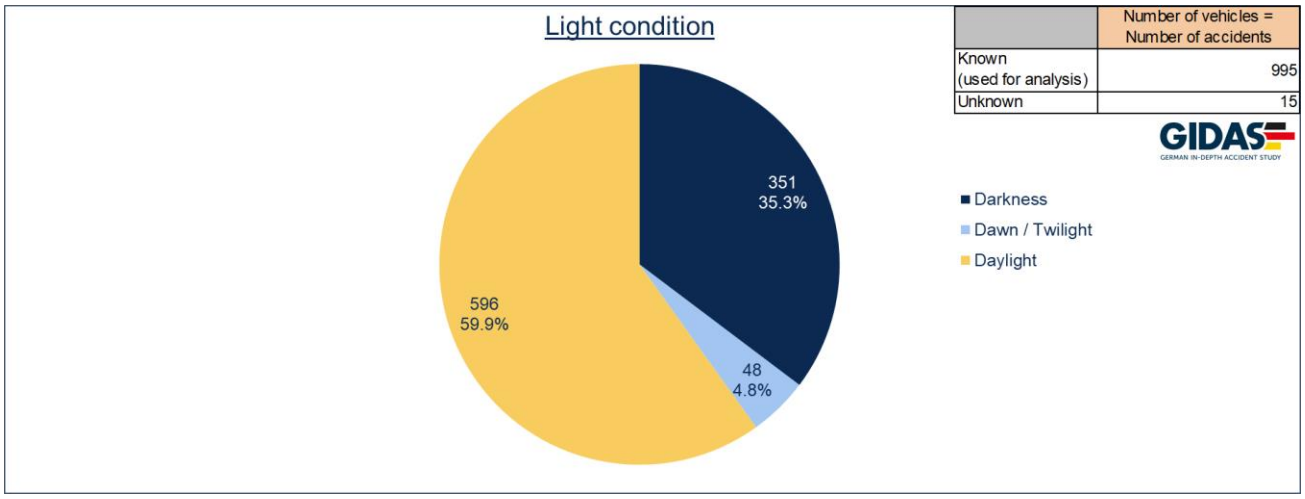


Figure 48: Light conditions during accidents in SCP-LD-PD [1]

About 60% of the accidents happened under daylight conditions. With more than 40%, a significant amount of the accidents in this scenario occurred in darkness or dawn/twilight.

Figure 49 shows the illumination of the road at accidents, which happened in darkness or dawn/twilight.

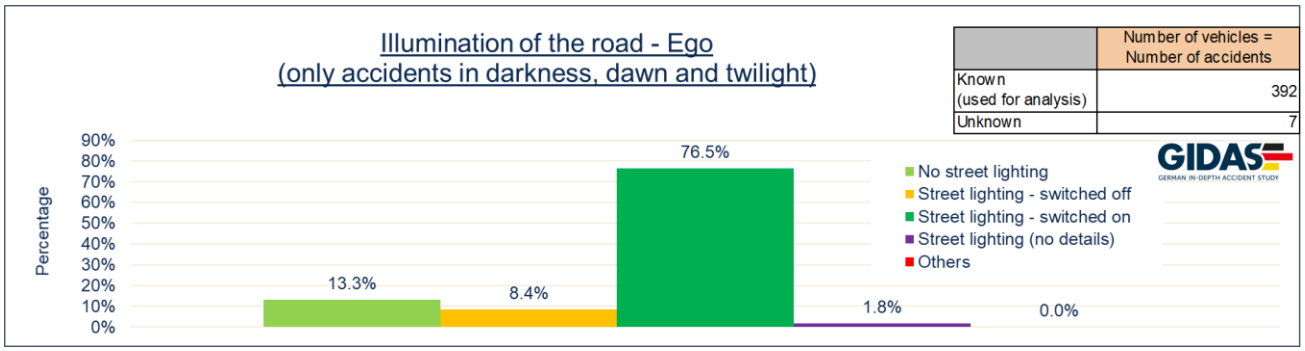


Figure 49: Illumination of the road during accidents SCP-LD-PD in darkness or dawn/twilight [1]

Three quarters of these cases happened on a road, which was illuminated with street lighting. In roughly one fifth of the cases, there was no illumination of the accident site, either due to no existing street lighting or due to switched off street lighting.

The percentage of view obstruction for the ego participant is shown in Figure 50.

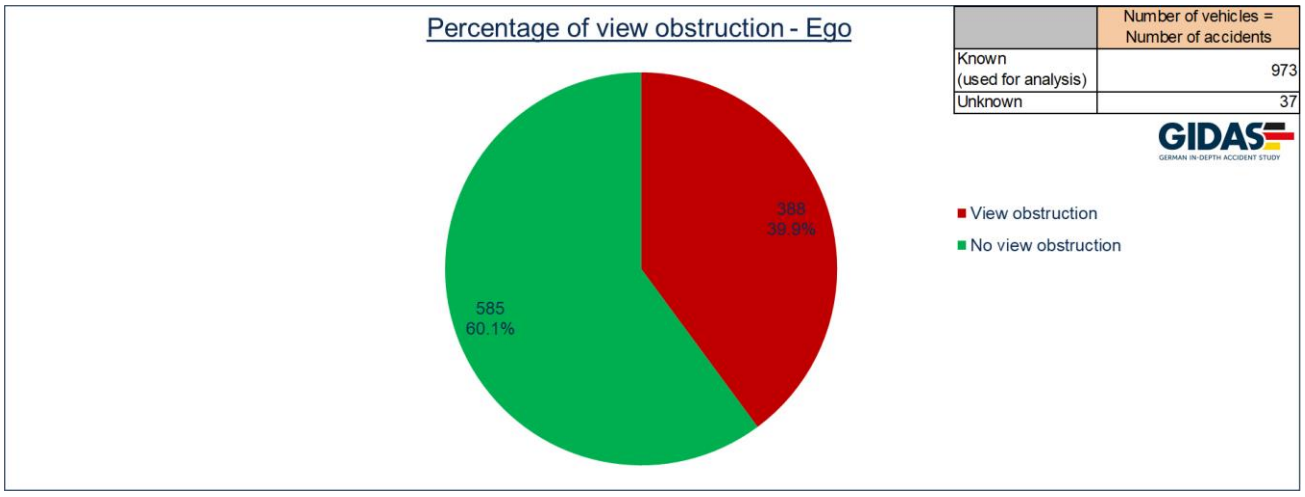


Figure 50: Percentage of view obstructions during accidents in SCP-LD-PD [1]

In nearly 40% of the accidents with cyclists in *SCP-LD-PD* there was a view obstruction for the ego participant at the time of the accident.

In the following figure (Figure 51) the kind of view obstruction is described for the cases, where a view obstruction existed.

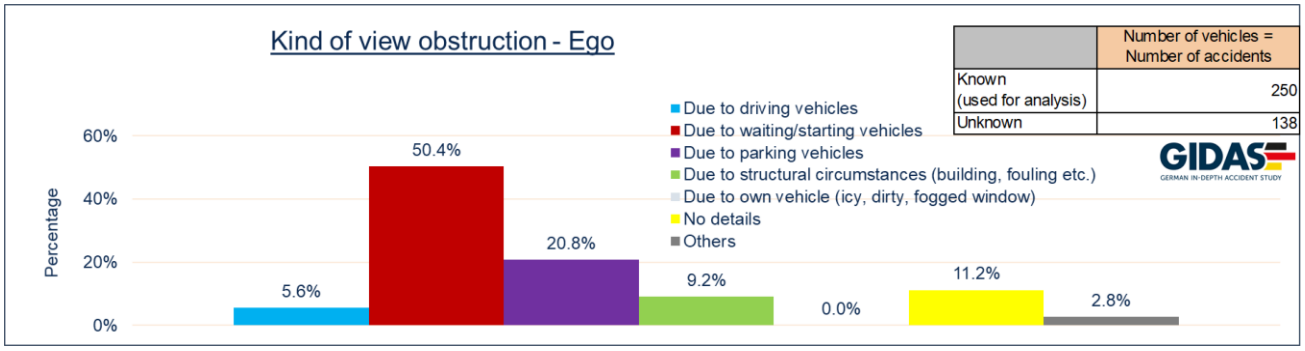


Figure 51: Kind of view obstructions during accidents in SCP-LD-PD [1]

This view obstruction was due to other vehicles in more than three quarters of the cases. Most of the vehicles were waiting or starting at the time they obstructed the view of the ego participant. In about every tenth of the cases the view obstruction was due to structural circumstances.

The road, where the ego participant was driving during the accident, is shown in Figure 52.

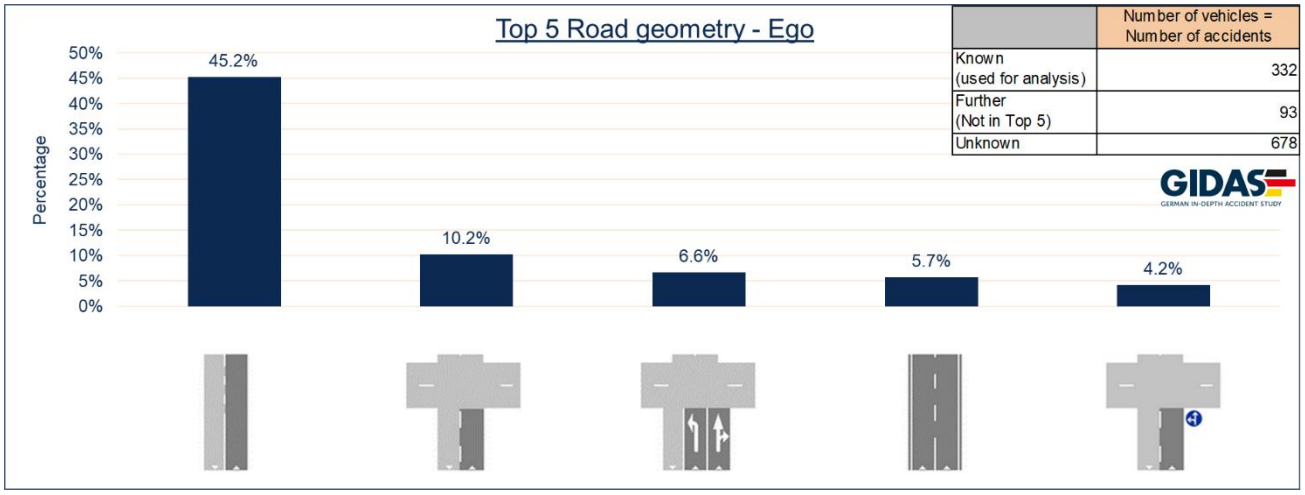


Figure 52: Top 5 Road geometry for the ego participant in accidents in SCP-LD-PD [1]

In more than half of the cases, the ego participant was driving on a road without access to an intersection (50.9%). In about every tenth case the ego participant drove on a road towards an intersection with a single lane for all directions prior to the accident.

The kind of traffic regulation during the accident for the ego participant is shown in Figure 53.

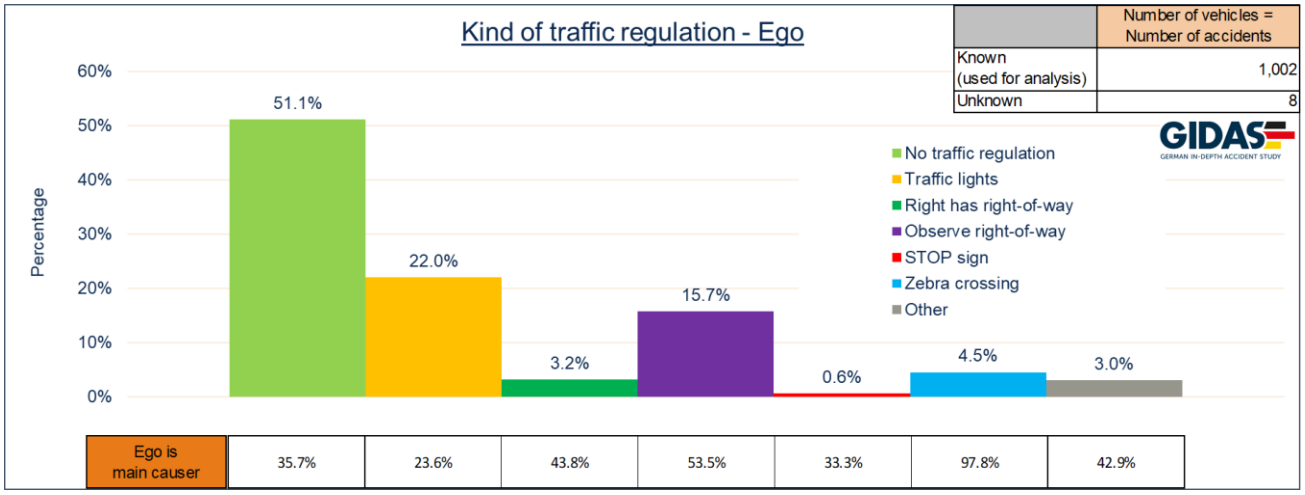


Figure 53: Kind of traffic regulation for the ego participant in accidents in SCP-LD-PD [1]

In more than half of the accidents there was no traffic regulation. In more than one third of them, the accident was mainly caused by the ego. The highest percentage of mainly causing ego participants can be found at zebra crossings.

In Figure 54 the traffic density during the accident for the ego participant is shown.

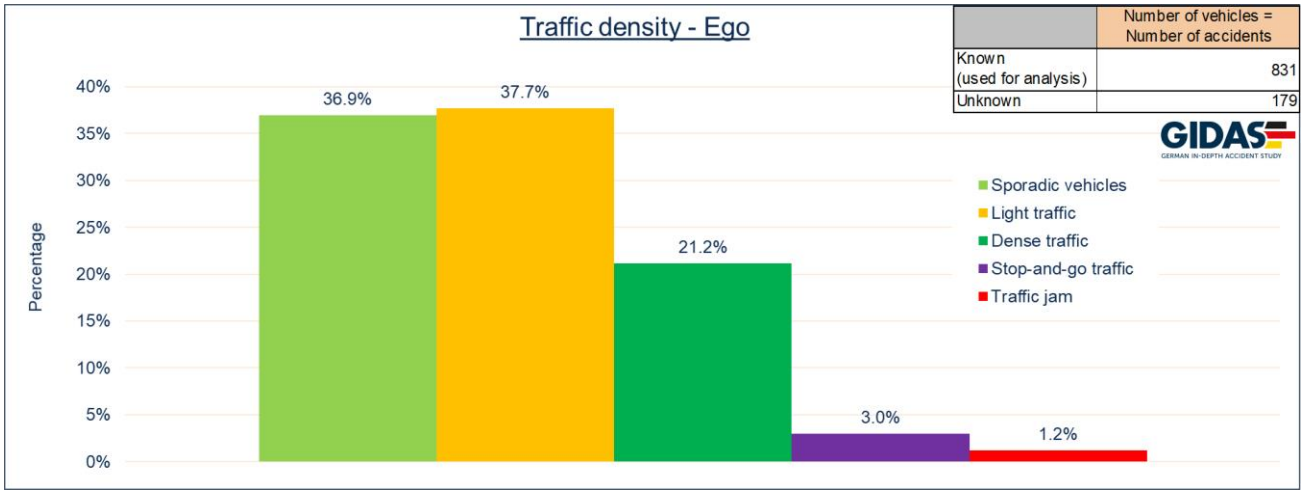


Figure 54: Traffic density during accidents in SCP-LD-PD [1]

During nearly three quarters of the accidents the traffic density was either light or only sporadic vehicles. One in five accidents happened in dense traffic situations. Stop-and-go traffic or traffic jams are not very common for this type of accidents.

In Figure 55 the most frequent main accident causations in *SCP-LD-PD* are shown.

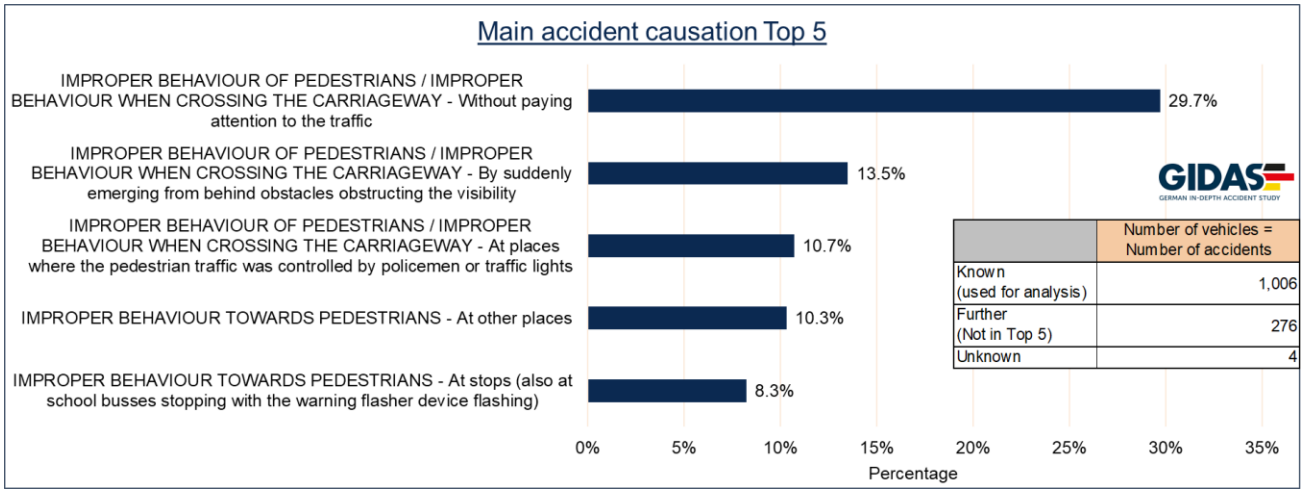


Figure 55: Top 5 main accident causation for accidents in SCP-LD-PD [1]

In 53.9% of the cases, the accident happened mainly because of improper behavior of the pedestrian. In most of these cases, the pedestrian paid no attention to the traffic.

In the following figure (Figure 56) the initial speed of the ego vehicle is shown.

Less than 10 cases
10…20 cases
More than 20 cases

Initial speed - Ego

Initial speed Ego [kph] From	To	Number of vehicles = Number of accidents	Total
0	5	51	5.9%
6	10	21	2.4%
11	15	20	2.3%
16	20	49	5.6%
21	25	47	5.4%
26	30	115	13.2%
31	35	72	8.3%
36	40	108	12.4%
41	45	102	11.7%
46	50	158	18.2%
51	55	43	4.9%
56	60	34	3.9%
61	65	16	1.8%
66	70	17	2.0%
71	75	3	0.3%
76	80	3	0.3%
81	85	1	0.1%
86	90	2	0.2%
91	95		0.0%
96	100	2	0.2%
101	…	5	0.6%

GIDAS

	Number of vehicles = Number of accidents
Known (used for analysis)	869
Unknown	141

Figure 56: Initial speed of ego during accidents in SCP-LD-PD [1]

In the majority of the cases (68.8%), the initial speed of the ego vehicle was between 26 kph and 55 kph. Only 9.6% of the ego vehicles drove faster than 55 kph.

3.6.3 SCENARIO CONCLUSION

A noticeable characteristic in *SCP-LD-PD* is the low number of daylight accidents compared to other scenarios. Special for *SCP-LD-PD* is the comparatively high percentage of view obstruction for the ego participant with the majority of the view obstructions caused by vehicles. Also unusual is the relatively low number of accidents which happened at intersections. Most of the accident scenes were not traffic regulated. Improper behaviour of the pedestrians was the most frequent main accident causation. Apart from that, *SCP-LD-PD* is defined through weather conditions without rain and light traffic. Initial speeds of the ego were mostly between 21 kph to 55 kph.

3.7 SCENARIO 6/8 - LOC-CU/SL - SINGLE

Figure 57 illustrates the participants in scenario 6 and 8, also called the *LOC-CU-Single* and *LOC-SL-Single,* summarized the *LOC-Single*. The ego participant in these scenarios are passenger cars. In *LOC-CU-Single* the ego participant loses the control about the vehicle in a curve. In *LOC-SL-Single* the ego participant loses the control about the car on a straight. These scenarios don't include any opponent.

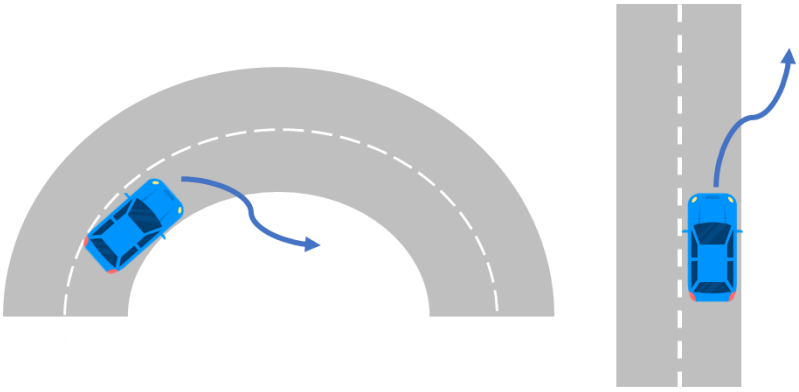


Figure 57: Pictogram LOC Single

3.7.1 SAFETY POTENTIAL

A system addressing and preventing the loss of control scenarios contains a safety potential for passenger cars, with the possibility to save 2.6% slightly injured, 6.1% severely injured and 7.4% fatally injured car occupants in the EU. More information about the safety potential of this scenario can be found in deliverable D1.1.

3.7.2 RESULTS

This chapter is divided in three subchapters because it is a combined scenario, existing of *LOC-CU-Single* and *LOC-SL-Single*. Most of the analyses were done for both of the scenarios together. These results can be found in chapter 3.7.2.1. The results of the special analyses, which have been done for each single scenario, can be found in the chapters 3.7.2.2 and 3.7.2.3.

3.7.2.1 LOC-Single

In Figure 58 the distribution of precipitation during the accidents is shown.

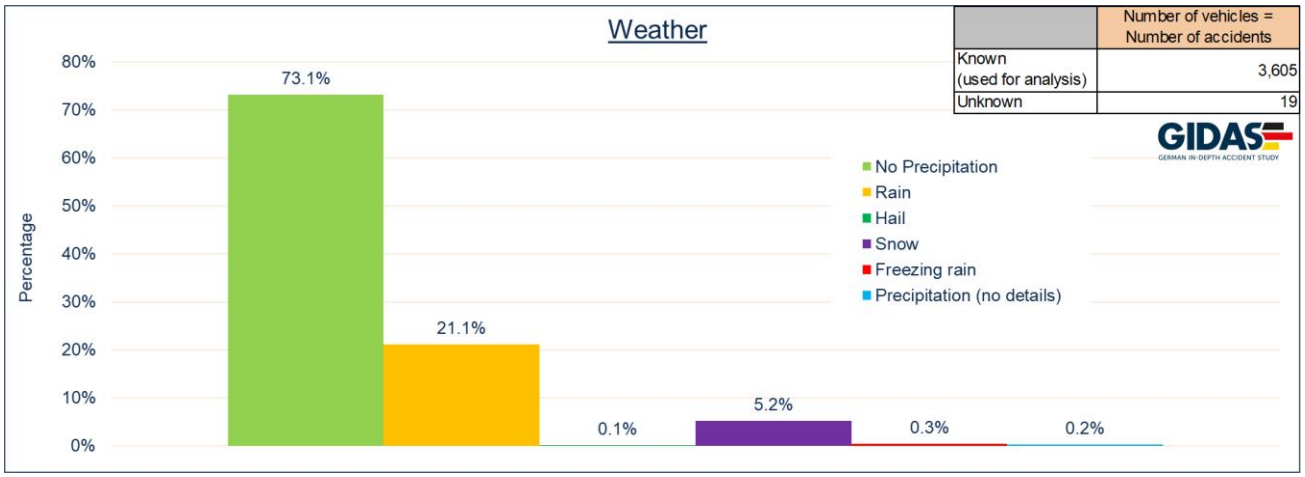


Figure 58: Weather conditions during accidents in LOC-Single [1]

The majority of the accidents happened on dry weather conditions. Every fifth accident happened during rain. With 5.2% a comparatively high percentage of the accidents happened while snow was

falling.

The condition of the road surface in *LOC-Single* is described in Figure 59.

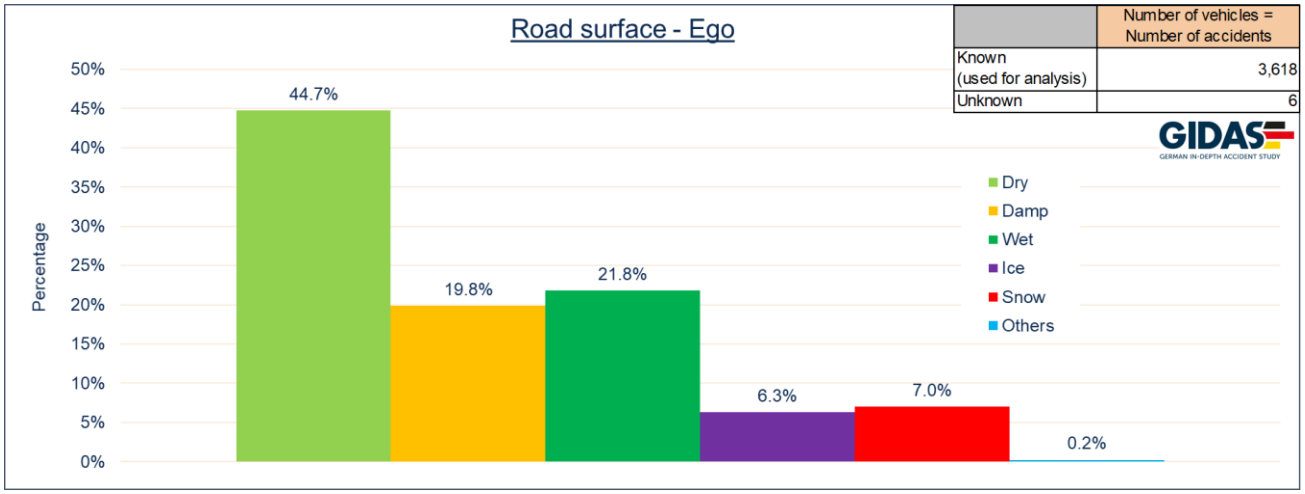


Figure 59: Road surface during accidents in LOC-Single [1]

More than 40% of the accidents happened on wet or damp road conditions. With 13.3% a high percentage of the vehicles had an accident on an icy or snowy road.

The distribution of corner radii is shown in Figure 60.

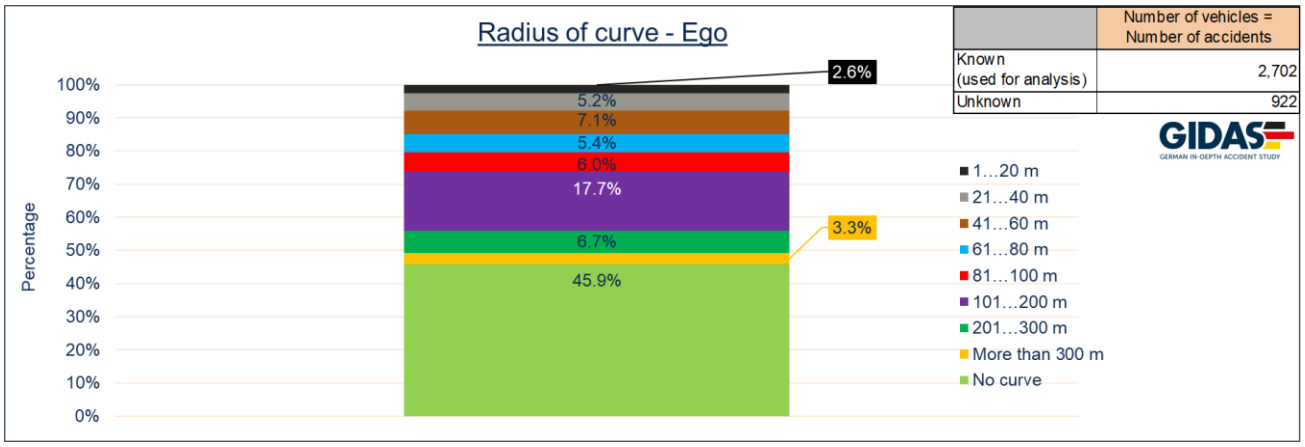


Figure 60: Radius of curve during accidents in LOC-Single [1]

Nearly 55% of the vehicles in loss of control accidents had an accident in a curve. The 45.9% of the accidents described with “no curve“ are the 1,241 vehicles, which lost control on a straight line in *LOC-SL-Single*.

In Figure 61 the traffic density during the accident for the ego participant is shown.

Figure 61: Traffic density during accidents in LOC-Single [1]

Only one in ten accidents happened in situations with dense traffic. At nearly 90% of the accident, there was only light traffic or sporadic vehicles during the accident.

In Figure 62 the most frequent main accident causations in *LOC-Single* are shown.

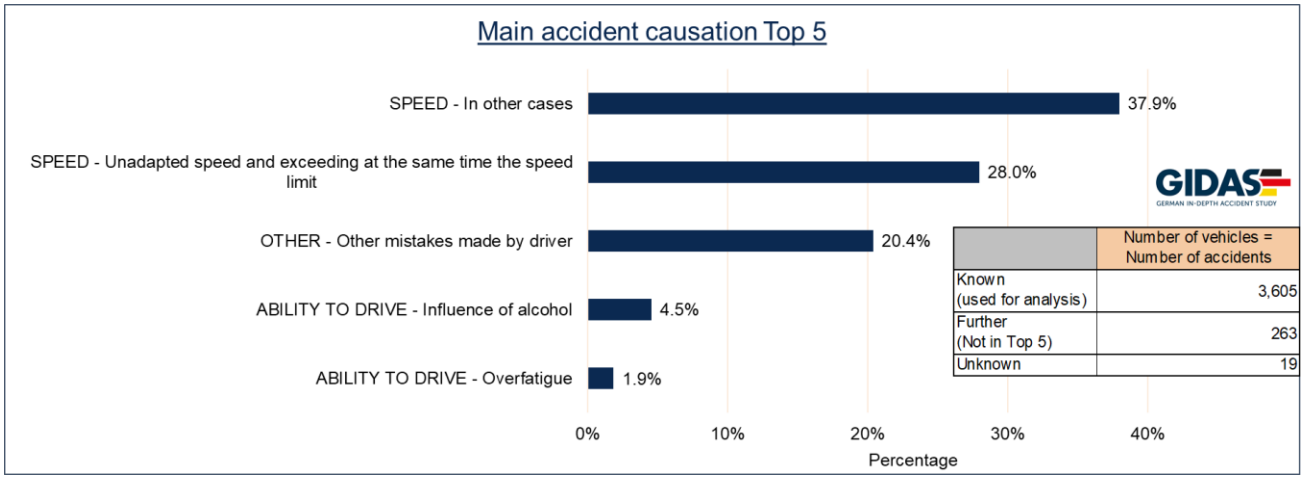


Figure 62: Top 5 main accident causation for accidents in LOC-Single [1]

Nearly two in three accidents were mainly caused by speeding. Alcohol was the main reason for the accident in 4.5% of the cases. For details regarding the main causation in curve or straight-line accidents please take a look at Figure 65 and Figure 68.

Figure 63 depicts the number of accidents, which were influenced by human failures.

