Connected Motorcycle Consortium

# CMC Basic Specification

## Accident Analysis

### United States

*Advanced analysis of US accidents:*
*based on official statistics (CRSS) and comparison to GIDAS (German In-Depth Accident Study) database.*

## Document Information

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# 1. Background and Objectives

In order to pursue the goal of "improving rider safety", CMC has conducted a comprehensive study of the most common PTW (Powered Two-Wheeler) accident scenarios documented in the GIDAS database (German In-Depth Accident Study). The aim of this comprehensive study is to identify common patterns and causes of accidents involving motorbikes in Germany.
In addition, CMC has expanded its research into accident-based investigations of PTW accidents to other regions. While European countries have already been investigated in a CMC study (CMC, 2023), the United States is the focus of this analysis.
By analysing these accidents, CMC seeks to gain a deeper understanding of the accident situations and the contributing factors specific to PTW accidents in the US. Through these efforts, CMC aims to contribute significantly to the reduction of motorcycle accidents and the improvement of rider safety on a global scale.

# 2. Study structure

The analysis of PTW accidents in the United States is conducted using the extensive data available in the Crash Report Sampling System (CRSS) database.
Based on the established approach of comparing German accident data with other regions (CMC, 2023), a similar methodology was applied to US accident data. This comparative analysis aimed to identify patterns and insights across different regions, compare the findings and finally analyse the common and different aspects.

# 3. About the CRSS data base

The CRSS database is a comprehensive dataset that includes a wide range of police-reported crashes with a focus on highway accidents. This dataset encompasses incidents involving all types of motor vehicles, as well as pedestrians and cyclists. The scope of the CRSS is broad, covering everything from minor property-damage-only crashes to severe accidents that result in fatalities. CRSS was established to produce a nationally representative probability sample (NHTSA, 2019). By providing a detailed and varied sample of crash reports, the CRSS serves as a valuable resource for analysing traffic safety and understanding the diverse factors that contribute to distinct types of accidents. This information is crucial for developing effective safety measures and policies aimed at reducing the frequency and severity of traffic accidents across various modes of transportation.

## 3.1 Forming of Accident Scenarios

The description of an accident sequence using predefined codes in the US, specifically with the CRSS, differs significantly from the approach used in Europe. One of the key differences lies in how critical situations are described and coded. In the CRSS, there is no clear and distinct description of a critical situation as seen in some European systems. Instead, the CRSS employs a coding system known as “Crash Type”. This system is designed to encompass both the critical situation leading up to the accident and the actual collision event itself. This dual-purpose coding system presents a unique challenge for researchers and analysts who require a clear delineation of critical situations for their studies. The lack of a distinct separation between the critical situation and the collision event can complicate the analysis, making it more difficult to isolate and examine the specific factors that contribute to the occurrence of accidents. Nevertheless, CRSS remains a valuable resource for understanding traffic accidents in the US. By carefully navigating the coding system and interpreting the data, researchers can still gain important insights into accident patterns and contributing factors.

### 3.2.1 Transformation of accident type

For the purposes of this study, identifying and understanding the critical situation was a crucial element. Therefore, it was necessary to map US crash types to the European accident types. This mapping process was complex and not straightforward due to the distinct levels of detail and information content inherent in the two different coding systems.

The CRSS coding system merges the critical situation with the collision constellation into an accident situation. In the US, the crash type means this accident situation. On the other hand, the European accident type refers to the critical situation itself. These differences between crash type (CRSS) and accident type (GIDAS) present a significant challenge (Figure 1). This integration makes it difficult to isolate and compare individual critical situations directly, as the European system typically allows. The European approach often provides a clearer and more distinct description of critical situations, enabling a more precise analysis of the factors leading to an accident.

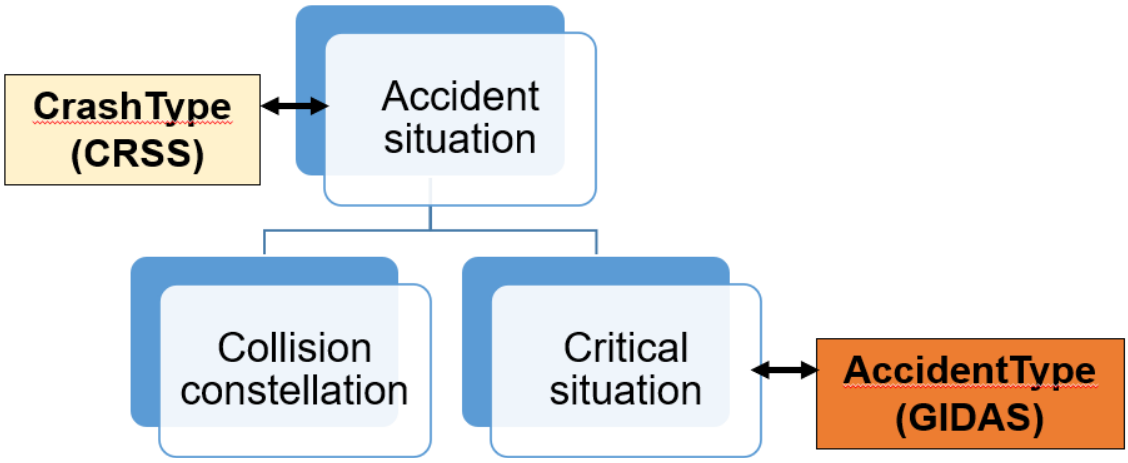



*Figure 1 Differences between crash type (CRSS) and accident type (GIDAS)*

To address this challenge, a detailed and methodical mapping process was undertaken. This involved carefully analysing the CRSS crash types and identifying corresponding European accident types. The goal was to create a comprehensive mapping that would allow for a meaningful comparison and analysis of critical situations across both datasets. Despite the difficulties, this mapping was essential for ensuring that the study could accurately assess and compare the critical situations in PTW accidents between US and Europe. The level at which “Accident Type” and “Crash Type” are assigned also differs significantly between the GIDAS and CRSS systems. This difference is illustrated in Figure 2.

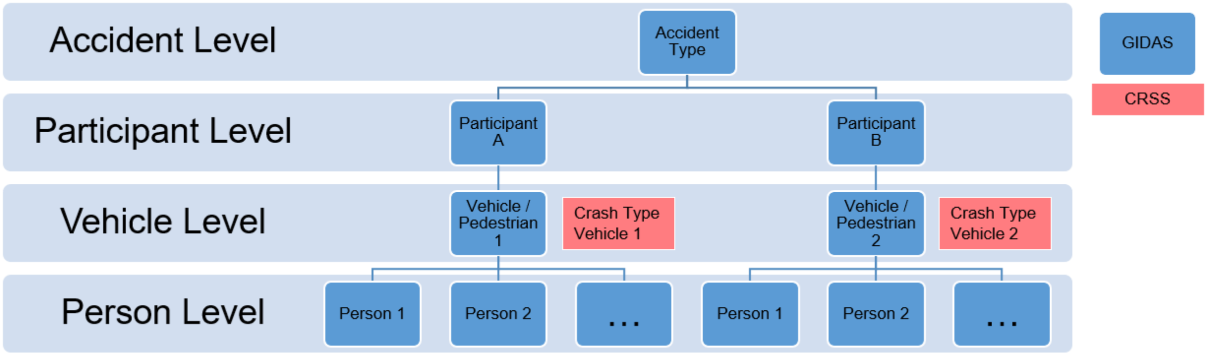



*Figure 2 Categorisation of crash type and accident type*

In the GIDAS database, the "Accident Type" (GDV, 2016) is assigned at a broader level, known as the "Accident Level". This approach encompasses all parties involved in the accident, providing a unified description of the entire accident scenario. By considering the interaction between all involved entities, the accident type in GIDAS offers a comprehensive overview of the circumstances leading to the accident.
In contrast, the "Crash Type" in CRSS is assigned at a more granular, vehicle-specific level, referred to as the "Vehicle Level". This means that each vehicle involved in a common accident is assigned its own crash type. This coding reflects the specific circumstances and dynamics from the perspective of that particular vehicle. As a result, the CRSS provides a detailed account of the accident from the viewpoint of each vehicle involved, rather than a unified scenario.
Accordingly, in GIDAS one "Accident Type" is assigned for the entire accident, whereas in CRSS up to two "Crash Types" describe an accident, depending on the number of vehicles involved. An overview of the accident scenarios with the corresponding accident/crash types can be found in Annex A (Figure 56, Figure 57, Figure 58, Figure 59).

To effectively compare and analyse data from these two systems, it is necessary to precisely map and translate the coding schemes between GIDAS and CRSS. This process involves understanding the nuances of each system and finding ways to align the broader accident types with the more granular crash types.

### 3.2.2 Definition of accident scenarios

As a result of the differences in coding systems between CRSS and GIDAS, the study could only derive and compare broader "accident scenarios" rather than individual critical situations. This limitation meant that although a direct comparison of specific critical situations was not feasible, the overall accident scenarios could still be analysed and compared. By focusing on these broader scenarios, the study was able to provide valuable insights into the patterns and trends of PTW accidents, albeit at a higher level of abstraction. The differences between CRSS and GIDAS are briefly summarised in Table 1. These differences highlight the challenges and complexities involved in comparing data from different regions and coding systems.

| CRSS | GIDAS |
|---|---|
| **Crash Type** = critical situation + collision constellation | **Accident Type** = critical situation |
| No assignment of the main causer of the accident | Participant A is generally the main causer |

| CRSS | GIDAS |
|---|---|
| Each vehicle has its own crash type | Participants together form Accident Type |
| Crash Type = vehicle level | Accident Type = accident level |
| Pedestrians are not considered as participants (bicycles neither) | All people involved are considered as participants |

*Table 1 Differences between GIDAS and CRSS*

Some crash types in CRSS could not be directly transferred to the predefined scenarios used in the study. This discrepancy arose because certain CRSS crash types did not have clear categories within the European accident scenarios framework. As a result, these unmatched crash types were classified under a broader category of "unknown scenarios." This classification challenge led to a higher proportion of unknown scenarios in the CRSS data compared to the GIDAS data.

# 4. Summary and comparison of the results

Figure 3 illustrates the outcome of the transformation, highlighting the increased presence of unknown scenarios within the CRSS dataset. This visualisation underscores the difficulties in achieving a one-to-one mapping between the two systems due to their differing structures and levels of detail.

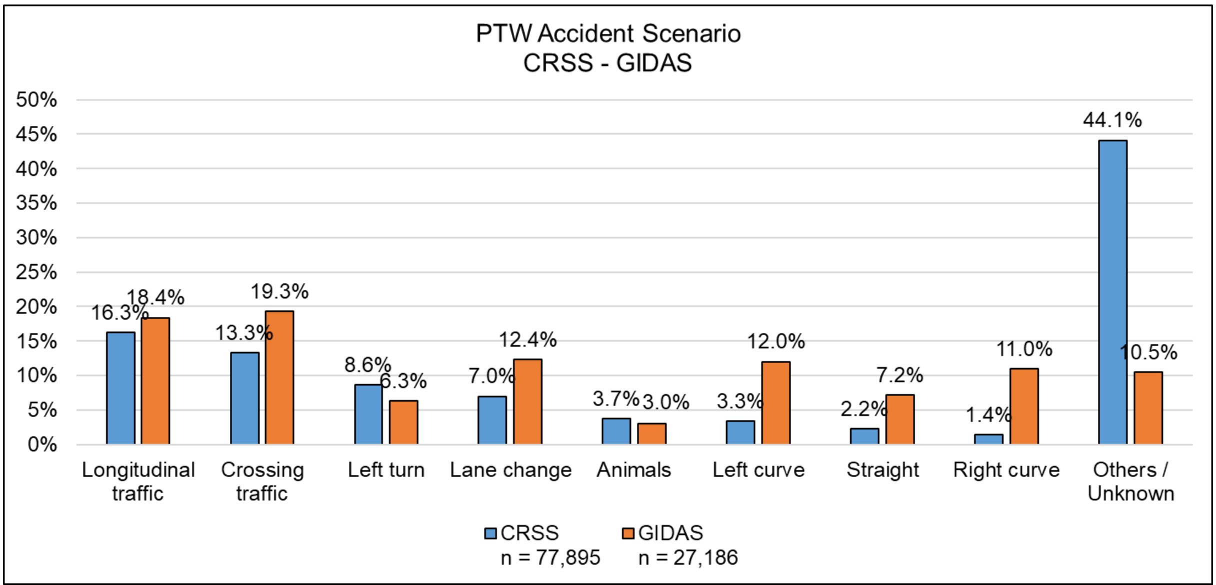



*Figure 3 Accident scenarios in CRSS and GIDAS*

By acknowledging these limitations, the study provides a more nuanced understanding of the data comparison process. It emphasises the importance of considering these unknown CMC scenarios when interpreting the results, as they represent a sizable portion of the CRSS data that could not be directly aligned with the GIDAS accident scenarios. The following ranking of the top four scenarios in the respective data sets thus emerges for the scenarios (Table 2). This ranking provides a clear comparison of the most common accident scenarios identified in both the German and US datasets.

| Rank | CRSS | GIDAS |
|---|---|---|
| 1 | Longitudinal Traffic | Crossing Traffic |
| 2 | Crossing Traffic | Longitudinal Traffic |
| 3 | Left Turn | Lane Change |
| 4 | Lane Change | Left Curve |

*Table 2 Ranking of accident scenarios*

In the US, according to CRSS, the “Longitudinal Traffic” and “Crossing Traffic” scenarios are the two most common accident scenarios, mirroring the findings in GIDAS. This similarity suggests that certain types of accidents are prevalent across both regions, possibly due to common driving behaviors or road conditions. However, there are notable differences in the ranking of other scenarios. For instance, the “Left Turn” scenario holds a higher priority in CRSS, being ranked third. This discrepancy indicates regional variations in accident patterns, which could be influenced by differences in road design, traffic regulations or driver behavior. As shown in Figure 3, the scenarios “Left Curve”, “Straight” and “Right Curve” are among the least frequently occurring in CRSS. This contrasts with their frequency in GIDAS, highlighting the unique characteristics of US traffic incidents. It is important to note that not all accidents could be assigned to the predefined scenarios. This is particularly true for the three mentioned scenarios, which are classified as “driving accidents” involving only one participant. The interpretation of “driving accidents” or “loss of control accidents” also differs between CRSS and GIDAS. In GIDAS, these accidents typically involve a vehicle losing control. In contrast, CRSS defines these accidents as incidents where a motorized and moving vehicle leaves the road. When evaluating these accident scenarios, it is crucial to consider not only the differences in categorisation but also the variations in their underlying definitions. These differences can significantly impact the analysis and understanding of accident data, emphasising the need for careful interpretation when comparing datasets from different regions.

