Overview of main accident scenarios in car-to-cyclist accidents for use in AEB-system test protocol

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ABSTRACT
The overall number of fatalities in road traffic accidents in Europe is decreasing. Unfortunately, the number of fatalities among cyclists does not follow this trend with the same rate [5]. In the Netherlands, a major share of killed cyclists in traffic accidents was the result of a collision with a motorised vehicle [2]. The automotive industry is making a significant effort in the development and implementation of safety systems in cars to avoid or mitigate an imminent crash with vulnerable road users, and more specifically with cyclists. The current state-of-the-art of active safety systems, Autonomous Emergency Braking (AEB), is being widely introduced. A car equipped with AEB makes use of on-board sensors such as camera and radar, to track and trace traffic participants that possibly interfere with the trajectory of the car. This information is used to warn the driver in case of a possibly critical situation and/or to brake in case the driver does not respond and the risk of collision does not decrease. Currently, AEB systems that are designed to avoid car-to-car collisions are part of the Euro NCAP star rating. In 2016, Euro NCAP will include AEB systems for pedestrians in the star rating. It is the intention of Euro NCAP to include AEB systems for cyclists in the star rating beginning of 2018 [3]. To support and prepare the introduction of Cyclist-AEB systems and the resulting consumer tests of such systems, TNO has taken the initiative to set-up a consortium of car manufacturers and suppliers with the support of Euro NCAP laboratories (such as BASt) to develop a testing system and test protocol for Cyclist-AEB systems. This paper reports the first steps towards this protocol in which an in-depth road accident study is performed to determine what accident scenarios are most relevant for car-to-cyclist collisions. Data of killed and seriously injured cyclists due to collision with a passenger car were included in this study. An overview is given for the following European countries: Germany, the Netherlands, Sweden, France, Italy, and the United Kingdom. Analysis shows that scenarios in which the bicyclist crosses the trajectory of a car in an approximately perpendicular direction is most relevant in all studied countries. Longitudinal scenarios in which car and cyclist are driving in the same direction and the cyclist is hit at the rear end by the car also cover a significant portion of serious accidents.

Keywords: car, cyclist, AEB, safety-systems, scenarios, accidents.

1 INTRODUCTION

Where the number of road fatalities for the EU28 is decreasing every year, the number of cyclist fatalities decreases at a slower pace. In Figure 1, an overview is given of the total number of road fatalities and cyclist fatalities for France, Germany, Italy, the Netherlands, Sweden plus the UK over the period of 2001 to 2012 [4]. This graph clearly shows that the trend for cyclists is not decreasing at the same rate as for all road fatalities. It is believed that this is the result of the strongly increasing popularity for cycling in Europe [5] and consequently the increasing number of cyclists on the road.

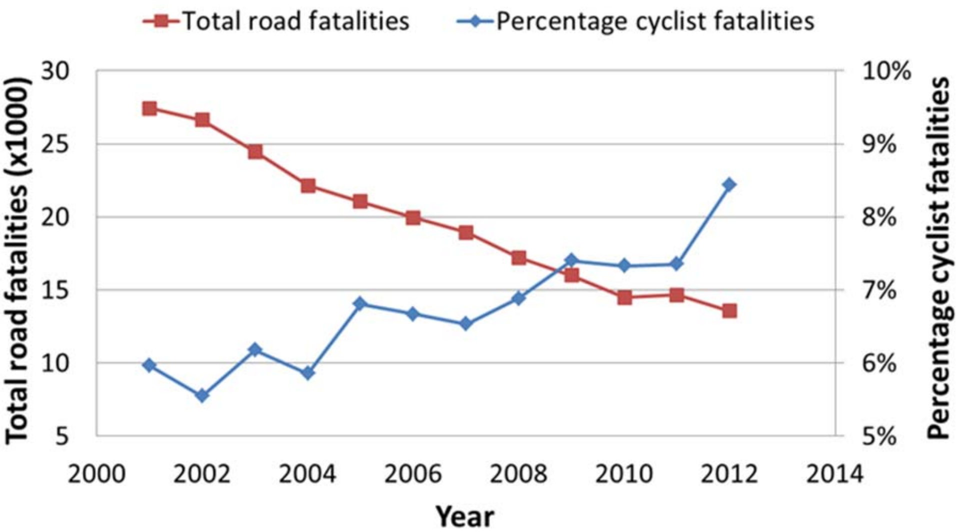


Figure 1. Trends of total road fatalities and cyclist fatalities for France, Germany, Italy, the Netherlands, Sweden plus the UK over the period of 2001 to 2012 [4].

To protect vulnerable road users in collisions with cars, the automotive industry is developing and implementing passive safety systems to mitigate injuries once a collision is unavoidable. More recently, in addition to passive safety systems, active systems are being developed and deployed that aim at collision avoidance and mitigation. With on-board sensors such as camera and radar, a real-time estimate is made of the current traffic situation, and the risk of running into a collision with other traffic participants is continuously calculated, in order to determine appropriate action. One of the most promising active safety systems, Autonomous Emergency Braking-systems (AEB) support the driver e.g. with an audio, visual and/or haptic warning and by automated braking to avoid or mitigate imminent crashes. Currently, AEB systems that aim at avoiding and mitigating car-to-car collisions are part of the Euro NCAP star rating. In 2016, Euro NCAP will make AEB for pedestrians part of their test protocol and star rating. Euro NCAP intends to include Cyclist-AEB systems in the safety assessment from 2018 [3].

In anticipation of the introduction of Cyclist-AEB systems and the corresponding consumer tests, a consortium (CATS: Cyclist-AEB Testing System) has been formed to prepare a test setup and test protocol that covers the most relevant accident scenarios for Cyclist-AEB systems and to develop the test tools necessary for such test. Data on accidents between cyclists and passenger cars have been collected from sources to cover as many different EU countries as possible. In addition to the CARE database [4], accident data have been collected specifically for Belgium, France, Germany, Hungary, Italy, the Netherlands, Spain, Sweden and the United Kingdom. Some data sources did not provide sufficient information on the accident configuration, and for this reason, data from Belgium, Spain and Hungary have not been included in this study. This paper presents data for France, Germany, Italy, the Netherlands, Sweden and the United Kingdom.