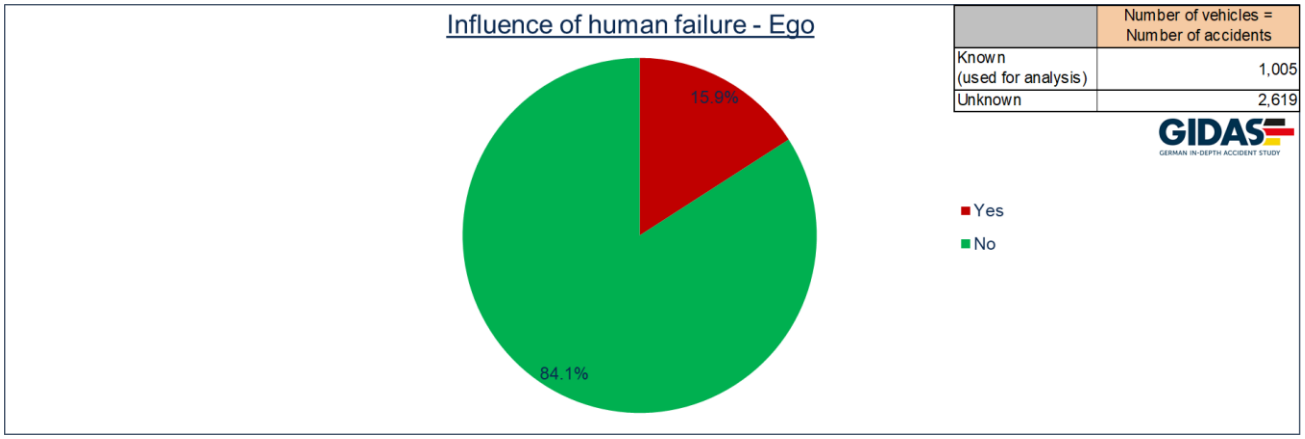


Figure 63: Influence of human failure for accidents in LOC-Single [1]

With a share of more than 80%, most of the accidents were not influenced by human failure of the driver of the ego vehicle.

In Figure 64 the initial speed of the ego vehicle is shown.

Less than 10 cases
10…20 cases
More than 20 cases

Initial speed - Ego

Initial speed Ego [kph] From	To	Number of vehicles = Number of accidents	Total
0	5	14	0.4%
6	10	2	0.1%
11	15	4	0.1%
16	20	6	0.2%
21	25	11	0.3%
26	30	22	0.7%
31	35	33	1.0%
36	40	80	2.4%
41	45	100	3.0%
46	50	234	7.1%
51	55	135	4.1%
56	60	213	6.5%
61	65	184	5.6%
66	70	309	9.4%
71	75	207	6.3%
76	80	291	8.8%
81	85	207	6.3%
86	90	236	7.2%
91	95	150	4.6%
96	100	218	6.6%
101	…	637	19.3%

GIDAS

	Number of vehicles = Number of accidents
Known (used for analysis)	3,293
Unknown	331

Figure 64: Initial speed of ego during accidents in LOC-Single [1]

A comparatively high percentage of the vehicles (19.3%) had a really high initial speed of more than 100 kph. At this, it should be mentioned, that nearly 70% of the accidents in scenario 6/8 happened on rural area or on highways.

3.7.2.2 LOC-CU-Single

In Figure 65 the most frequent main accident causations in *LOC-CU-Single* are shown.

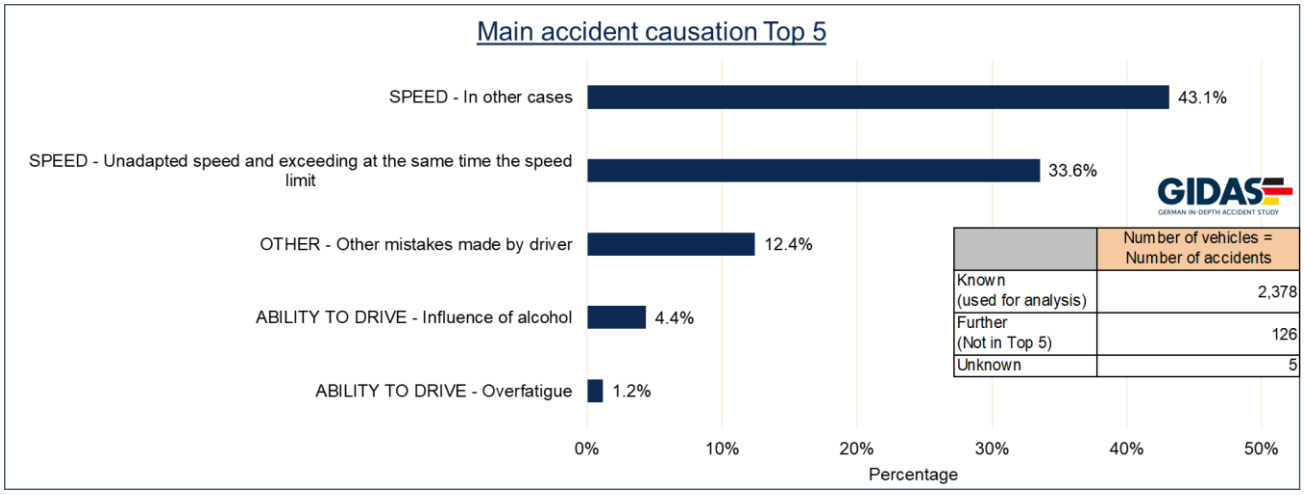


Figure 65: Top 5 main accident causation for accidents in curves in LOC-CU-Single [1]

Three quarters of the loss of control accidents in curves were mainly caused by speeding. One third of the accidents were caused because of speeding and exceeding the speed limit. Mistakes made by the driver were the main accident causation in one in eight accidents.

Figure 66 shows the number of accidents, where human failures were influencing the accidents for loss of control accidents in *LOC-CU-Single*.

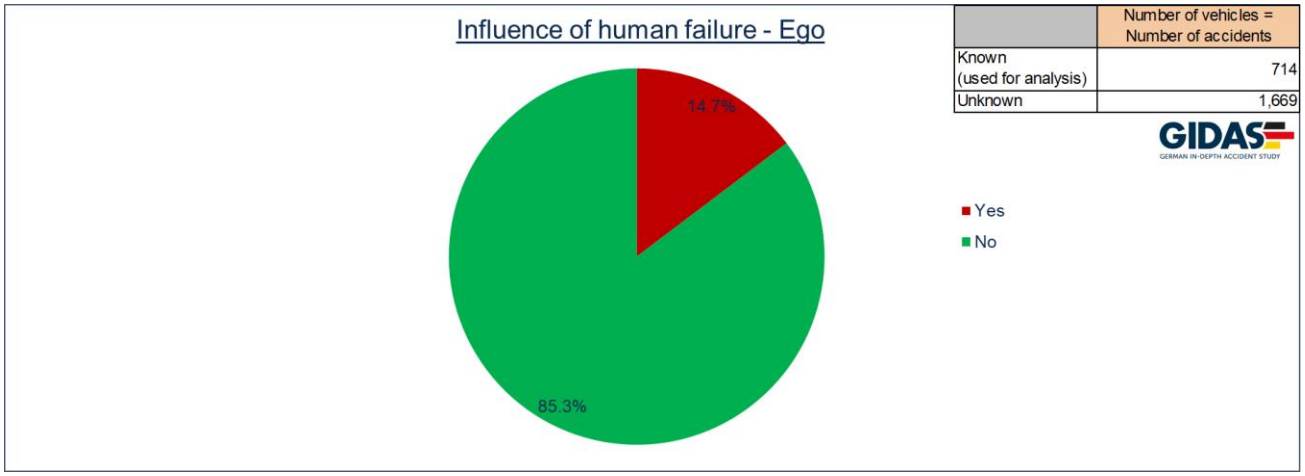


Figure 66: Influence of human failure during accidents in curves in LOC-CU-Single [1]

The percentage of the influence of human failure was lower in loss of control accidents in a curve than in loss of control accidents on straight roads (Figure 69).

Figure 67 shows the initial speed of the ego vehicles and the curve radii, the ego vehicles were driving during the accident.

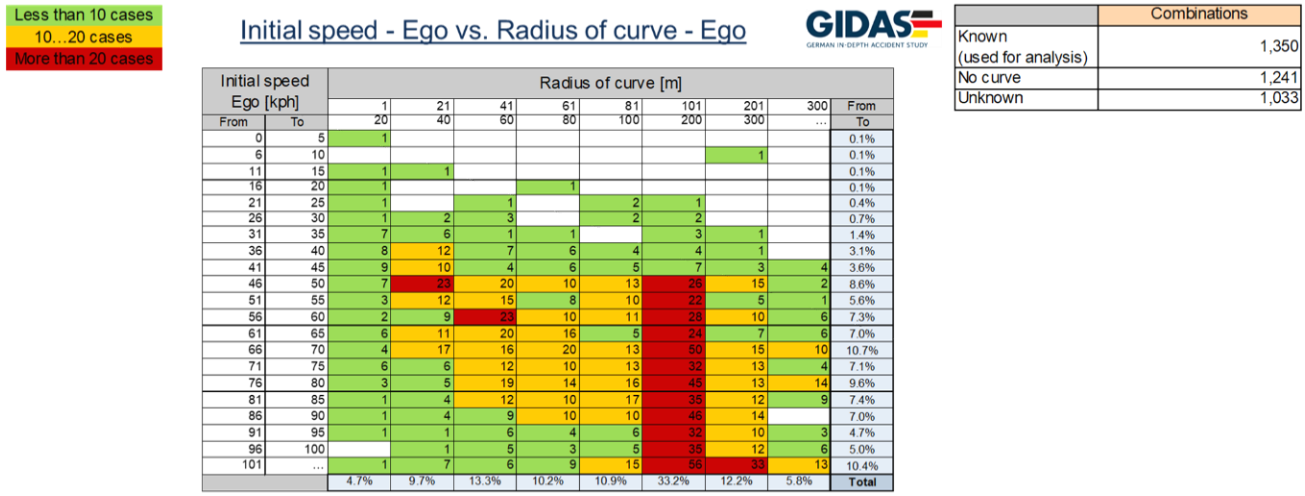


Figure 67: Initial speed vs. radius of curve from the ego participant in LOC-CU-Single [1]

Nearly 55% of the vehicles in curves with a radius of more than 80 m had an initial speed of more than 50 kph. 32.4% of the vehicles in curves with a radius of more than 100 m had an initial speed of more than 70 kph.

3.7.2.3 LOC-SL-Single

Figure 68 shows the most frequent main accident causations in *LOC-SL-Single*.

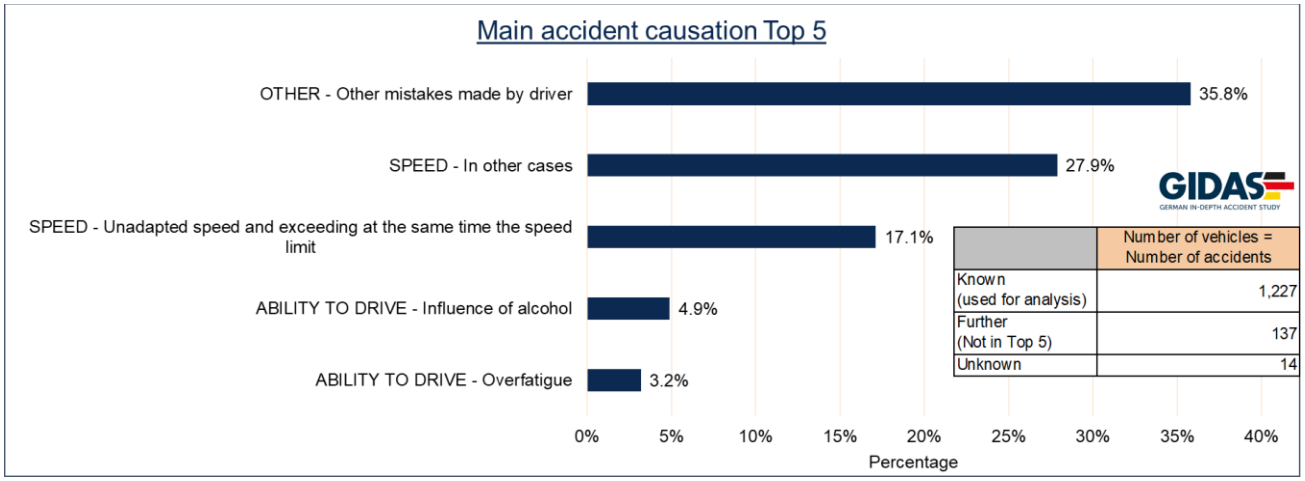


Figure 68: Top 5 main accident causation for accidents on straights in LOC-SL-Single [1]

45% of the loss of control accidents on straight roads were mainly caused by speeding. More than one third of the cases had the cause „other“. Those causations cannot be described more detailed, but they include cases like distraction.

Figure 69 shows the number of accidents, where human failures influenced the accidents for loss of control accidents in *LOC-SL-Single*.

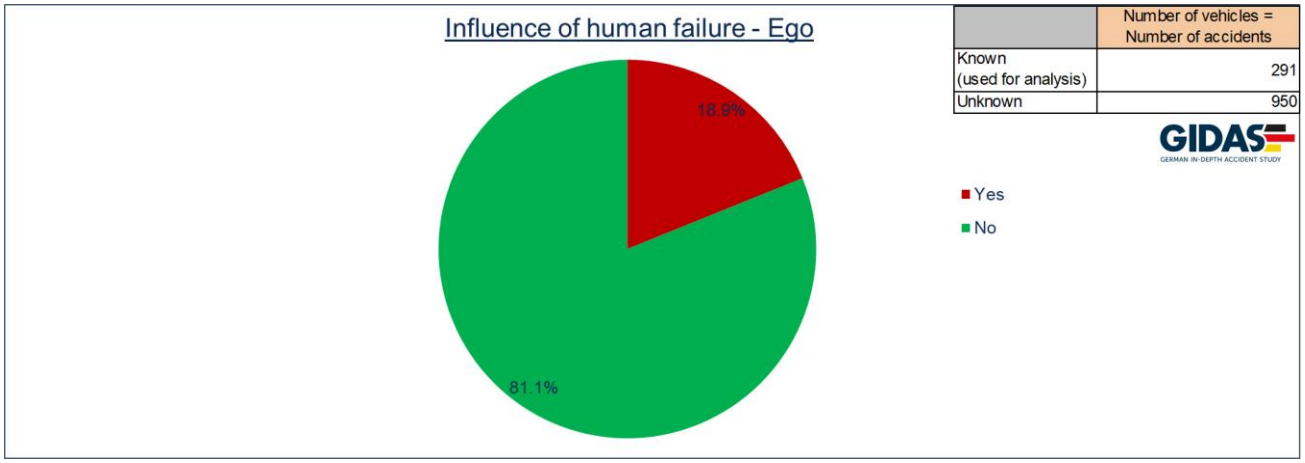
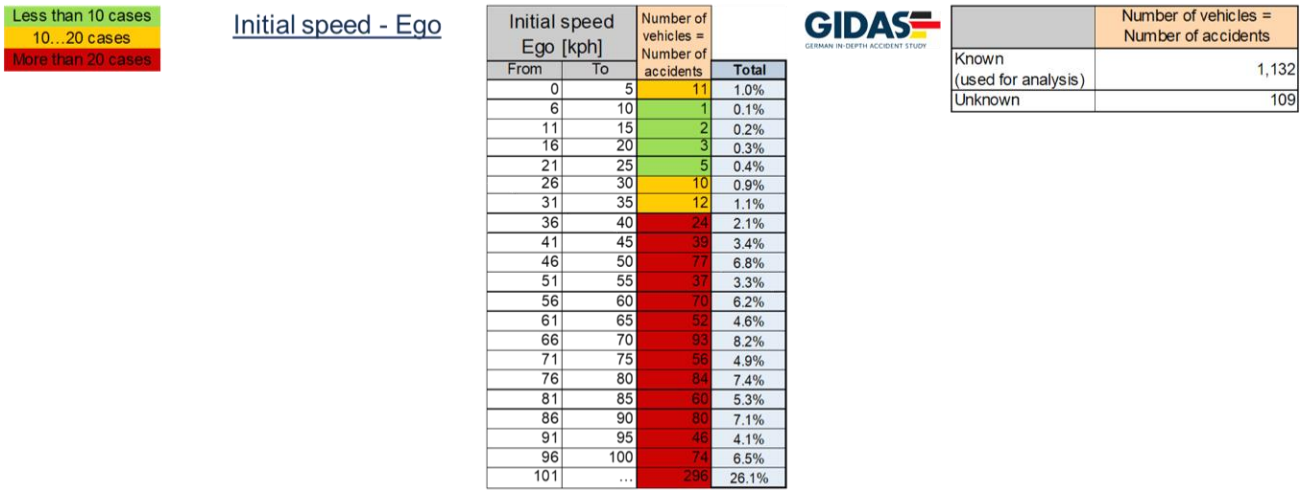


Figure 69: Influence of human failure during accidents on straights in LOC-SL-Single [1]

The percentage of the influence of human failures was higher in loss of control accidents on straight roads than in loss of control accidents in a curve (Figure 66).

Figure 70 shows the initial speed of the ego vehicle.



Initial speed Ego [kph] From	To	Number of vehicles = Number of accidents	Total
0	5	11	1.0%
6	10	1	0.1%
11	15	2	0.2%
16	20	3	0.3%
21	25	5	0.4%
26	30	10	0.9%
31	35	12	1.1%
36	40	24	2.1%
41	45	39	3.4%
46	50	77	6.8%
51	55	37	3.3%
56	60	70	6.2%
61	65	52	4.6%
66	70	93	8.2%
71	75	56	4.9%
76	80	84	7.4%
81	85	60	5.3%
86	90	80	7.1%
91	95	46	4.1%
96	100	74	6.5%
101	…	296	26.1%

Figure 70: Initial speed from the ego participant in LOC-SL-Single [1]

A comparatively high percentage of the vehicles (26.1%) had a very high initial speed of more than 100 kph. Nearly half of the vehicles had an initial speed of more than 80 kph.

3.7.3 SCENARIO CONCLUSION

Special for *LOC-Single* is the relatively high number of rain or snow during the accidents, which resulted in a slippery road surface. Speeding was the most frequent main accident causation for both scenarios. Also unique for these accident scenarios is the relatively high number of accidents during darkness or dawn. The curves in *LOC-CU-Single* mostly had a radius between 101 and 200 m, while speeds were relatively high. Human failure occurred more often at accidents in straight lines than in curves. The traffic in these scenarios was mostly light.

3.8 SCENARIO 7 SCP-LD - PASSENGER CAR

Figure 71 illustrates the participants in scenario 7, also called the *SCP-LD-PC*. The ego participant in this scenario is a passenger car. The opponent is also a passenger car coming from the left direction.

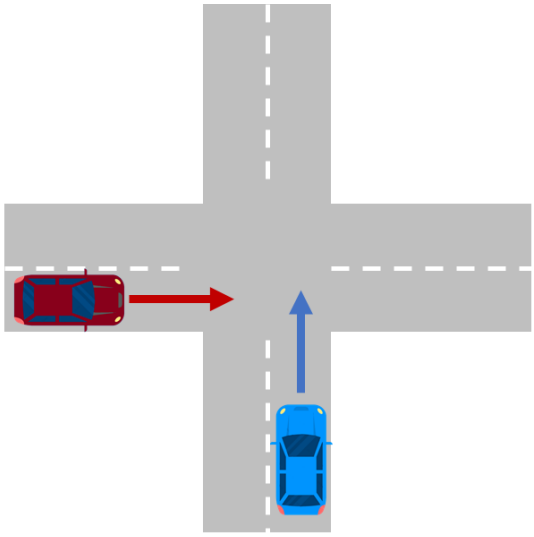


Figure 71: Pictogram SCP-LD-PC

3.8.1 Safety potential

A system addressing and preventing *SCP-LD-PC* contains a safety potential for passenger cars, with the possibility to save 5.1% slightly injured, 3.2% severely injured and 0.5% fatally injured car occupants in the EU. More information about the safety potential of this scenario can be found in deliverable D1.1.

3.8.2 Results

Figure 72 shows the distribution of precipitation during the accidents.

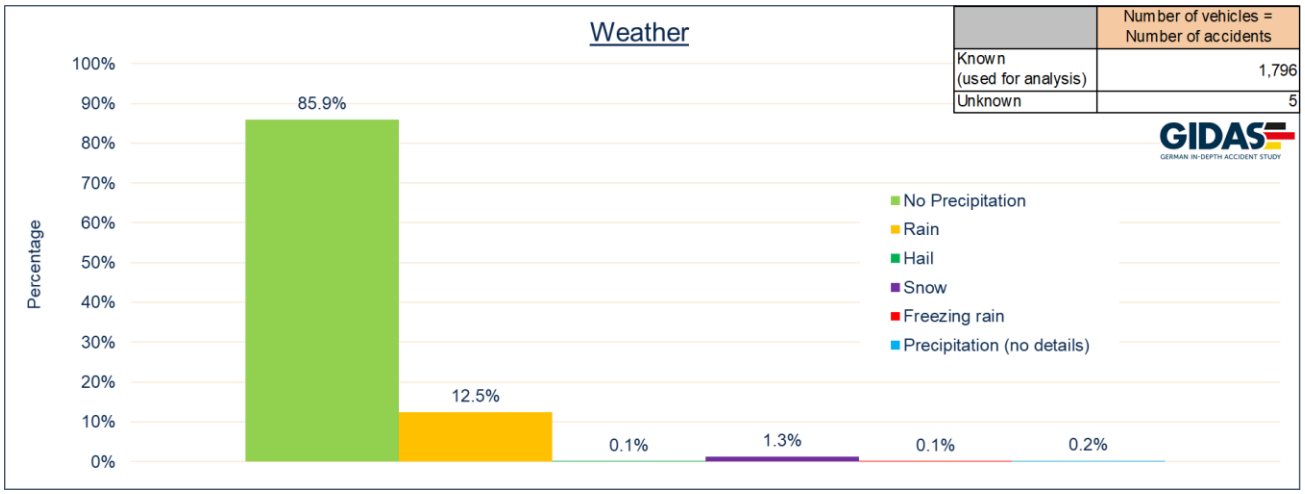


Figure 72: Weather conditions during accidents in SCP-LD-PC [1]

The majority of the accidents happened on dry weather conditions. One in eight accidents happened in rainy situations.

Figure 73 gives an overview of the light conditions during the accidents in *SCP-LD-PC*.

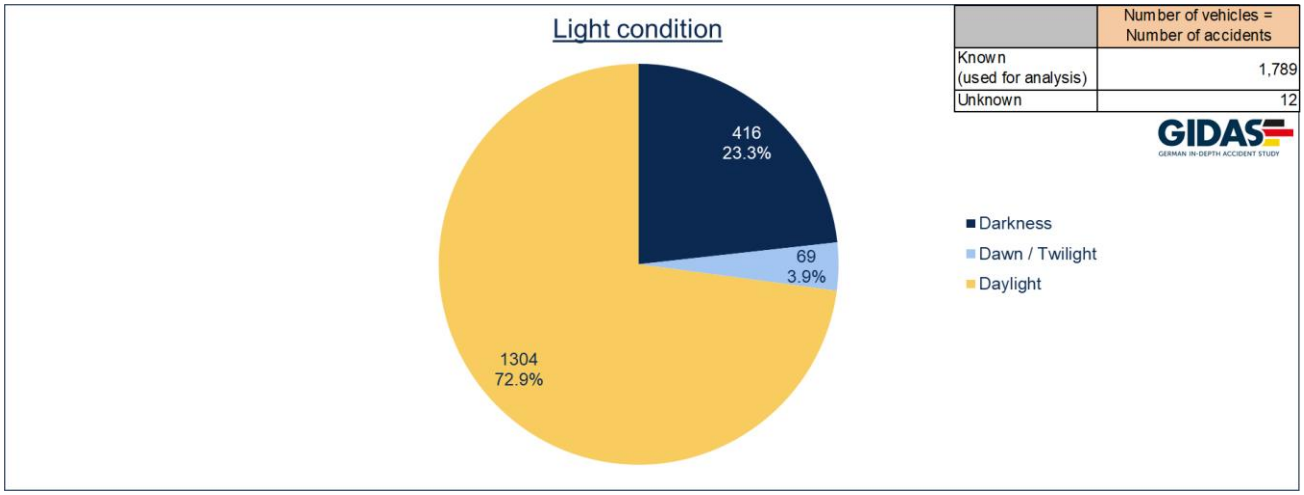


Figure 73: Light conditions during accidents in SCP-LD-PC [1]

About three quarters of the accidents happened under daylight conditions. More than 27% of the accidents occurred in darkness or dawn/twilight.

Figure 74 shows the illumination of the road at accidents, which happened in darkness or dawn/twilight.

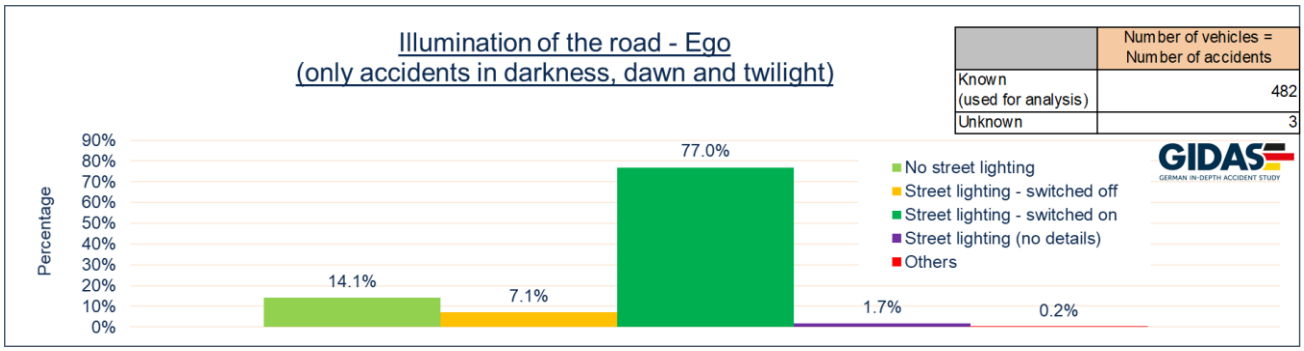


Figure 74: Illumination of the road during accidents in SCP-LD-PC in darkness or dawn/twilight [1]

In more than three quarters of these cases, the road was illuminated with street lighting. In roughly one fifth of the cases, there was no illumination of the accident site, either due to no existing street lighting or due to switched off street lighting.

Figure 75 visualizes the percentage of view obstruction for ego participants.

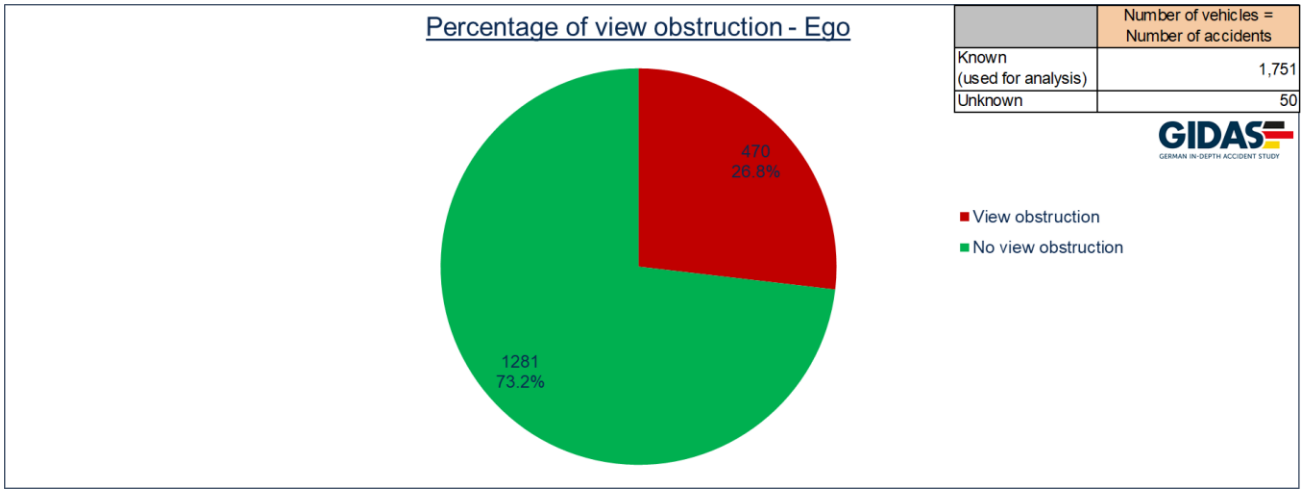


Figure 75: Percentage of view obstructions during accidents in SCP-LD-PC [1]

In over a quarter of the accidents in scenario 7 there was a view obstruction for the ego participant at the time of the accident.

In the following figure (Figure 76) the kind of view obstruction is shown for the cases, where a view obstruction existed.

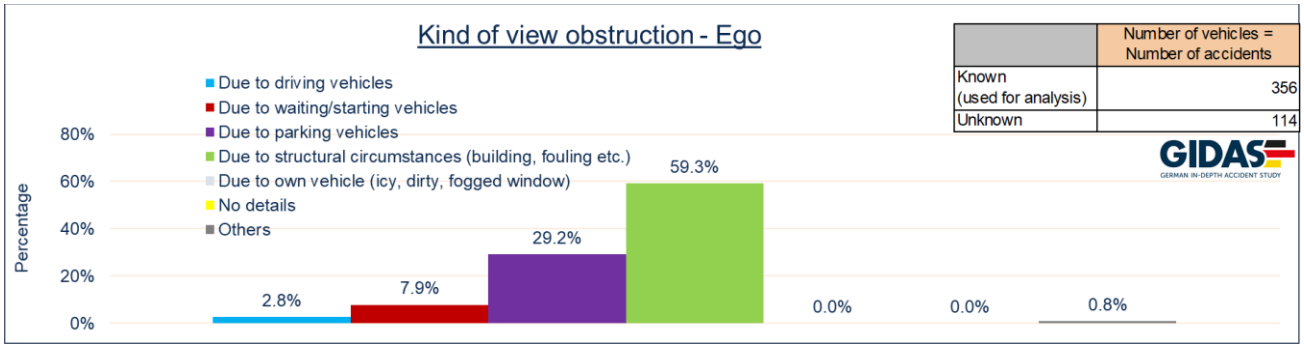


Figure 76: Kind of view obstructions during accidents in SCP-LD-PC [1]

The view obstruction was due to structural circumstances in more than half of the cases. In almost 40% of the cases the view obstruction was due to other vehicles. Most of them were parking during the time of the accident.

In Figure 77 the most frequent road geometries for the ego participant in *SCP-LD-PC* are shown.

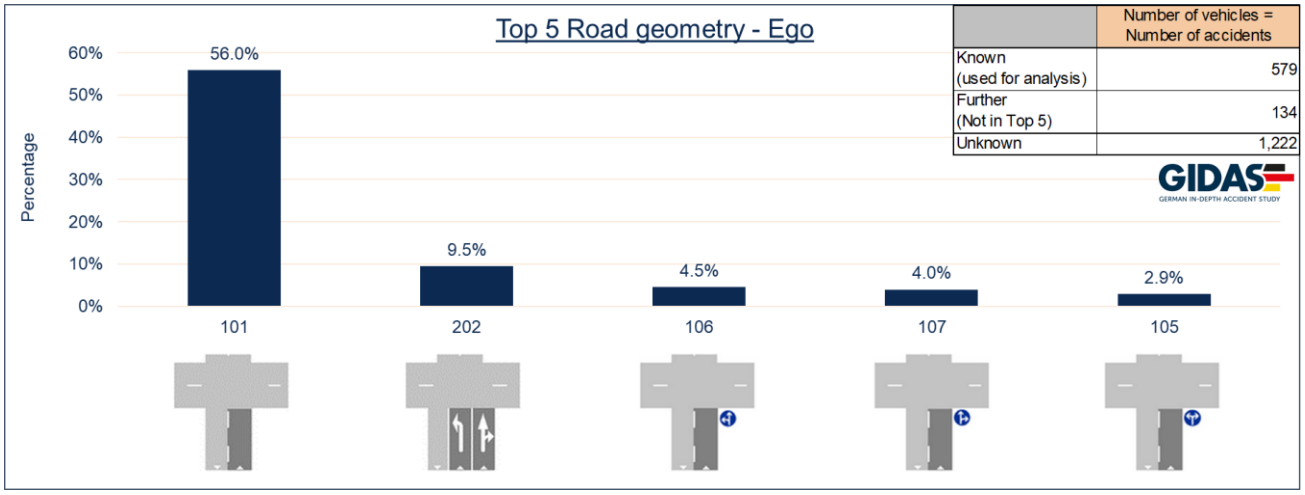


Figure 77: Top 5 Road geometry for the ego participant in accidents in SCP-LD-PC [1]

All of the Top 5 road geometries are roads on intersections. In the majority of the cases (56%), there was one single lane for all directions. In further 11.4% the ego vehicle drove on a road with one single lane, which was restricted regarding the right of turning.