Figure 4 shows the proportion of the location of all accidents involving PTW. Around 70 % of the accidents in the US happened in urban areas. In GIDAS the share of urban areas was around 60 %.

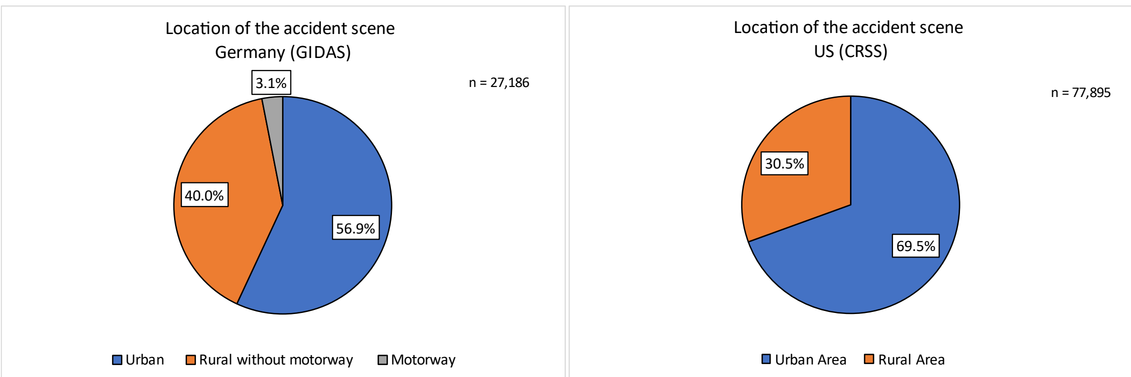



*Figure 4 Location – All accidents*

Table 3 shows a detailed analysis of the proportion of different descriptions of the accident scene in GIDAS and CRSS. The share of “intersection” accident scene in GIDAS is around 40 % and in CRSS the share of "intersection" accident scene is around 37 %.

| GIDAS<br>n = 27,186 | | CRSS<br>n = 77,895 | |
|---|---|---|---|
| Straight | 27.7% | Non-Junction | 47.2 % |
| Bend | 23.4% | Intersection | 22.5 % |
| Crossing | 20.7% | Intersection-Related | 14.2 % |
| Junction | 19.6% | Driveway Access Related | 9.3 % |
| Property Exit | 5.8% | Entrance/Exit Ramp Related | 2.1 % |
| Roundabout | 1.4% | Through Roadway | 1.7 % |
| Car Park | 0.8% | Other location within Inter-change Area | 1.0 % |
| Other | 0.6% | Driveway Access | 0.8 % |
| | | Entrance/Exit Ramp | 0.6 % |
| | | Not Reported | 0.2 % |
| | | Crossover-Related | 0.1 % |
| | | Railway Grad Crossing | 0.1 % |
| | | Acceleration/Deceleration Lane | 0.0 % |

*Table 3 Accident scene – All accidents*

After categorising the crash types into the defined scenarios, the three most frequent scenarios were thoroughly analysed: the Longitudinal Traffic Scenario, the Crossing Traffic Scenario, and the Left Turn Scenario. These scenarios were selected based on their frequency and impact, making them critical for detailed examination. For a comprehensive comparison with German data, the analyses of the most frequent critical situations within these respective scenarios in GIDAS are utilised. This comparison aims to highlight similarities and differences in accident patterns between the datasets, providing valuable insights into regional variations in traffic incidents. To classify these analyses effectively, a brief overview of the primary accident situations is provided.

## 4.1 Longitudinal Traffic Scenario

The accident types illustrated in Figure 5 account for 24 % of the total critical situations in the Longitudinal Traffic Scenario (LTS) in GIDAS. This indicates that nearly a quarter of all critical situations in this scenario are represented by these specific accident types, highlighting their significance in the overall accident landscape.

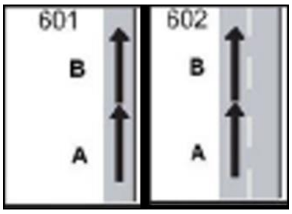



*Figure 5 Selected accident types of longitudinal traffic in GIDAS*

The crash types illustrated in Figure 6 account for 62 % of the Longitudinal Traffic Scenario in CRSS. This underscores the prevalence of these crash types within the Longitudinal Traffic Scenario in CRSS.

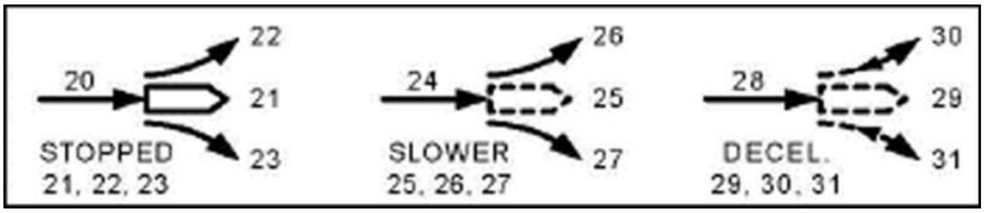



*Figure 6 Selected crash types of longitudinal traffic in CRSS*

Almost 24 % of the accidents in the Longitudinal Traffic Scenario in CRSS occurred in rural areas. This statistic highlights the significant presence of rural locations in these types of accidents. When compared to the data for the critical situations in GIDAS, there is a noticeable higher proportion of urban locations in the CRSS dataset (Figure 7). It is important to note that the critical situations in the GIDAS dataset do not necessarily involve an intersection. This contrasts with the CRSS data, where the assumption seems to apply more regarding the crash types shown in Figure 6. In the CRSS dataset, intersections appear to be a more common scene for accidents in the Longitudinal Traffic Scenario.

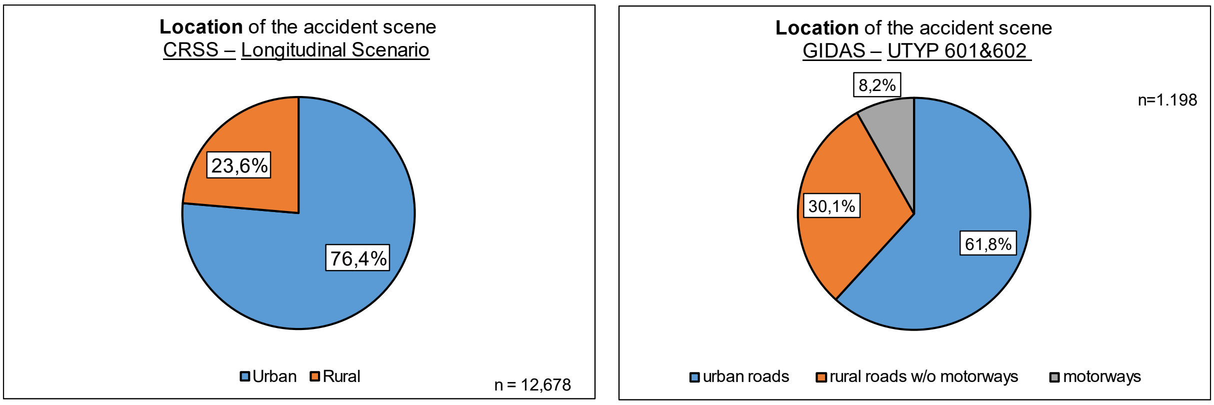



*Figure 7 Location – LTS*

The analysis of the accident scene further confirms the assumption that in the CRSS dataset, the scene of the accident was more frequently at an intersection (Table 4). This finding underscores the importance of considering the specific context and location of accidents when analysing and comparing different datasets.

| CRSS<br>n = 12,678 | | GIDAS<br>n = 1,198 | |
|---|---|---|---|
| Non-Junction | 58.6 % | Straight | 70.0% |
| Intersection-Related | 30.1 % | Junction | 11.5% |
| Driveway Access Related | 4.9 % | Crossing | 8.8% |
| Intersection | 2.2 % | Bend | 7.0% |
| Through Roadway | 1.8 % | Roundabout | 1.0% |
| Entrance/Exit Ramp | 0.7 % | Property Exit | 1.0% |
| Driveway Access | 0.6 % | Other | 0.7% |
| Other location within Interchange Area | 0.5 % | | |
| Not Reported | 0.3 % | | |
| Crossover-Related | 0.1 % | | |
| Entrance/Exit Ramp Related | 0.1 % | | |
| Acceleration/Deceleration Lane | 0.1 % | | |

*Table 4 Accident scene – LTS*

The evaluation of weather conditions revealed that most accidents in the Longitudinal Traffic Scenario within CRSS occurred under clear weather conditions (Figure 8). This finding indicates that most accidents happened when visibility was good and there were no adverse weather factors influencing the driving environment.

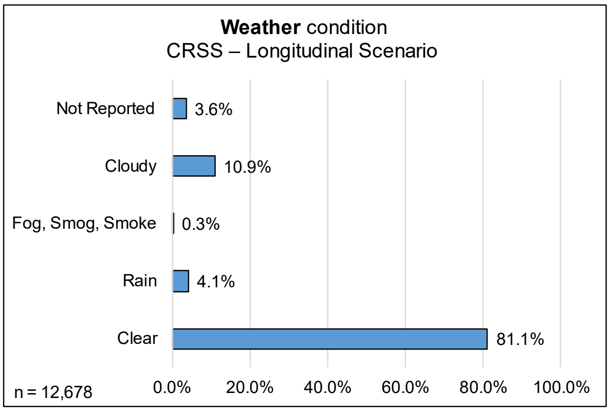



*Figure 8 Weather condition – LTS (CRSS)*

In Figure 9 the outcomes from the GIDAS dataset are shown. In both the CRSS and GIDAS evaluations, dry conditions were predominant, suggesting that a considerable number of accidents occurred when the roads were dry and free from rain.

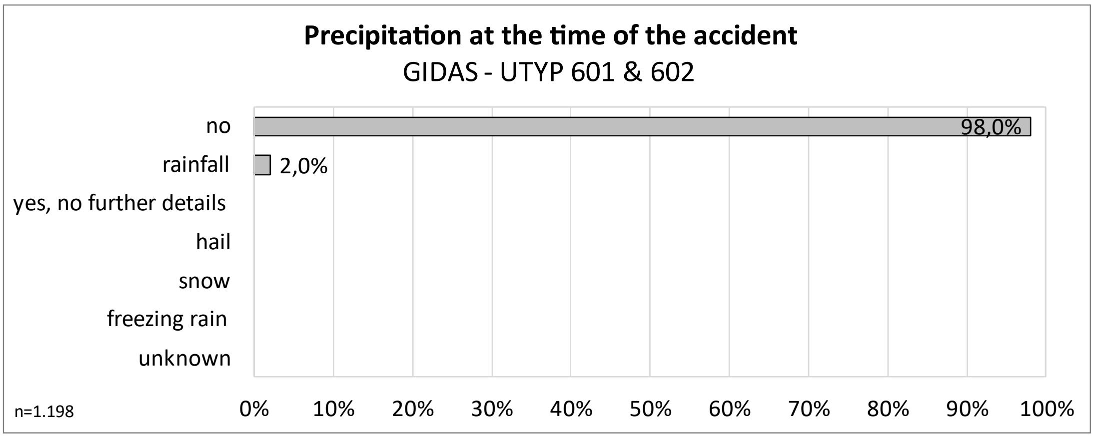



*Figure 9 Precipitation – UTYP 601 & 602 (GIDAS)*

The evaluation of the kind of road user in this scenario is shown in Figure 10 for CRSS and in Figure 11 for GIDAS. A significant difference in the evaluation is that the distinction of the parties in CRSS is vehicle-specific and in GIDAS it is at participant level. This difference in categorisation makes a direct comparison difficult, as the two datasets classify the involved parties in distinct ways. Additionally, the distinction between individual vehicle types or participant types also varies between the two datasets. For instance, in CRSS, a bicycle user is not listed. However, if you compare the tendencies of both evaluations, motorcycles are more common for vehicle 1 in CRSS and for participant A in GIDAS.