As data originate from different sources, data had to be merged into one common scenario template before analysing the importance of different accident scenarios. The used methods are discussed in the next section. After the data has been collected into the common template, the results of the analyses will be shown per country, differences between countries will be discussed and an overall conclusion on the relevance of different scenarios will be drawn.

2 METHOD

A road traffic accident data analysis has been performed covering 6 European countries:

France: Data are considered from LAB (Laboratoire d'Accidentologie et de Biomécanique et d'études du comportement humain PSA Peugeot Citroën – RENAULT) that use a database created for the French project called VOIESUR [6]. The objective of this database is to have an intermediary level of detail between national data and in-depth data. The codification has been done from French police reports. About 8.500 accident cases were coded by a specialist during 1,5 years. The databases distinguishes between fatalities, severely injured (hospitalized for at least 24h) and slightly injured (received medical care but not admitted to hospital for more than 24h).

Germany: Three data sources for Germany have been studied:

GIDAS, the German In-Depth Accident Study, is a cooperation between BASt and the Automotive Research Association (FAT). Approximately 2,000 accidents involving personal injury are recorded in the area of Dresden and Hanover annually. From GIDAS, data were used for fatalities (check-box: killed within 30 days after the accident) and seriously injured coded as AIS2+ , excl. fatalities (according to the abbreviated injury scale [7]).

GIDAS-based PCM [8]: By simulating the pre-crash scenario, additional and standardized data to describe the pre-crash-sequence of an accident are generated and documented in an additional database called GIDAS-based Pre-Crash-Matrix (PCM) in very high detail. The PCM contains the major relevant data to reproduce the pre-crash-sequence of traffic accidents from the GIDAS database until 5 seconds before the first collision.

German national accident data comprising a five years period from 2008 to 2012 from the official German national accident statistics enriched by data from BASt.

Italy: Fiat Group Automobiles enforces accident data collection from 2011. The in-depth accident database is an FIAT internal database [9] with the following information: accident circumstances, vehicle and injury severity (killed, injured, not injured; each injury is coded according to AIS [7]). For the CATS activities, a distinction is made between fatalities (killed) and injured (MAIS ≥ 2, excl. fatalities). Data are collected in cooperation with several Italian Universities and the police.

Netherlands: BRON Netherlands national road crash register; police registered numbers of casualties, drivers and crashes [10]. Serious road injuries are reported to be casualties who have been seriously injured in a traffic crash in the Netherlands. This means that they have been admitted to a (Dutch) hospital with injury of a minimum AIS value of 2 for which they received treatment. The seriously injured numbers are exclusive of the number of fatalities (defined as killed due to the accident, within 30 days after the accident happened).

Sweden: Data are used from the Swedish Transport Administration fatal database STA and the Swedish Traffic Accident Data Acquisition STRADA [11]. STRADA is a national information system collecting data of injuries and accidents in the entire road transport system. STRADA is based on information from the police as well as the hospitals. The hospital records consist of ICD diagnoses and AIS coded injuries. Car-to-cyclists cases resulting AIS2+ were selected from STRADA.

United Kingdom: The STATS19 Road Accident dataset is used for the UK [12]. The police definition of serious injury covers casualties admitted to hospital, as well as those with specific types of injury (for example fractures or severe cuts). Severity of injury is known to be prone to misclassification in STATS19 due to the difficulties of such assessment by non-experts at the scene of the accident. Comparisons with death registration statistics show that very few, if any road accident fatalities are not reported to the police.

Accidents involving one bicycle and one M1 vehicle (passenger car) were selected. The bicycle is defined as a legal bicycle, which excludes mopeds, scooters or speed-pedelecs. Results will be presented for the numbers of fatalities (or killed K) and of seriously injured (SI).

Table 1. Overview of analyzed road traffic accident data sources

#	Country	Source	Killed (K)		Seriously Injured (SI)		Period
			definition	*n*	*definition*	*n*	
1	France	LAB	Fatal	72	severely injured	620	2011
2	Germany	GIDAS based PCM	Fatal	11	AIS2+	360	1999-2012
3	Germany	GIDAS*	Fatal	12	AIS2+	514	2006-2013
4	Germany	National accident statistics	Fatal	345	AIS2+	11964	2008-2012
5	Italy	FIAT internal database	Fatal	23	AIS2+	17	2003-2014
6	Netherlands	BRON	Fatal	902	seriously injured	10854	2000-2013
7	Sweden	STA/STRADA	Fatal	104	AIS2+	435	2005-2014 K 2010-2014 SI
8	UK	STATS19	Fatal	116	seriously injured	2699	2008-2010

The following pre-processing of data was performed before the data were used:

- Five datasets referring to German accidents were received for analysis from different sources: 3 based on GIDAS, one dataset using the GIDAS-based Pre-Crash-Matrix (PCM), and one dataset referring to national accident statistics. In a sensitivity study [13], these 5 datasets were compared. As the study revealed that the same trends in distribution over the scenarios are found, only one dataset has been selected for inclusion in the current study. The GIDAS-based PCM dataset provides most details on accident parameters, and is consequently used. Analyses have shown that PCM is highly representative for GIDAS and GIDAS is highly representative for Germany.
- The dataset from the UK (STATS19) has been translated towards right-hand driving conditions at the EU main land.

To provide sufficient data for analysis, cases in the various databases for a larger period of time are considered. The evolution of accident scenarios with time is not studied, and consequently the occurrence of scenarios is assumed constant.
Figure 2 shows the accident scenarios that are distinguished in CATS. As can be seen in this figure, the road layout is not included in the scenario definitions; the scenario is defined by the combination of the orientation of the bicycle with respect to the car and the driving manoeuvre of the car and the bicycle. This is similar to the approach as used in the FP7 AsPeCSS project to propose pedestrian test scenarios [12], which formed the basis for the Euro NCAP pedestrian test protocol. Accident data

* Three independent studies using the GIDAS database were received; only the one in which AIS2+ does not include fatalities is shown in the table for clarity.

from 6 European countries have been analysed and the number of fatalities and seriously injured were distinguished regarding the 10 scenarios from Figure 2. Accidents that could not be assigned to any of the 10 scenarios have been allocated to the group Remaining (Re).