The kind of traffic regulation during the accident for the ego participant is shown in Figure 78.

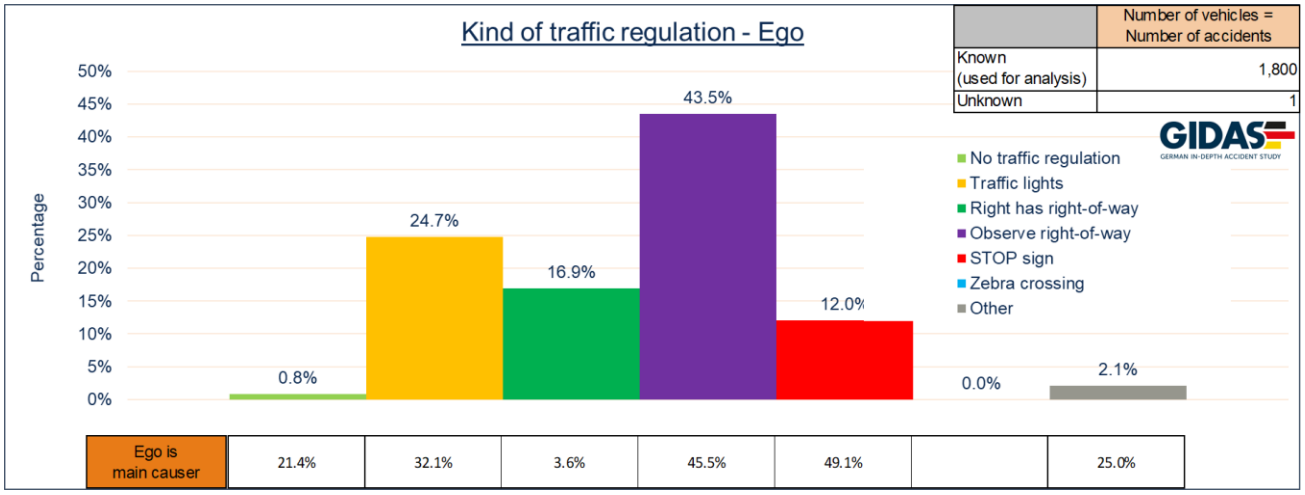


Figure 78: Kind of traffic regulation for the ego participant in accidents in SCP-LD-PC [1]

In 43.5% of the accidents one participant had to observe the right-of-way. In only 45.5% of them, the accident was mainly caused by the ego participant. Nearly half of the accidents were mainly caused by the ego participant in cases, where one participant had to observe a STOP sign. The least percentage of main causing ego participants (3.6%) can be found in cases, where one participant as vehicle from right has right-of-way.

The traffic density during the accident for the ego participant is shown in Figure 79.

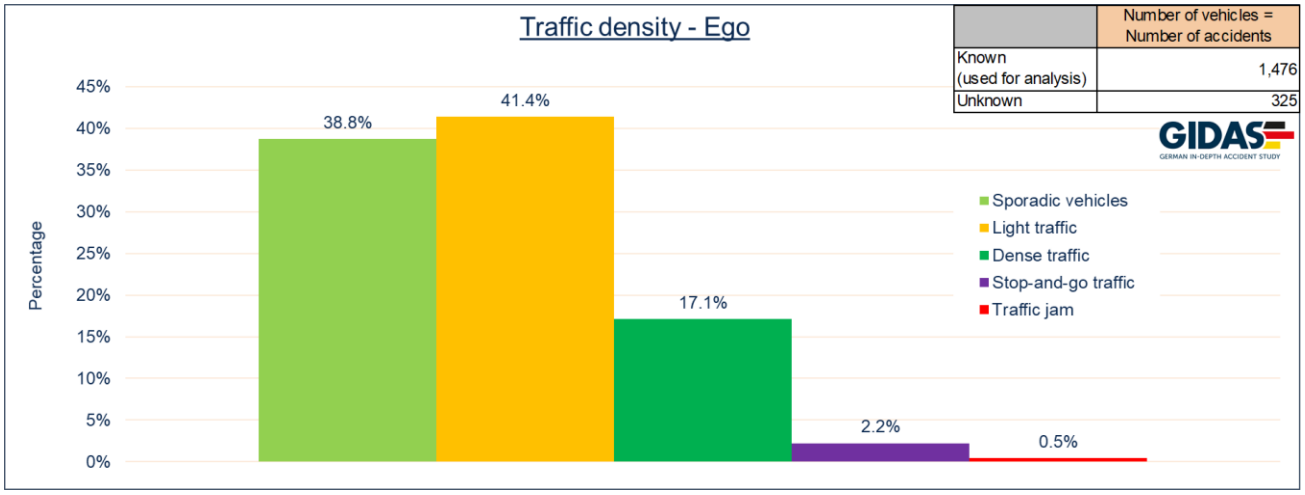


Figure 79: Traffic density for the ego participant in accidents in SCP-LD-PC [1]

During four out of five accidents the traffic density was “light traffic“ or “sporadic vehicles“. Only 17.5% of the accidents happened in a dense traffic situation.

The most frequent main accident causations in *SCP-LD-PC* are shown in Figure 80.

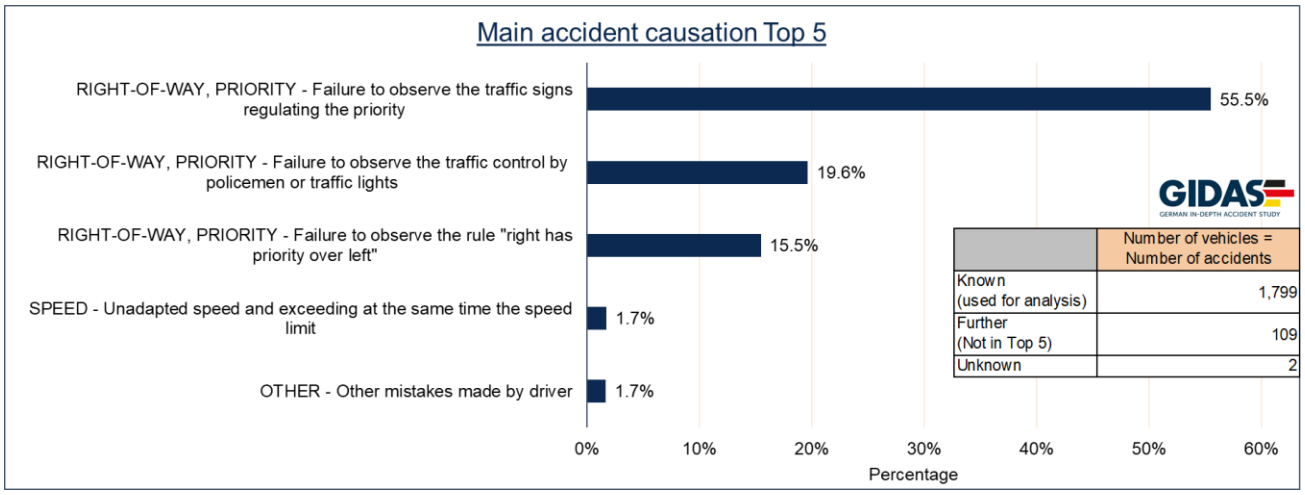


Figure 80: Top 5 main accident causation in accidents in SCP-LD-PC [1]

More than 90% of the accident were caused mainly by right of priority problems. More than half of the cases, the accident was mainly caused by a failure at observing the traffic signs regulating the priority.

The initial speed of the ego participant and the opponent in *SCP-LD-PC* is shown in Figure 81.

Less than 10 cases
10…20 cases
More than 20 cases

GIDAS GERMAN IN-DEPTH ACCIDENT STUDY

	Combinations
Known (used for analysis)	1,592
Unknown	209

Initial speed - Ego vs. Opponent

Initial speed Ego [kph] From	To	Initial speed Opponent [kph] 0	6	11	16	21	26	31	36	41	46	51	56	61	66	71	76	81	86	91	96	101	From
		5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	…	To
0	5	12	3	1		5	4	1	12	13	18	11	9	3	2	4		2					6.3%
6	10	4			2	1	4	2	6	4	12	5		2	2		1			1		1	3.0%
11	15			2	4		2	5	2	9	13	9	10	1	3			2	2				4.0%
16	20	2	2	2	4	5	5	8	7	9	10	4	5	6	1	2	1						4.6%
21	25	1		2	3	7	11	7	12	7	10	11	4	2	2			2				1	5.2%
26	30	3	3	1	8	10	22	17	21	24	20	8	5	3	3			1	1			1	9.5%
31	35	6	1	4	5	17	16	19	16	18	28	3	8	5	3	1	2	1	1				9.5%
36	40	14	3	8	14	7	22	14	28	11	20	14	2	6	2		2				1	1	10.5%
41	45	11	7	8	9	13	12	18	19	18	20	4	3	3	1	2							9.3%
46	50	37	4	14	18	16	22	23	18	24	43	8	7	5	2		3	1			1		15.5%
51	55	12	6	6	9	6	12	11	10	15	13	5	5	1		1	2	2					7.3%
56	60	12	2	2	5	8	9	6	10	2	6	5	2	2	2		1	1					4.7%
61	65	7	3	3	1	3	6	3	1	4	2	5		1	1		1			1			2.6%
66	70	6	1	1	3	3	5	4	5	3	6	2	4	1		1	1						2.9%
71	75	4	1	2	2	1	4		2	4	2	1	1			1						1	1.6%
76	80			1	2	2	5	1	4	1	1	1	2										1.3%
81	85	1		2	3	2	2				1												0.7%
86	90	2		1	1	1	1			1		1											0.5%
91	95		1																				0.1%
96	100	2				2	2		1														0.4%
101	…	1		2	3	1	2		1														0.6%
		8.6%	2.3%	3.9%	6.0%	6.9%	10.6%	8.7%	10.9%	10.5%	14.0%	6.1%	4.2%	2.6%	1.5%	0.8%	0.9%	0.8%	0.3%	0.1%	0.1%	0.3%	Total

Figure 81: Initial speed of ego and opponent during accidents in SCP-LD-PC [1]

In the majority of the cases (61.6%), the initial speed of the ego vehicle was between 26 kph and 55 kph. The initial speed of the opponent vehicle was also most frequently between 26 kph and 55 kph (60.7%).

3.8.3 Scenario conclusion

Special for *SCP-LD-PC* is the high percentage of view obstruction for the ego participant with the majority of the view obstructions caused by structural circumstances and vehicles. Accidents in *SCP-LD-PC* happened mostly at intersections with one lane, with a participant required to observe the right of way. A failure to observe the traffic signs regulating the priority was the most frequent main accident causation. The initial speed of the ego vehicle was similar to the one of the opponent vehicles. Most of them were between 26 kph and 55 kph. Apart from that, *SCP-LD-PC* is defined through weather conditions without rain, often daylight and light traffic.

3.9 Scenario 9 SCP-LD - Bicycle

Figure 82 illustrates the participants in scenario 9, also called the *SCP-LD-BC*. The ego participant in this scenario is a passenger car. The opponent is a bicycle coming from the left direction.

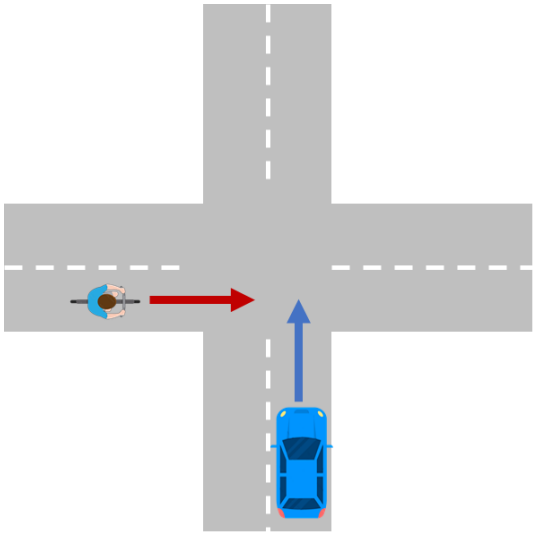


Figure 82: Pictogram SCP-LD-BC

3.9.1 SAFETY POTENTIAL

A system addressing and preventing *SCP-LD-BC* would prevent 5.9% of the slightly, 5.3% of the severely and 1.2% of the fatally injured cyclists in the EU. More information about the safety potential of this scenario can be found in deliverable D1.1.

3.9.2 RESULTS

In Figure 83 the distribution of precipitation during the accidents is shown.

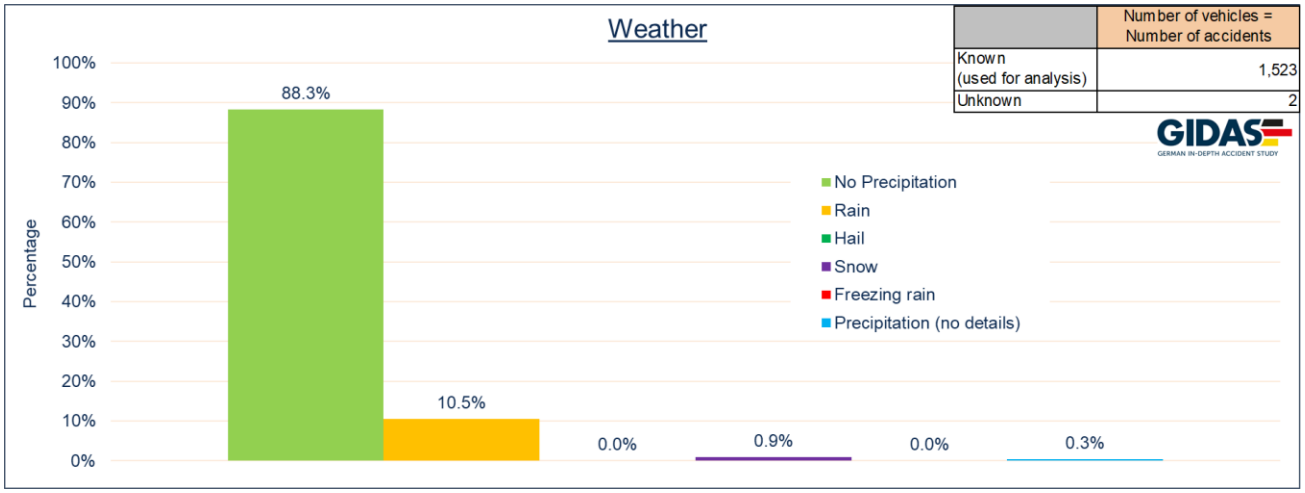


Figure 83: Weather conditions during accidents in SCP-LD-BC [1]

The majority of the accidents happened in dry weather conditions. About one in ten accidents happened in rainy situations.

In Figure 84 an overview of the light conditions during the accidents in *SCP-LD-BC* is shown.

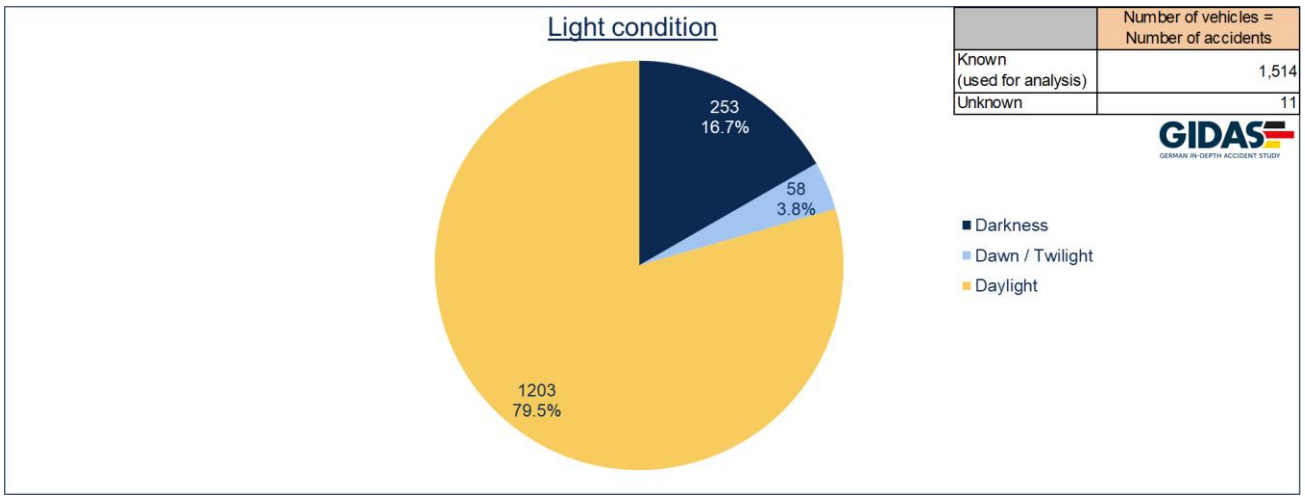


Figure 84: Light conditions during accidents in SCP-LD-BC [1]

More than three quarters of the accidents happened under daylight conditions. More than 20% of the accidents occurred in darkness or dawn/twilight.

Figure 85 describes the illumination of the road during accidents happening in darkness or dawn/twilight.

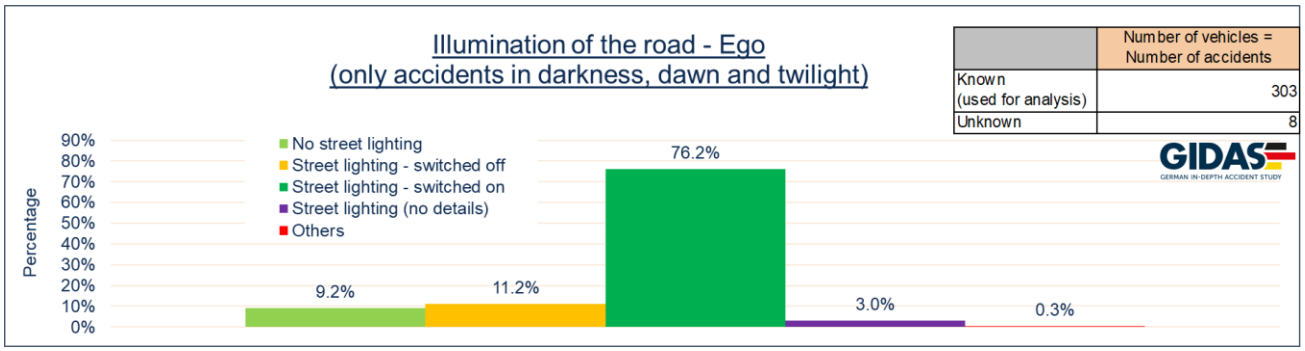


Figure 85: Illumination of the road during accidents in SCP-LD-BC in darkness or dawn/twilight [1]

In more than three quarters of these cases, the road was illuminated with street lighting. In roughly one fifth of the cases, there was no illumination of the accident site, either due to no existing street lighting or due to switched off street lighting.

The percentage of view obstruction for the ego participant is shown in Figure 86.

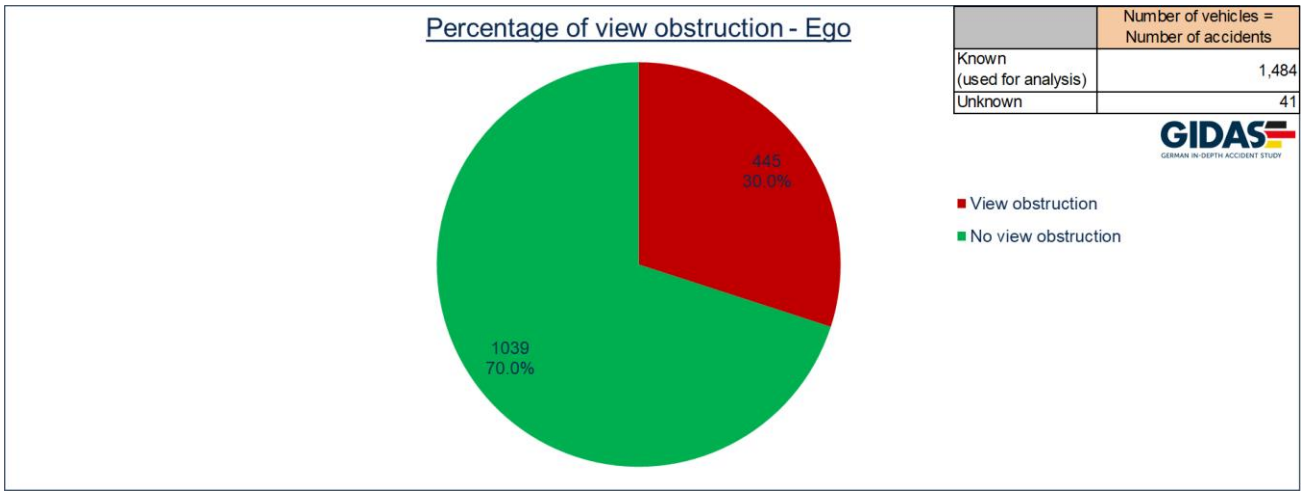


Figure 86: Percentage of view obstructions during accidents in SCP-LD-BC [1]

In more than two out of three of the accidents in scenario 9 there was no view obstruction for the ego participant at the time of the accident.

In the following figure (Figure 87) the kind of view obstruction is shown for the cases, where a view obstruction existed.

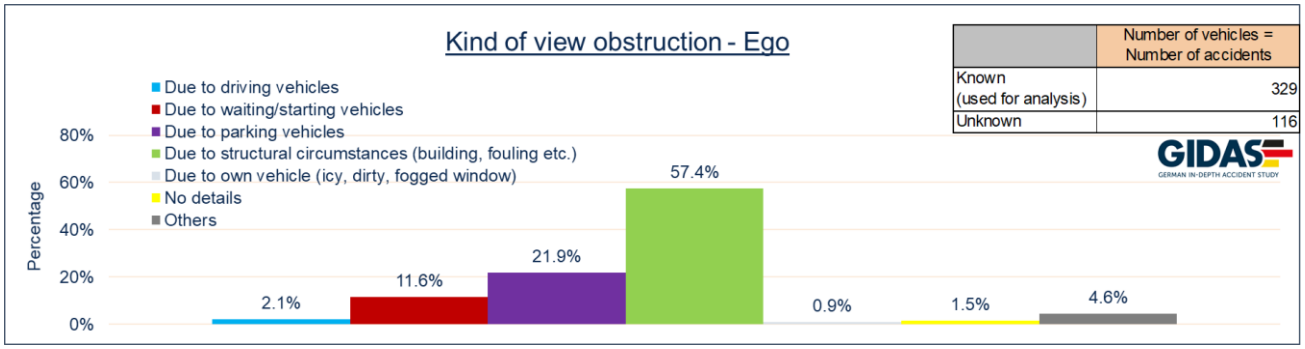


Figure 87: Kind of view obstructions during accidents in SCP-LD-BC [1]

The view obstruction was due to structural circumstances in more than half of the cases. In more than 35% of the cases the view obstruction was due to other vehicles. Most of them were parking during the time of the accident.

The road, where the ego participant was driving during the accident, is shown in Figure 88.

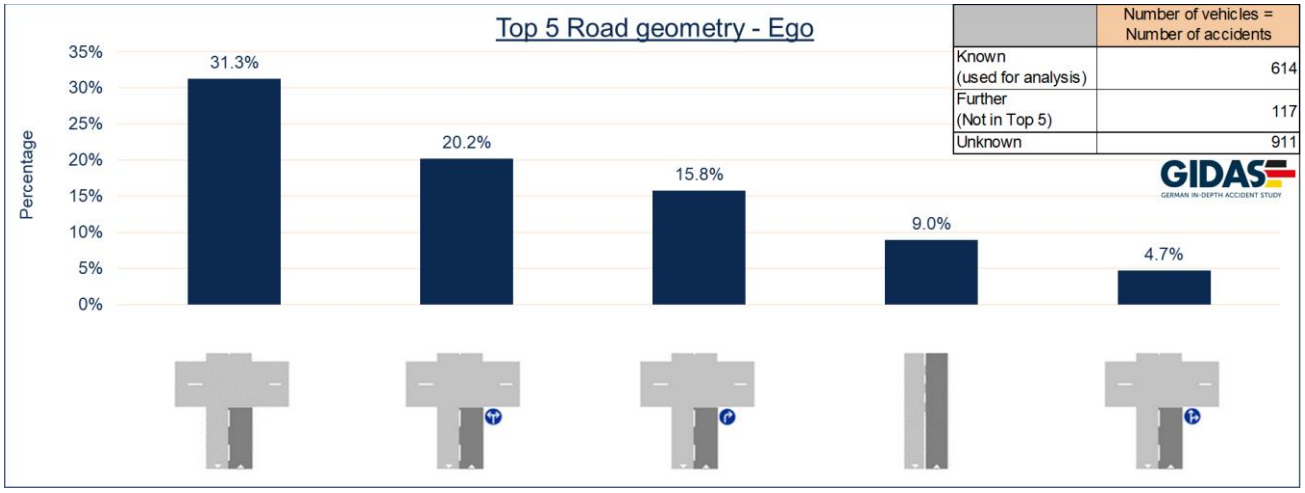


Figure 88: Top 5 Road geometry for the ego participant in accidents in SCP-LD-BC [1]

The highest percentage (31.3%) can be found in roads with one single lane for all directions towards an intersection. In further 40.7% the ego vehicle drove on a road with one single lane being restricted regarding the right of turning.

The kind of traffic regulation during the accident for the ego participant is shown in Figure 89.

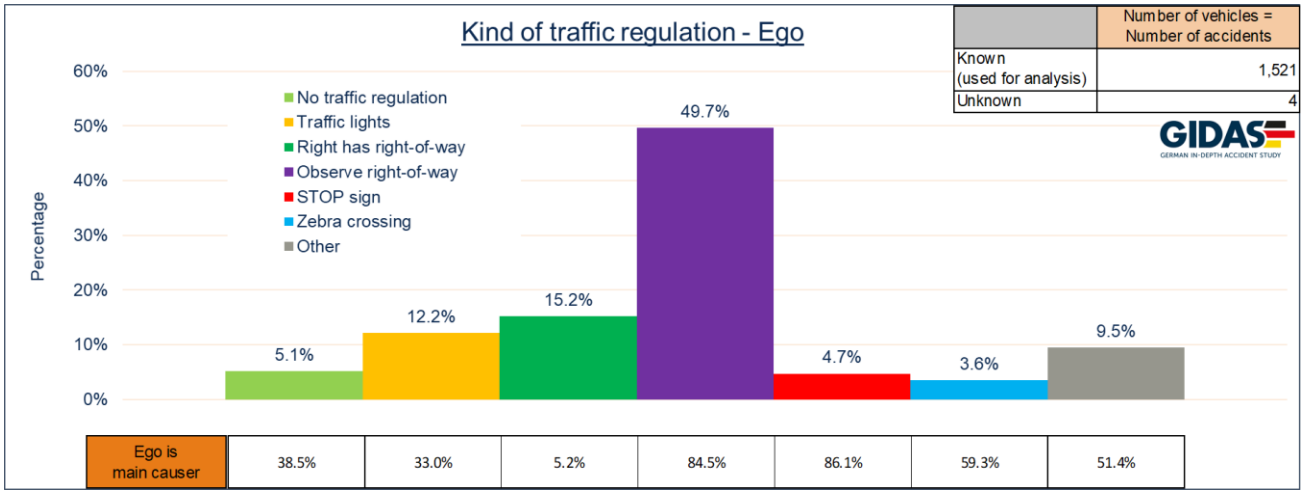


Figure 89: Kind of traffic regulation for the ego participant in accidents in SCP-LD-BC [1]

In nearly half of the accidents one participant had to observe right-of-way. In 84.5% of those cases, the accident was mainly caused by the ego participant. The highest percentage of main causing ego participant can be found in cases, where one participant had to observe a STOP sign. The least percentage of main causing ego participant (5.2%) can be found in cases, where on participant as a vehicle from the right had right-of-way.

In Figure 90 the traffic density during the accident for the ego participant is shown.

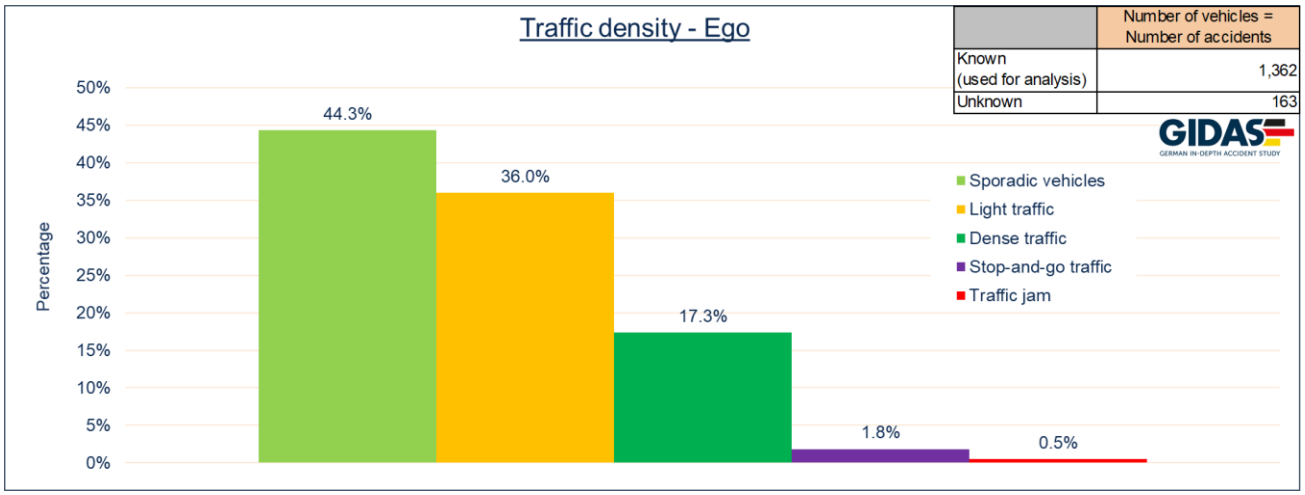


Figure 90: Traffic density during accidents in SCP-LD-BC [1]

During four out of five accidents the traffic density was either light or only sporadic vehicles. 17.3% of the ego participants had an accident during dense traffic. Stop-and-go traffic or traffic jams are uncommon for this type of accidents.

In Figure 91 the most frequent main accident causations in *SCP-LD-BC* are shown.