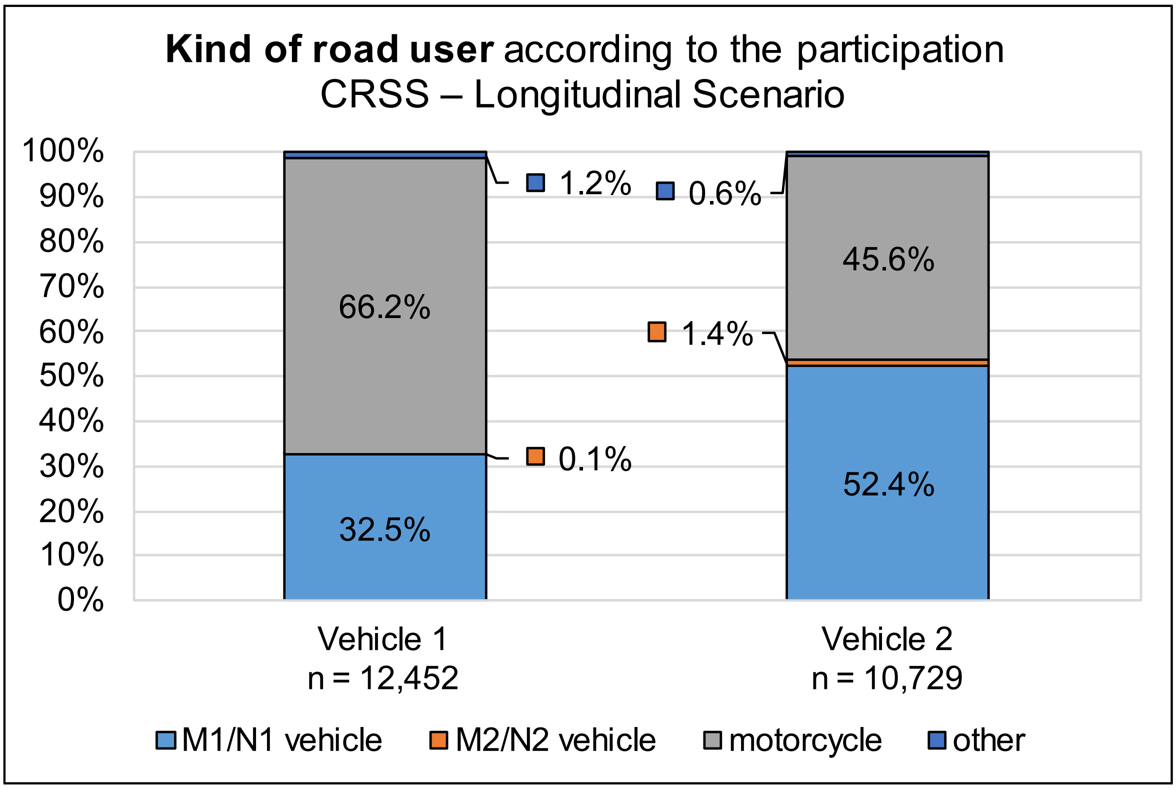



*Figure 10 Kind of road user – LTS (CRSS)*

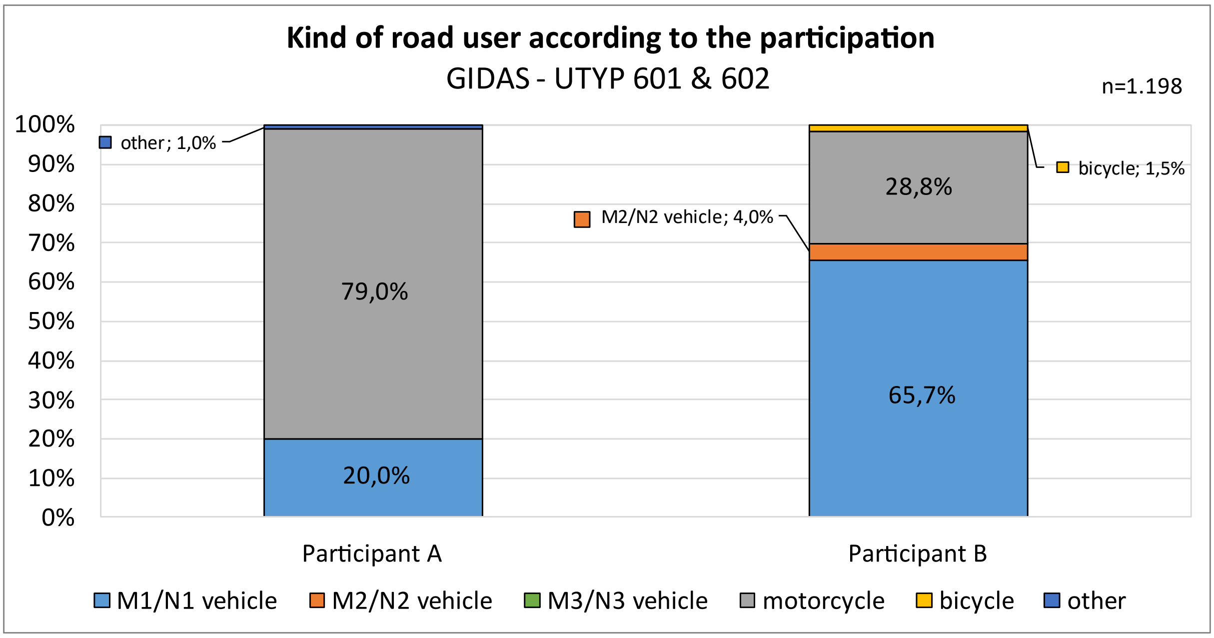



*Figure 11 Kind of road user – UTYP 601 & 602 (GIDAS)*

The analysis of the initial speed of the vehicles in CRSS reveals significant differences in the speeds of the two vehicles involved in accidents (Figure 12). This disparity in speed highlights a critical aspect of the Longitudinal Traffic Scenario. Specifically, it becomes evident that around half of all accidents in this scenario involve a stationary vehicle 2. This finding underscores the prevalence of situations where one vehicle is not in motion at the time of the collision. This observation, in turn, suggests that many of these accidents occurred at intersections or in other low-speed areas where traffic control measures are in place. Intersections, with their complex traffic patterns and frequent stops, are common sites for such incidents. The presence of traffic signals, stop signs, and other control mechanisms in these areas often results in vehicles coming to a halt, thereby increasing the likelihood of collisions involving stationary vehicles.

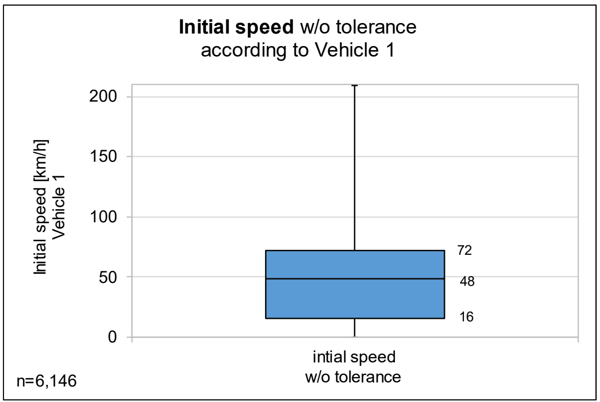




*Figure 12 Initial speed – LTS (CRSS)*

By contrast, the speeds of the participants in the GIDAS dataset are much closer together (Figure 13). This observation indicates that both vehicles involved in the accidents were moving at similar speeds. Such a pattern suggests that these accidents occurred in situations where there were no intersections or other traffic control measures that would cause one vehicle to stop or slow down significantly. The similarity in vehicle speeds implies that the accidents happened in more fluid traffic conditions, possibly on open roads or highways where vehicles maintain a consistent speed. This contrasts with the CRSS data, where the significant speed differences often point to intersection-related incidents involving stationary or slow-moving vehicles.

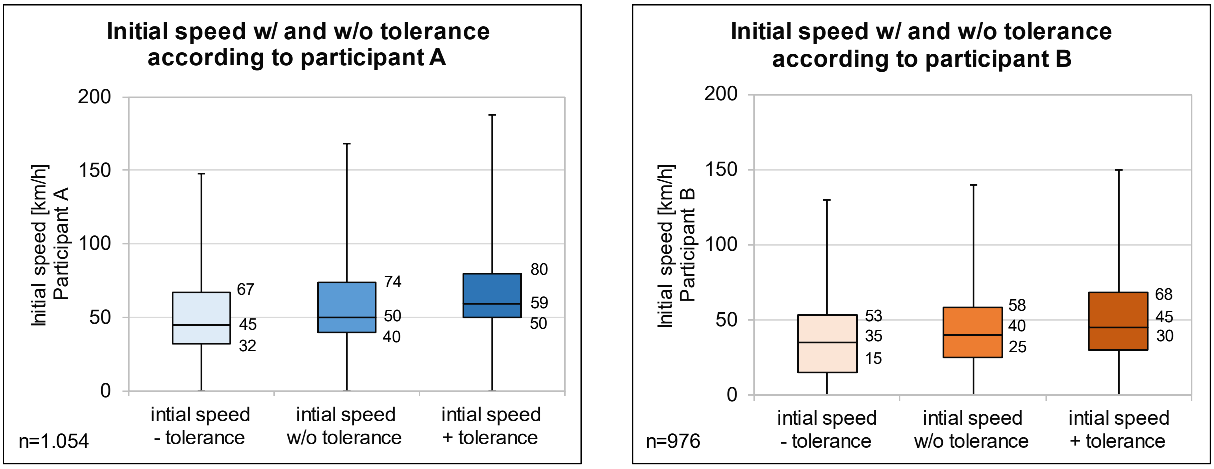



*Figure 13 Initial speed – UTYP 601 & 602 (GIDAS)*

## 4.2 Crossing Traffic Scenario

The accident type illustrated in Figure 14 accounts for 40 % of the total critical situations in the Crossing Traffic Scenario (CTS) within GIDAS. This substantial proportion highlights the prevalence and importance of this specific accident type within the Crossing Traffic Scenario in GIDAS. The letter “W” in Figure 14 stands for a waiting obligation of the participant involved (participant A).

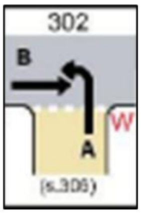



*Figure 14 Selected accident type of crossing traffic in GIDAS*

The crash types illustrated in Figure 15 account for 36 % of the Crossing Traffic Scenario in CRSS. This underscores the prevalence of these crash types within the Crossing Traffic Scenario in CRSS.

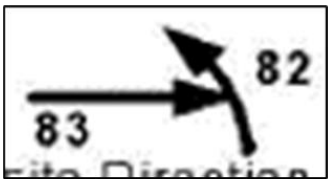



*Figure 15 Selected crash types of crossing traffic in CRSS*

The evaluation of the location data reveals a comparable distribution of urban and rural areas across both data sources (Figure 16). Specifically, in both GIDAS and CRSS, the proportion of rural locations is around 30 %. GIDAS exhibits a slightly higher percentage of rural locations compared to CRSS.