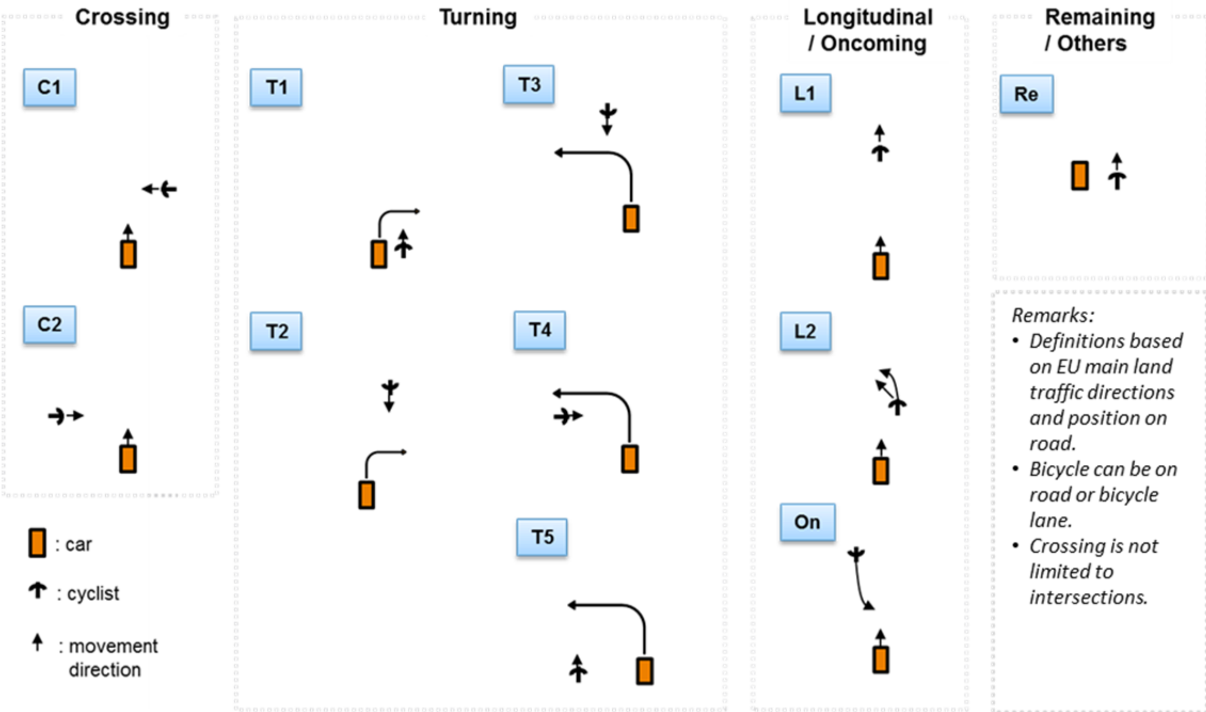


Figure 2 Overview of distinguished car-to-cyclist accident scenarios

Table 2. Description of car-to-cyclist accident scenarios

Scenario	Description
C1	• Car driving straight • Cyclist crossing the vehicle path from the near side
C2	• Car driving straight • Cyclist crossing the vehicle path from the far side
T1	• Car turning right • Cyclist is riding straight in the same direction as the heading of the car before turning • Blind spot scenario
T2	• Car turning right • Cyclist is riding straight in the opposite direction as the heading of the car before turning
T3	• Car turning to the left, crossing the (straight) bicycle path • Cyclist coming from the opposite direction, riding straight
T4	• Car turning to the left, crossing the (straight) bicycle path • Cyclist is riding straight, coming from the far side of the car. • Some similarity with C2
T5	• Car turning to the left, crossing the (straight) bicycle path • Cyclist is riding straight in the same direction as the heading of the car before turning
L L1 L2	• Car and cyclist driving in the same direction • Cyclist is riding straight and hit by the car from the rear • Cyclist is swerving to the left in front of the car and hit by the car from the rear
On	• Car driving straight, possibly driving towards the far road side in a passing manoeuvre • Bicyclist coming in the opposite (on-coming) direction riding straight
Re	• All other scenarios that are not covered by any of the previously described scenarios.

An extensive check has been performed to determine whether the 10 scenarios given in Figure 2 cover all relevant scenarios for car-to-cyclist collisions. This was done by comparing the scenarios of Figure 2 to an approach followed by Autoliv [14] in which a matrix is used with 12 scenarios that do cover 100% of all possible collision variations:

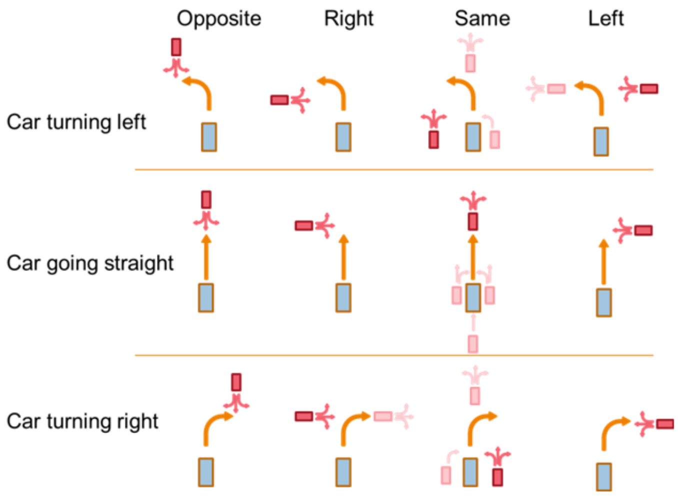


Figure 3. Matrix approach to cover 100% of the collision scenarios

In Figure 4 all CATS scenarios are merged with the matrix approach. Since the scenarios in GIDAS-based PCM are well described, data from this database are used to check how well the CATS scenarios cover the relevant scenarios. The percentages that are given in each of the matrix cells indicate the percentage of GIDAS-based PCM AIS2+ cases that cover the scenarios in that cell. The match is shown for AIS2+ to have a sufficient number of representative cases to be divided over the scenarios. Cells that solely include 'pink' car turning scenarios cover only a small portion of the GIDAS-based PCM scenarios (less than 3%), except for T14 (which covers a percentage of 11%). This is due to the strict definition of a turning car in GIDAS-based PCM, where a car with a small steering angle is already defined as turning, which is not the case in other databases. Actually, there is a large similarity between the T14 and the C1 scenario.