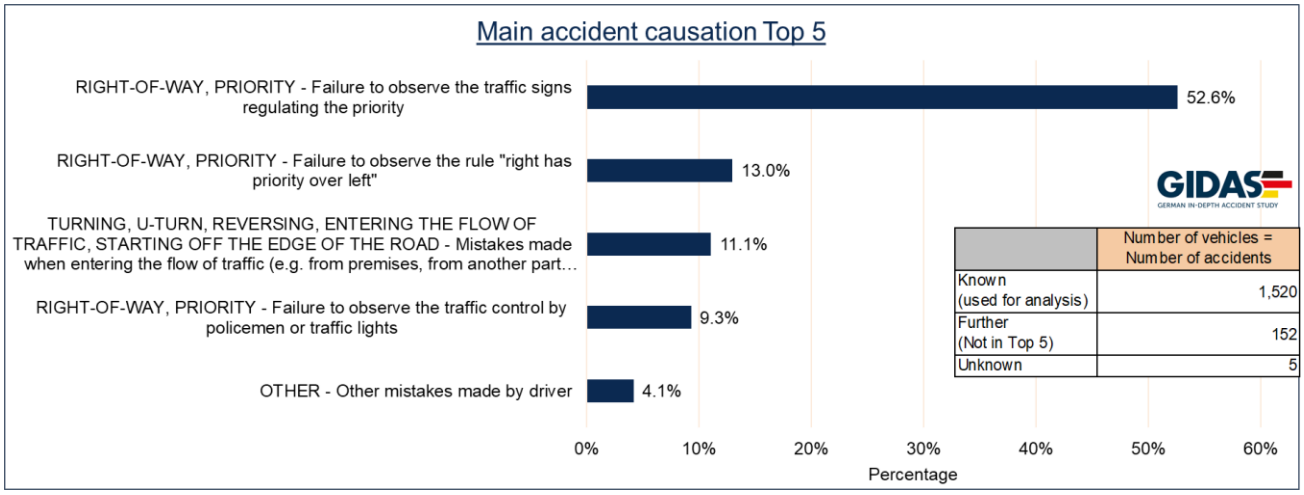


Figure 91: Top 5 main accident causation in accidents in SCP-LD-BC [1]

Nearly three out of four accidents were caused mainly by right of way priority problems. In more than half of the cases, the accident was mainly caused by a failure to observe the traffic signs regulating the priority.

In the following figure (Figure 92) the initial speed of the ego vehicle and the opponent vehicle are shown.

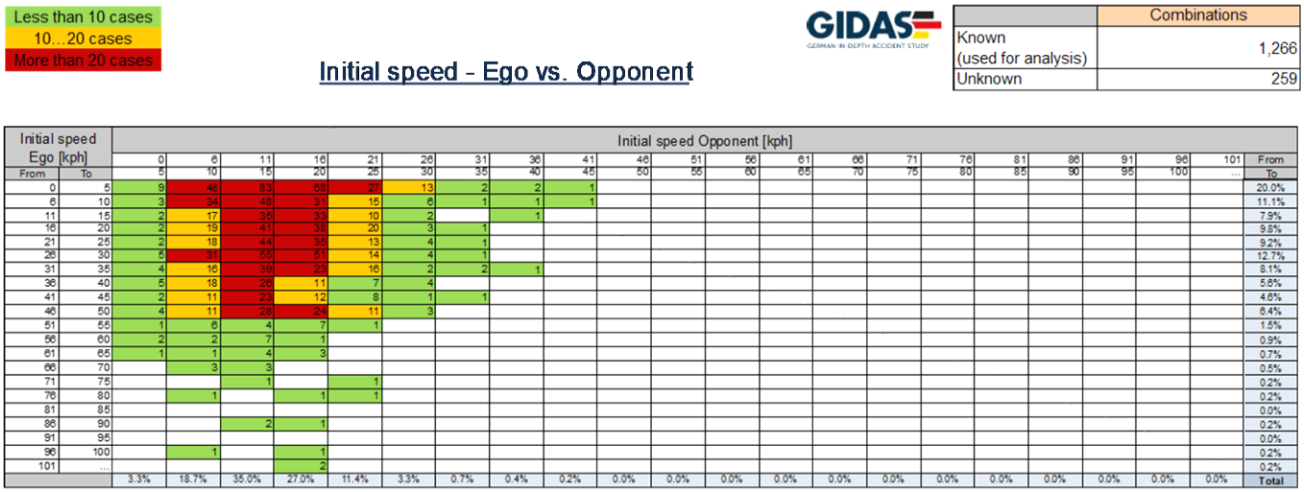


Figure 92: Initial speed of ego and opponent during accidents in SCP-LD-BC [1]

More than half of the ego vehicles (58.0%) had an initial speed less than 26 kph. The initial speed of the opponent bicycle was most frequently slower with speeds between 6 kph and 25 kph (92.1%).

3.9.3 Scenario conclusion

Special for *SCP-LD-BC* is the high number of view obstruction for the ego participant with the majority of the view obstructions caused by structural circumstances. The initial speed of the ego vehicle was mostly between 0 kph and 55 kph. Thus, it was often higher than the speed of the opponents. Accidents in scenario 9 happened often at intersections, with the ego participant was required to observe the right of way. A failure to observe the traffic signs regulating the priority was the most frequent main accident causation. Apart from that, *SCP-LD-BC* is defined through weather conditions

without rain, often daylight and light traffic.

3.10 SCENARIO 10 RE-FV - PASSENGER CAR

Figure 82 illustrates the participants in scenario 10, also called the *RE-FV-PC*. The ego participant in this scenario is a passenger car. The opponent is a passenger car driving in front of the ego.

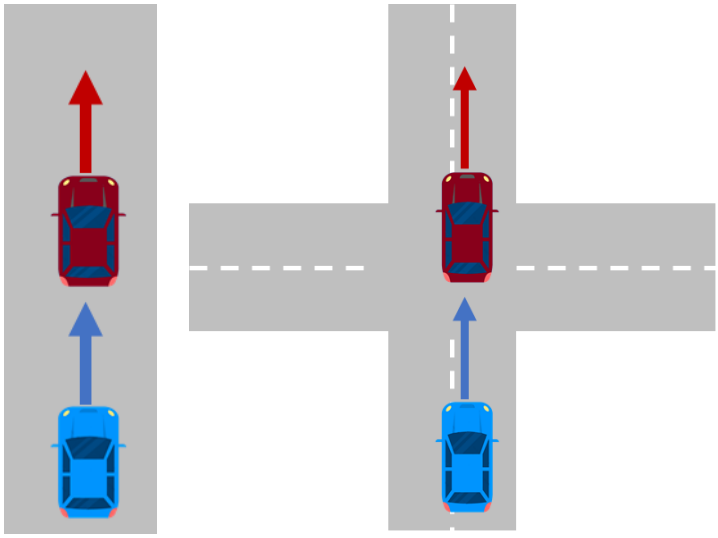


Figure 93: Pictogram RE-FV-PC

3.10.1 SAFETY POTENTIAL

A system addressing and preventing the *RE-FV-PC* would prevent 9.2% of the slightly, 2.9% of the severely and 1.4% of the fatally injured car occupants in the EU. More information about the safety potential of this scenario can be found in deliverable D1.1.

3.10.2 RESULTS

Figure 94 shows the distribution of precipitation during the accidents.

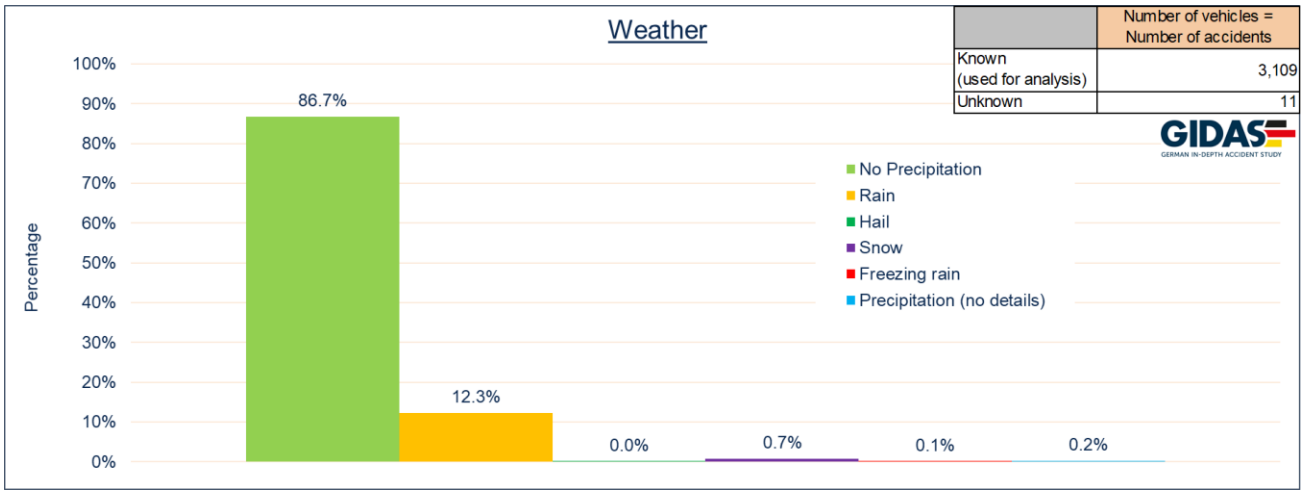


Figure 94: Weather conditions during accidents in RE-FV-PC [1]

The majority of the accidents happened on dry weather conditions. A little more than one in ten accidents happened in rainy situations.

In Figure 95 an overview of the light conditions during the accidents in *RE-FV-PC* is given.

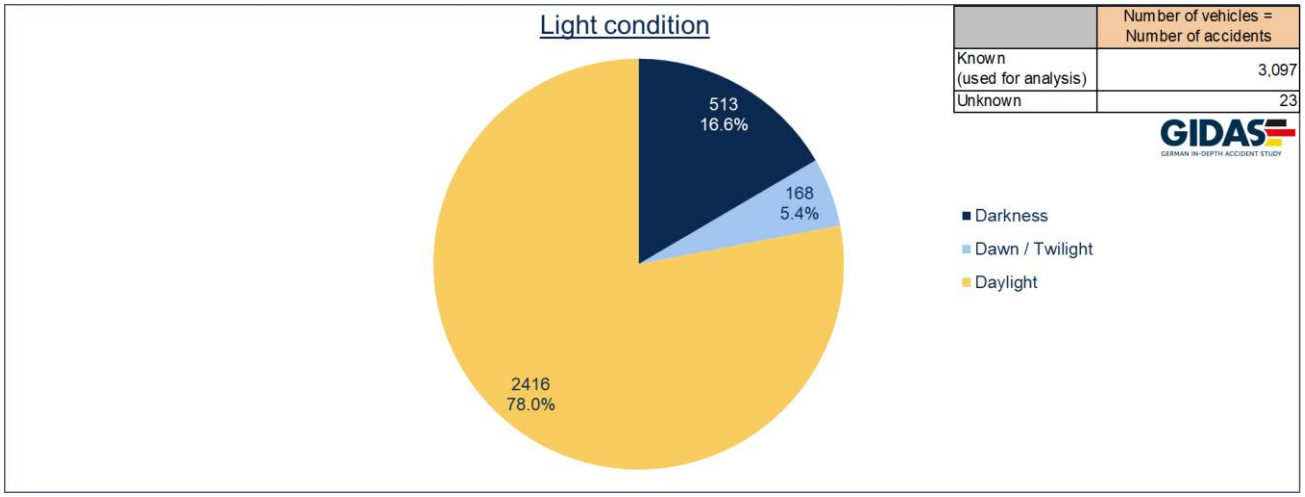


Figure 95: Light conditions during accidents in RE-FV-PC [1]

Most accidents happened under daylight conditions. 22% of the accidents happened in the darkness or dawn/twilight.

Figure 96 visualizes the percentage of view obstruction for ego participants.

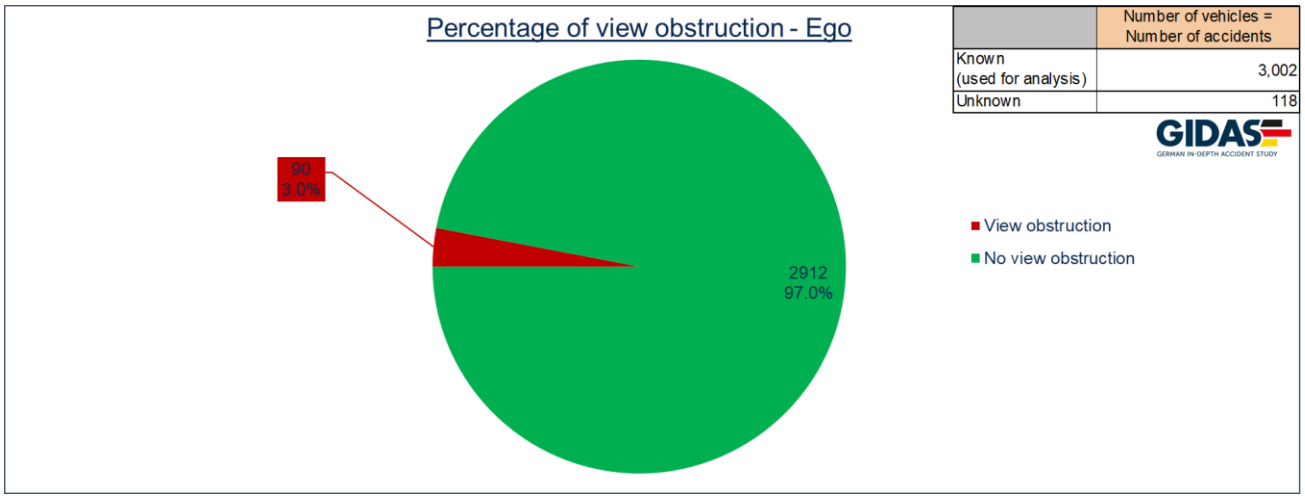


Figure 96: Percentage of view obstruction during accidents in RE-FV-PC [1]

With a share of only 3%, view obstructions were no problem for the ego vehicle in *RE-FV-PC*.

In the following figure (Figure 97) the kind of view obstruction is shown for those cases, where a view obstruction existed.

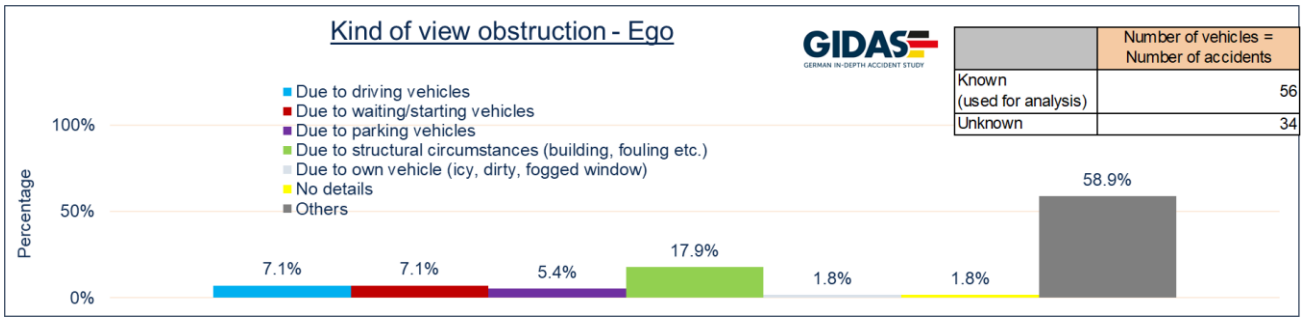


Figure 97: Kind of view obstruction during accidents in RE-FV-PC [1]

In the small percentage of cases, where a view obstruction had an influence on the driver of the ego vehicle, the “others” group had the biggest share. Most of the “others” were blinding by the sun.

The road, where the ego participant was driving during the accident, is shown in Figure 98.

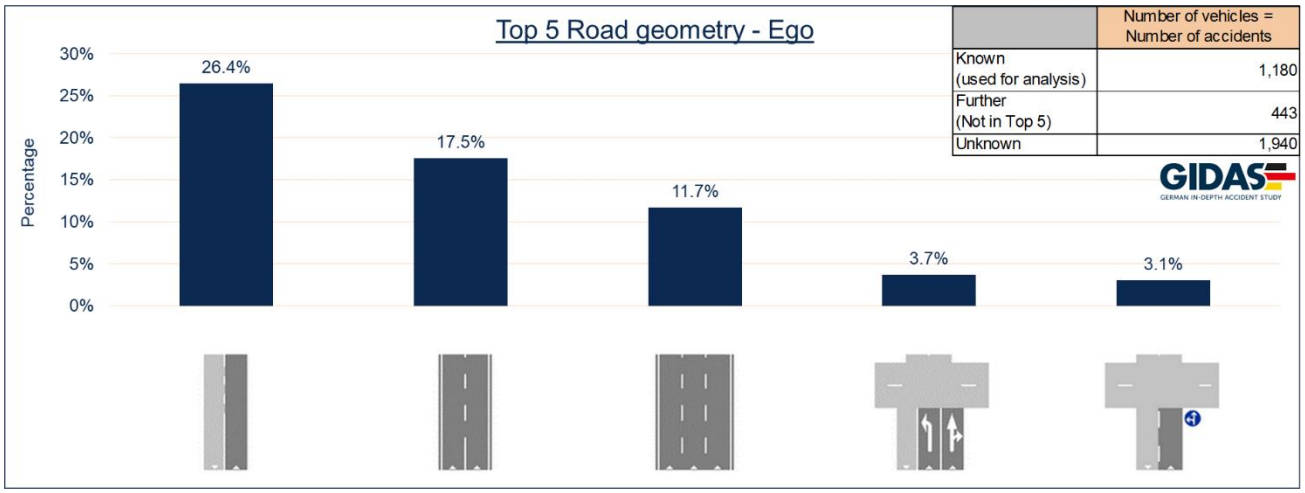


Figure 98: Top 5 Road geometry for the ego participant in RE-FV-PC [1]

More than 50% of the accidents occurred on open roads with one, two or three lanes in one direction and no connection to an intersection.

In Figure 99 the traffic density during the accident for the ego participant is shown.

Figure 99: Traffic density during accidents in RE-FV-PC [1]

With more than one out of three, most of the accidents occurred in dense traffic. Also, a comparatively high percentage of accidents happened in stop-and-go or traffic jam situations.

In Figure 100 the most frequent main accident causations in *RE-FV-PC* are shown.

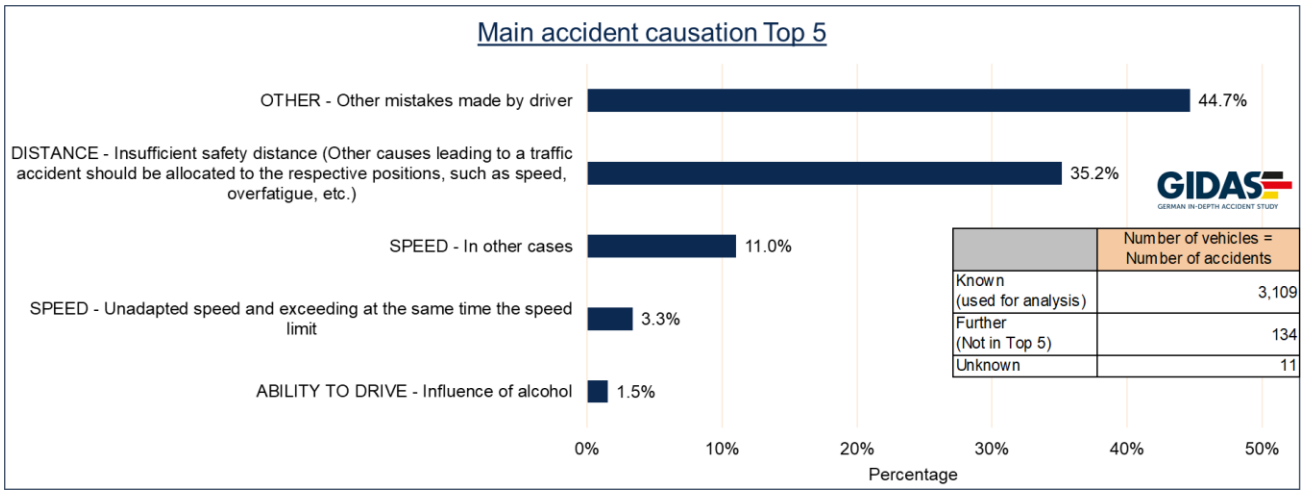


Figure 100: Top 5 main accident causation for accidents in RE-FV-PC [1]

The highest percentage of accidents were caused due to other mistakes by the driver. This category includes distraction of the driver. Insufficient safety distance was the main causation for more than every third of the accidents. 14.3% of the accidents happened because of speeding.

Figure 101 shows the initial speed of the ego vehicle and the opponent vehicle.

Less than 10 cases
10…20 cases
More than 20 cases

GIDAS GERMAN IN-DEPTH ACCIDENT STUDY

	Combinations
Known (used for analysis)	2,433
Unknown	687

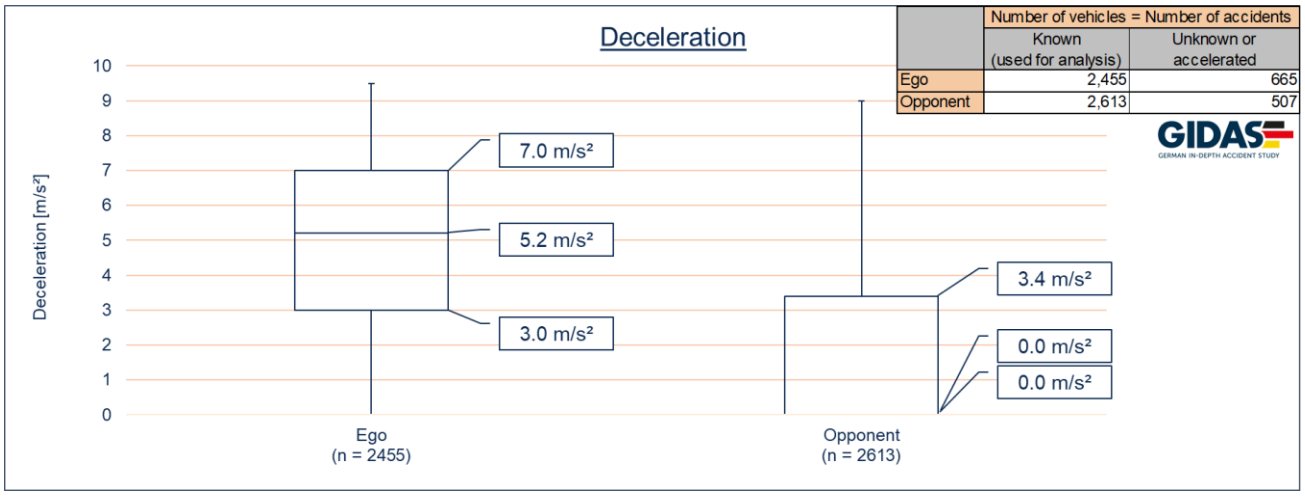
Initial speed - Ego vs. Opponent

Initial speed Ego [kph]		Initial speed Opponent [kph]																				
From	To	0 5	6 10	11 15	16 20	21 25	26 30	31 35	36 40	41 45	46 50	51 55	56 60	61 65	66 70	71 75	76 80	81 85	86 90	91 95	96 100	101 ...	From To
0	5	116	2						1	1	2										1		5.1%
6	10	22	6	4		1																	1.4%
11	15	31	9	10						1													2.1%
16	20	34	7	6	20		1		1														2.8%
21	25	38	5	4	6	17	2	1	1														3.0%
26	30	94	6	8	4	10	46	4															7.1%
31	35	63	10	10	5	5	24	15	2				1										5.5%
36	40	84	2	11	9	9	12	14	46	3	4												8.0%
41	45	88	6	16	8	19	12	7	22	58	8	1					1						10.0%
46	50	241	8	11	14	12	17	10	24	32	151	3											21.5%
51	55	67	3	4	2	7	5	3	4	11	20	18		1	1								6.0%
56	60	61	5	6	5	4	3	4	3	3	19	4	16		1								5.5%
61	65	26		1	2		2		2	1	6	3	6	5	1								2.3%
66	70	39	3	2	1	3	2	1	1	2	4	1	4	7	17	2	1						3.7%
71	75	10			1	3	3		2	1	3	1	1	1	2	6	1				1		1.5%
76	80	23	1	4		1	2		1		2	1	3	1	1	1	15		1				2.3%
81	85	9		1		1	1		1		1		1	1	1		6	2		1			1.1%
86	90	9			2		1	1	3		1		2		2	2	1	1	5	1			1.3%
91	95	5	1	1	1	1									1		1	1		1			0.5%
96	100	4			1		1		2	1	2		1	2	4	2	3		6		13		1.7%
101	...	20	2	2	3	2	1	1	3	1	9	2	10	3	5	7	13	9	10	6	24	52	7.6%
		44.6%	3.1%	4.2%	3.5%	3.9%	5.5%	2.5%	4.9%	4.6%	9.5%	1.4%	1.8%	0.9%	1.5%	0.8%	1.7%	0.5%	0.9%	0.4%	1.6%	2.1%	Total

Figure 101: Initial speed of ego and opponent during accidents in RE-FV-PC [1]

Nearly half of the opponent vehicles were driving very slowly between 0 kph and 5 kph. There was also a notable number of accidents in high-speed situations with a speed of more than 100 kph.

In Figure 102 the deceleration of both participants is described with the help of a boxplot.



	Number of vehicles = Number of accidents	
	Known (used for analysis)	Unknown or accelerated
Ego	2,455	665
Opponent	2,613	507

GIDAS GERMAN IN-DEPTH ACCIDENT STUDY

Figure 102: Deceleration of ego and opponent during accidents in RE-FV-PC [1]

There were only few ego vehicles, which did not notice a vehicle standing or decelerating in front of them and thus collided without decelerating with the opponent vehicle. Most of the opponent vehicles had a low deceleration.

Figure 103 shows the percentage of braking of the ego vehicle and the opponent.

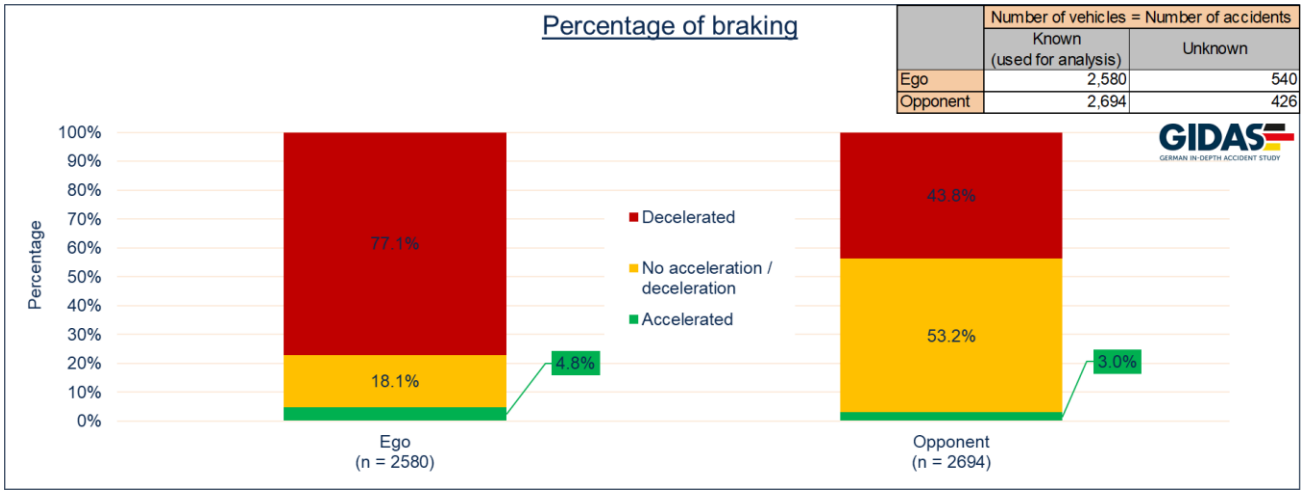


Figure 103: Percentage of braking of ego and opponent during accidents in RE-FV-PC [1]

More than three quarters of the ego vehicles decelerated prior to the accident. Nearly 5% of the ego vehicles accelerated. More than half of the opponents had no acceleration or deceleration prior to the accident.

The following figure (Figure 104) shows the deceleration of the ego vehicle and the opponent vehicle.

Less than 10 cases
10…20 cases
More than 20 cases

Deceleration - Ego vs. Opponent

GIDAS

	Combinations
Known (used for analysis)	2,274
Unknown	846

Deceleration Ego [m/s²]		Deceleration Opponent [m/s²]										
		0	1.1	2.1	3.1	4.1	5.1	6.1	7.1	8.1	9.1	From
From	To	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	To
0	1.0	315	14	54	47	20	5	5	3	1		20.4%
1.1	2.0	20	15	8	7							2.2%
2.1	3.0	28	6	31	16	4	1					3.8%
3.1	4.0	69	6	40	36	7	2	1	1			7.1%
4.1	5.0	161	6	56	51	57	10	2	3			15.2%
5.1	6.0	150	1	53	59	34	17	9	3	1		14.4%
6.1	7.0	151	6	45	86	29	14	21	5	2		15.8%
7.1	8.0	215	6	32	57	53	19	3	41	2		18.8%
8.1	9.0	27	1	2	9	6	4	1		1		2.2%
9.1	10.0	1										0.0%
		50.0%	2.7%	14.1%	16.2%	9.2%	3.2%	1.8%	2.5%	0.3%	0.0%	**Total**

Figure 104: Deceleration of ego and opponent during accidents in RE-FV-PC [1]

Many of the decelerating opponent vehicles (66.8%) had a low deceleration up to 3.0 m/s² prior to the accident. About 51% of the ego vehicles were braking hard with more than 5 m/s².

3.10.3 Scenario conclusion

Special for *RE-FV-PC* is the comparatively high percentage of high traffic density, stop and go or traffic jam. Accidents in *RE-FV-PC* happened relatively rarely at intersections. Not further described mistakes made by the driver were the most frequent main accident causation, followed by insufficient safety distance. The initial speed of the ego vehicle was mostly higher than the one of the opponents, which was mostly lower than 5 kph. Most of the ego vehicles were braking with high decelerations prior to the accident. Apart from that, *RE-FV-PC* is defined through weather conditions without rain, often daylight and only rarely view obstructions

3.11 SCENARIO 11 RE-PV - PASSENGER CAR

Figure 105 illustrates the participants in scenario 11, also called the *RE-PV-PC*. The ego participant in this scenario is a passenger car. The opponent is a passenger car driving in behind the ego.

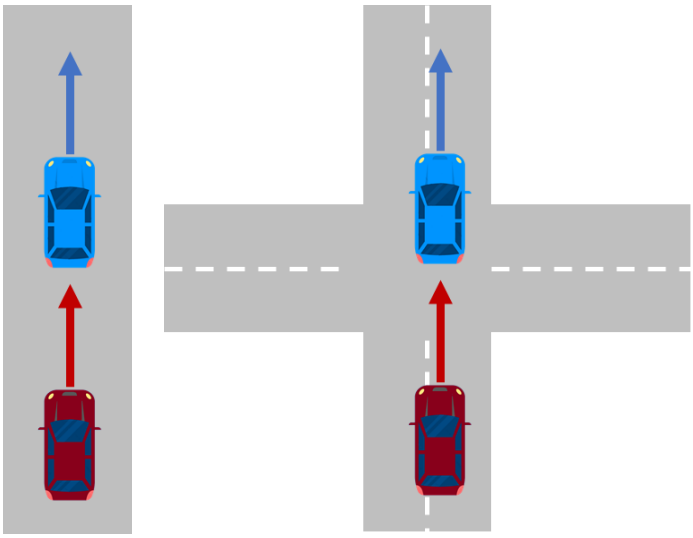


Figure 105: Pictogram RE-PV-PC

3.11.1 SAFETY POTENTIAL

A system addressing and preventing the rear end previous vehicle scenarios would prevent 10.9% of the slightly, 2.8% of the severely and 0.5% of the fatally injured car occupants in the EU. More information about the safety potential of this scenario can be found in deliverable D1.1.

3.11.2 RESULTS

Figure 106 shows the distribution of precipitation during the accidents in *RE-PV-PC*.