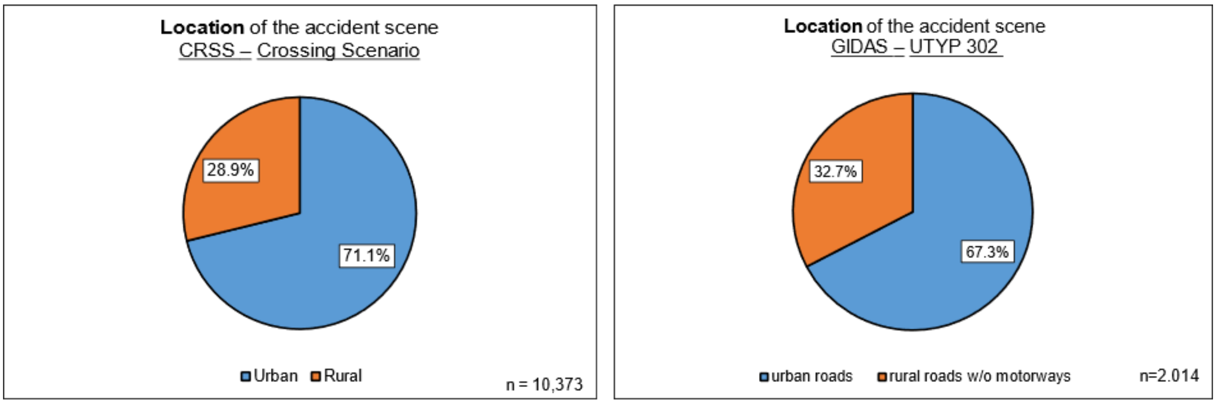



*Figure 16 Location – CTS*

The analysis of the accident scene data reveals a consistent pattern across both data sources (Table 5). Specifically, CRSS indicates that approximately 77 % of accidents occur at intersections. In comparison, GIDAS reports a slightly higher intersection share of around 83 %.

| CRSS<br>n = 10,373 | | GIDAS<br>n = 2,014 | |
|---|---|---|---|
| Intersection | 70.8% | Junction | 53.2% |
| Driveway Access Related | 21.6% | Crossing | 29.5% |
| Intersection-Related | 6.6% | Property Exit | 16.1% |
| Driveway Access | 0.8% | Other | 0.8% |
| Non-Junction | 0.2% | Car Park | 0.4% |

*Table 5 Accident scene - CTS*

The evaluation of weather conditions revealed that most accidents in the Crossing Traffic Scenario within CRSS occurred under clear weather conditions (Figure 17). This finding indicates that most accidents happened when visibility was good and there were no adverse weather factors influencing the driving environment.

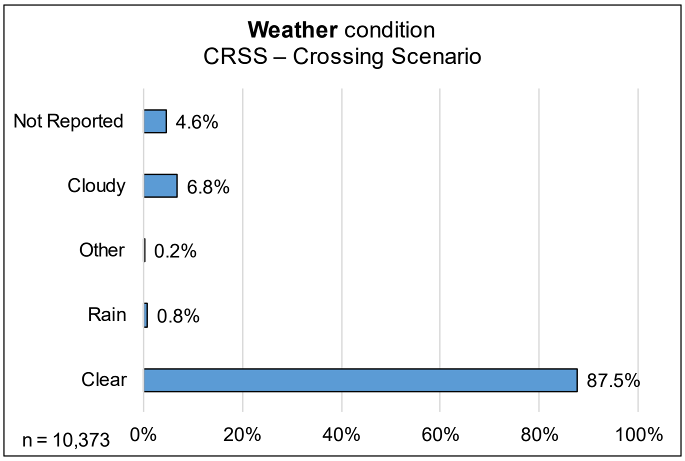



*Figure 17 Weather condition – CTS (CRSS)*

In Figure 18 the outcomes from the GIDAS dataset are shown. In both the CRSS and GIDAS evaluations, dry conditions were predominant, suggesting that a considerable number of accidents occurred when the roads were dry and free from rain.

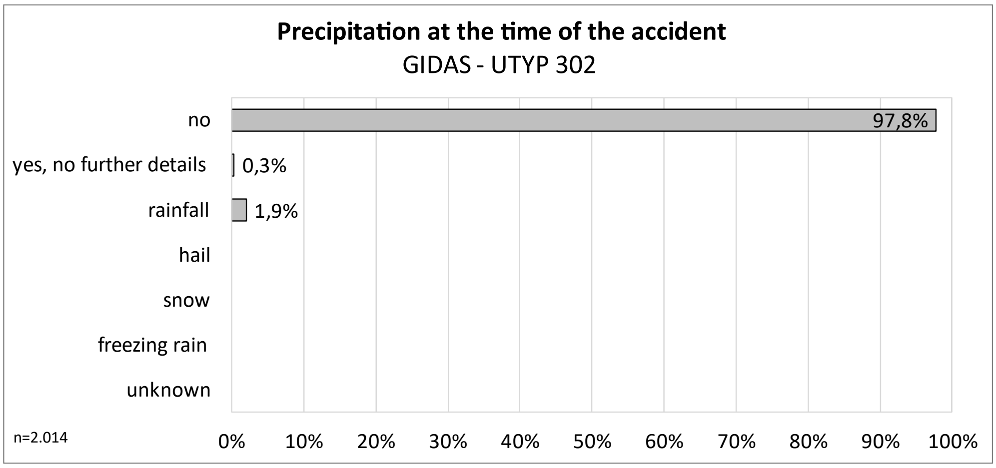



*Figure 18 Precipitation – UTYP 302 (GIDAS)*

The evaluation of the kind of road user in this scenario is shown in Figure 19 for CRSS and in Figure 20 for GIDAS. A significant difference in the evaluation is that the distinction of the parties in CRSS is vehicle-specific and in GIDAS it is at participant level. This difference in categorisation makes a direct comparison difficult, as the two datasets classify the involved parties in distinct ways.

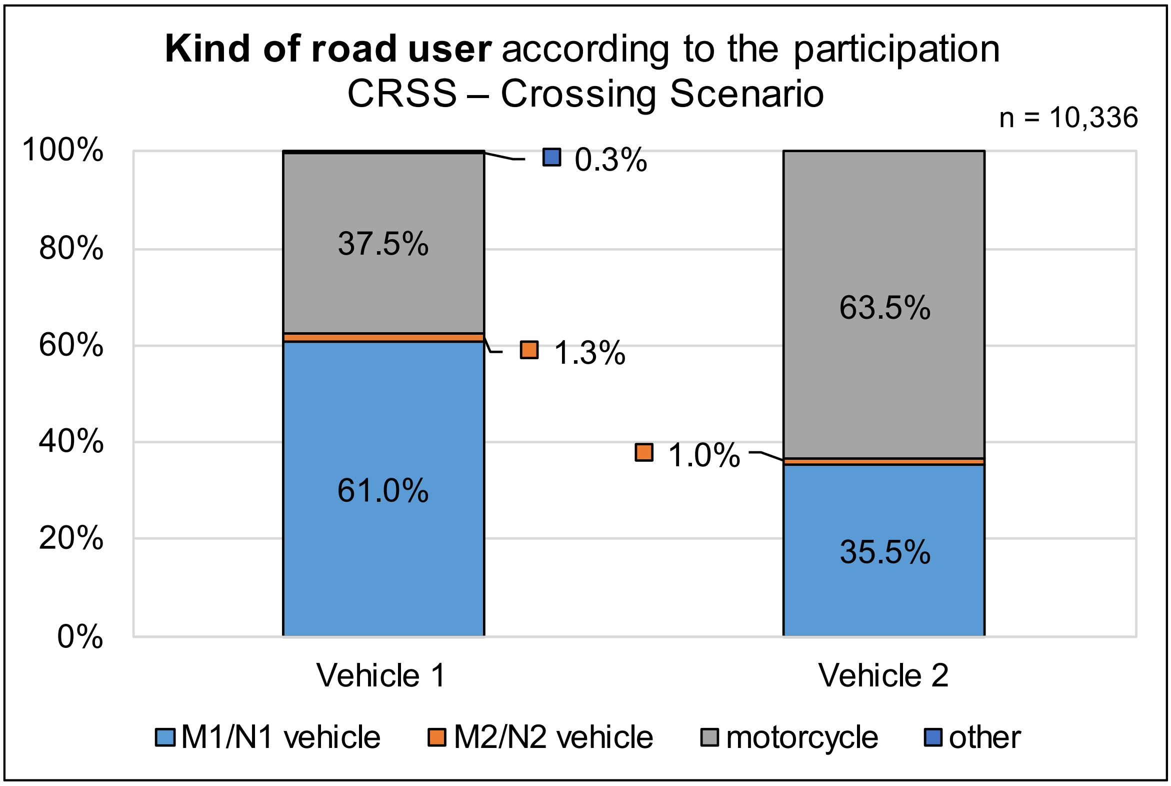



*Figure 19 Kind of road user – CTS (CRSS)*

The evaluation of CRSS data reveals a more balanced distribution of vehicle types involved in crossing accidents. For instance, in the case of vehicle 1, 61 % were classified as M1/N1 vehicles, while just under 38 % were motorcycles. Conversely, for vehicle 2, the distribution is almost reversed, with 64 % being motorcycles and around 36 % being M1/N1 vehicles.
When compared to the critical situation depicted in GIDAS, significant differences become apparent. Specifically, in accident type 302 within the GIDAS dataset, the distribution of vehicle types among the involved parties is more distinct. For example, 96 % of participant A consisted of M1/N1 vehicles, whereas 98 % of participant B were motorcycles. In this particular accident type, participant A is obligated to wait before making a turn. These differences highlight the varying dynamics and vehicle type distributions captured by the two data sources.

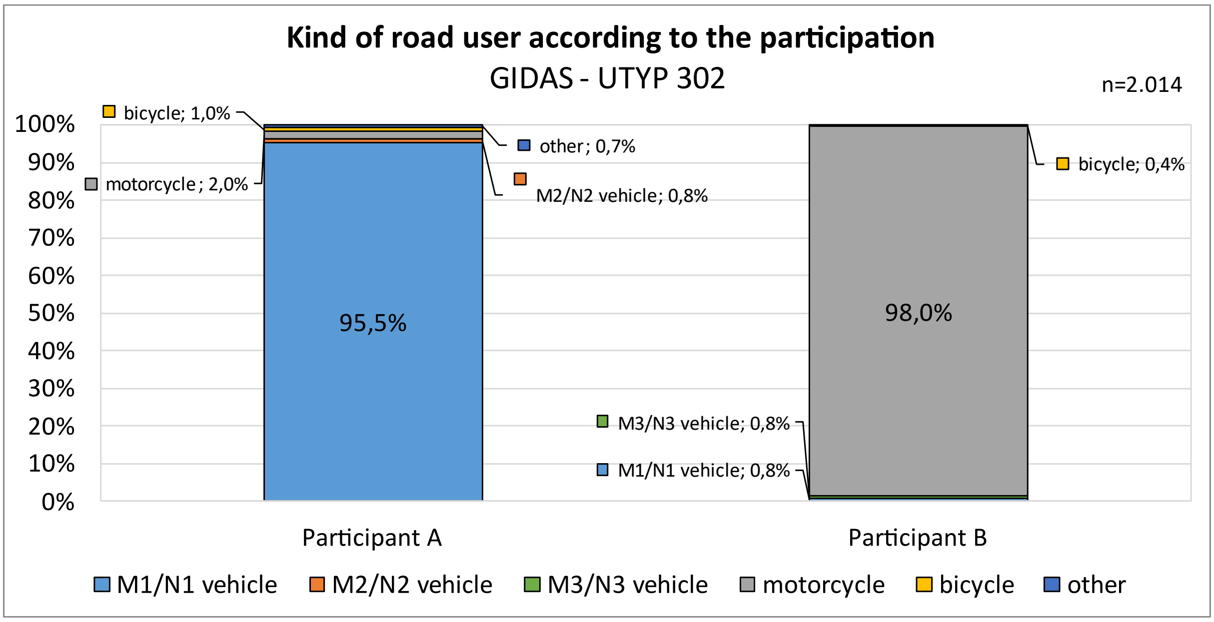



*Figure 20 Kind of road user – UTYP 302 (GIDAS)*

The initial speed of the two vehicles in CRSS data falls within a similar range of values, indicating a consistent pattern for vehicle 1 and vehicle 2 (Figure 21). As both speeds are close to each other, it can be assumed that many accidents occurred in moving traffic and have fewer stationary or slow-moving participants.

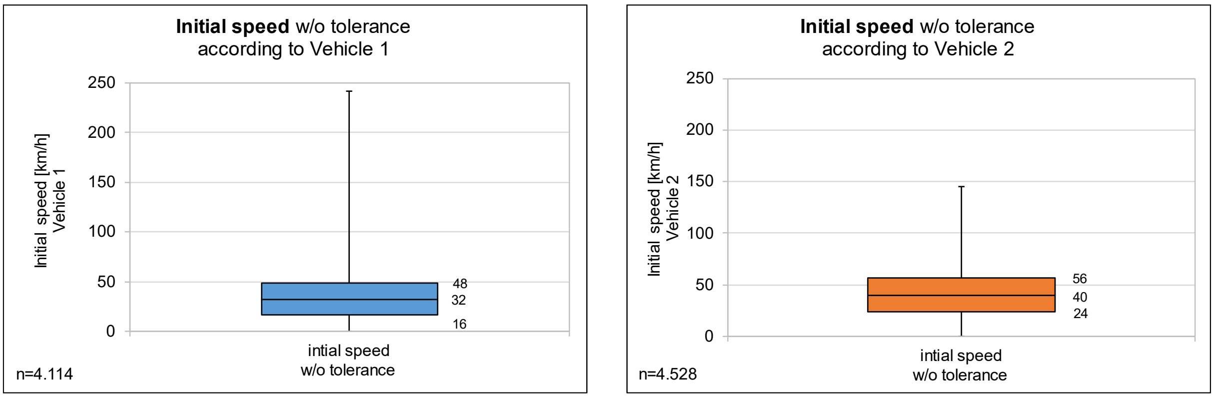



*Figure 21 Initial speed – CTS (CRSS)*

However, when evaluating the initial speed in GIDAS for accident type 302, significant differences in the range of values are observed (Figure 22). Specifically, the speed for participant B is notably higher than that for participant A. This discrepancy highlights the distinct nature of the critical situations described in the two datasets. In the GIDAS analysis, one vehicle, referred to as participant A, is subject to a waiting obligation before proceeding, which is reflected in its lower initial speed. This waiting obligation is a critical factor in the dynamics of the accident scenario. In contrast, the crossing scenario in the CRSS data encompasses several critical situations, none of which clearly impose a waiting obligation on any vehicle. This lack of a defined waiting obligation in the CRSS scenarios results in a more uniform distribution of initial speeds between the vehicles involved. These differences underscore the importance of understanding the specific context and conditions described by each dataset. The GIDAS data provides a more detailed account of scenarios where waiting obligations significantly influence vehicle speeds, while the CRSS data offers a broader view of various critical situations without such specific constraints. This comparison highlights the value of using multiple data sources to gain a comprehensive understanding of accident dynamics and the factors influencing vehicle behavior.