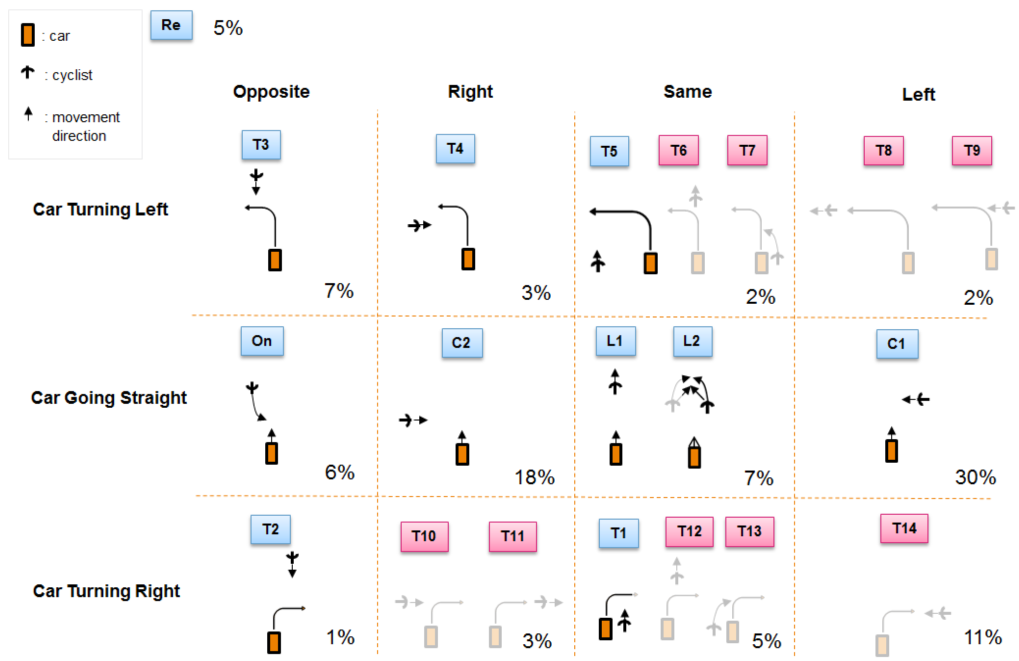


Figure 4. Merging the GIDAS based PCM scenarios to the CATS scenarios in the matrix approach

The mixed cells {T5, T6, T7} and { T1, T12, T13} only cover a relatively small percentage (≤5%), and in those cells, the scenarios T1 and T5 (that are part of the CATS scenarios) are more likely to occur than the other scenarios. The remaining group Re covers for example the scenarios in which the cyclists is colliding with a slow or parked vehicle. This group is distinguished from the L scenarios.

Making the conversion from the scenarios in Figure 2 to the matrix approach in Figure 3, confirms that all relevant scenarios are captured by the scenarios from the CATS approach in Figure 2, except for scenario T14, which shows large similarities with C1. Consequently, the scenario classification from Figure 2 will be used from now on.
The data from the databases do not show a clear distinction between the scenarios L1 and L2. In Figure 5, the heading and position of the bicycle with respect to the car is given for many different longitudinal scenarios from the detailed GIDAS-based PCM database at 2 seconds before collision. Even in these detailed data, no clear distinction can be made between the L1 and L2 scenario.

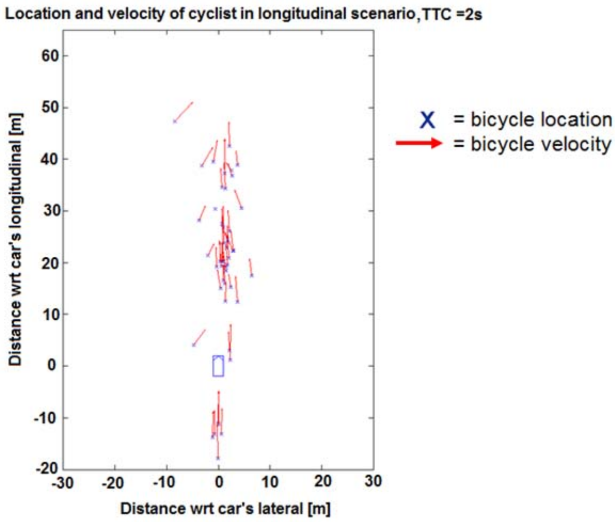


Figure 5. Location and heading of bicycle with respect to the car for several cases 2 seconds before collision.

Consequently, these two scenarios are combined into one longitudinal scenario L. For the definition of the test protocol in a later stage, the selection of test parameters should reflect the fact that both L1 and L2 are covered by L.

Now that the scenario classification is selected, the distributions for these scenarios in the different databases need to be determined. Since each database uses a different strategy in coding scenarios, this conversion is done per database separately. By means of an example, Appendix A shows how the conversion is performed for the databases from the 6 countries.

For selection and prioritization of car-to-cyclist accident scenarios to be included in a test protocol, information needs to be further merged into a single percentage for each scenario. This percentage should provide an indication how many fatalities and seriously injured are covered in the 6 considered countries. A weighting method is proposed in which an average percentage is determined over the 6 countries, based on the number of cyclist fatalities per million inhabitants taken from the CARE database [4]. In this way, a single percentage for each scenario results, weighting the percentages for the different countries to the number of cyclists fatalities per million inhabitants. In other words, the larger the percentage of cyclist fatalities in a country, the larger the weight of the specific car-to-cyclist scenarios that are found for the related country. The weighting factors are given in the table below:

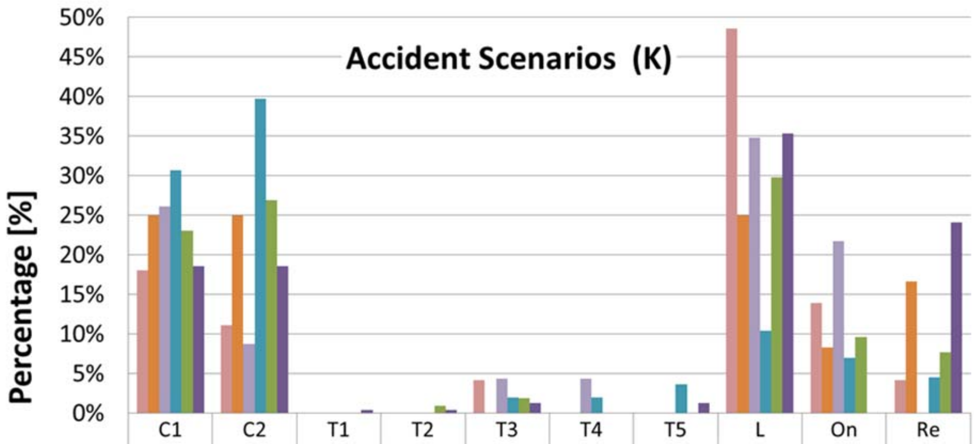
Table 3. Weighting factors based on the ratio of cyclist fatalities and the total number of road fatalities per one million inhabitants in 2001-2010 [4]

Country	# road fatalities per million inhabitants	# cyclist fatalities per million inhabitants	Weighting [%]
France	62	2,8	11%
Germany	45	6,0	26%
Italy	68	5,4	-
Netherlands	32	9,2	38%
Sweden	28	3,6	15%
UK	30	2,3	10%

The FIAT internal database is not considered in this weighting, since the cases in the database are assumed not to be representative for Italy, and therefore this database cannot be used for statistical analyses.
Further research is needed to develop an appropriate approach for weighting the results for essentially different databases.

3 RESULTS AND DISCUSSION

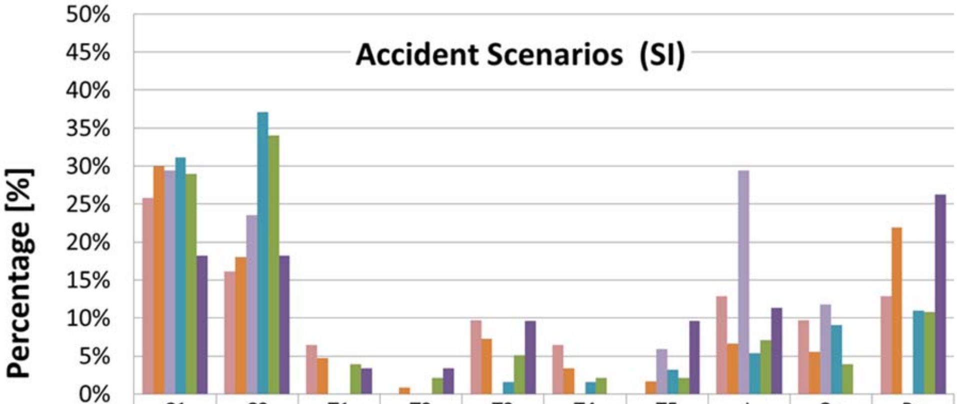
For the 6 considered countries, the percentages of killed and seriously injured are calculated for each of the accident scenarios from Figure 2. This results in the following distributions of fatally injured (K) and seriously injured (SI) over the different accident scenarios:



	C1	C2	T1	T2	T3	T4	T5	L	On	Re
France	18%	11%	0%	0%	4%	0%	0%	49%	14%	4%
Germany	25%	25%	0%	0%	0%	0%	0%	25%	8%	17%
Italy	26%	9%	0%	0%	4%	4%	0%	35%	22%	0%
Netherlands	31%	40%	0%	0%	2%	2%	4%	10%	7%	5%
Sweden	23%	27%	0%	1%	2%	0%	0%	30%	10%	8%
UK	19%	19%	0%	0%	1%	0%	1%	35%	0%	24%

Figure 6. Distribution of fatally injured over the 9 accident scenarios that are distinguished for 6 EU countries.

Figure 6 clearly shows that, looking to the number of fatalities, the scenarios C1 (crossing cyclist from the near side), C2 (crossing cyclist from the far side) and L (longitudinal scenario where the vehicle collides from the rear of the cyclist) are dominant. Also the On-scenario (in which the front of the car collides with the front of the cyclist) seems relevant, but it covers clearly a smaller number of accidents than C1, C2 and L. From the turning scenarios (T1 to T5), only T3 (cyclist running straight, vehicle turning left) seems to be of relevance, but the fraction for T3 is small compared to C1, C2, or L.



	C1	C2	T1	T2	T3	T4	T5	L	On	Re
France	26%	16%	6%	0%	10%	6%	0%	13%	10%	13%
Germany	30%	18%	5%	1%	7%	3%	2%	7%	6%	22%
Italy	29%	24%	0%	0%	0%	0%	6%	29%	12%	0%
Netherlands	31%	37%	0%	0%	2%	2%	3%	5%	9%	11%
Sweden	29%	34%	4%	2%	5%	2%	2%	7%	4%	11%
UK	18%	18%	3%	3%	10%	0%	10%	11%	0%	26%

Figure 7. Distribution of seriously injured over the 9 accident scenarios that are distinguished for 6 EU countries.