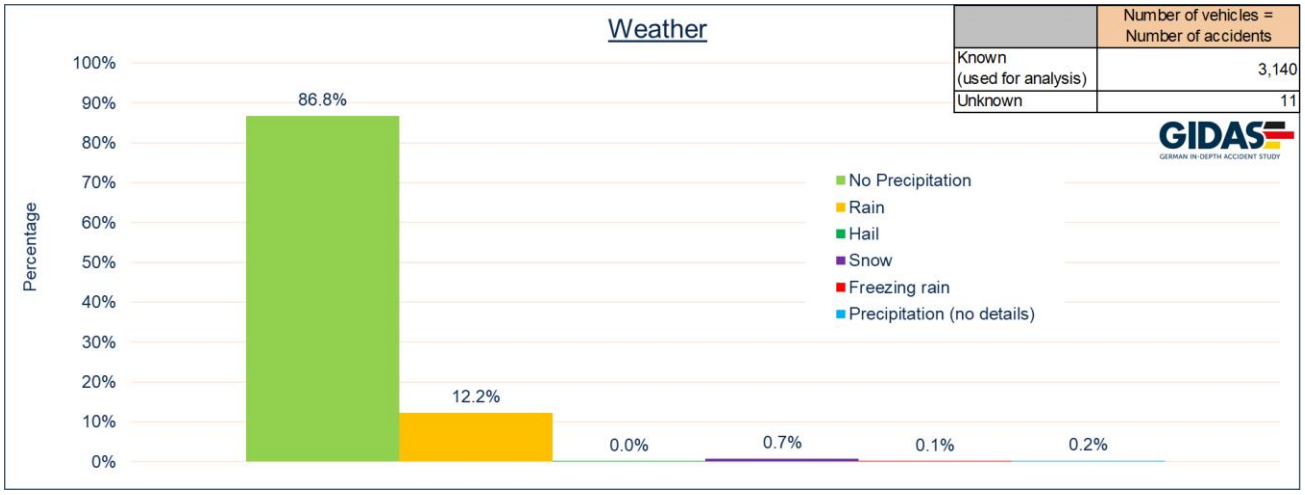


Figure 106: Weather conditions during accidents in RE-PV-PC [1]

The majority of the accidents happened on dry weather conditions. A little more than one in ten accidents happened in rainy situations.

Figure 107 gives an overview over the light conditions during the accidents.

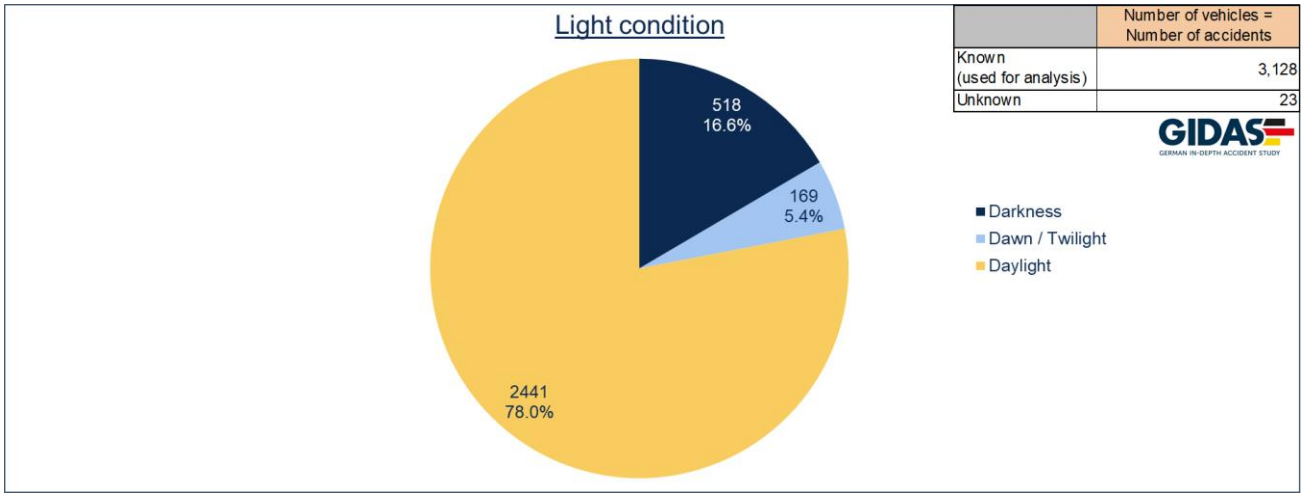


Figure 107: Light conditions during accidents in RE-PV-PC [1]

Most accidents happened under daylight conditions. 22% of the accidents happened in the darkness or dawn/twilight

In Figure 108 the percentage of view obstruction for ego participants is shown.

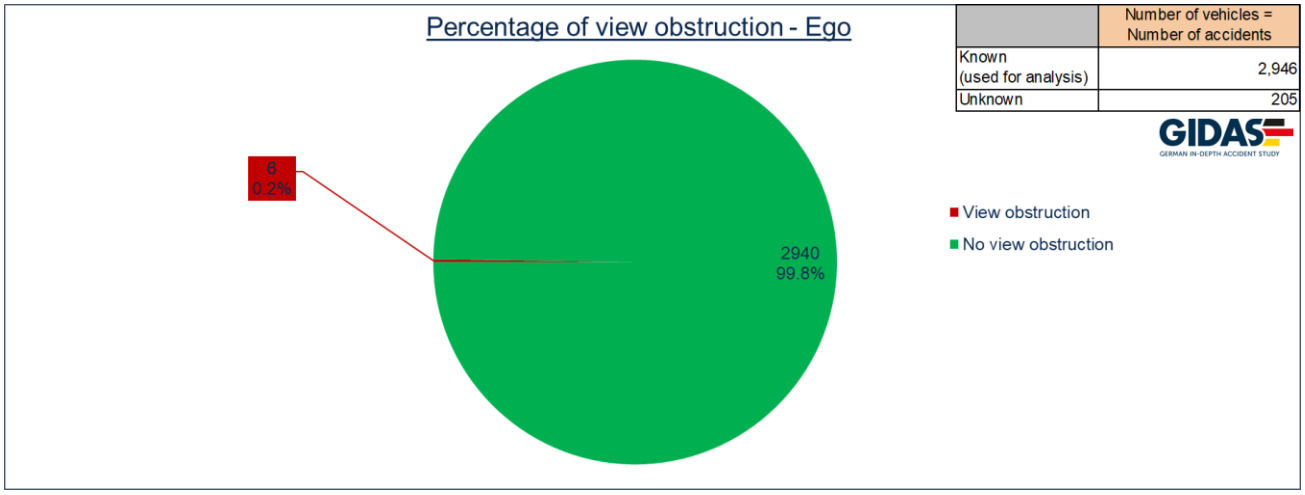


Figure 108: Percentage of view obstruction during accidents in RE-PV-PC [1]

View obstructions were no problem for the ego vehicle in *RE-PV-PC*.

In the following figure (Figure 109) the kind of view obstruction is shown in the less cases, where a view obstruction existed.

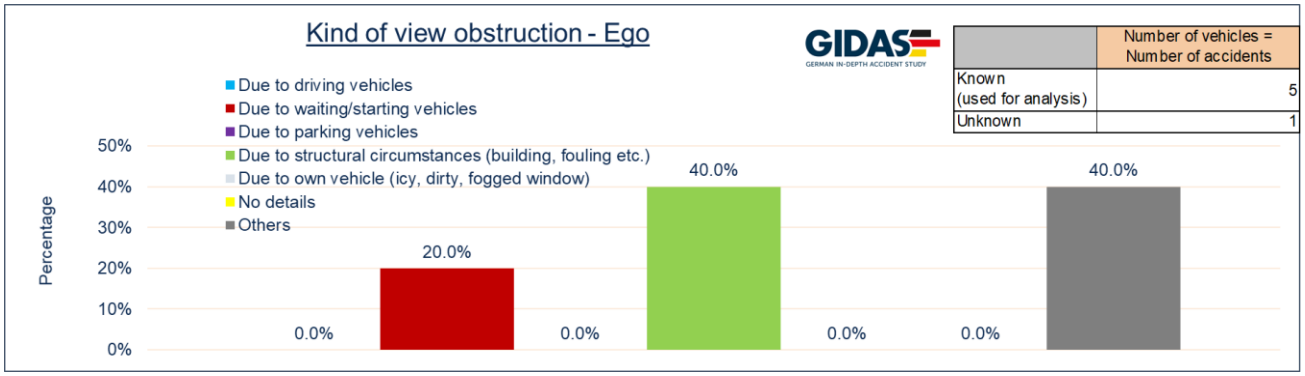


Figure 109: Kind of view obstruction during accidents in RE-PV-PC [1]

In the small number of cases mostly “others“ and “structural circumstances” were the reason for view obstructions.

In Figure 110 an overview of the road, where the ego participant was driving during the accident, is given.

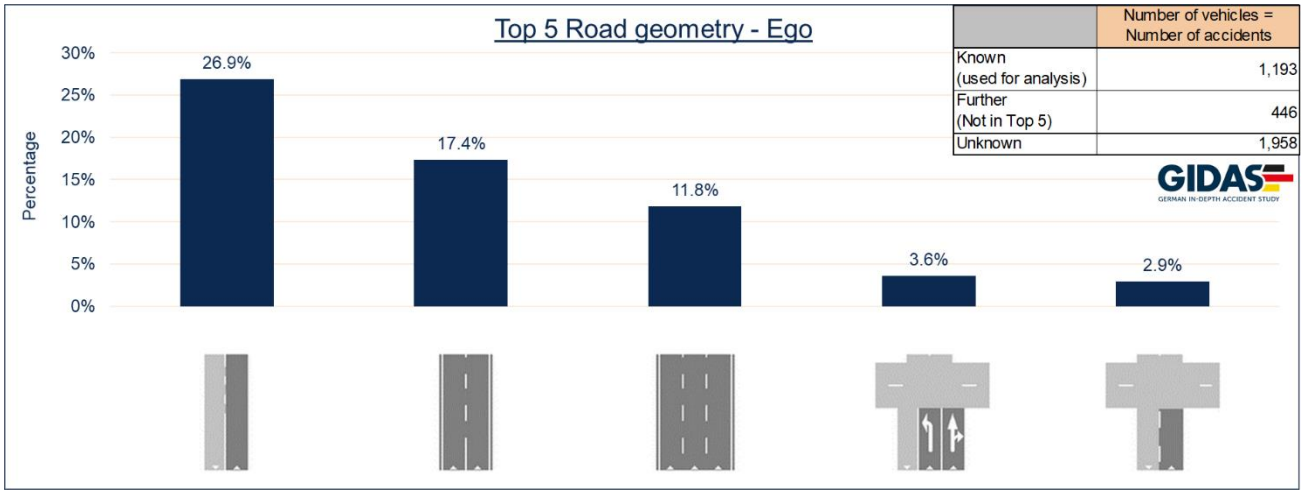


Figure 110: Top 5 Road geometry for the ego participant in RE-PV-PC [1]

More than half of the accidents occurred on open roads with one, two or three lanes in one direction and no connection to an intersection.

In Figure 111 the traffic density at the accident site for the ego is shown.

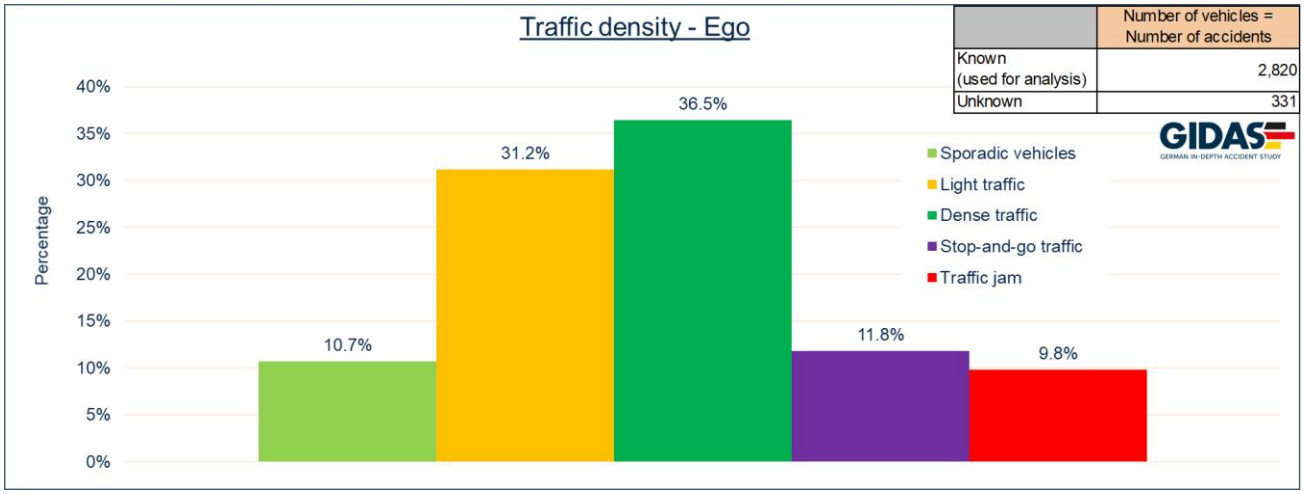


Figure 111: Traffic density during accidents in RE-PV-PC [1]

With more than one out of three, most of the accidents occurred in dense traffic. Also a comparatively high percentage of accidents happened in stop-and-go or traffic jam situations.

Figure 112 describes the most frequent main accident causations in *RE-PV-PC*.

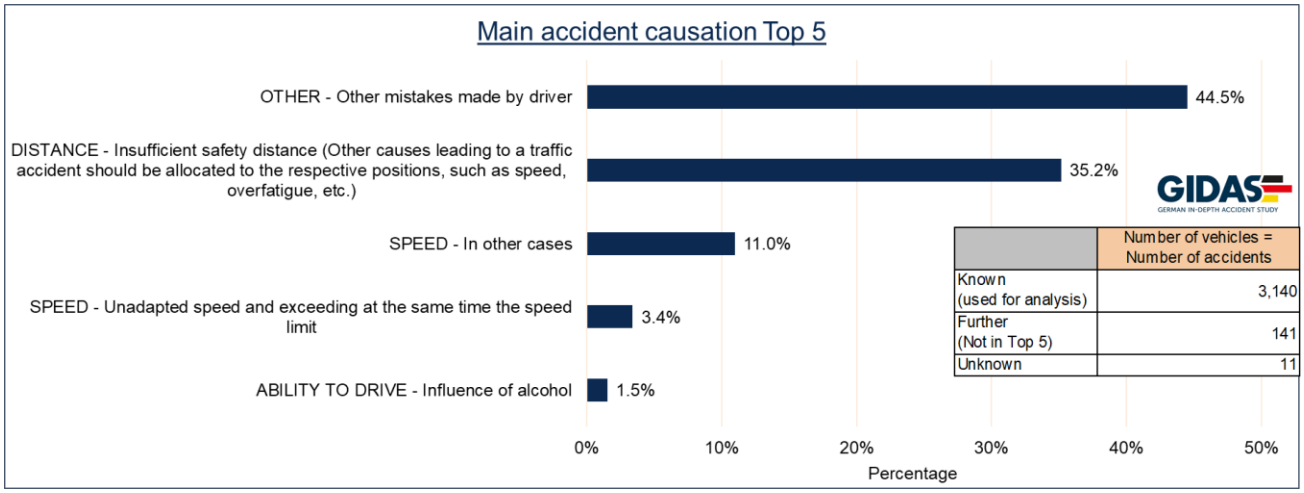
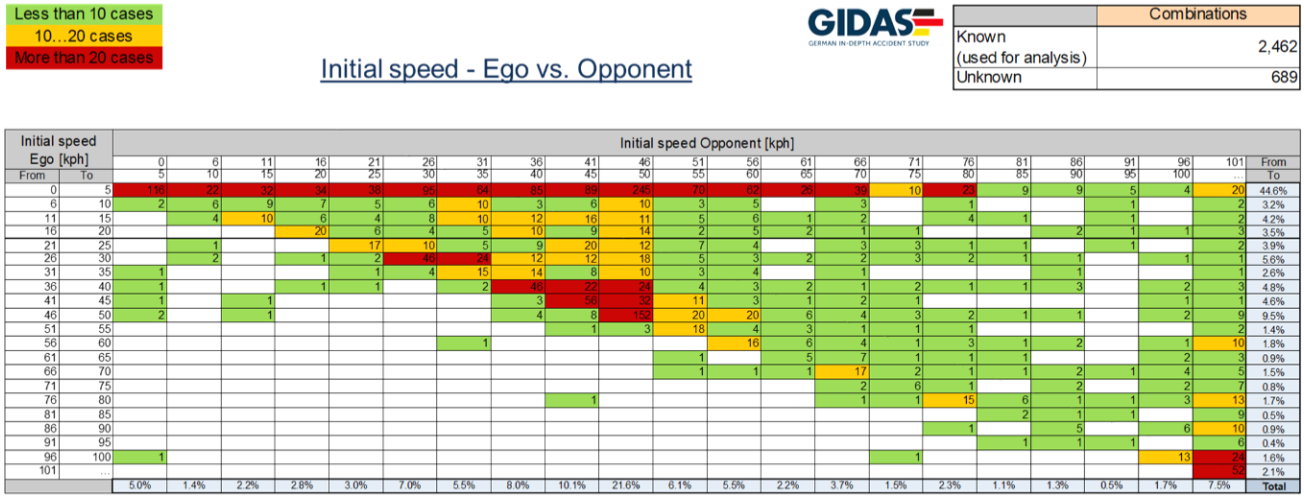


Figure 112: Top 5 main accident causation for accidents in RE-PV-PC [1]

The highest percentage of accidents were caused due to other mistakes by the driver. This category includes distraction of the driver. Insufficient safety distance was the main causation for more than every third of the accidents. 14.4% of the accidents happened because of speeding.

Figure 113 shows the initial speeds of the ego vehicle and the opponent.



Initial speed Ego [kph]		Initial speed Opponent [kph]																							
From	To	0 5	6 10	11 15	16 20	21 25	26 30	31 35	36 40	41 45	46 50	51 55	56 60	61 65	66 70	71 75	76 80	81 85	86 90	91 95	96 100	101 …	From To
0	5	116	22	32	34	38	95	64	85	89	245	70	62	26	39	10	23	9	9	5	4	20	44.6%
6	10	2	6	9	7	5	6	10	3	6	10	3	5		3		1			1		2	3.2%
11	15		4	10	6	4	8	10	12	16	11	5	6	1	2		4	1		1		2	4.2%
16	20				20	6	4	5	10	9	14	2	5	2	1	1			2	1	1	3	3.5%
21	25		1			17	10	5	9	20	12	7	4		3	3	1	1		1		2	3.9%
26	30		2		1	2	46	24	12	12	18	5	3	2	2	3	2	1	1		1	1	5.6%
31	35	1				1	4	15	14	8	10	3	4		1				1			1	2.6%
36	40	1			1	1		2	46	22	24	4	3	2	1	2	1	1	3		2	3	4.8%
41	45	1		1					3	56	32	11	3	1	2	1					1	1	4.6%
46	50	2		1					4	8	152	20	20	6	4	3	2	1	1		2	9	9.5%
51	55									1	3	18	4	3	1	1	1					2	1.4%
56	60							1					16	6	4	1	3	1	2		1	10	1.8%
61	65											1		5	7	1	1	1			2	3	0.9%
66	70											1	1	1	17	2	1	1	2	1	4	5	1.5%
71	75														2	6	1		2		2	7	0.8%
76	80									1					1	1	15	6	1	1	3	13	1.7%
81	85																	2	1	1		9	0.5%
86	90																1		5		6	10	0.9%
91	95																	1	1	1		6	0.4%
96	100	1														1					13	24	1.6%
101	…																					52	2.1%
		5.0%	1.4%	2.2%	2.8%	3.0%	7.0%	5.5%	8.0%	10.1%	21.6%	6.1%	5.5%	2.2%	3.7%	1.5%	2.3%	1.1%	1.3%	0.5%	1.7%	7.5%	Total

Figure 113: Initial speed of ego and opponent during accidents in RE-PV-PC [1]

Nearly half of the ego vehicles were driving very slowly (between 0 kph and 5 kph). There were also a notable number of accidents in high-speed situations with both participants driving more than 100 kph.

The deceleration of both participants is described in Figure 114 with the help of a boxplot.

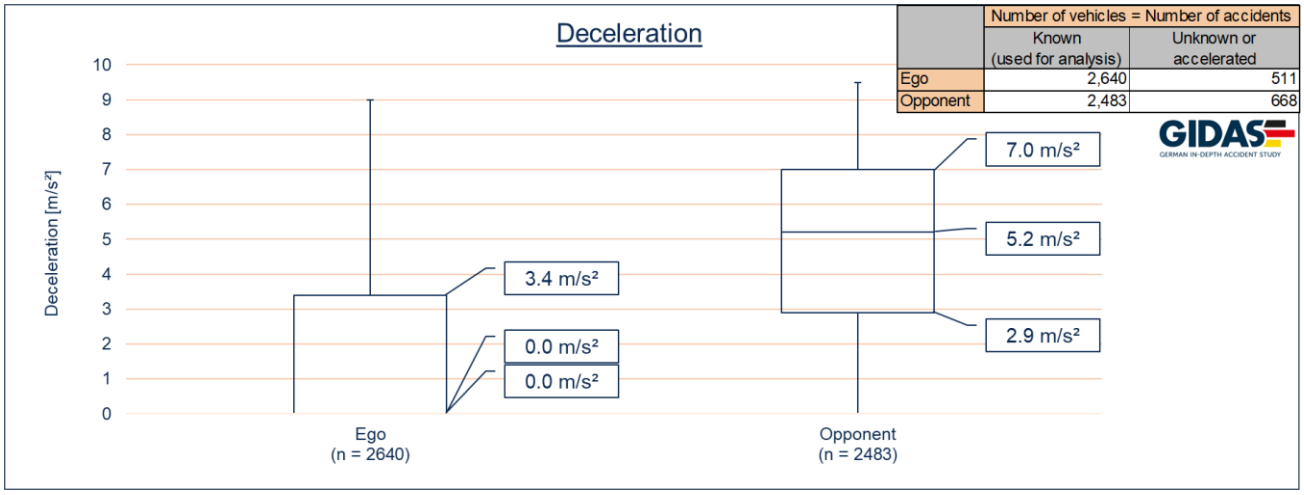


Figure 114: Deceleration of ego and opponent during accidents in RE-PV-PC [1]

There were only few opponent vehicles, which did not notice a vehicle standing or decelerating in front of them and thus collided without deceleration with the ego vehicle. Most of the ego vehicles had a low deceleration.

Figure 115 shows the percentage of braking of both participants in *RE-PV-PC*.

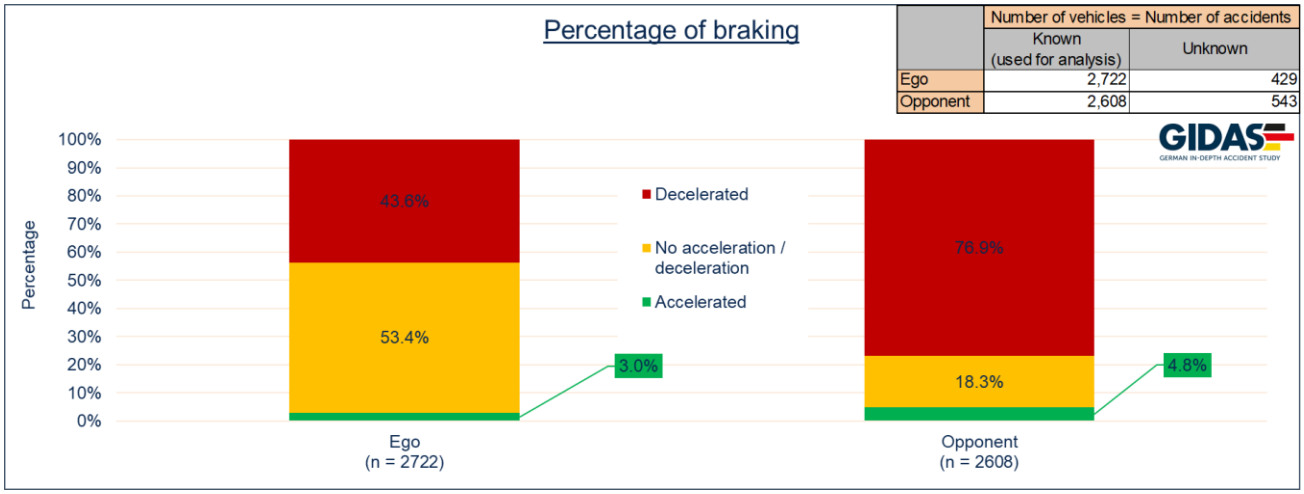


Figure 115: Percentage of braking of ego and opponent during accidents in RE-PV-PC [1]

More than three quarters of the opponent vehicles decelerated prior to of the accident. Nearly 5% of the opponent vehicles accelerated. More than half of the ego vehicles had no acceleration or deceleration prior to the accident.

In the following figure (Figure 116) the deceleration of the ego vehicle and the opponent are shown.

Less than 10 cases
10…20 cases
More than 20 cases

GIDAS GERMAN IN-DEPTH ACCIDENT STUDY

	Combinations
Known (used for analysis)	2,299
Unknown	852

Deceleration - Ego vs. Opponent

Deceleration Ego [m/s²]		Deceleration Opponent [m/s²]										
		0	1.1	2.1	3.1	4.1	5.1	6.1	7.1	8.1	9.1	From
From	To	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	To
0	1.0	324	20	28	70	164	152	152	218	27	1	50.3%
1.1	2.0	14	15	6	6	6	1	6	6	1		2.7%
2.1	3.0	54	8	31	40	56	53	46	32	2		14.0%
3.1	4.0	47	7	16	36	52	59	87	58	9		16.1%
4.1	5.0	21		4	7	58	34	29	53	6		9.2%
5.1	6.0	5		1	2	10	17	14	19	4		3.1%
6.1	7.0	5			1	2	9	21	3	1		1.8%
7.1	8.0	3			1	3	3	5	41			2.4%
8.1	9.0	1					1	2	2	1		0.3%
9.1	10.0											0.0%
		20.6%	2.2%	3.7%	7.1%	15.3%	14.3%	15.7%	18.8%	2.2%	0.0%	Total

Figure 116: Deceleration of ego and opponent during accidents in RE-PV-PC [1]

Many of the decelerating ego vehicles (66.9%) had a low deceleration up to 3.0 m/s² prior to the crash. About 51% of the opponent vehicles were braking hard with more than 5 m/s².

3.11.3 Scenario conclusion

Special for *RE-PV-PC* is the comparatively high percentage of high traffic density. Accidents in *RE-PV-PC* happened relatively rarely at intersections. Not further described mistakes made by the driver were the most frequent main accident causation, followed by insufficient safety distance. The initial speed of the opponent was mostly higher than the one of the ego vehicles, which was mostly lower than 5 kph. Most of the opponent vehicles were braking with high decelerations prior to the accident. Apart from that, *RE-PV-PC* is defined through weather conditions without rain, often daylight and very rarely view obstructions

3.12 Scenario 12 LTAP-OD - Passenger cars

Figure 117 illustrates the participants in scenario 12, also called the *LTAP-OD-PC*. The ego participant in this scenario is a passenger car turning to the left. The opponent is also a passenger car coming from the opposite direction.

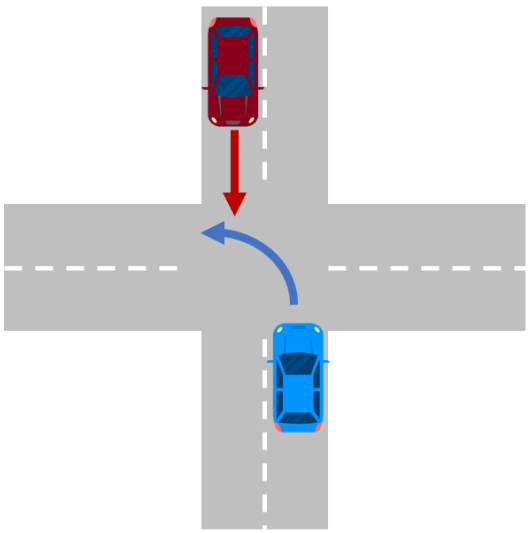


Figure 117: Pictogram LTAP-OD-PC

3.12.1 SAFETY POTENTIAL

A system addressing and preventing *LTAP-OD-PC* would prevent 3.5% of the slightly, 2.2% of the severely and 0.5% of the fatally injured car occupants in the EU. More information about the safety potential of this scenario can be found in deliverable D1.1.

3.12.2 RESULTS

In Figure 118 the distribution of precipitation during the accidents is shown.

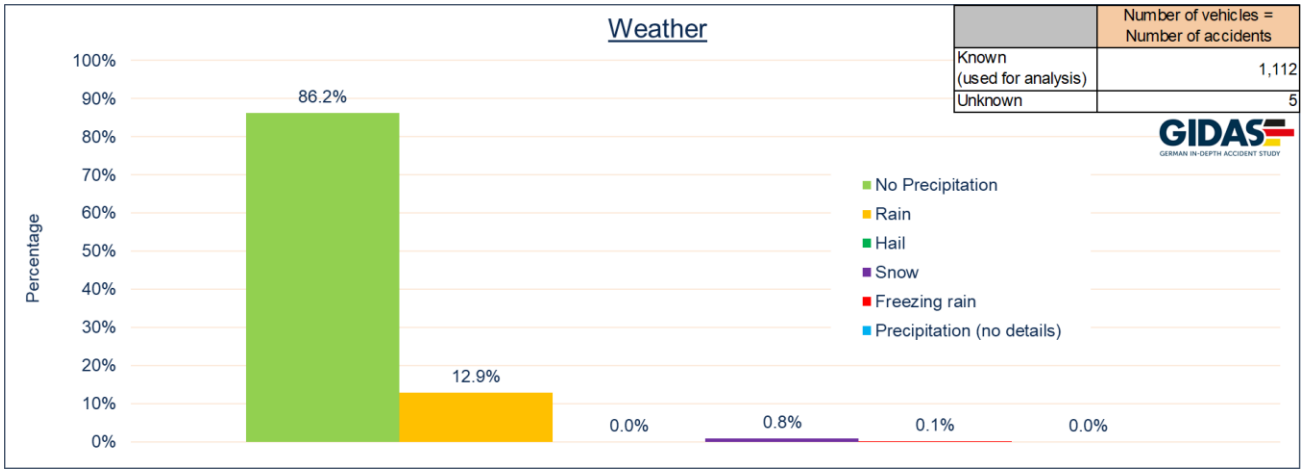


Figure 118: Weather conditions during accidents in LTAP-OD-PC [1]

The majority of the accidents happened on dry weather conditions. A little more than one in ten accidents happened in rainy situations.

In Figure 119 an overview of the light conditions during the accidents in *LTAP-OD-PC* is shown.