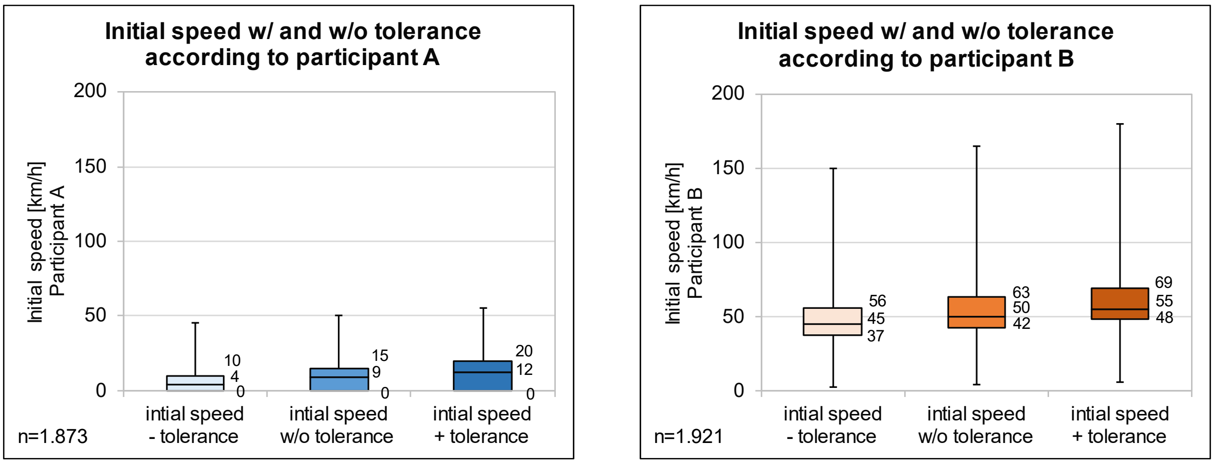



*Figure 22 Initial speed – UTYP 302 (GIDAS)*

## 4.3 Left Turn Traffic Scenario

The accident type illustrated in Figure 23 accounts for 92 % of the total critical situations in the Left Turn Scenario (LEFTS) within GIDAS. This substantial proportion highlights the prevalence and importance of this specific accident type within the Left Turn Scenario in GIDAS.

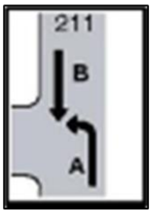



*Figure 23 Selected accident type of left turn in GIDAS*

The crash types illustrated in Figure 24 account for 100 % of the Left Turn Scenario in CRSS. This underscores the prevalence of these crash types within the Left Turn Scenario in CRSS. Due to the detailed and concise nature of the situations described in both data sources, it is possible to make a direct comparison of the Left Turn Scenario between the two datasets. GIDAS and CRSS both provide valuable insights into this specific type of accident scenario.

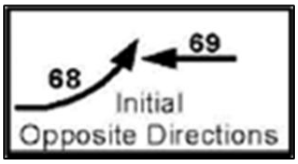



*Figure 24 Crash types of left turn in CRSS*

The evaluation of the location data reveals a comparable ratio of urban and rural locations across both data sources (Figure 25). Specifically, in both GIDAS and CRSS, the proportion of urban locations range between 76 % and 79 %. This indicates a consistent representation of urban areas in both datasets.

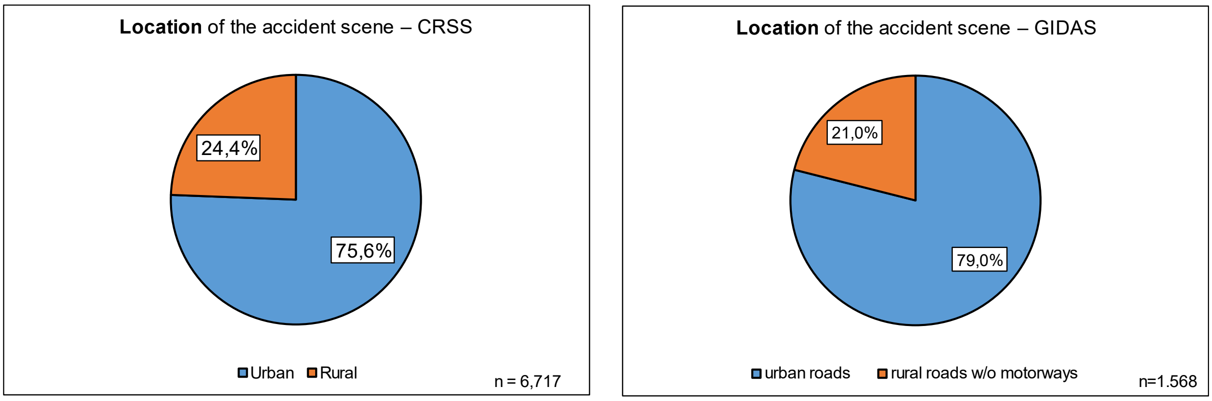



*Figure 25 Location – LEFTS*

The analysis of the accident scene data reveals a consistent pattern across both data sources (Table 6). Specifically, CRSS indicates that approximately 74 % of accidents occur at intersections. In comparison, GIDAS reports a slightly higher intersection share of around 79 %.

| **CRSS n = 6,717** | | **GIDAS n = 1,568** | |
|---|---|---|---|
| Intersection | 73.3% | Crossing | 42.9% |
| Driveway Access Related | 24.4% | Junction | 35.9% |
| Driveway Access | 1.9% | Property Exit | 20.4% |
| Intersection-Related | 0.2% | Straight | 0.8% |
| Not Reported | 0.2% | | |

*Table 6 Accident scene – LEFTS*

The evaluation of weather conditions revealed that the majority of accidents in the Left Turn Scenario within CRSS and GIDAS occurred under clear weather conditions (Figure 26). This finding indicates that most accidents happened when visibility was good and there were no adverse weather factors influencing the driving environment.

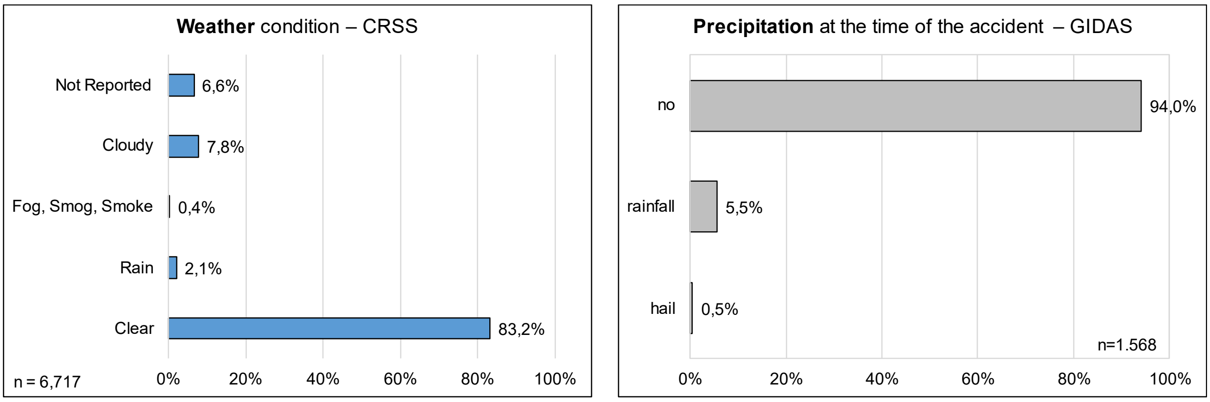



*Figure 26 Weather condition – LEFTS*

The evaluation of the kind of road user in this scenario is shown in Figure 27 for CRSS and in Figure 28 for GIDAS. By meticulously classifying the critical situations within this scenario, it became feasible to conduct a direct comparison of the kinds of road users involved. This classification process allowed for a detailed analysis of the various participants in the accidents. In both GIDAS and CRSS, the classification of critical situations provided a clear framework for identifying and comparing the different road users. This comparison revealed patterns and trends in the involvement of diverse types of road users in accidents, highlighting the similarities between the two datasets. In this context, participant A (GIDAS) can be evaluated on an equal footing with vehicle “68” (CRSS). The same applies to the second participant. Participant B (GIDAS) corresponds to vehicle “69” (CRSS). As a result of the comprehensive analysis, it becomes evident that in both GIDAS and CRSS, participant A (vehicle “68”), which refers to the party turning left across the driving line of participant B (vehicle “69”), predominantly consisted of M1/N1 vehicles. Specifically, approximately 90 % of the participants’ A vehicles in both data sources were classified as M1/N1 vehicles, indicating a strong consistency between the two datasets. Similarly, the distribution of road users for participant B, the party whose driving line is crossed by participant A, shows a comparable pattern. According to the analysis, over 90 % of the participants’ B vehicles were motorcycles in both GIDAS and CRSS. These findings highlight the importance of understanding the specific roles and behaviors of different vehicle types in left-turn scenarios. The consistent distribution of M1/N1 vehicles for participant A (vehicle “68”) and motorcycles for participant B (vehicle “69”) across both data sources provides valuable insights into the dynamics of such accidents.