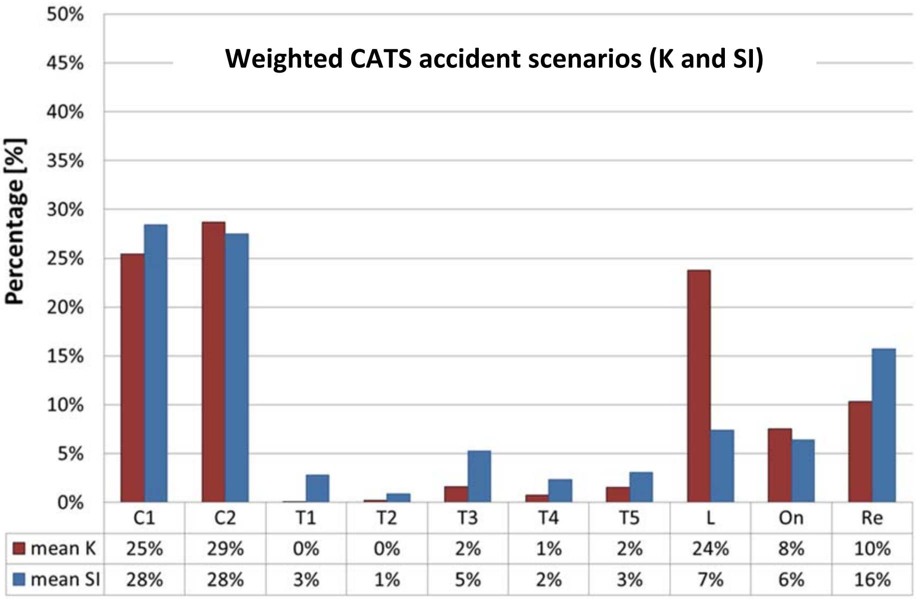
The relevance of the top-3 of scenarios for fatalities does not deviate between countries; the top-3 scenarios contain the same scenarios for all 6 countries (Appendix: Figure 10), except for the fatal scenarios in France and Italy. Some deviations are seen in priorities per country between the top-3 of C1, C2, and L. For France, a considerable higher fraction of fatalities is found for the longitudinal scenario L, compared to the crossing scenarios C1 and C2. It should be noted that the data from France only cover the period of one year, and that a relatively small number of fatalities have been included in this study. In contrast, for the Netherlands the L-scenario is rather small compared to C1 and C2. Covering 14 years and over 900 fatalities in total, this is expected to be significant. A possible reason is found in the wide application of separated bike lanes, especially along rural roads in the Netherlands. Herewith the cyclists and motorized vehicles are physically separated, leading to only a relatively small number of fatalities in L-scenarios. In general, due to the high speed difference on rural roads, a collision according to an L scenario will more easily result in fatal injury for the cyclist. This not only leads to a small percentage for L in the Netherlands, but also to relatively higher values for C1 and C2.

Another striking result is the fact that in the Netherlands the C2 scenario (bike crossing from far side) shows a higher percentage than the C1 scenario (bike from near-side). A possible explanation results from the fact that the parameters describing the accident scenario in the Dutch BRON database [10] are limited. An approach is followed in which scenarios as described in BRON are translated to the scenarios from Figure 2. For many crossing scenarios in BRON, no distinction is made between near side or far side scenarios (see Appendix A). Consequently, 50% of those crossing scenarios are allocated to C1 and the other 50% to C2. Other scenarios are clearly indicated as far side, making the fraction of C2 scenarios larger than the C1 scenarios.

The distribution for accidents leading to seriously injured cyclists deviates slightly from that for fatalities. Most clearly seen is the strong decrease in the percentage allocated to the L scenario. Although still present as one of the top-3 dominant scenarios, it cannot easily be distinguished from the On-scenario, except for Italy, where the L scenario for seriously injured is as important as the C1 crossing scenario (Appendix B Figure 11).

It should be noted that the data from Italy come from an in-depth database and are not intended to perform statistical analyses with. Therefore, in the remainder of this paper, the small number of Italian cases will not be considered for further analysis and comparison with other countries.

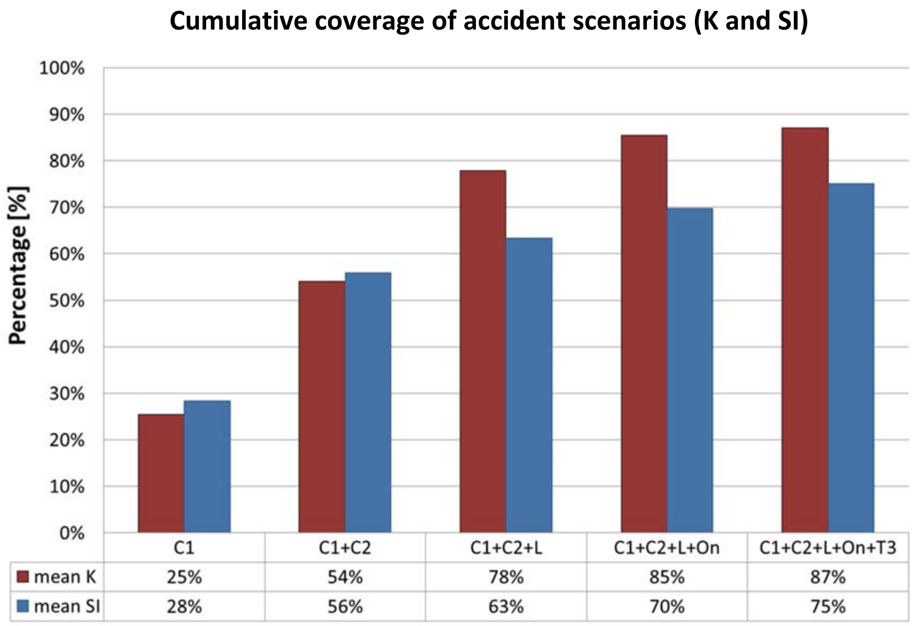
Based on the weighting method that is proposed in the previous section, an average percentage is determined over 5 countries (the original 6 minus Italy), based on the number of cyclist fatalities per million inhabitants taken from the CARE database [4]. The weighted average over the countries except Italy, using the factors from Table 3, is given in the next graph (for both fatalities and seriously injured):



	C1	C2	T1	T2	T3	T4	T5	L	On	Re
mean K	25%	29%	0%	0%	2%	1%	2%	24%	8%	10%
mean SI	28%	28%	3%	1%	5%	2%	3%	7%	6%	16%

Figure 8. Distribution of fatalities and seriously injured over the 9 accident scenarios, weighted average over 5 countries. The red columns refer to fatalities (K), where the blue columns refer to seriously injured (SI).

This figure shows that C1 and C2-scenarios are dominant and equally important, followed by the L-scenario. Less important is the On-scenario. From the scenarios where the car is making a turn (T), the T3-scenario is most common, but this scenario is covering less accidents than the C1, C2, and L scenario. Next graph presents the cumulative coverage of the most important scenarios:



	C1	C1+C2	C1+C2+L	C1+C2+L+On	C1+C2+L+On+T3
mean K	25%	54%	78%	85%	87%
mean SI	28%	56%	63%	70%	75%

Figure 9. Cumulative coverage of scenarios in the order of importance.