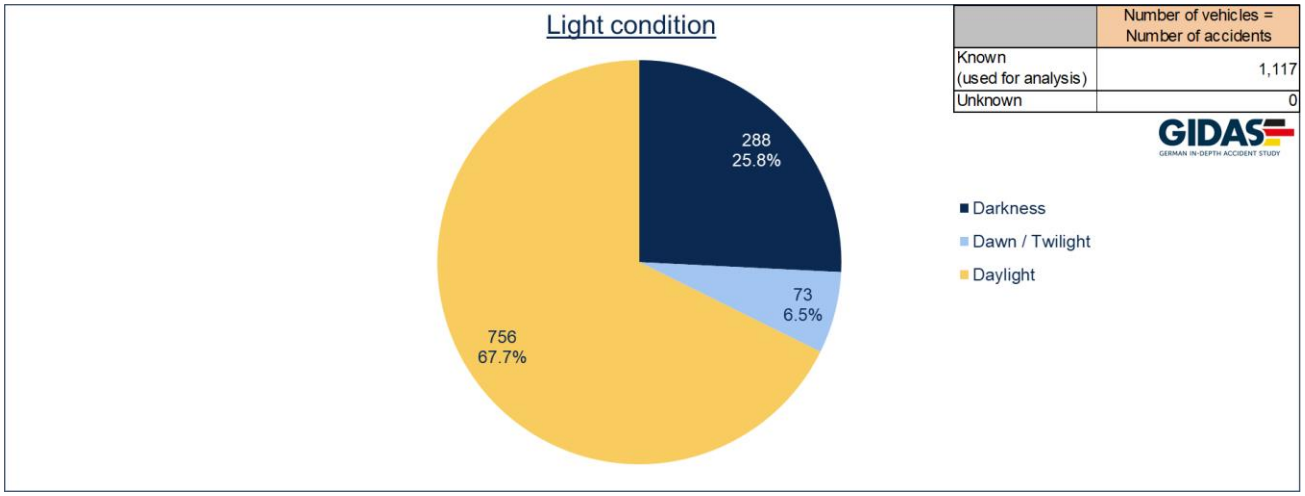


Figure 119: Light conditions during accidents in LTAP-OD-PC [1]

Most accidents happened under daylight conditions. Nearly a third of the accidents happened in the

darkness or dawn/twilight.

Figure 120 shows the illumination of the road during accidents, which happened in darkness or dawn/twilight.

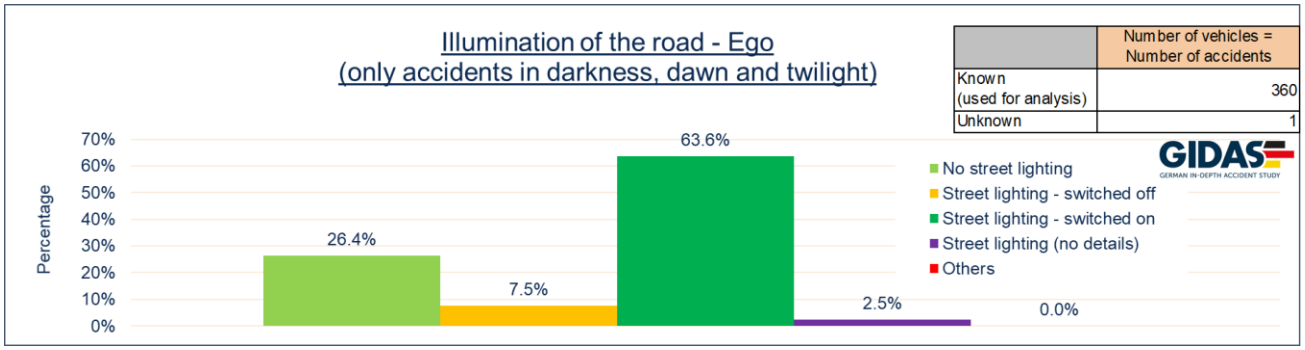


Figure 120: Illumination of the road during accidents in LTAP-OD-PC in darkness or dawn/twilight [1]

In nearly two out of three of those accidents, the road was illuminated with street lighting. In more than a third of the cases, there was no illumination of the accident site, either due to no existing street lighting or due to switched off street lighting

The percentage of view obstruction for the ego participant is shown in Figure 121.

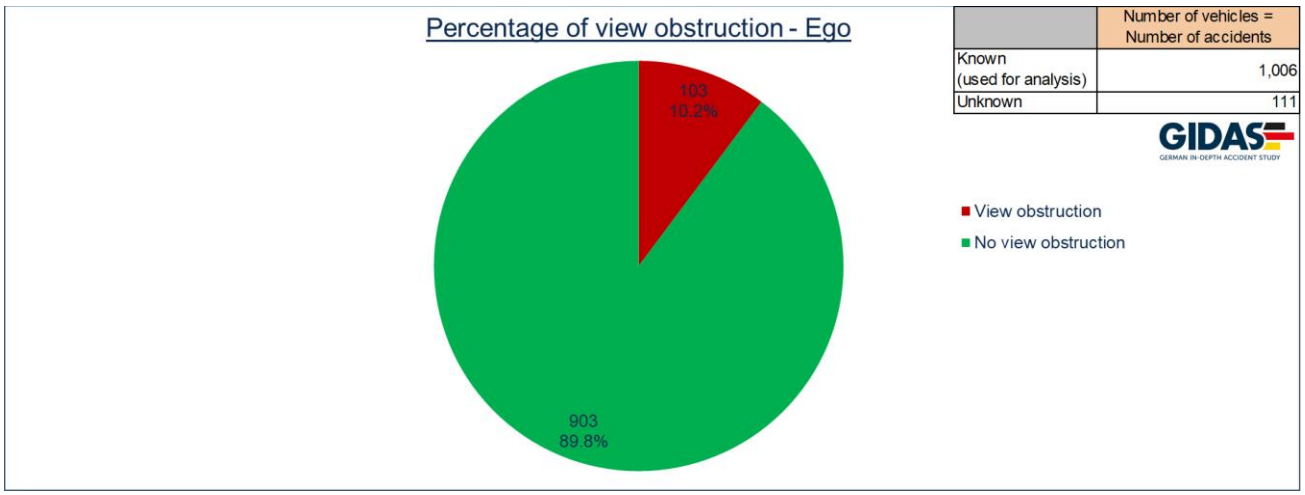


Figure 121: Percentage of view obstruction during accidents in LTAP-OD-PC [1]

In nearly 90% of the accidents in *LTAP-OD-PC* there was no view obstruction for the ego participant at the time of the accident.

In the following figure (Figure 122) the kind of view obstruction is shown for the cases, where a view obstruction existed.

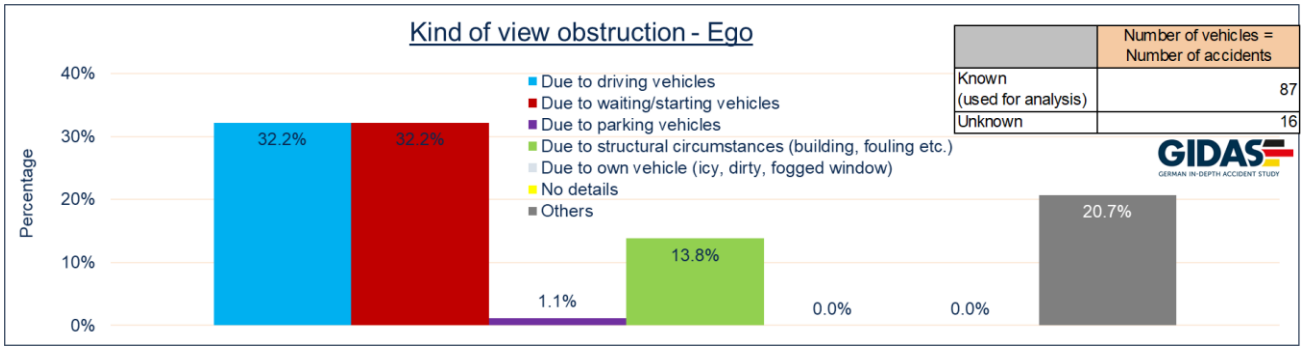


Figure 122: Kind of view obstruction during accidents in LTAP-OD-PC [1]

Most of the drivers with view obstruction were obstructed by other driving or waiting vehicles (64.4%).

The road, where the ego participant was driving during the accident, is shown in Figure 123.

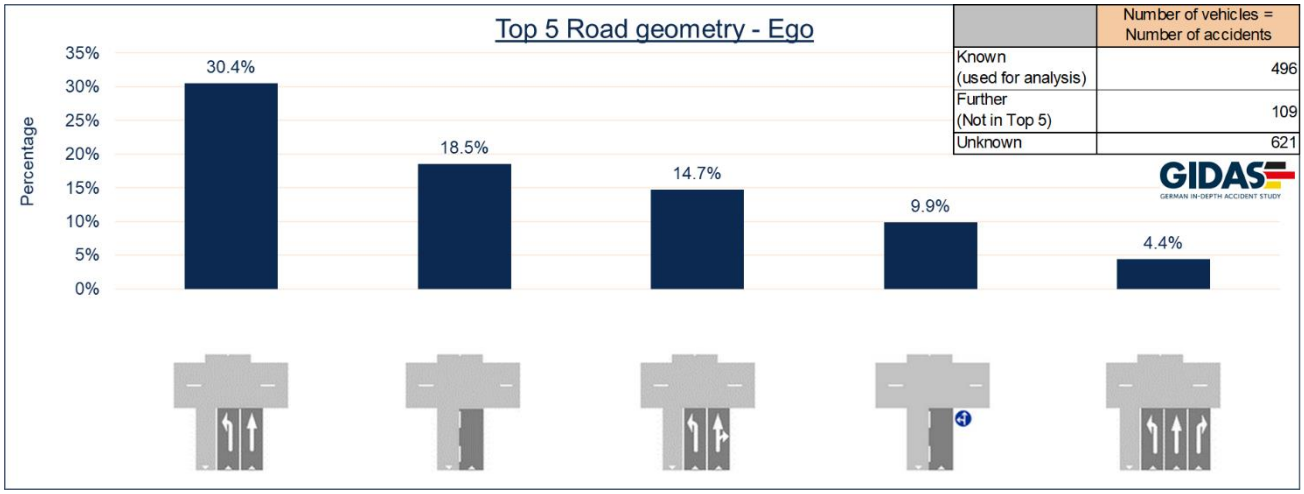


Figure 123: Top 5 Road geometry for the ego participant in LTAP-OD-PC [1]

In nearly half of the cases, the ego vehicle drove on a road towards an intersection with a left turning lane, having another lane on the right side. Here it is not clear, if the vehicle actually drove on the left turning lane.

The kind of traffic regulation during the accident for the ego participant is shown in Figure 124.

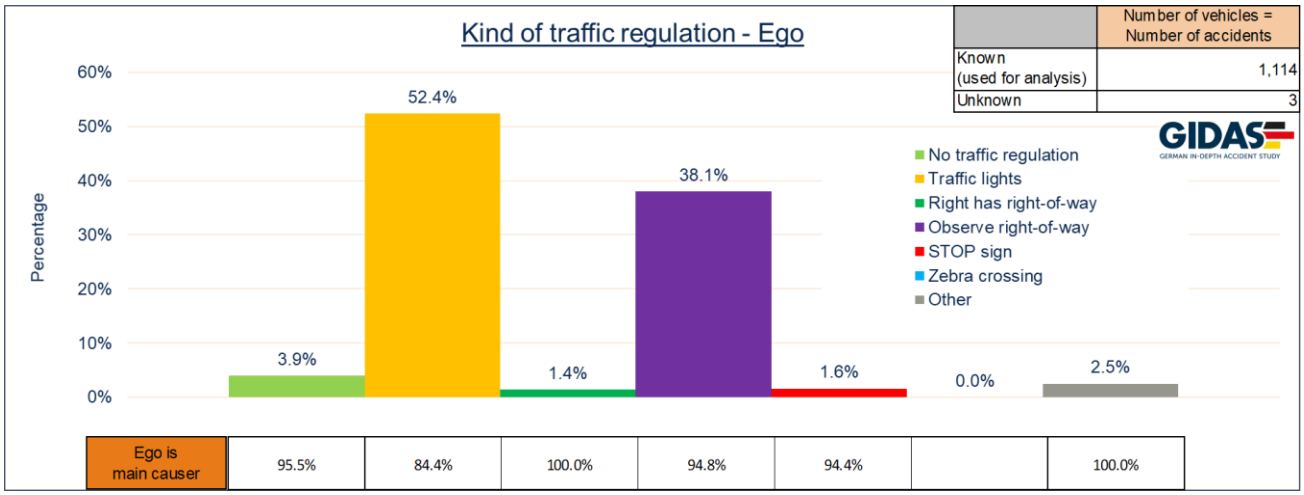


Figure 124: Kind of traffic regulation for the ego participant in LTAP-OD-PC [1]

In more than half of the accidents there were traffic lights regulating the traffic at the accident site. In 84.4% of these cases, the accident was mainly caused by the ego.

The traffic density during the accident for the ego participant is shown in Figure 125.

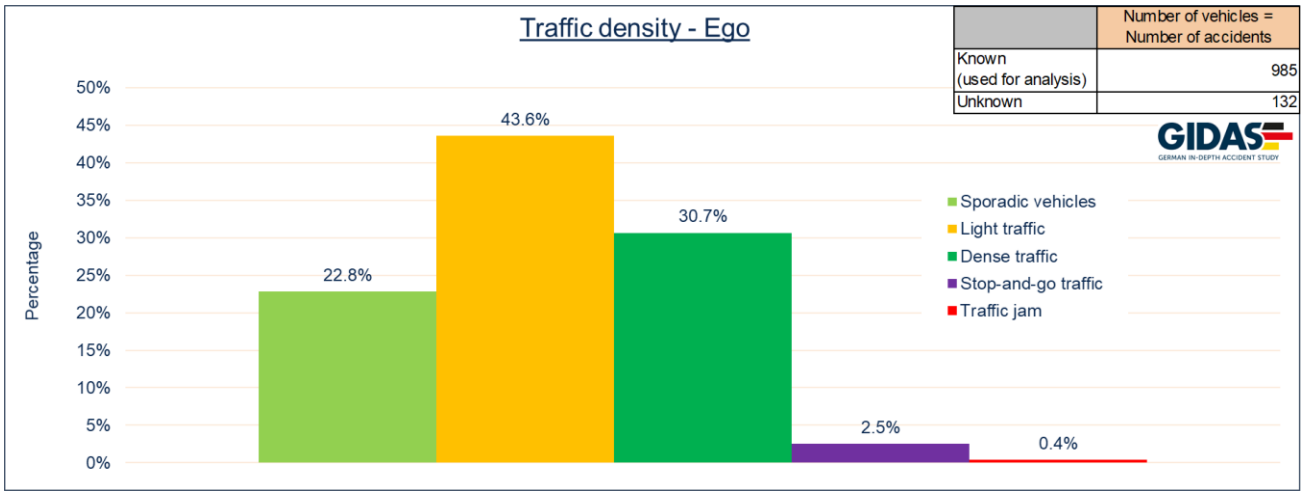


Figure 125: Traffic density during accidents in LTAP-OD-PC [1]

In two third of the cases, on the accident site were only sporadic vehicles or light traffic. Nearly every third driver had an accident in a dense traffic situation.

The most frequent main accident causations in *LTAP-OD-PC* are shown in Figure 126.

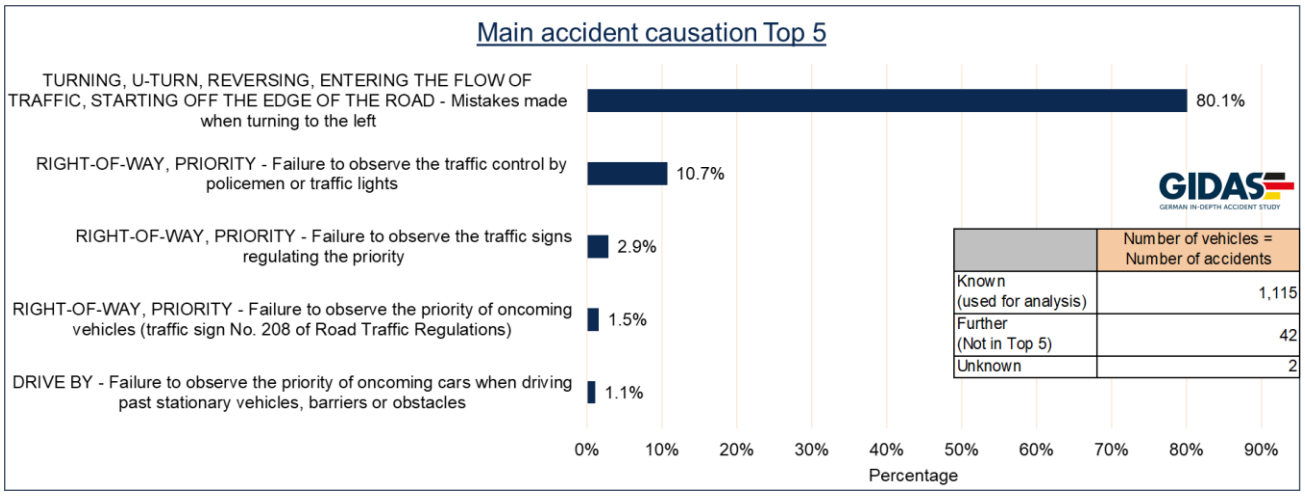


Figure 126: Top 5 main accident causation for accidents in LTAP-OD-PC [1]

Four in five accidents were caused by a mistake at turning to the left. Further, in nearly 11% the causer ignored the traffic lights respectively the traffic control by policeman.

The initial speed of the ego participant and the opponent vehicle in *LTAP-OD-PC* is shown in Figure 127.

Less than 10 cases
10…20 cases
More than 20 cases

GIDAS GERMAN IN-DEPTH ACCIDENT STUDY

	Combinations
Known (used for analysis)	1,034
Unknown	83

Initial speed - Ego vs. Opponent

Initial speed Ego [kph]		Initial speed Opponent [kph]																					
From	To	0 5	6 10	11 15	16 20	21 25	26 30	31 35	36 40	41 45	46 50	51 55	56 60	61 65	66 70	71 75	76 80	81 85	86 90	91 95	96 100	101 ...	From
0	5	14	1				2	2	5	12	27	12	8	7	8	4	4	2	1	2			10.7%
6	10						1	2	11	5	17	6	9	5	4	5	1	1	1			1	6.7%
11	15	2	1	1		4	4	2	5	12	30	9	15	10	10	5	3	3	2			1	11.5%
16	20				4	1	2	5	12	17	28	18	12	11	7	4		3	3	1	2	2	12.8%
21	25	1	1	1	2	6	7	1	10	12	27	18	7	10	13	6	7	3		1	1		13.0%
26	30	1			1	5	6	5	10	12	40	18	12	10	13	4	4	2	2	2	1	1	14.4%
31	35	1				1	2	7	5	6	28	18	9	4	7	5	2	1	3	1	1		9.8%
36	40	3		1			4	1	4	4	17	14	10	8	4	2	1	3	2				7.5%
41	45	3			2	1	1	3	1	5	8	5	4	5	5	2	4		1				4.8%
46	50	2					3	1	4	2	16	11	7	2	4	2			2				5.4%
51	55				1			2	3	2	3	7			1	1			2				2.1%
56	60								1			1			1								0.3%
61	65	1	1		1						1	1											0.5%
66	70													2	1		1						0.4%
71	75																						0.0%
76	80														1								0.1%
81	85																						0.0%
86	90																						0.0%
91	95																						0.0%
96	100																						0.0%
101	...																						0.0%
		2.7%	0.4%	0.3%	1.1%	1.7%	3.1%	3.0%	6.9%	8.6%	23.4%	13.3%	9.0%	7.2%	7.6%	3.9%	2.6%	1.7%	1.8%	0.7%	0.5%	0.5%	Total

Figure 127: Initial speed of ego and opponent during accidents in LTAP-OD-PC [1]

Most of the ego vehicles (78.8%) had an initial speed of less than 36 kph. Compared to these, the opponent vehicles were in many cases faster, mostly between 36 kph and 70 kph (76.0%). The maximum initial speed of the opponent was higher than the one from the ego vehicle.

3.12.3 Scenario conclusion

Accidents in *LTAP-OD-PC* happened mostly at intersections which were regulated by traffic lights. A mistake made when turning to the left was the most frequent main accident causation. Traffic was relatively dense. View obstructions appeared only rarely. Daylight during *LTAP-OD-PC* was not as common as in other scenarios. The initial speed of the opponent was mostly higher than the one of the ego vehicles. Apart from that, *LTAP-OD-PC* is defined through weather conditions without rain.

3.13 Scenario 13 LTAP-OD - Powered two-wheeler

Figure 128 illustrates the participants in scenario 13, also called the *LTAP-OD-PTW*. The ego participant in this scenario is a passenger car turning to the left. The opponent is a powered two-wheeler coming from the opposite direction.

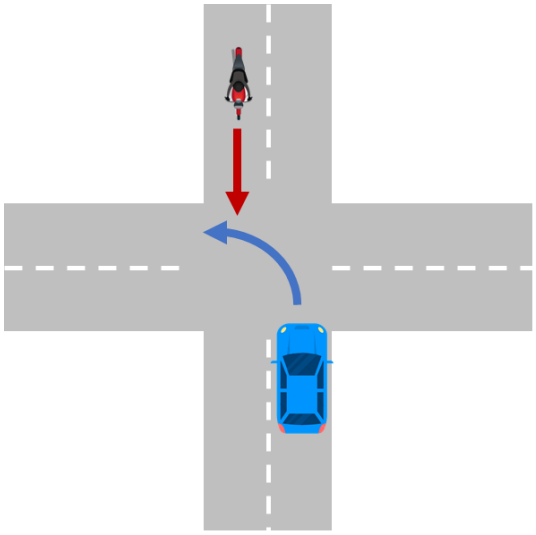


Figure 128: Pictogram LTAP-OD-PTW

3.13.1 SAFETY POTENTIAL

A system addressing and preventing *LTAP-OD-PTW* would prevent 2.7% of the slightly, 3.9% of the severely and 3.1% of the fatally injured powered two-wheeler riders in the EU. More information about the safety potential of this scenario can be found in deliverable D1.1.

3.13.2 RESULTS

In Figure 129 the distribution of precipitation during the accidents is shown.

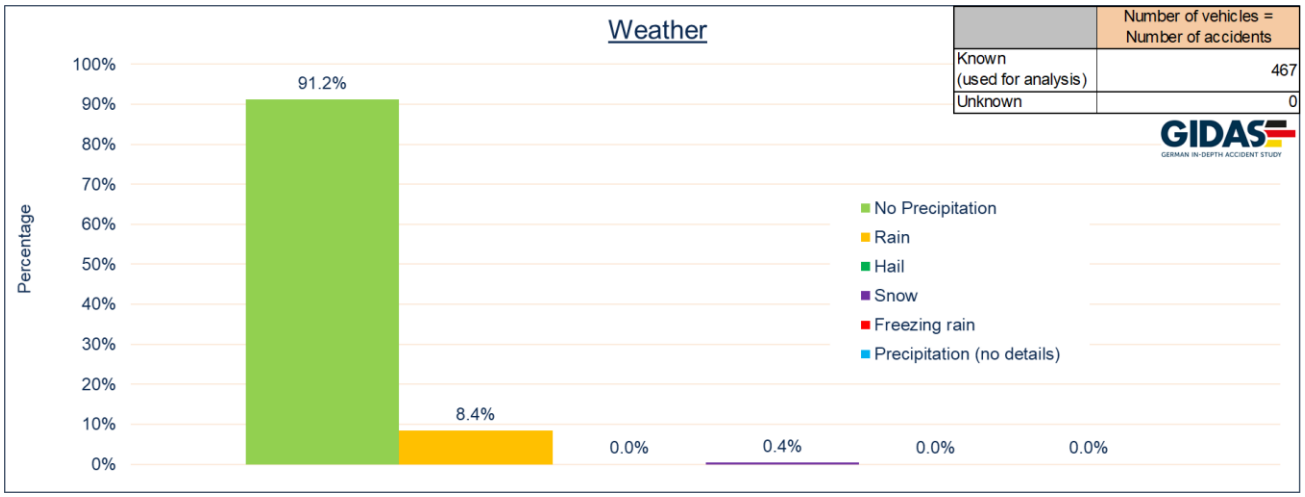


Figure 129: Weather conditions during accidents in LTAP-OD-PTW [1]

The majority of the accidents happened on dry weather conditions. The percentage of this was higher, compared to accidents with passenger cars with the same constellation in *LTAP-OD-PC* (Figure 118). Only 8.4% of the accidents happened in rainy situations.

In Figure 130 an overview of the light conditions during the accidents in *LTAP-OD-PTW* is shown.

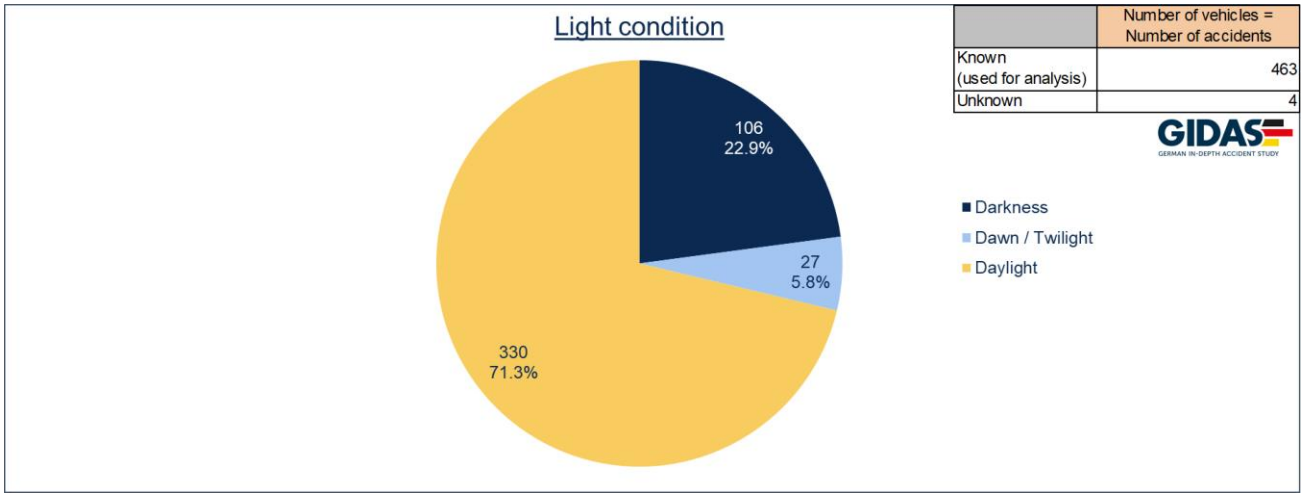


Figure 130: Light conditions during accidents in LTAP-OD-PTW [1]

Most of the accidents happened under daylight conditions. Nearly 28.7% of the accidents happened in the darkness or dawn/twilight.

Figure 131 shows the illumination of the road during accidents, which happened in darkness or dawn/twilight.

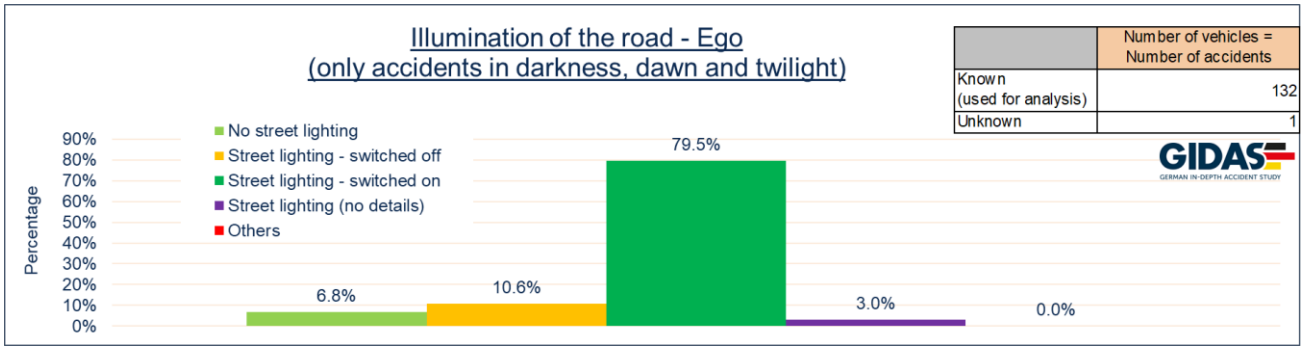


Figure 131: Illumination of the road during accidents in LTAP-OD-PTW in darkness or dawn/twilight [1]

In more than three quarters of these cases, the road was illuminated with street lighting. In only 17.4% of the cases, there was no illumination of the accident site, either due to no existing street lighting or due to switched off street lighting.

The percentage of view obstruction for the ego participant is shown in Figure 132.

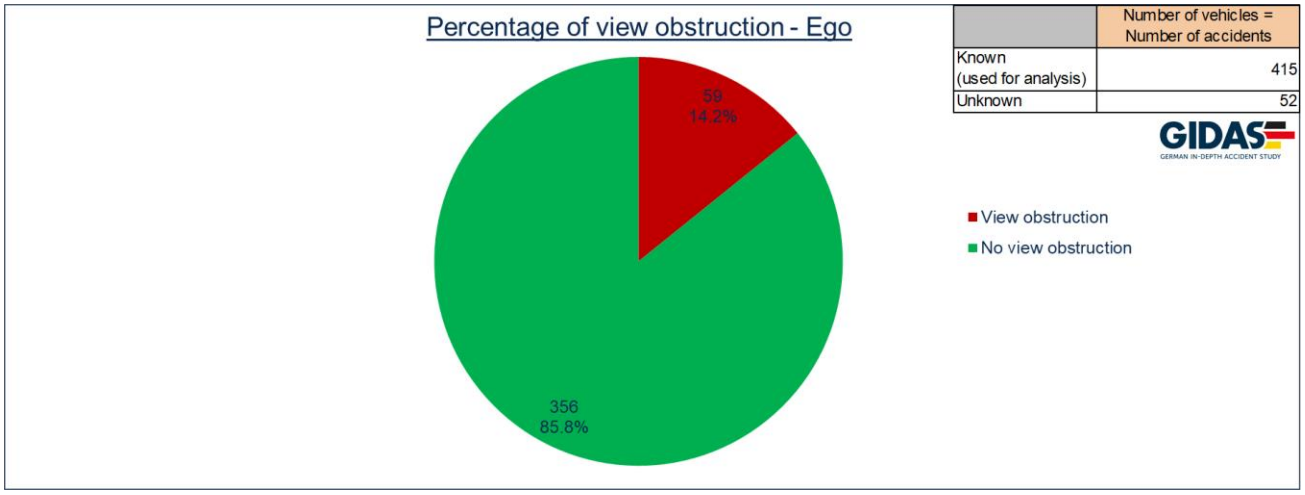


Figure 132: Percentage of view obstruction during accidents in LTAP-OD-PTW [1]

In about 14% of the accidents in *LTAP-OD-PTW*, there was a view obstruction for the ego participant at the time of the accident.

In the following figure (Figure 133) the kind of view obstruction is shown for the cases, where a view obstruction existed.

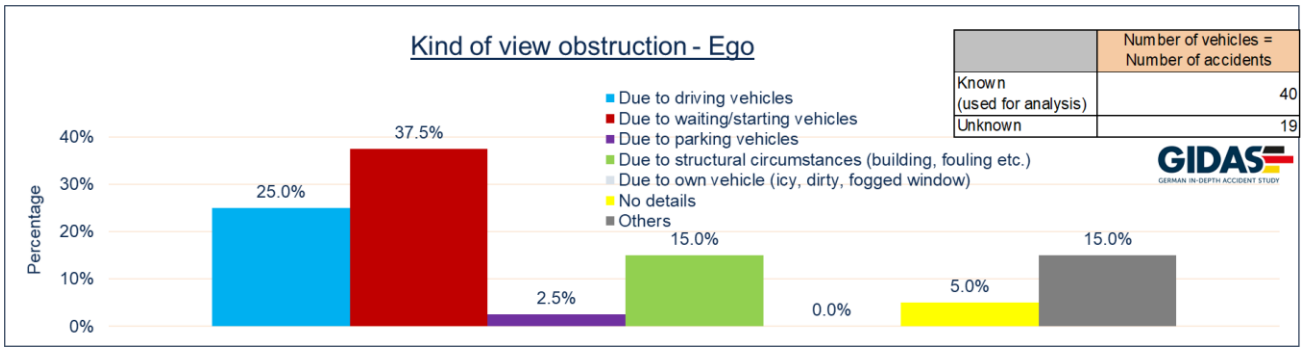


Figure 133: Kind of view obstruction during accidents in LTAP-OD-PTW [1]

Most of the drivers, which had a view obstruction, were obstructed by other driving or waiting vehicles (64.4%).