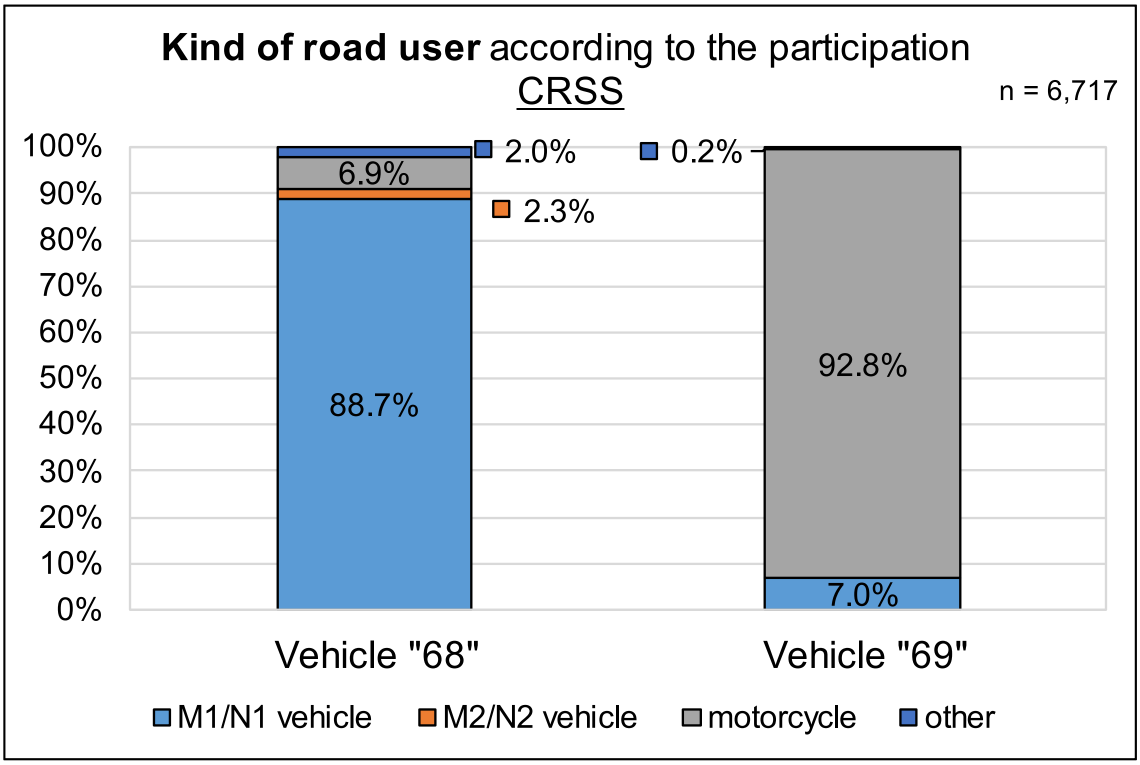



*Figure 27 Kind of road user – LEFTS (CRSS)*

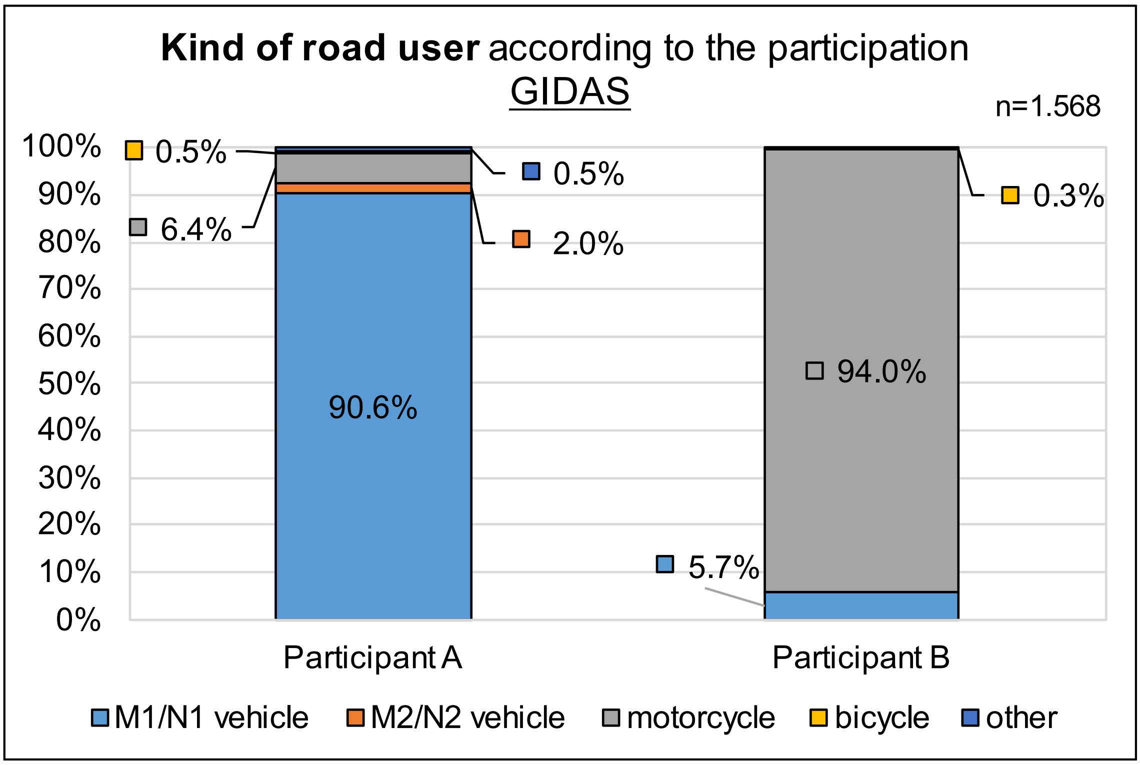



*Figure 28 Kind of road user – LEFTS (GIDAS)*

The analysis of the initial speed for participant A (vehicle “68”) showed comparable values for Germany and the US (Figure 29).

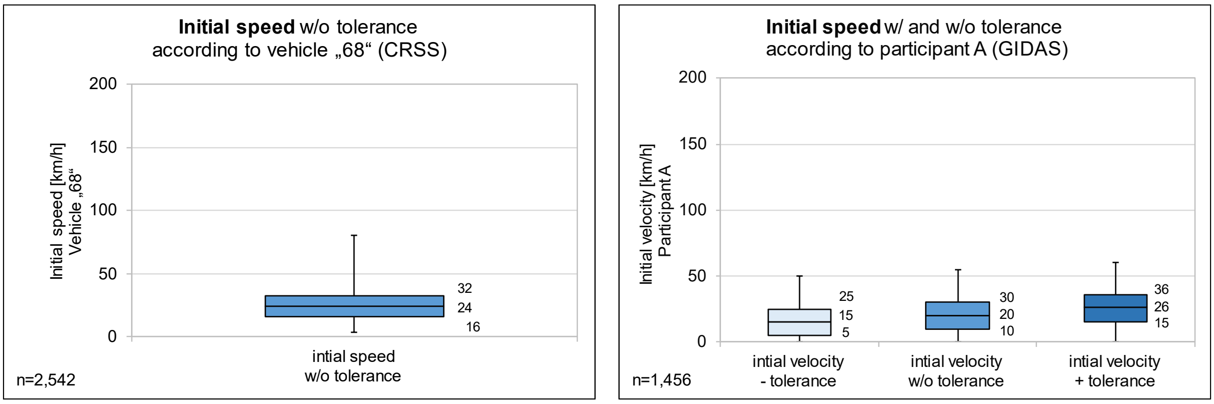



*Figure 29 Initial speed – vehicle “68” and participant A – LEFTS*

The analysis of the initial speed for participant B (vehicle “69”) showed comparable values for Germany and the US (Figure 30). One notable commonality between the two data sources, GIDAS and CRSS, is the observation that participant B (vehicle “69”) was traveling at a higher speed than participant A (vehicle “68”).

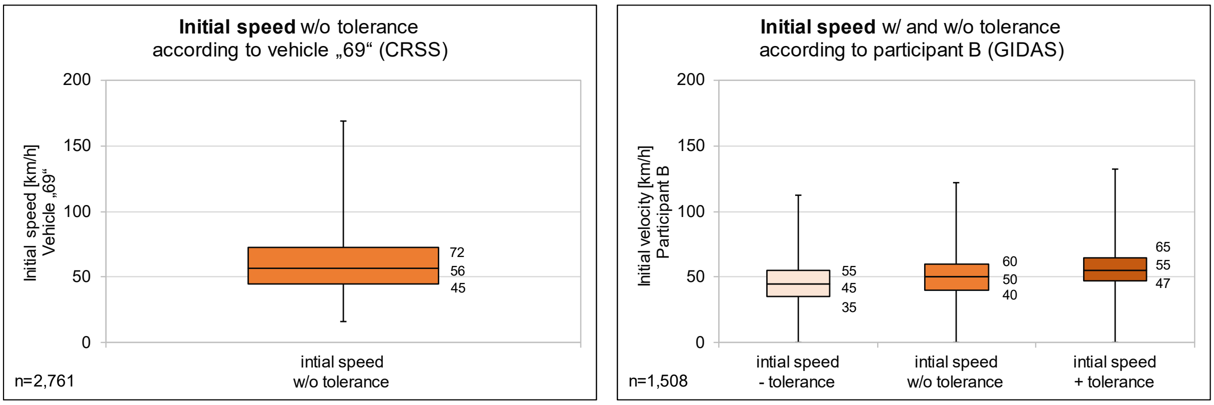



*Figure 30 Initial speed – vehicle “69” and participant B – LEFTS*

## 4.4 Summary

A direct comparison of critical situations before an accident was not feasible between GIDAS and CRSS due to the different categorisation and classification methods used for critical situations and the actual collisions. To make the data comparable, it was necessary to identify these differences, which then led to the categorisation of accident scenarios. Based on this categorisation, entire scenarios could be compared. In this document, the accident scenarios in CRSS were compared with the most common accident types for these scenarios in GIDAS. Generally, many parallels in the accident situations between the two data sources were identified. However, there were also some significant differences, which can be partly explained by the different basic descriptions of the situations.

In the **Longitudinal Traffic Scenario** within CRSS, 24 % of the accidents occurred in rural areas. When compared to GIDAS, there is a higher proportion of urban locations in the CRSS dataset. It is important to note that critical situations in GIDAS do not necessarily involve intersections, whereas in CRSS, intersections are more commonly the scene of accidents. The evaluation of weather conditions in the CRSS dataset revealed that most accidents in the Longitudinal Traffic Scenario occurred under clear weather conditions, indicating good visibility and no adverse weather factors. Comparing this with GIDAS, both datasets show that dry conditions were predominant, suggesting that many accidents happened on dry roads. The evaluation of road users shows a key difference in categorisation between the two datasets. In CRSS, the distinction is vehicle-specific, while in GIDAS, it is at the participant level. This makes direct comparison challenging. However, trends indicate that motorcycles are more common for vehicle 1 in CRSS and for participant A in GIDAS. The analysis of initial vehicle speeds in CRSS reveals significant differences between the two vehicles involved in accidents, with around half of the accidents involving a stationary vehicle 2. This suggests that many accidents occurred at intersections or low-speed areas with traffic control measures. In contrast, GIDAS shows that the speeds of the participants are much closer together, indicating that accidents occurred in more fluid traffic conditions, such as open roads or highways. These findings highlight the varying dynamics captured by the two datasets. CRSS data emphasises the role of intersections and stationary vehicles in Longitudinal Traffic Scenario accidents, while GIDAS data points to more consistent speeds and fluid traffic conditions.

The evaluation of location data for the **Crossing Traffic Scenario** shows a comparable distribution of urban and rural areas in both GIDAS and CRSS. Specifically, the proportion of rural locations is around 30 % in both datasets. However, GIDAS exhibits a slightly higher percentage of rural locations compared to CRSS. The evaluation of road users reveals differences in categorisation between the two datasets. CRSS distinguishes parties based on vehicle types, while GIDAS categorises them at the participant level. CRSS data shows a balanced distribution of vehicle types in crossing accidents. In contrast, the GIDAS data for accident type 302 shows a more distinct distribution. Another striking difference is that participant A in GIDAS often must wait before turning. The initial speed of vehicles in CRSS data falls within a similar range, indicating accidents in more fluent traffic rather than one stationary or slow-moving participant. However, in GIDAS, significant differences are observed in accident type 302, where the speed of participant B is notably higher than the speed of participant A. This reflects the waiting obligation of participant A in GIDAS, which is not present in CRSS scenarios, leading to a more uniform speed distribution in CRSS.

Due to the detailed and concise nature of the situations described in both GIDAS and CRSS, it is possible to make a direct comparison of the **Left Turn Scenario** between these two datasets. The evaluation of location data reveals a comparable ratio of urban and rural locations across both datasets. Specifically, in both GIDAS and CRSS, the proportion of urban locations range between 76 % and 79 %. This indicates a consistent representation of urban areas in both datasets, ensuring that the findings are reflective of similar environments. The evaluation of weather conditions shows that most accidents in the Left Turn Scenario within both CRSS and GIDAS occurred under clear weather conditions. This indicates that most accidents happened when visibility was good and there were no adverse weather factors influencing the driving environment. By meticulously classifying the critical situations within this scenario, it became feasible to conduct a direct comparison of the types of road users involved. Both GIDAS and CRSS provide a clear framework for identifying and comparing different road users. The analysis reveals that in both datasets, participant A (vehicle “68”), the party turning left across the driving line of participant B (vehicle “69”), predominantly consists of M1/N1 vehicles. Approximately 90 % of participant A’s vehicles in both data sources are classified as M1/N1 vehicles. Similarly, over 90 % of participant B’s vehicles are motorcycles in both GIDAS and CRSS. The analysis of the initial speed for participant A (vehicle “68”) and participant B (vehicle “69”) shows comparable values for Germany and the US. A notable commonality between the two data sources is the observation that participant B was consistently traveling at a higher speed than participant A. This difference in speed dynamics is crucial for understanding the nature of left-turn accidents and the potential risks involved. The consistent patterns observed in location data, accident scenes, and types of road users across both GIDAS and CRSS highlight the reliability of these datasets.

When comparing the German PTW accident data with US PTW accident data, clear similarities and differences were observed, similar to the comparison with the European PTW accident data. There are differences in how road users are described. In Germany, participant A is typically identified as the main causer of the accident, whereas this designation is absent in CRSS. However, both systems share similarities in the potential influencing factors. The basic circumstances, such as location of the accident scene, the accident scene itself and weather conditions, are similar in CRSS and GIDAS. Once these similarities and differences have been identified, the GIDAS data can serve as a starting point for understanding US accident situation. This approach highlights the importance of recognising and addressing the differences in data categorisation and classification to enable meaningful comparisons.

# 5. Analysis results in detail (CRSS)

Now that the analyses of the scenarios in CRSS have been compared with selected critical situations in GIDAS and the most important findings have been worked out, a detailed overview of the results of the analysis of PTW accidents in CRSS follows. As a brief reminder, the scenarios analysed are shown in Figure 31. As marked in this image, the scenarios “Longitudinal traffic”, “Crossing traffic” and “Left turn” are analysed in detail.