4 CONCLUSION

Putting the scenarios in order of relevance and importance, considering the number of fatalities and seriously injured due to car-to-cyclist collisions in the EU-countries France, Germany, Italy, the Netherlands, Sweden and the UK, the next sequence applies: C1, C2, L, On and T3. The scenarios C1, C2 and L together cover already between 78% and 63% of the fatal and serious car-to-cyclist accidents respectively.

Table 4. Description of scenarios in order of importance to cyclist casualties due to collision with a passenger car.

Scenario	Description	% covered for K	% covered for SI
C1	• Car driving straight • Cyclist crossing the vehicle path from the near side	25	28
C2	• Car driving straight • Cyclist crossing the vehicle path from the far side	29	28
L L1 L2	• Car and cyclist driving in the same direction • Cyclist is riding straight and hit by the car from the rear • Cyclist is swerving to the left in front of the car and hit by the car from the rear	24	7
On	• Car driving straight, possibly driving towards the far road side in a passing manoeuvre • Bicyclist coming in the opposite (on-coming) direction riding straight	8	6
T3	• Car turning to the left, crossing the (straight) bicycle path • Cyclist coming from the opposite direction, riding straight	2	5

Next step in the test protocol development is the determination of the test parameters such as vehicle speed, bicycle speed, the presence of view blocking obstructions, collision point on the vehicle, type of bicycle and size of cyclist. Moreover, parameters describing the level of light or precipitation need to be selected. The car-to-cyclist accidents from the databases used for scenario selection will be studied to provide ranges for these parameters that give a representative coverage of the real-life conditions. In addition to that, observation studies may be used in case not all parameters can be selected based on the currently available data in the databases. These studies might for instance be used for the presence and size of view blocking obstructions.

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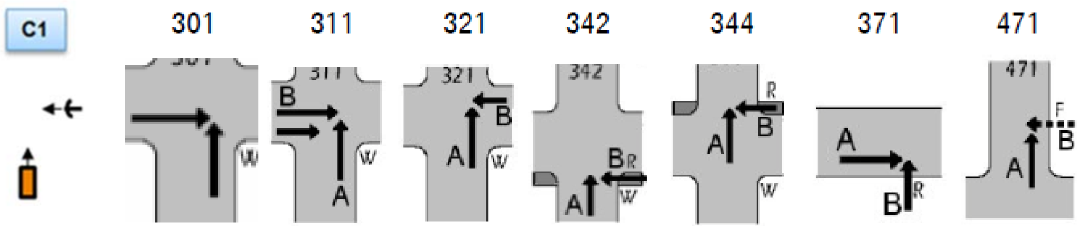
APPENDIX A: CONVERSION OF DATABASES TO CATS SCENARIOS

In each of the databases, the accident scenarios describing the movement of car and bicycle just before the collision, is coded and described in a different way. Consequently, the conversion of scenarios from the database to the scenarios from Figure 2, has been performed separately. The conversion for each of the countries is explained by an example:

France: LAB France provided the data according to the scenarios from Figure 2. Although a distinction was made in e.g. C1 for a regular intersection and C1 for a roundabout, in the total results such distinction is no longer made.

Germany: In the GIDAS database, the scenarios are coded with a 3-digit code. In a conversion table the different scenarios are related to the scenarios from Figure 2. As an example, the figure below shows which GIDAS scenarios are all considered a bicycle crossing from the near side C1:



Italy: Each of the 40 cases in the FIAT internal database were studied separately. From a description of the movement of bicycle and car, one of the CATS scenarios was selected. Thereafter, for each of the CATS scenarios, the number of cases (fatal or seriously injured) were added to the results shown in Figure 6 and Figure 7.

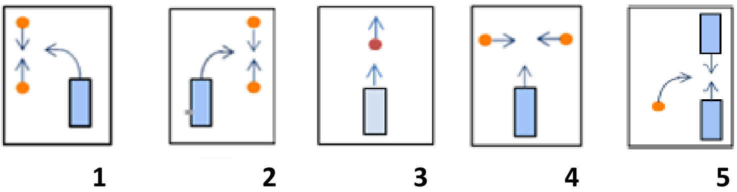
The Netherlands: In the BRON database, each case is related to a manoeuvre. A list of many different manoeuvres is used in BRON. By selecting car-to-cyclist fatalities (and similar for seriously injured), the number of cases per manoeuvre is given, and the resulting list is sorted upon the percentage of cases covered by the manoeuvre. Only those manoeuvres are considered that at least cover 2% of the cases. In the table below, an example is given for fatalities for some of the most relevant manoeuvres:

Manoeuvre	# fatalities	CATS scenarios	Distribution proposed
Side impact on crossing	327	C1 / C2	50% C1, 50% C2
Other side impact	190	C1 / C2	50% C1, 50% C2
Right side impact with crossing vehicle	85	C2	100% C2
Rear end collision without turning	75	L1 / L2	50% L1, 50% L2
Frontal without lane change	63	On	100% On

After the manoeuvres have been attributed to the CATS scenarios, all cases (for fatalities and seriously injured separately) are added for the CATS scenarios, to come to the results given in Figure 6 and Figure 7.

Sweden: Autoliv provided the data according to the scenarios from Figure 2 [11]. Each accident case was opened up from the two databases STA and STRADA and accident descriptions were studied in detail case-by-case to conclude the most likely accident scenario in each case.

UK: Data from the UK were distinguished in 5 accident scenarios according to [15]:



In a second step, CATS scenarios were allocated to each of these 5 scenarios according to the next scheme:

UK accident scenario	CATS scenarios	Distribution proposed
1	T1 / T2	50% T1, 50% T2
2	T3 / T5	50% T3, 50% T5
3	L1 / L2	50% L1, 50% L2
4	C1 / C2	50% C1, 50% C2
5	C1 / C2	50% C1, 50% C2

All CATS scenarios that could not be allocated to one of the UK scenarios was put in the group “other”. This group consists of T4, On, and Re. No further distinction was made for the latter group, which results in the fact that no estimate is given for the percentage covered by the On-scenario.