The road, where the ego participant was driving during the accident, is shown in Figure 134.

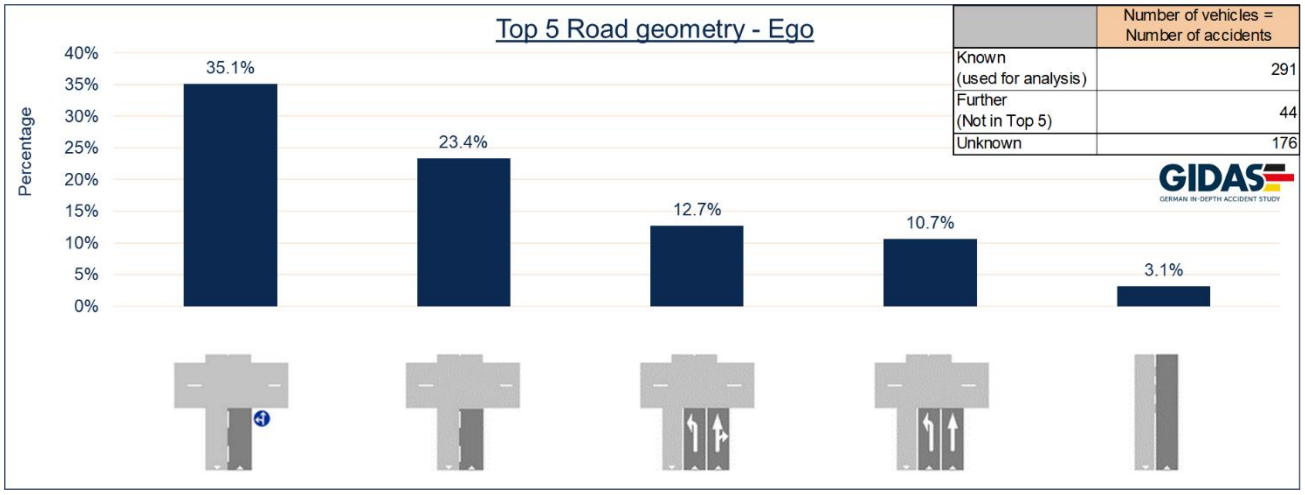


Figure 134: Top 5 Road geometry for the ego participant in LTAP-OD-PTW [1]

In 58.5% of the cases, the ego vehicle drove on a road towards an intersection with a single lane. In 35.1% the ego vehicle was only allowed to drive straight on or turn to the left. Here it is not clear, if the vehicle actually drove on the lane which was dedicated for turning to the left.

The kind of traffic regulation during the accident for the ego participant is shown in Figure 135.

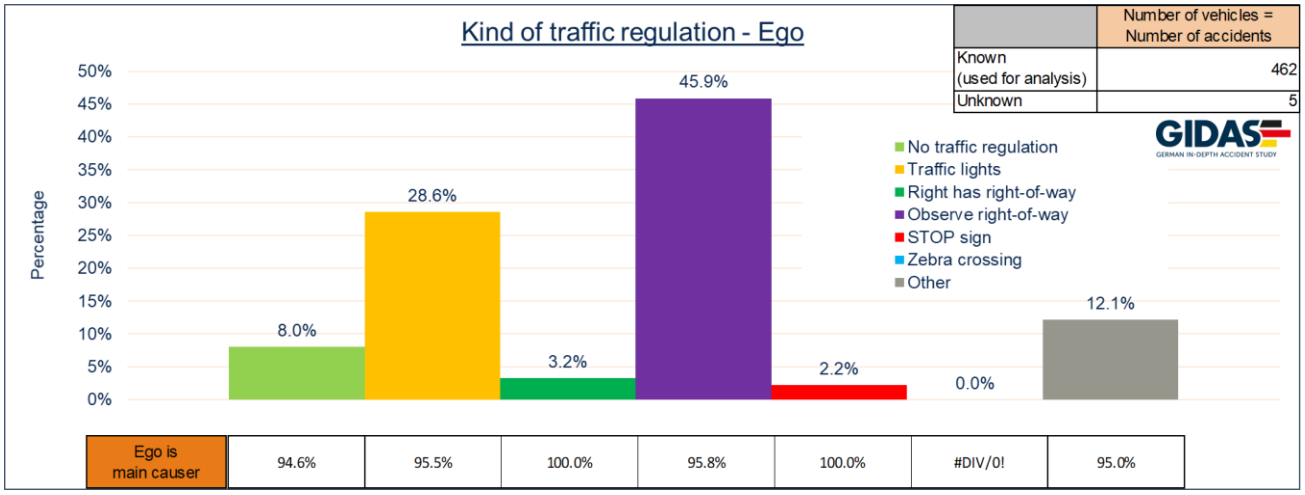


Figure 135: Kind of traffic regulation for the ego participant in LTAP-OD-PTW [1]

In nearly half of the cases (45.9%) the main causer had to observe the right-of-way. In more than 95% of these cases, the ego vehicle was the main causer of the accident.

In Figure 136 the traffic density during the accident for the ego participant is shown.

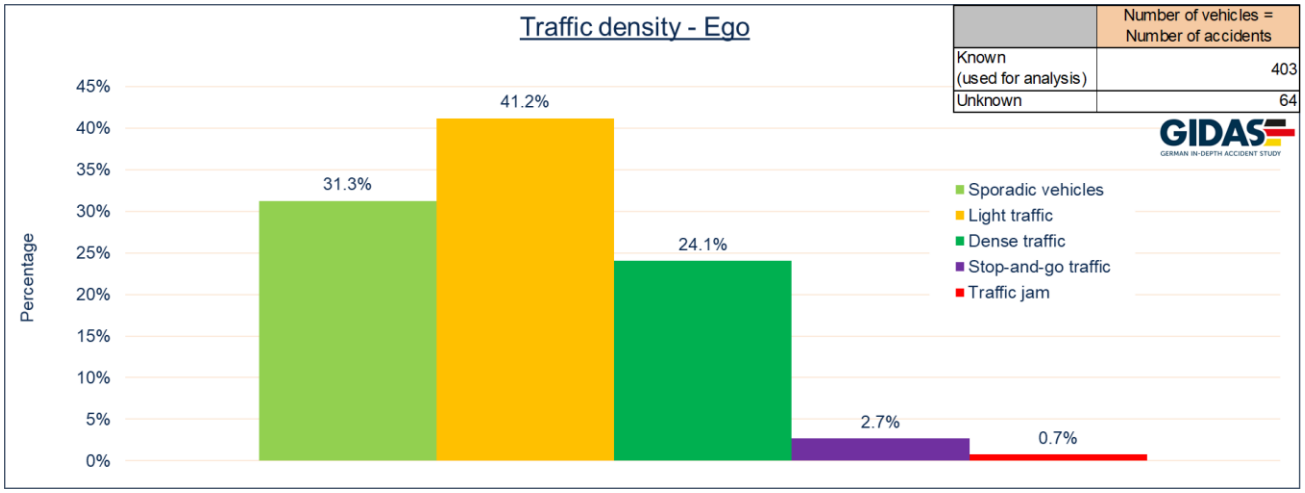


Figure 136: Traffic density during accidents in LTAP-OD-PTW [1]

In more than two out of three cases, on the accident site were only sporadic vehicles or light traffic. Nearly every fourth driver had an accident in a dense traffic situation.

In Figure 137 the most frequent main accident causations in *LTAP-OD-PTW* are shown.

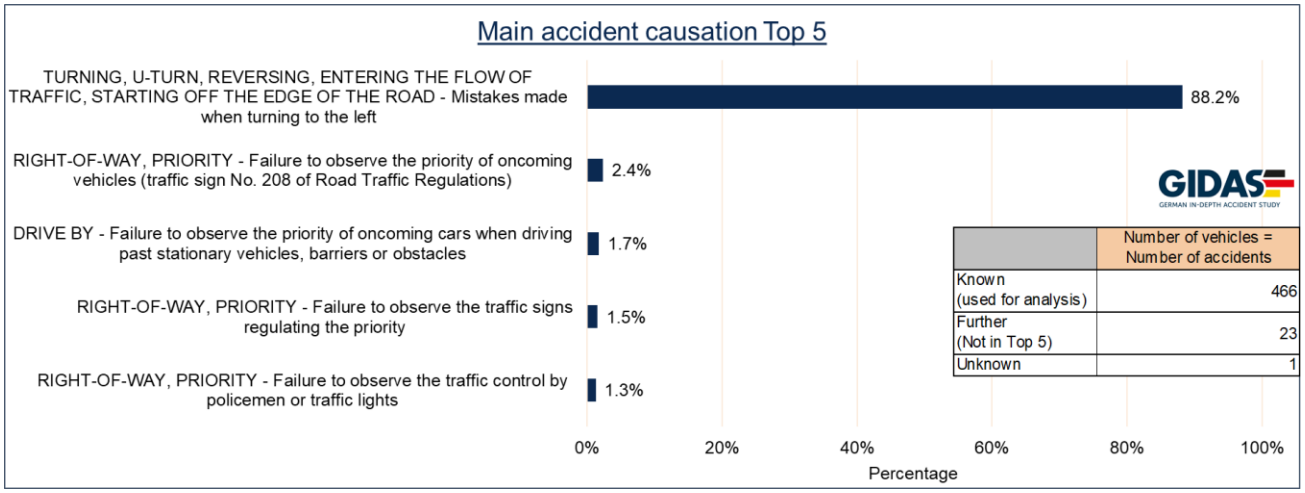


Figure 137: Top 5 main accident causation for accidents in LTAP-OD-PTW [1]

The predominant percentage of accidents were mainly caused by a mistake made when turning to the left. The Top 5 covers more than 95% of all the cases in this scenario.

In the following figure (Figure 138) the initial speed of the ego vehicle and the opponent vehicle is shown.

Less than 10 cases
10…20 cases
More than 20 cases

GIDAS GERMAN IN-DEPTH ACCIDENT STUDY

	Combinations
Known (used for analysis)	399
Unknown	68

Initial speed - Ego vs. Opponent

Initial speed Ego [kph] From	To	Initial speed Opponent [kph] 0	6	11	16	21	26	31	36	41	46	51	56	61	66	71	76	81	86	91	96	101	From
		5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	…	To
0	5	3		1	2	1		3	7	8	11	5	3	2	3	3	2		1			1	14.0%
6	10					1	5	3	4	7	4	2	1		1	1		1			1	1	8.0%
11	15					2	4	2	10	3	9	4	4		3	1							10.5%
16	20				1	7	5	6	13	17	12	7	4		2	2	1			1		2	20.1%
21	25		1			1	4	5	5	4	9	7	2	2		2						2	11.0%
26	30				2	2	7	3	11	10	14	4	4		3	4	1	1	1		1	2	17.5%
31	35					1	1	1	4	5	5	3	1	1	1		1						6.0%
36	40		1			1	1	1	2	3	6	3		1	1						1		5.3%
41	45						2			2	2	2		2	1			1				1	3.3%
46	50						1			4	5	2	2	1									3.8%
51	55															1							0.3%
56	60																						0.0%
61	65								1														0.3%
66	70																						0.0%
71	75																						0.0%
76	80																						0.0%
81	85																						0.0%
86	90																						0.0%
91	95																						0.0%
96	100																						0.0%
101	…																						0.0%
		0.8%	0.5%	0.3%	1.3%	4.0%	7.5%	6.0%	14.3%	15.8%	19.3%	9.8%	5.3%	2.3%	3.8%	3.5%	1.3%	0.8%	0.5%	0.3%	0.8%	2.3%	Total

Figure 138: Initial speed of ego and opponent during accidents in LTAP-OD-PTW [1]

In most of the cases (63.7%), the initial speed of the ego vehicle was between 0 kph and 25 kph. The initial speed of the opponent vehicle was most frequently (65.2%) between 31 kph and 55 kph. The maximum initial speed of the opponent was higher than the one of the ego vehicles.

3.13.3 Scenario conclusion

Accidents in *LTAP-OD-PTW* happened mostly at intersections, where a participant (mostly the ego) had to observe the right of way. A mistake made when turning to the left was the most frequent main accident causation. Traffic was comparatively dense. The initial speed of the opponent was mostly higher than the one of the ego vehicles. Apart from that, *LTAP-OD-PTW* is defined through weather conditions without rain, no view obstructions and a low percentage of accidents during daylight compared to other scenarios.

3.14 Scenario 14 LTAP-LD - Passenger cars

Figure 139 illustrates the participants in scenario 14, also called the *LTAP-LD-PC*. The ego participant in this scenario is a passenger car turning to the left. The opponent is also a passenger car coming from the left direction.

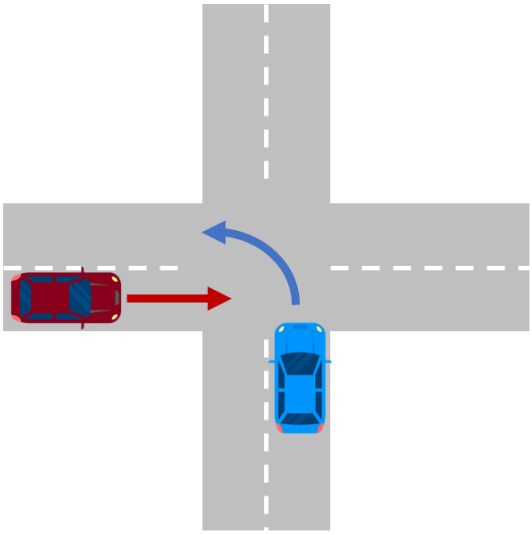


Figure 139: Pictogram LTAP-LD-PC

3.14.1 SAFETY POTENTIAL

A system addressing and preventing *LTAP-LD-PC* would prevent 2.4% of the slightly, 1.6% of the severely and 0.2% of the fatally injured car occupants in the EU. More information about the safety potential of this scenario can be found in deliverable D1.1.

3.14.2 RESULTS

Figure 140 shows the distribution of precipitation during the accidents.

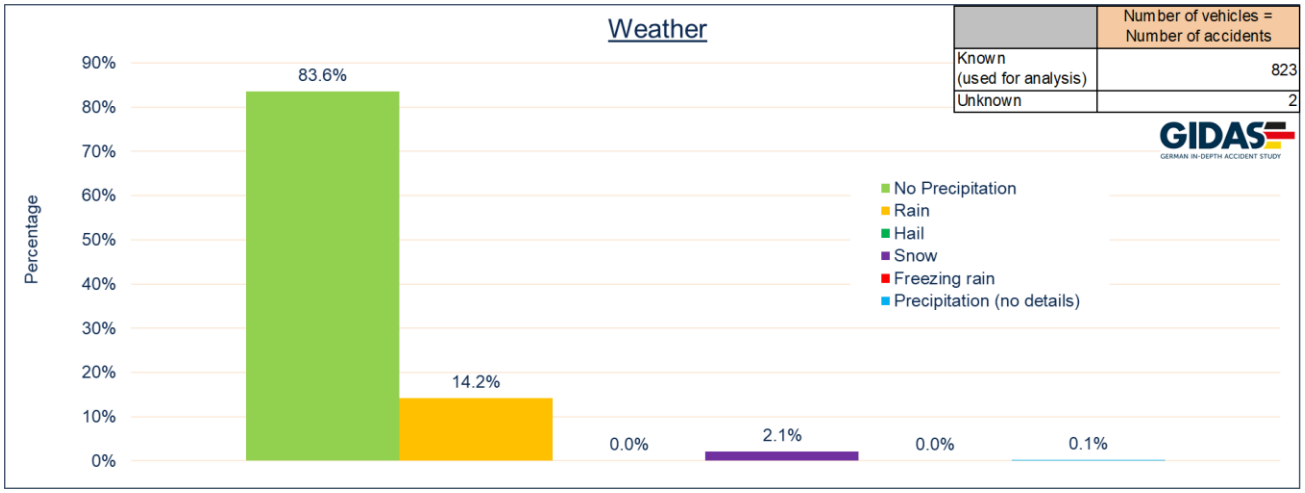


Figure 140: Weather conditions during accidents in LTAP-LD-PC [1]

Most of the accidents happened on dry weather conditions. 14.2% of the accidents happened in rainy situations.

In Figure 141 an overview of the light conditions during the accidents in *LTAP-LD-PC* is shown.

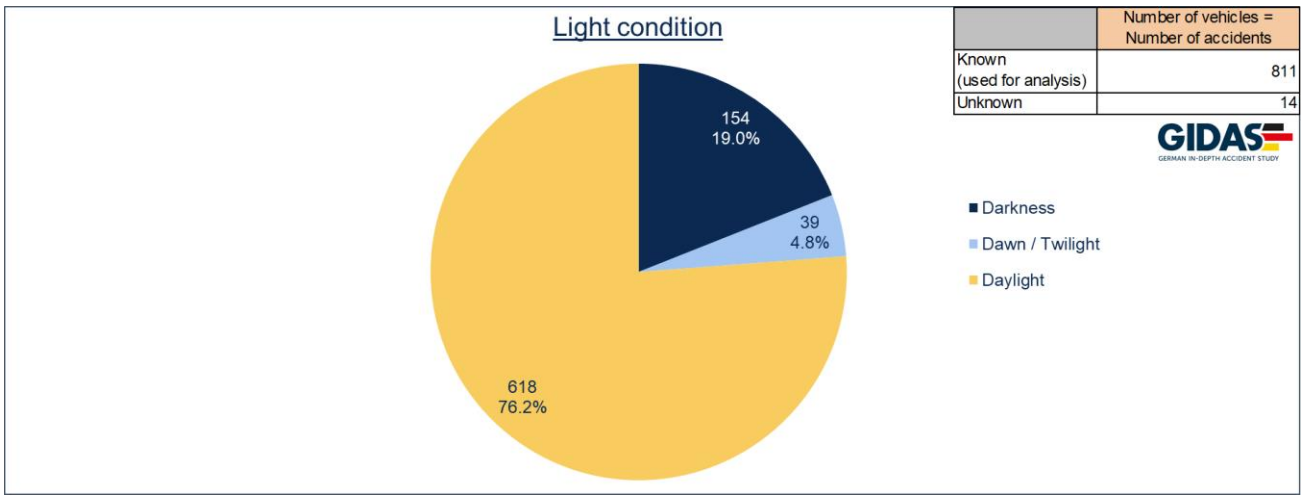


Figure 141: Light conditions during accidents in LTAP-LD-PC [1]

Most accidents happened under daylight conditions. Nearly one quarter of the accidents happened in darkness or dawn/twilight.

Figure 142 shows the illumination of the road during accidents, which happened in darkness or dawn/twilight.

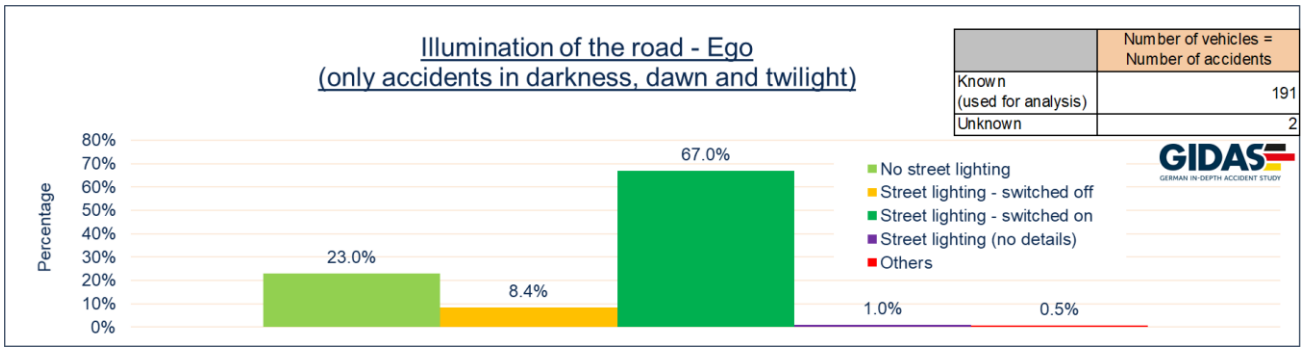


Figure 142: Illumination of the road during accidents in LTAP-LD-PC in darkness or dawn/twilight [1]

In a little more than two out of three of these cases, the road was illuminated with street lighting. In nearly a third of these cases, there was no illumination of the accident site, either due to no existing street lighting or due to switched off street lighting

Figure 143 visualizes the percentage of view obstruction for ego participants.

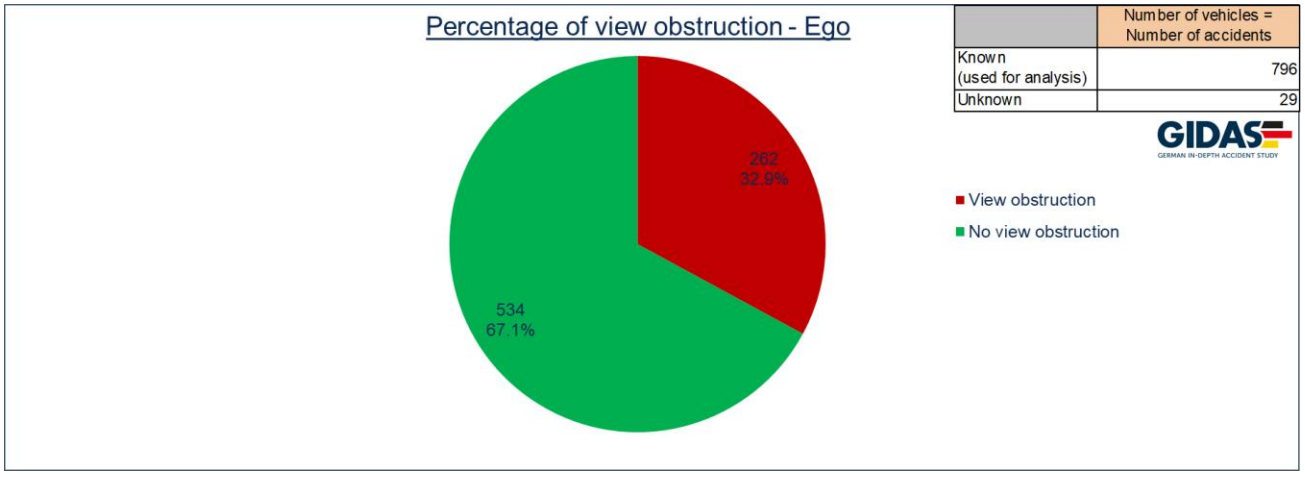


Figure 143: Percentage of view obstruction during accidents in LTAP-LD-PC [1]

A comparatively high percentage of nearly 33% of the ego vehicles was influenced by a view obstruction.

In the following figure (Figure 144) the kind of view obstruction is shown in the cases, where a view obstruction existed.

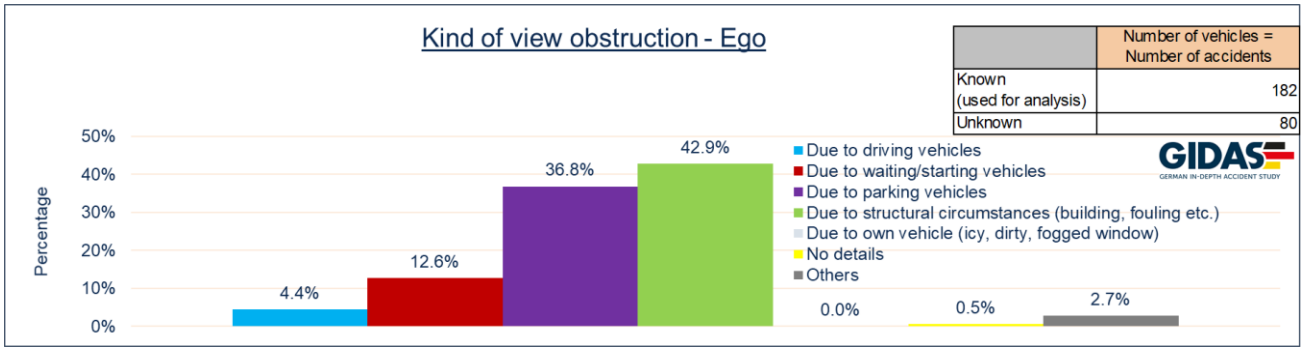


Figure 144: Kind of view obstruction during accidents in LTAP-LD-PC [1]

Most of the drivers with an existing view obstruction were obstructed due to structural circumstances (42.9%).

The road, where the ego participant was driving during the accident, is shown in Figure 145.

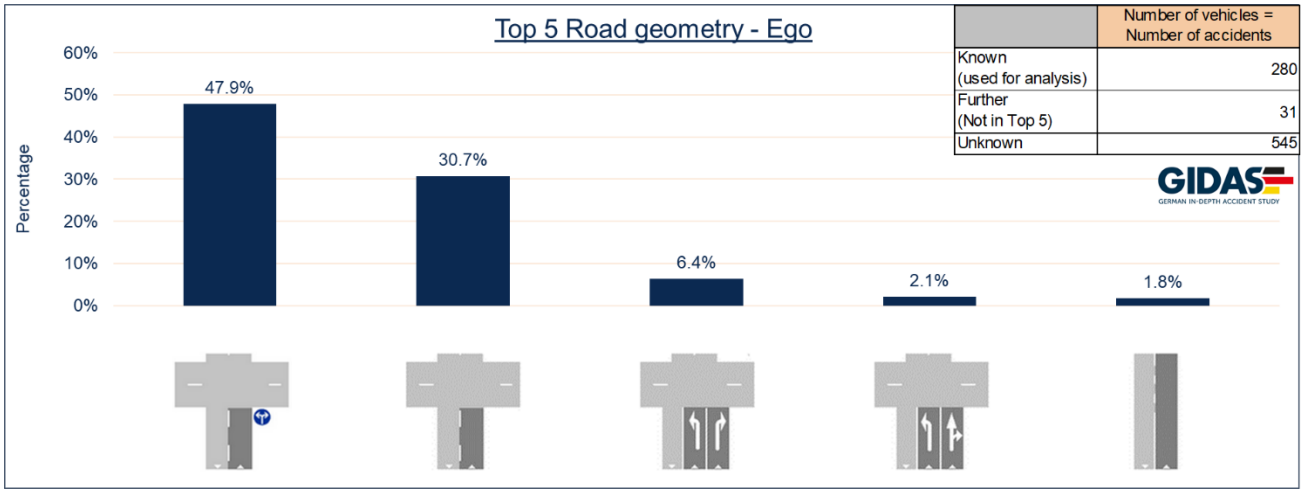


Figure 145: Top 5 Road geometry for the ego participant in LTAP-LD-PC [1]

In more than three quarters of the cases, the ego vehicle drove on a road with a single lane towards an intersection. In nearly half of the cases, the driver of the ego vehicle was only allowed to turn right or left.

Figure 146 shows the kind of traffic regulation for the ego participant.

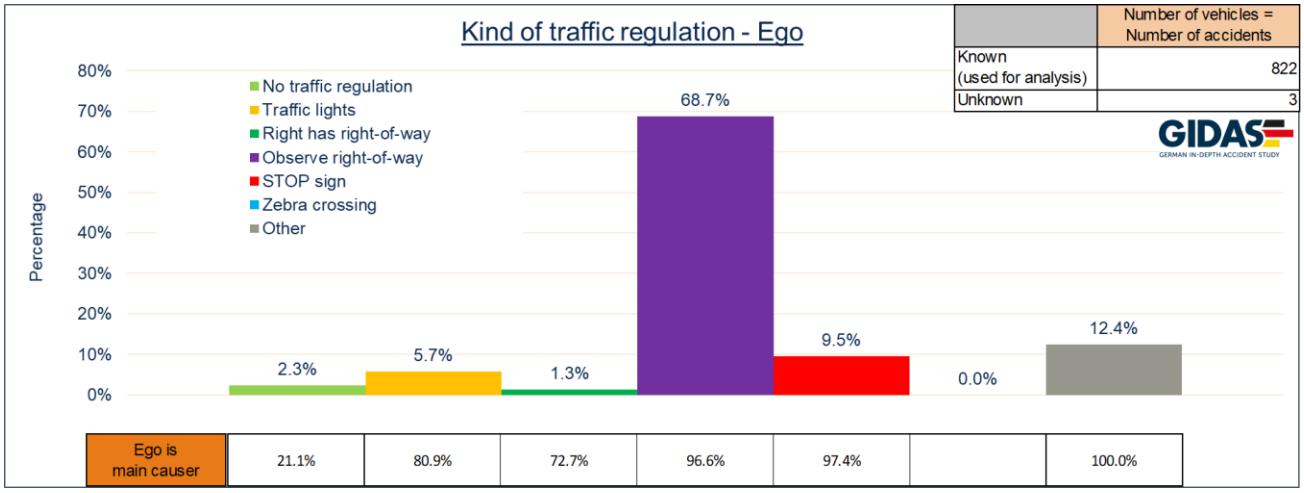


Figure 146: Kind of traffic regulation for the ego participant in LTAP-LD-PC [1]

In more than two third of cases one participant had to observe the right-of-way. In more than 96% of these cases, the ego vehicle was the main causer of the accident. The least percentage main causing ego participants can be found in accident scenes without traffic regulation.

In Figure 147 the traffic density during the accident for the ego participant is shown.

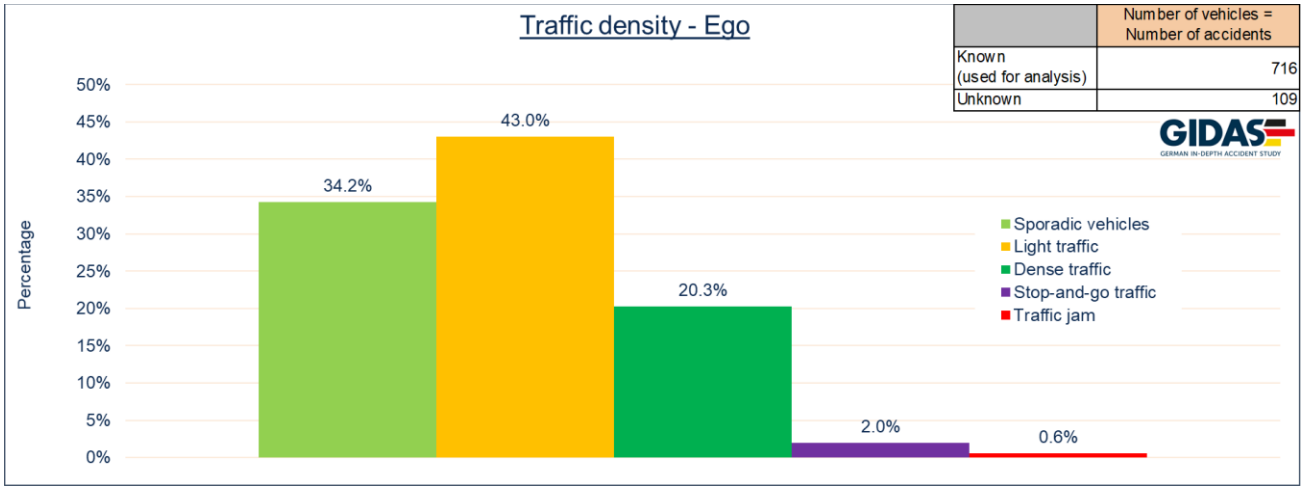


Figure 147: Traffic density for the ego participant in LTAP-LD-PC [1]

In 77.2% of the cases, on the accident site were only sporadic vehicles or light traffic at the time of the accident. Every fifth driver had an accident in a dense traffic situation.

In Figure 148 the most frequent main accident causations in *LTAP-LD-PC* are shown.