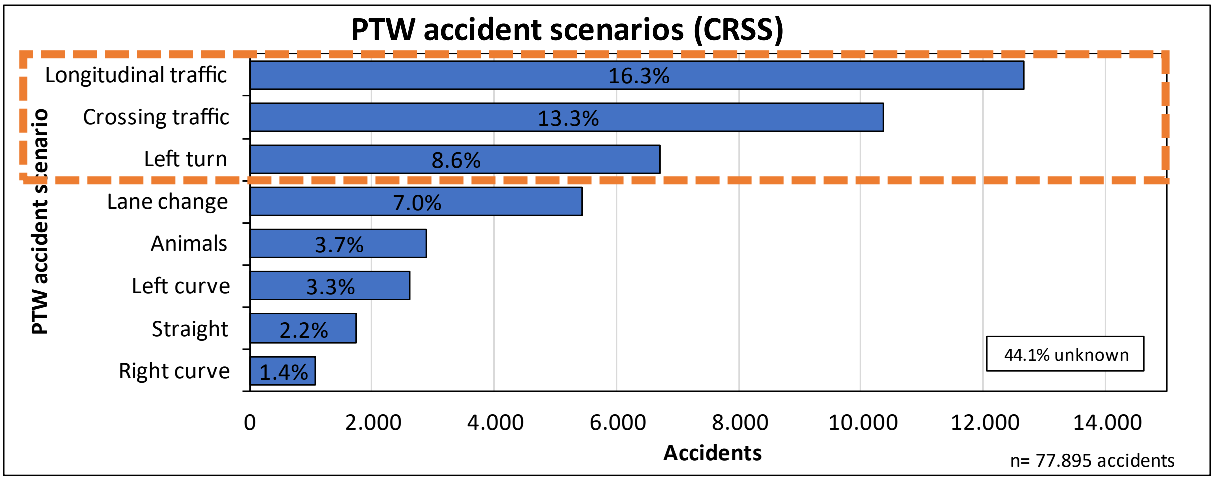



*Figure 31 Main common accident scenarios an CRSS*

## 5.1 Longitudinal Traffic Scenario

The results of the analysis of the location and the kind of road users in the Longitudinal Traffic Scenario (LTS) in CRSS are presented in Figure 32. As illustrated in the diagram below, more than three quarters of the location in the Longitudinal Traffic Scenario is situated in urban areas. The distribution of those involved in these critical situations predominantly includes M1/N1 vehicles and motorcycles. Other types of participants are less frequently involved in this scenario.

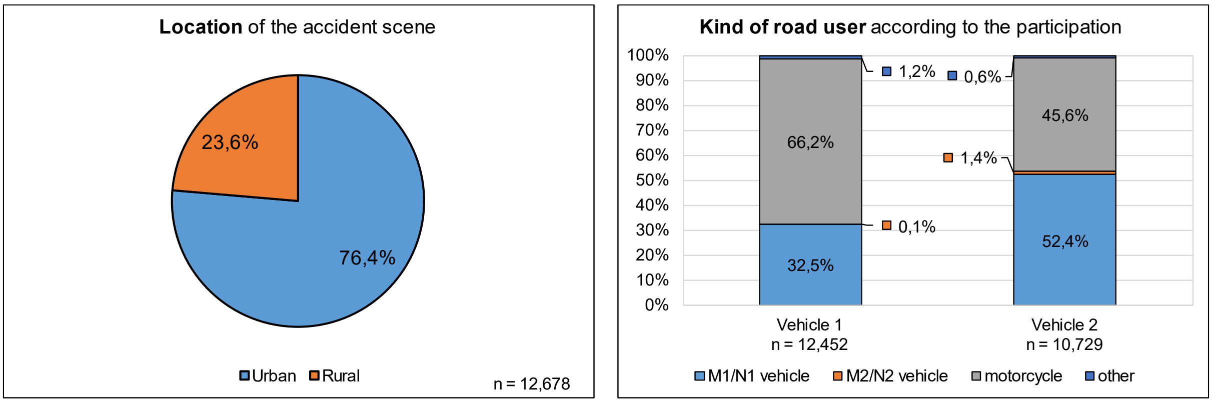



*Figure 32 LTS (CRSS) – Location and Kind of road users*

The results of the analysis of the type of intersection and the accident scene in the Longitudinal Traffic Scenario in CRSS are presented in Figure 33. In 68 % of the critical situations within this context, the incident did not occur at an intersection. This suggests that critical situations were less likely to arise from right-of-way rules typically associated with intersections. Furthermore, the evaluation of the entire accident scene revealed that in 59 % of the cases, there was no intersection in proximity. However, in an additional 30 % of the cases, the description of the scene was “intersection-related”. For better readability, Table 7 shows the breakdown of the accident scene by frequency.

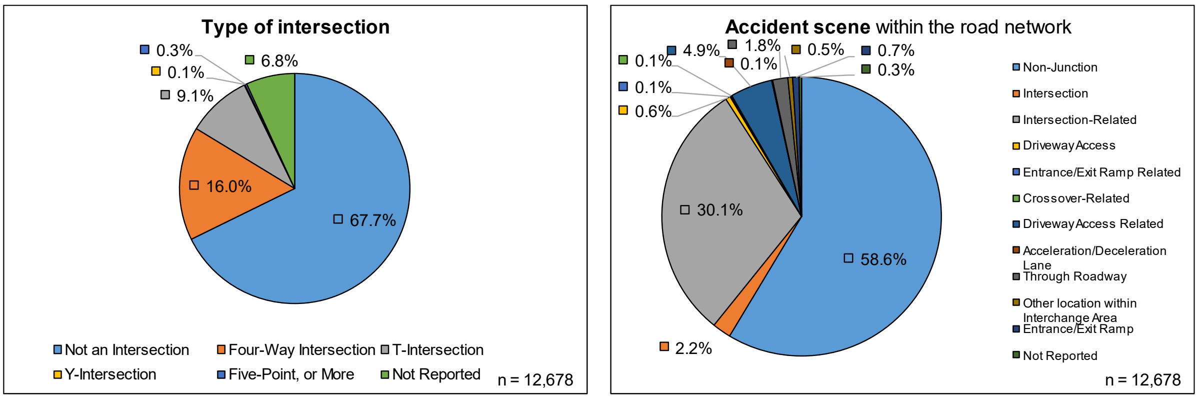



*Figure 33 LTS (CRSS) – Type of intersection and Accident scene*

| | |
|---|---|
| Non-Junction | 58.6 % |
| Intersection-Related | 30.1 % |
| Driveway Access Related | 4.9 % |
| Intersection | 2.2 % |
| Through Roadway | 1.8 % |
| Entrance/Exit Ramp | 0.7 % |
| Driveway Access | 0.6 % |
| Other location within Interchange Area | 0.5 % |
| Not Reported | 0.3 % |
| Crossover-Related | 0.1 % |
| Entrance/Exit Ramp Related | 0.1 % |
| Acceleration/Deceleration Lane | 0.1 % |

*Table 7 LTS (CRSS) – Ranking of accident scenes*

The results of the analysis of the lighting and weather condition in the Longitudinal Traffic Scenario are presented in Figure 34. The analysis of the lighting conditions indicates that critical situations in the Longitudinal Traffic Scenario predominantly occur during daylight hours, accounting for 74 % of the cases. In another 17 % of the cases, it was dark, but the area was illuminated by streetlamps or similar lighting sources. This means that in 91 % of the cases, adequate lighting conditions were present. A similar pattern emerges when examining weather conditions. In 81 % of the cases, clear weather conditions were recorded, while 11 % of the cases noted “cloudy” conditions. Only 4 % of the cases involved rain, indicating that dry road conditions were prevalent in the majority of incidents.

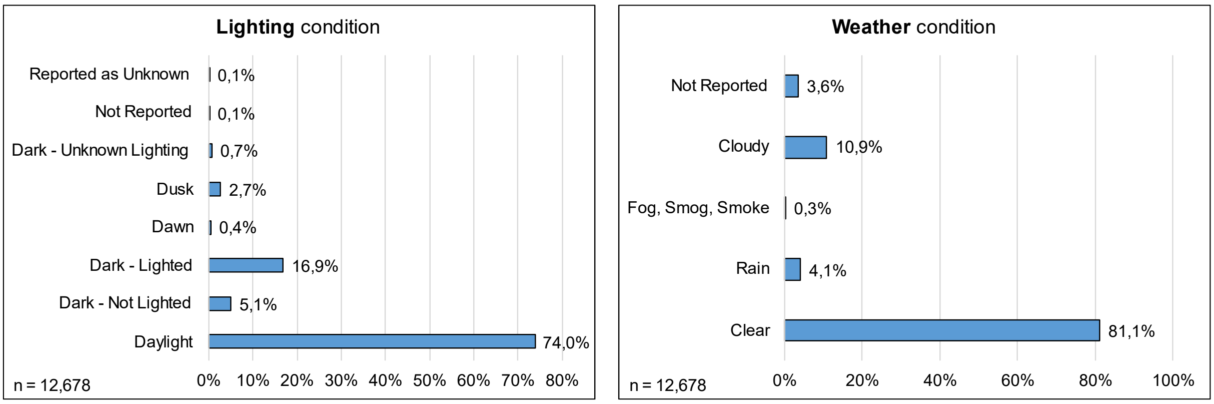



*Figure 34 LTS (CRSS) – Lighting and Weather condition*

Figure 35 provides an overview of the prevailing speed limits for the Longitudinal Traffic Scenario in CRSS. The most common speed limits observed in this scenario ranged between 60 km/h and 90 km/h.

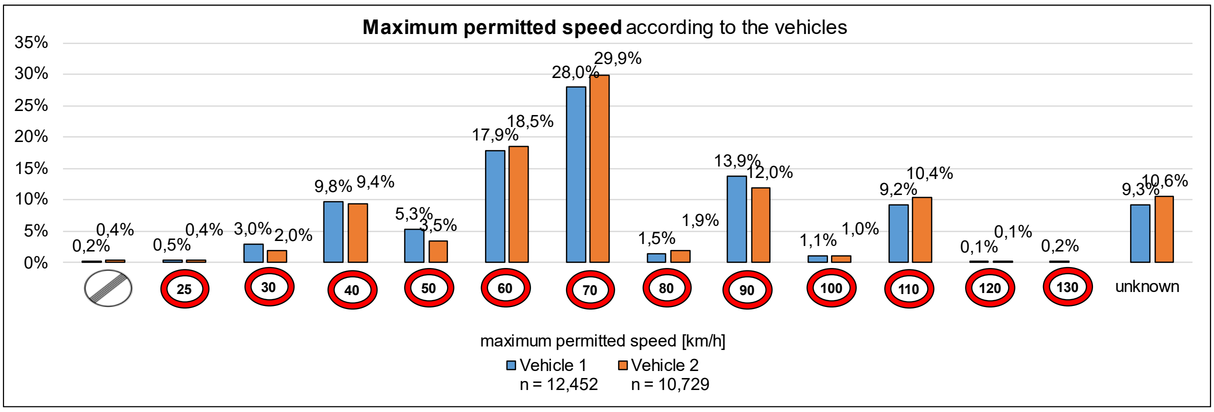



*Figure 35 LTS (CRSS) – Speed limits*

The results of the analysis of exceeding the speed limit in the Longitudinal Traffic Scenario in CRSS are presented in Figure 36. A comparison of the speed limits with the recorded speeds driven shows that vehicle 1 had exceeded the speed limit more frequently than vehicle 2.

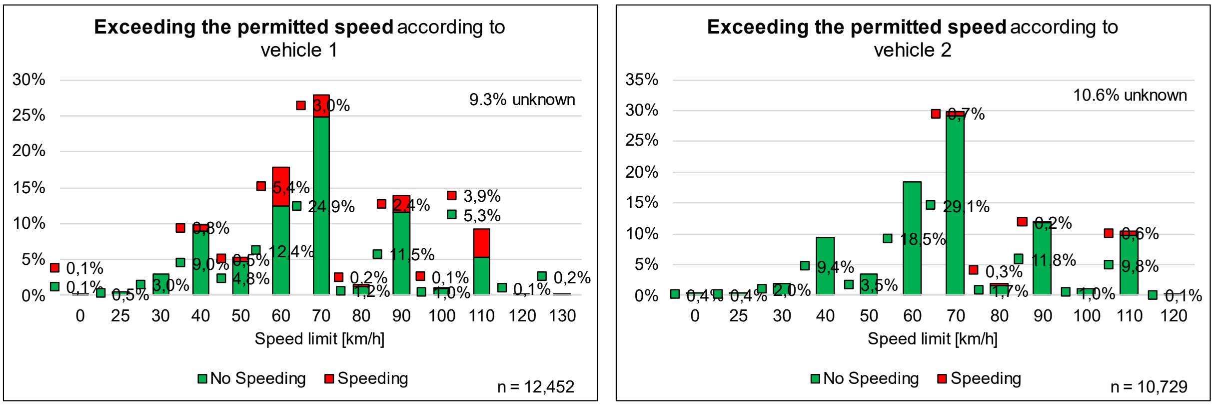



*Figure 36 LTS (CRSS) – Exceeding the speed limit*

The results of the analysis of the initial speed in the Longitudinal Traffic Scenario in CRSS are presented in Figure 37. It can be observed that significantly higher speeds were registered for vehicle 1. Although in a longitudinal accident the speed of vehicle 1 should be higher than that of vehicle 2, it is particularly evident from the data that the median speed for vehicle 2 is 0 km/h, indicating that vehicle 2 was stationary in many of the recorded incidents.