APPENDIX B: OVERVIEW OF SCENARIO RELEVANCE PER COUNTRY

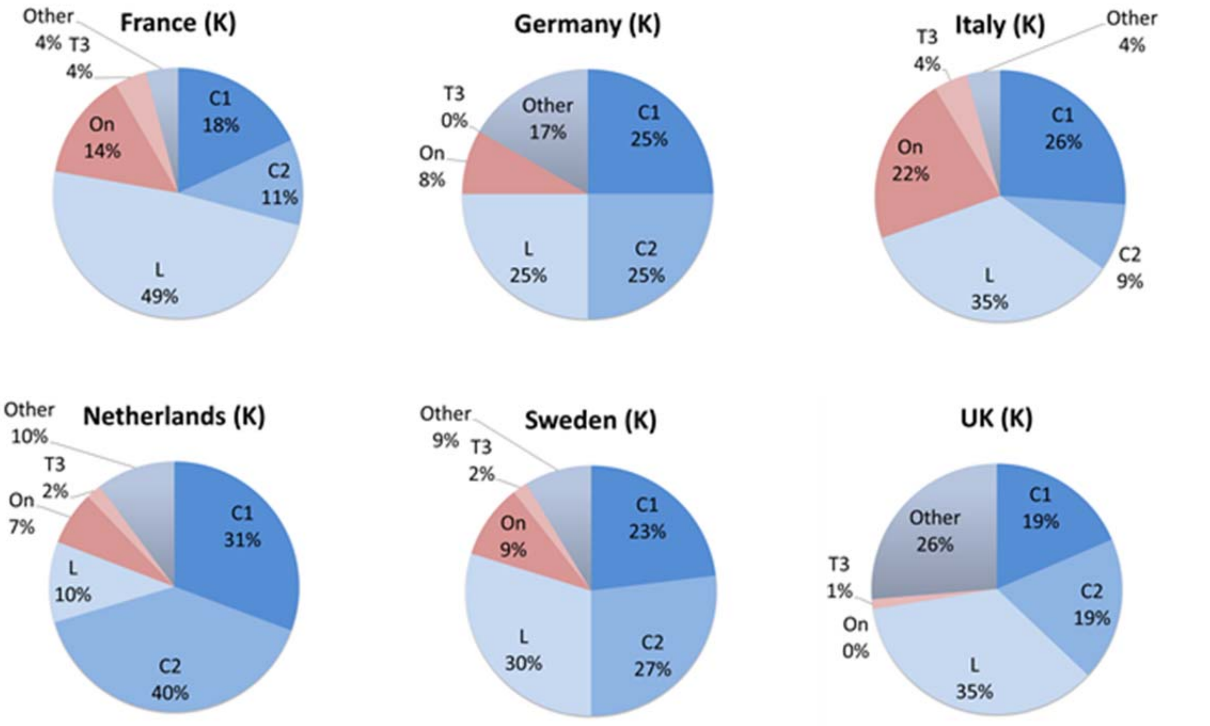


Figure 10. The distribution of scenarios per country for the fatal cyclist accidents. In blue the scenarios C1, C2 and L, in red the scenarios On and T3, and in grey all remaining scenarios (other).

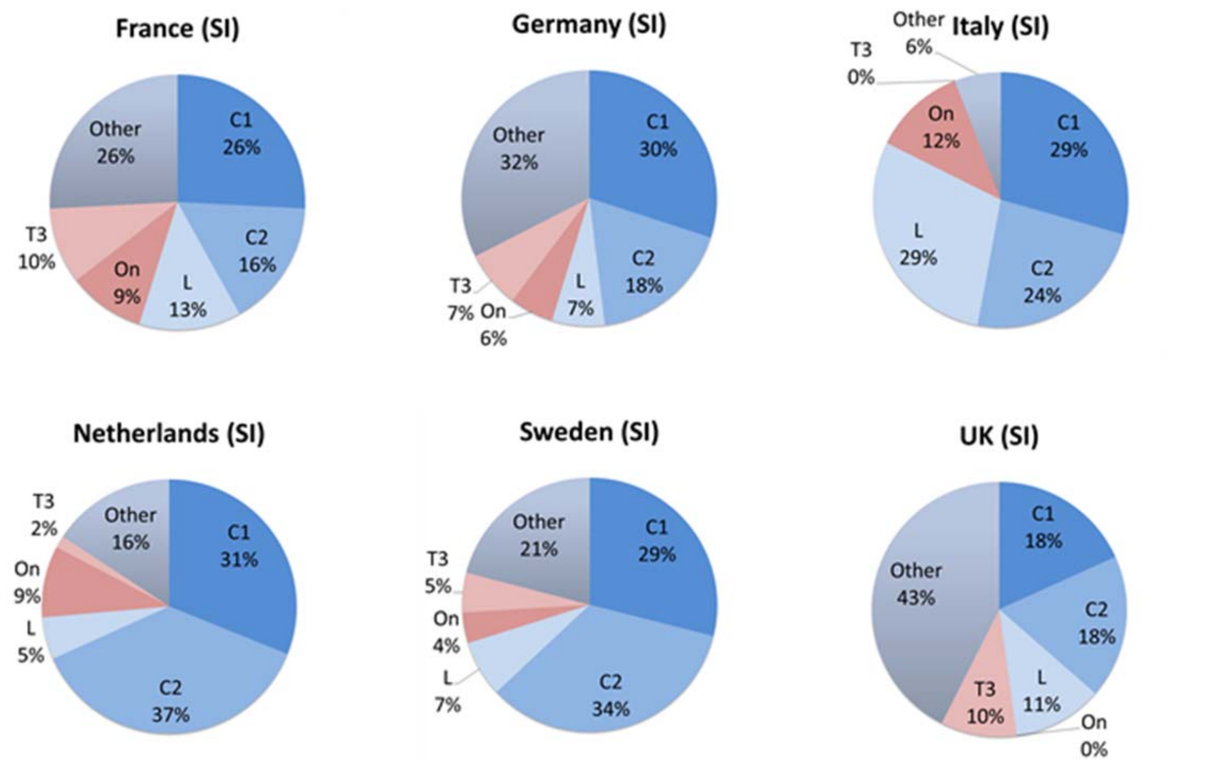


Figure 11. The distribution of scenarios per country for cyclist accidents resulting in serious injuries. In blue the scenarios C1, C2 and L, in red the scenarios On and T3, and in grey all remaining scenarios (other).