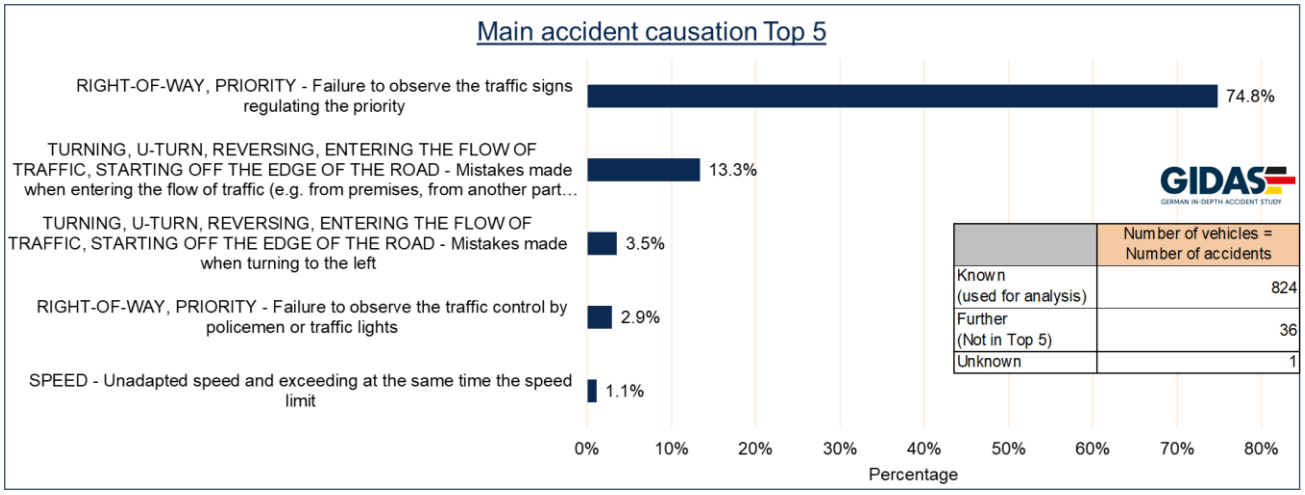


Figure 148: Top 5 main accident causation for accidents in LTAP-LD-PC [1]

Nearly three quarters of the accidents were mainly caused by a failure at observing the traffic signs regulating the priority.

The following figure (Figure 149) shows the initial speed of the ego vehicle and the opponent vehicle.

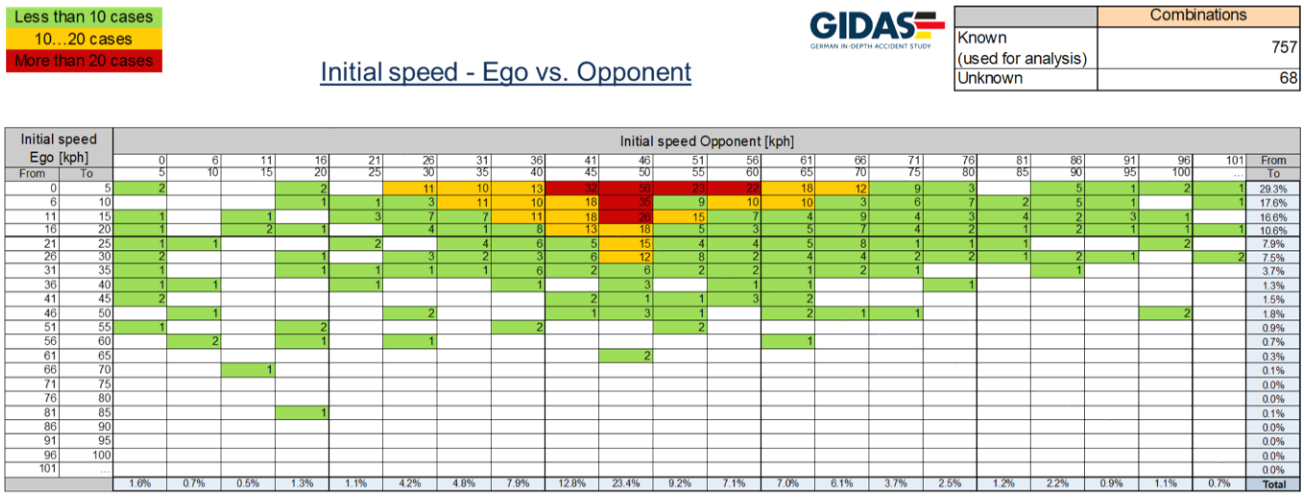


Figure 149: Initial speed of ego and opponent during accidents in LTAP-LD-PC [1]

In 63.5% of the cases, the initial speed of the ego vehicle was less than 16 kph. The initial speed of the opponent vehicle was most frequently between 36 kph and 65 kph (67.5%). The highest initial speed of the opponent was higher than the one of the ego vehicles.

3.14.3 Scenario conclusion

Accidents in *LTAP-LD-PC* happened mostly at intersections, where a participant (mostly the ego) had to observe the right of way. Failures to observe the traffic signs regulating the priority were the most frequent main accident causations. The traffic density was mostly comparatively light. View obstructions appeared relatively often. Most of them were due to vehicles and structural circumstances. Daylight and no rain during *LTAP-LD-PC* were relatively common. The initial speed of the opponent was mostly higher than the one of the egos.

3.15 SCENARIO 15 LTAP-LD - POWERED TWO-WHEELER

Figure 150 illustrates the participants in scenario 15, also called the *LTAP-LD-PTW*. The ego participant in this scenario is a passenger car turning to the left. The opponent is a powered two-wheeler coming from the left direction.

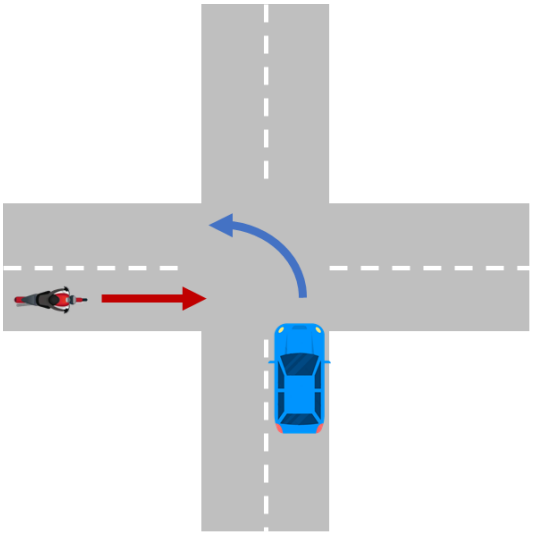


Figure 150: Pictogram LTAP-LD-PTW

3.15.1 SAFETY POTENTIAL

A system addressing and preventing *LTAP-LD-PTW* would prevent 3.7% of the slightly, 3.8% of the severely and 1.6% of the fatally injured powered two-wheeler occupants in the EU. More information about the safety potential of this scenario can be found in deliverable D1.1

3.15.2 RESULTS

In Figure 151 the distribution of precipitation during the accidents is shown.

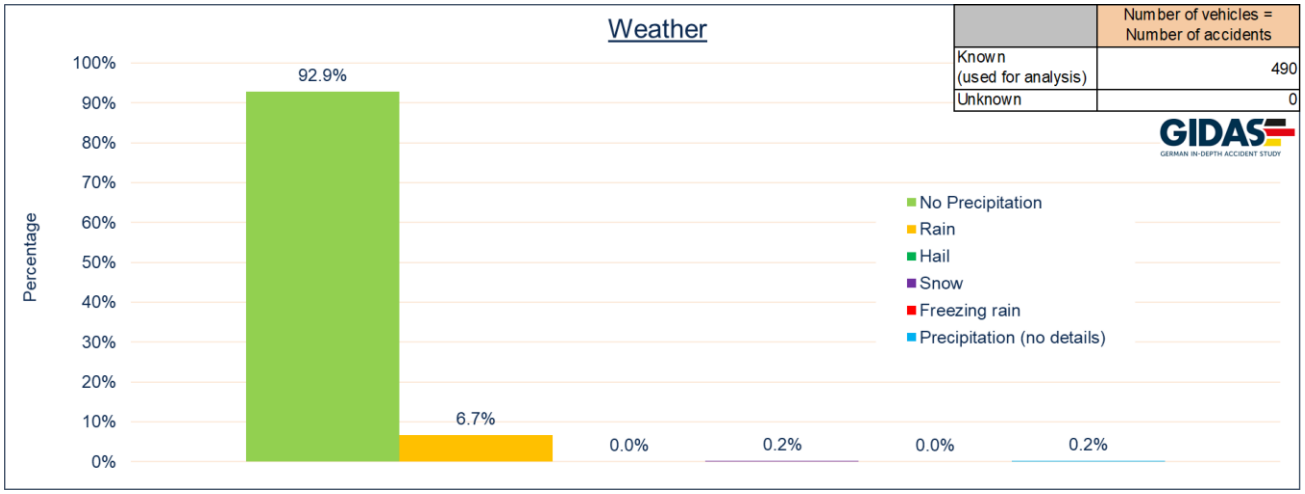


Figure 151: Weather conditions during accidents in LTAP-LD-PTW [1]

The majority of the accidents happened on dry weather conditions. Compared to other scenarios, only a relatively small percentage of accidents (6.7%) happened in rainy situations.

Figure 152 gives an overview of the light conditions during the accidents in *LTAP-LD-PTW*.

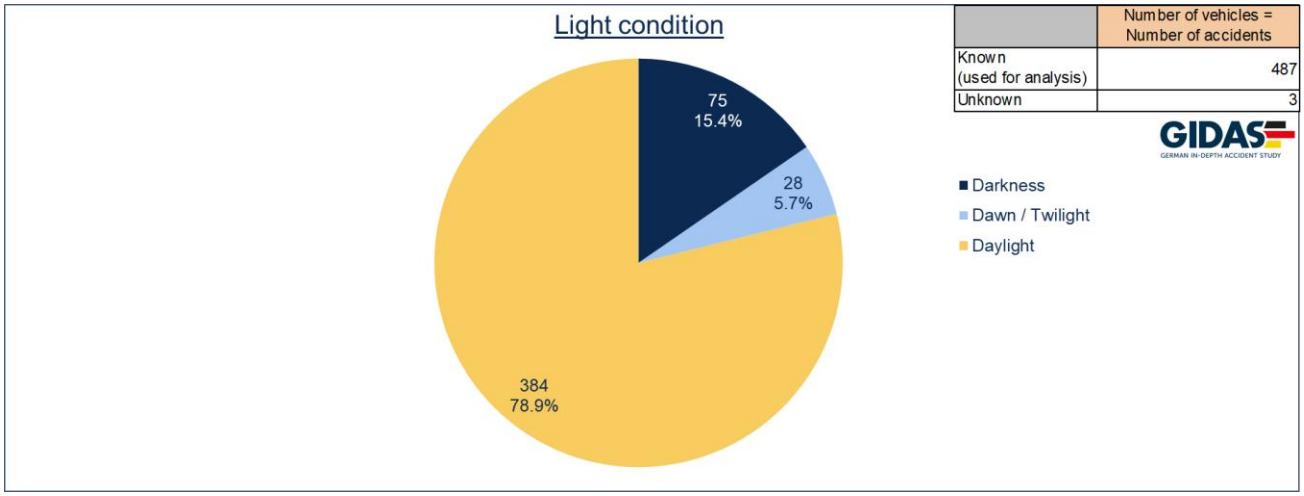


Figure 152: Light conditions during accidents in LTAP-LD-PTW [1]

Most accidents happened under daylight conditions. Only 21.1% of the accidents happened in the darkness or dawn/twilight.

Figure 153 shows the illumination of the road during accidents, which happened in darkness or dawn/twilight.

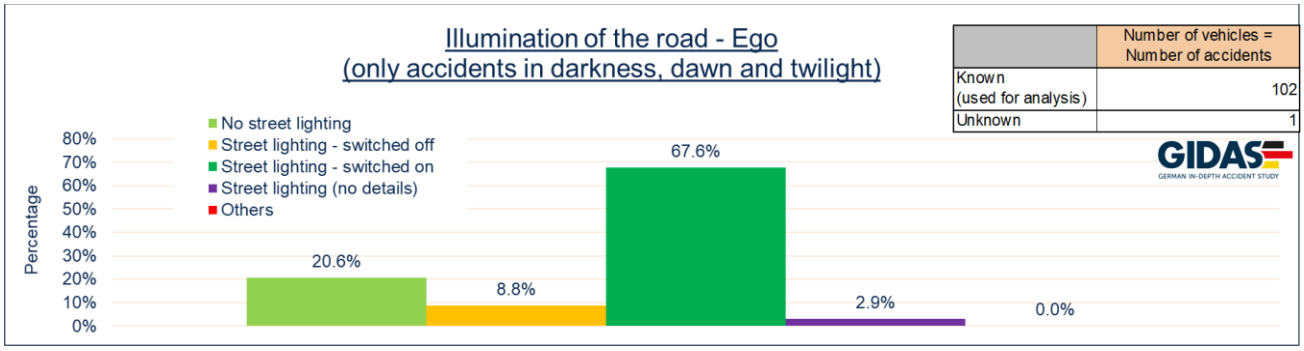


Figure 153: Illumination of the road during accidents in LTAP-LD-PTW [1]

In a little more than two out of three of these cases, the road was illuminated with street lighting. In nearly one third of the cases, there was no illumination of the accident site, either due to no existing street lighting or due to switched off street lighting

In Figure 154 the percentage of view obstruction for ego participants is shown.

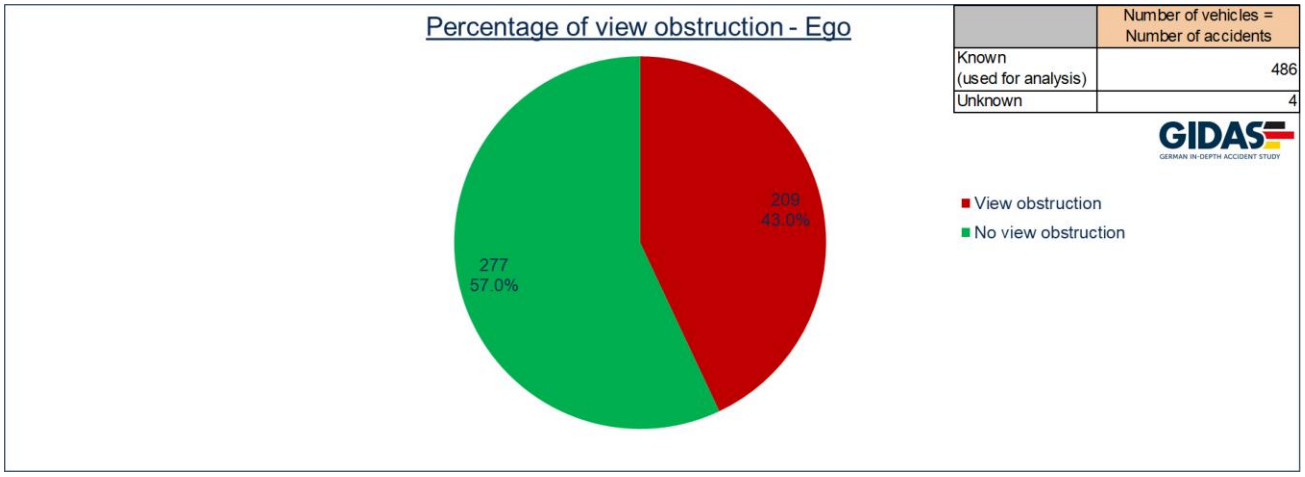


Figure 154: Percentage of view obstruction during accidents in LTAP-LD-PTW [1]

In a comparatively high percentage of 43% of the ego vehicles, the driver was influenced by a view obstruction.

In the following figure (Figure 155) the kind of view obstruction is shown for the cases, where a view obstruction existed.

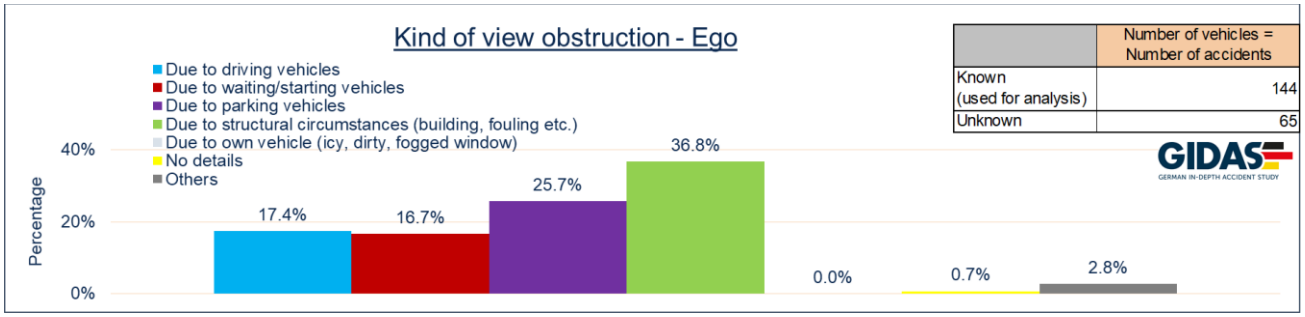


Figure 155: Kind of view obstruction during accidents in LTAP-LD-PTW [1]

Over one third of the view obstructions were due to structural circumstances. Also a high percentage of view obstructions was due to other vehicles (59.8%). Most of them were parking during the time of the accident.

In Figure 156 the road, where the ego participant was driving during the accident, is shown.

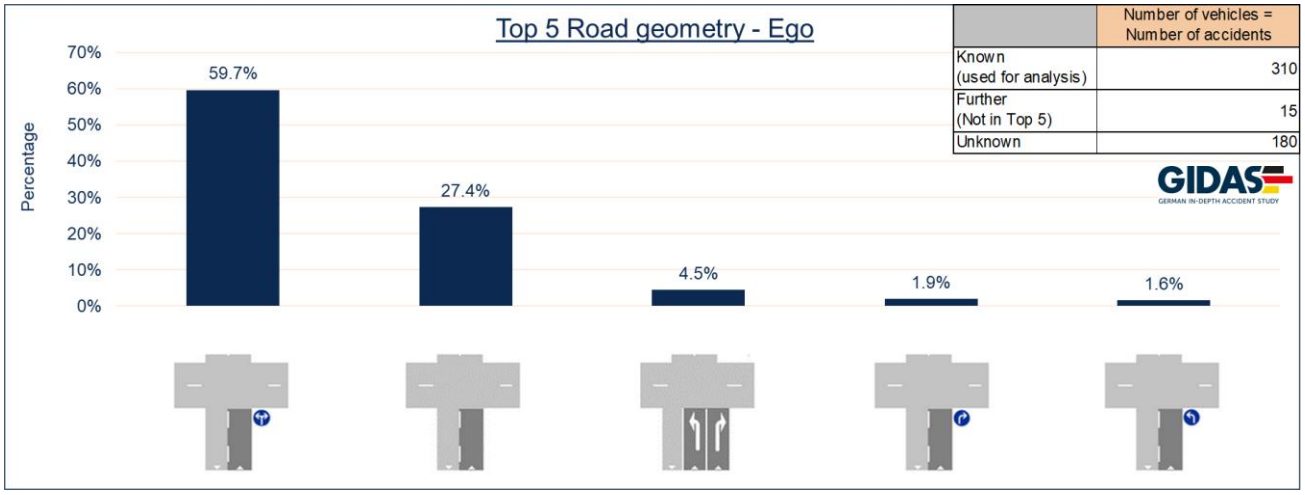


Figure 156: Top 5 Road geometry for the ego participant in LTAP-LD-PTW [1]

In nine of ten of the cases, the ego vehicle drove on an intersectional road with one single lane. In more than half of the cases, the driver of the ego vehicle was only allowed to turn right or left.

Figure 157 shows the kind of traffic regulation for the ego participant.

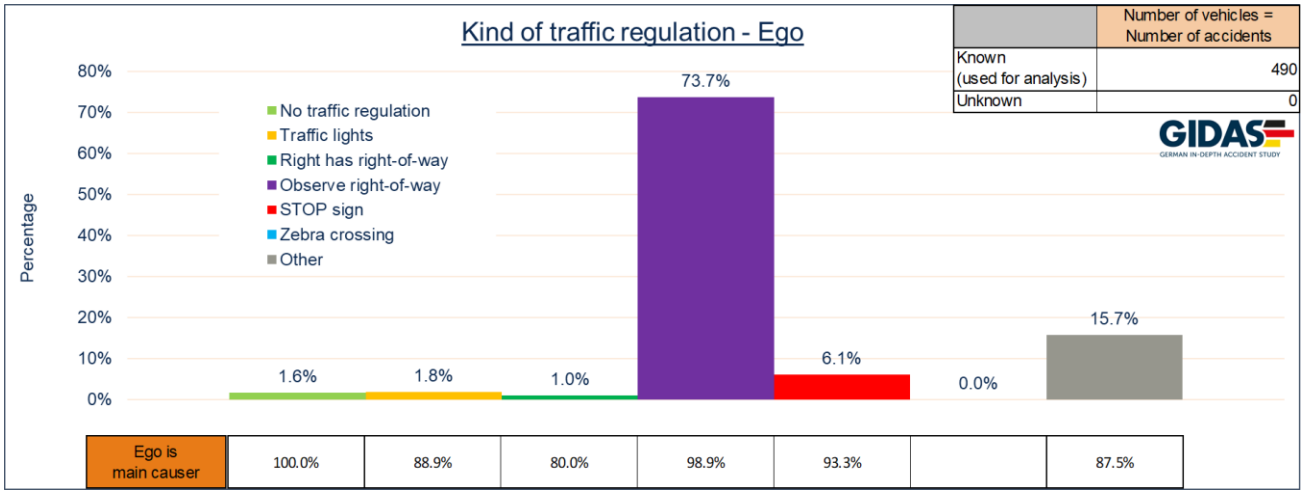


Figure 157: Kind of traffic regulation for the ego participant in LTAP-LD-PTW [1]

In the majority of cases (73.7%) one participant had to observe the right-of-way. In nearly all these cases, the ego vehicle was the main causer.

In Figure 158 the traffic density at the accident site for the ego is shown.

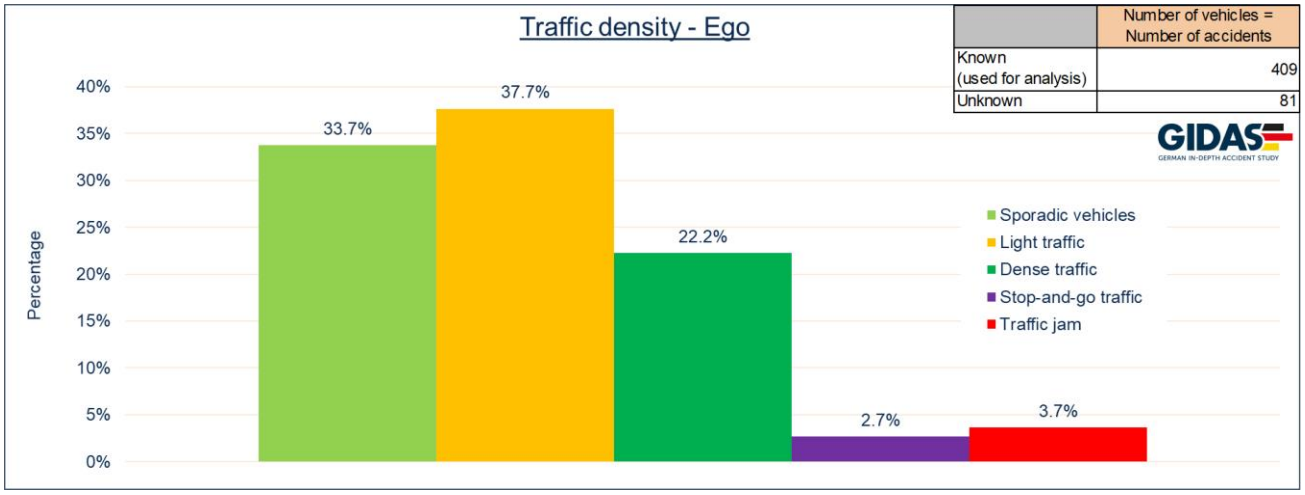


Figure 158: Traffic density for the ego participant in LTAP-LD-PTW [1]

In 71.4% of the cases, there was only sporadic vehicles or light traffic. About every fifth driver had an accident in a dense traffic situation.

In Figure 159 an overview of the main accident causations is given.

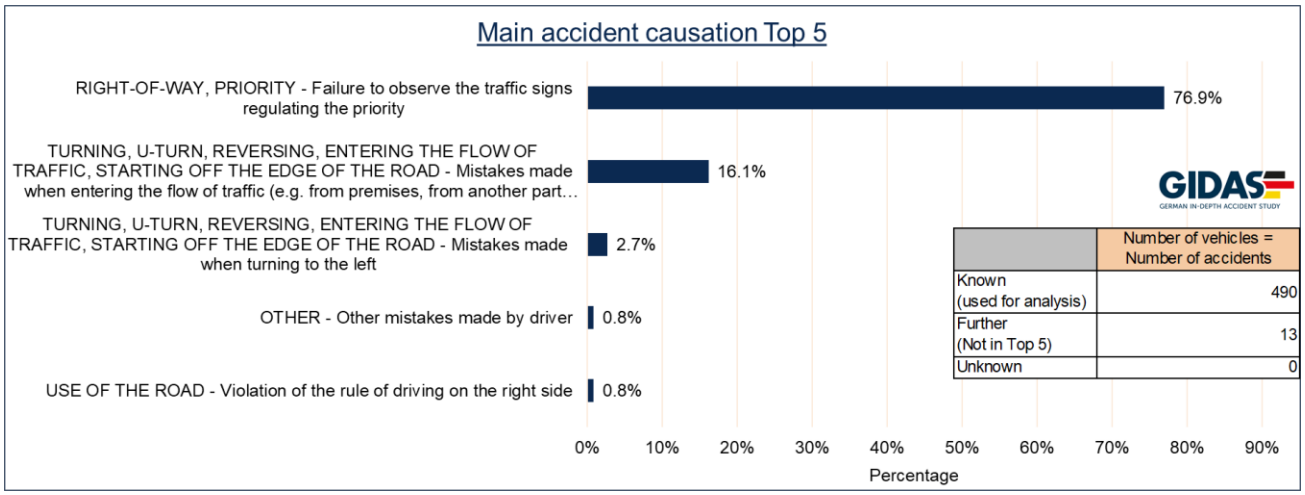


Figure 159: Top 5 main accident causation for accidents in LTAP-LD-PTW [1]

More than three out of four accidents were mainly caused by a failure at observing the traffic signs regulating the priority.

Figure 160 shows the initial speed of the ego vehicle and the opponent vehicle.

Less than 10 cases
10…20 cases
More than 20 cases

GIDAS GERMAN IN-DEPTH ACCIDENT STUDY

	Combinations
Known (used for analysis)	419
Unknown	71

Initial speed - Ego vs. Opponent

Initial speed Ego [kph] From	To	Initial speed Opponent [kph] 0	6	11	16	21	26	31	36	41	46	51	56	61	66	71	76	81	86	91	96	101	From
		5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	...	To
0	5	1			2	5	7	11	22	26	48	17	11	5	6	3	4	4	3			1	41.1%
6	10				1		4	12	17	11	14	2	3	3	3	3		1		1	2		18.4%
11	15	2	1		1	3	3	3	5	7	15	4	5	2	1			1	1				12.9%
16	20		1		1	3	5	9	8	8	9	2	6	2	2	2	2	1		1			14.8%
21	25	1			1		6	2	1	3	2	2	1	1								1	5.0%
26	30			1		1	1	4	2	3	1	1								1			3.6%
31	35							2		1			1										1.0%
36	40	1			2				3	1													1.7%
41	45										1	1											0.5%
46	50		1			1				2							1						1.2%
51	55																						0.0%
56	60																						0.0%
61	65																						0.0%
66	70																						0.0%
71	75																						0.0%
76	80																						0.0%
81	85																						0.0%
86	90																						0.0%
91	95																						0.0%
96	100																						0.0%
101	...																						0.0%
		1.2%	0.7%	0.2%	1.9%	3.1%	6.2%	10.3%	13.8%	14.8%	20.5%	6.9%	6.4%	3.1%	2.9%	1.9%	1.7%	1.7%	1.0%	0.7%	0.5%	0.5%	Total

Figure 160: Initial speed of ego and opponent during accidents in LTAP-LD-PTW [1]

In 63.5% of the cases, the initial speed of the ego vehicle was less than 16 kph. The initial speed of the opponent vehicle was most frequently between 31 kph and 60 kph (72.8%). The maximum initial speed of the opponent was higher than the one of the ego vehicles.

3.15.3 Scenario conclusion

Accidents in *LTAP-LD-PTW* happened mostly at intersections with a single lane, with one participant (mostly the ego) having to observe the right of way. Failures to observe the traffic signs regulating the priority was the most frequent main accident causation. The traffic density was comparatively light. View obstructions appeared relatively often. Most of them were due to vehicles and structural circumstances. Daylight and no rain during *LTAP-LD-PTW* were a little more often than in other scenarios. The initial speed of the opponent was mostly higher than the one of the ego vehicles.

CONCLUSION

This deliverable D1.2 is the last report of the WP1 which is focused on the accident data analysis and the definition of the relevant accident scenarios and their parameters. D1.2 is a continuation of Deliverable D1.1.

It contains all the results of the analyses carried out in the In-depth study of the selected accident scenarios according to the relevant parameters defined among the set of 16. With in-depth analysing the 15 most relevant scenarios listed in section 2 of this deliverable and further described in the SECUR deliverable D1.1, 70.6% of all the KSI accidents are covered.

In most of the scenarios, the percentage of cases with precipitation were relatively similar. In the loss of control scenarios, precipitation was more common, whereas in scenarios with cyclists or powered two-wheelers precipitation was more uncommon.

Similarly, accidents happened more often under daylight conditions when cyclists or powered two-wheelers were involved.

View obstructions were very unusual for Rear End accidents. In scenarios with pedestrians the view was often obstructed due to waiting or parking vehicles. In Straight Crossing Path scenarios, view obstructions due to structural circumstances were more often occurring than in other scenarios.

The Left Turn Across Path and Straight Crossing Path scenarios most of the time happened at intersections. At intersection the accidents with pedestrians are not the most frequent compared to other participants for similar scenarios. Furthermore, Oncoming and Rear End accident scenarios were also more unlikely to happen at intersections compared to other scenarios.

In Left Turn Across Path scenarios, the ego vehicle was most of the time the main accident causer. In these accidents, the ego often had to observe the right of way.

When the opponent was coming from the opposite direction during the Left Turn Across Path accidents, the traffic was also often regulated with traffic lights.

Traffic density was often higher at Rear End scenarios.

Mistakes when turning to the left were often the main accident causation in Left Turn Across Path and Oncoming scenarios, whereas speeding was most of the times the main accident causation in Loss of Control accidents.

The speed of the ego participant was mostly higher than the speed of the opponent vehicle during Straight Crossing Path accidents, while it was more likely lower during Left Turn Across Path accidents.

In Oncoming accidents, the rate of human failure was higher than in the Loss of Control accidents.

The representativity of the in-depth analysed data in GIDAS got confirmed with by analysing the IGLAD database regarding the distribution of the KSI occupants in the EU. These analyses can be found in the SECUR deliverable D1.1.

Finally, the above results are used in the next steps of the project and in particular for the definition of the SECUR use cases in WP3 (see D3.1) and to define the testing scenarios in WP5 (see D5.1).

ACKNOWLEDGEMENTS

The SECUR Project consortium would like to acknowledge for their support and work all the Partners and Third Parties involved:

Partners

Contributors

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[1] GIDAS, GIDAS Database, 2021.

[2] German Federal Statistic Office, DESTATIS Database.

[3] French Ministry Of Transport, BAAC Database, 2019.

[4] European Commission, Annual Accident Report 2018, 2018.

TABLE OF ILLUSTRATIONS

TABLE OF TABLES