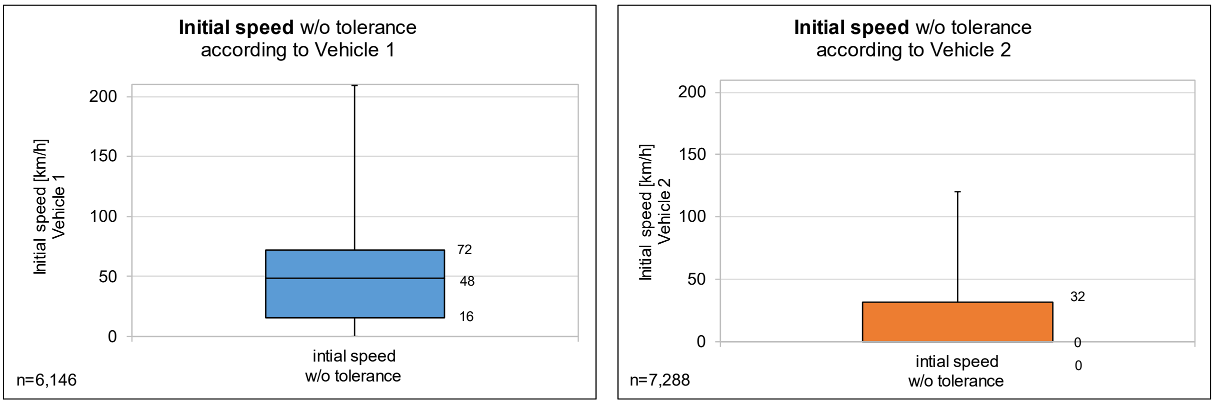



*Figure 37 LTS (CRSS) – Initial speed*

The analysis of driver related factors in the Longitudinal Traffic Scenario in CRSS is presented in Figure 38. For vehicle 1, no driver related factors were recorded in 87 % of the cases. This indicates that in most incidents, there were no specific issues attributed to the behaviour or condition of the driver of vehicle 1. For vehicle 2, this value is even higher, at 99 %. This further supports the observation that vehicle 2 was often stationary and not actively contributing to the dynamics of the incidents.

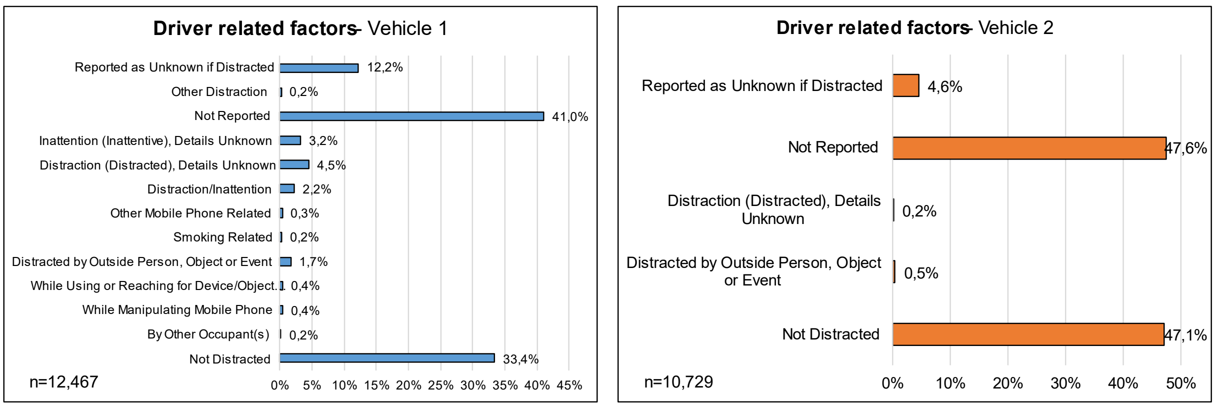



*Figure 38 LTS (CRSS) – Driver related factors*

The analysis of vehicle related factors in the Longitudinal Traffic Scenario in CRSS is presented in Figure 39. According to the diagrams, the influence of vehicle-related factors is less than 4 % for vehicle 1 and 1 % for vehicle 2. Vehicle-related influences are therefore the exception in this scenario.

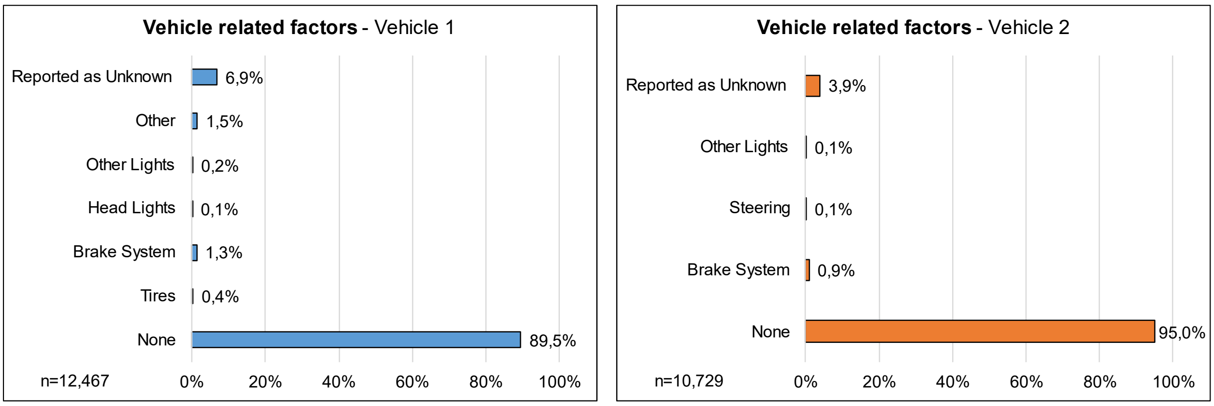



*Figure 39 LTS (CRSS) – Vehicle related factors*

## 5.2 Crossing Traffic Scenario

The results of the analysis of the location and the kind of road users in the Crossing Traffic Scenario (CTS) in CRSS are presented in Figure 40. As illustrated in the diagram below, around 29 % of the accident scene location in the Crossing Traffic Scenario is situated in rural areas. The distribution of those involved in these critical situations predominantly includes M1/N1 vehicles and motorcycles. Other types of participants are less frequently involved in this scenario.

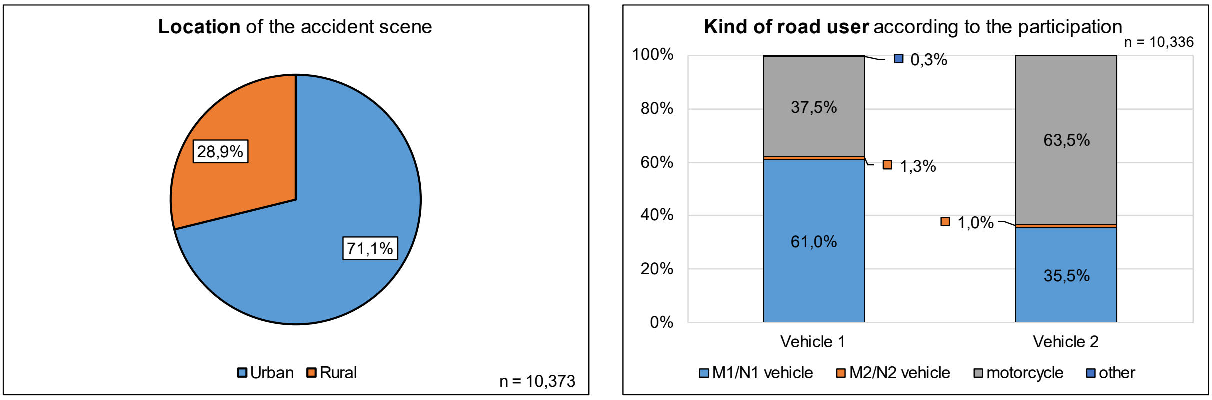
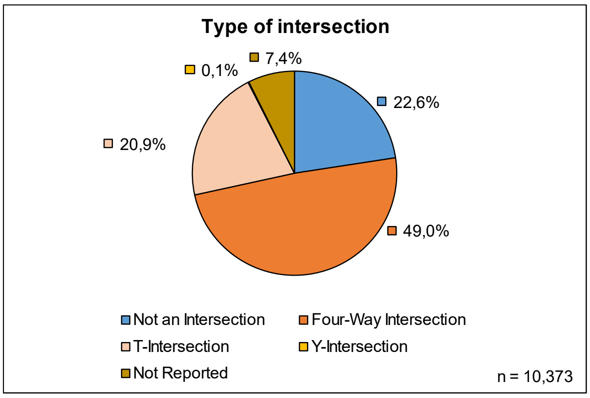



*Figure 40 CTS (CRSS) – Location and Kind of road user*

The results of the analysis of the type of intersection and the accident scene in the Crossing Traffic Scenario in CRSS are presented in Figure 41. As can be seen in the diagrams below, almost all accidents in the Crossing Traffic Scenario are located in the area of an intersection (77 %) or an area with right of way (22 %). The left-hand side of the diagram contains a detailed description and breakdown of the intersections.



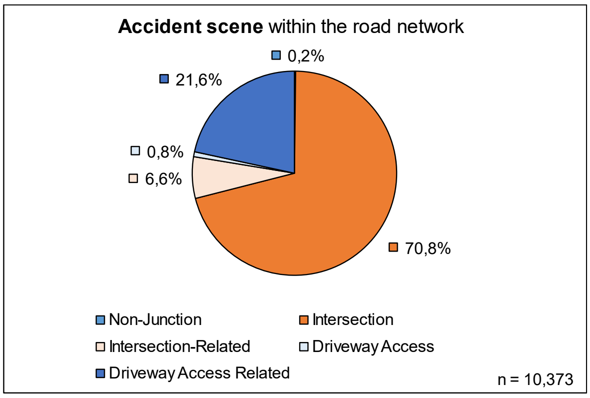
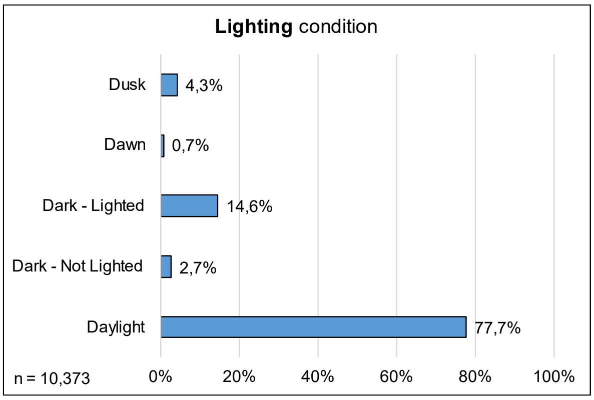




*Figure 41 CTS (CRSS) – Type of intersection and Accident scene*

The results of the analysis of the lighting and weather conditions in the Crossing Traffic Scenario are presented in Figure 42. The analysis of the lighting conditions indicates that critical situations in the Crossing Traffic Scenario predominantly occur during daylight hours, accounting for 78 % of the cases. In another 15 % of the cases, it was dark, but the area was illuminated by streetlamps or similar lighting sources. This means that in 93 % of the cases, adequate lighting conditions were present. A similarly pattern emerges when examining weather conditions. In 88 % of the cases, clear weather conditions were recorded, while 7 % of the cases noted “cloudy” conditions. Only 1 % of the cases involved rain, suggesting that dry road conditions were prevalent in the majority of incidents.



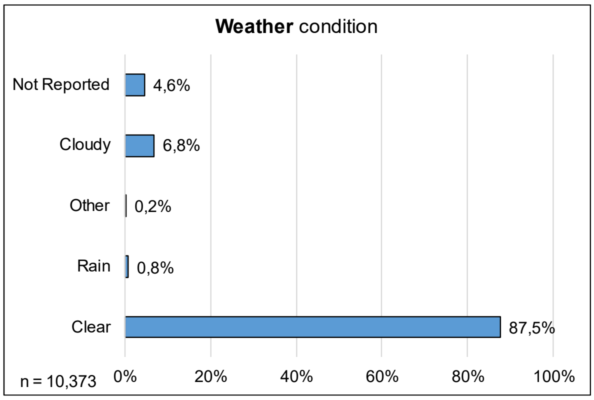




*Figure 42 CTS (CRSS) – Lighting and Weather condition*

In Figure 43 follows an overview of the prevailing speed limits for the Crossing Traffic Scenario in CRSS. The most common speed limits observed in this scenario ranged between 40 km/h and 70 km/h.

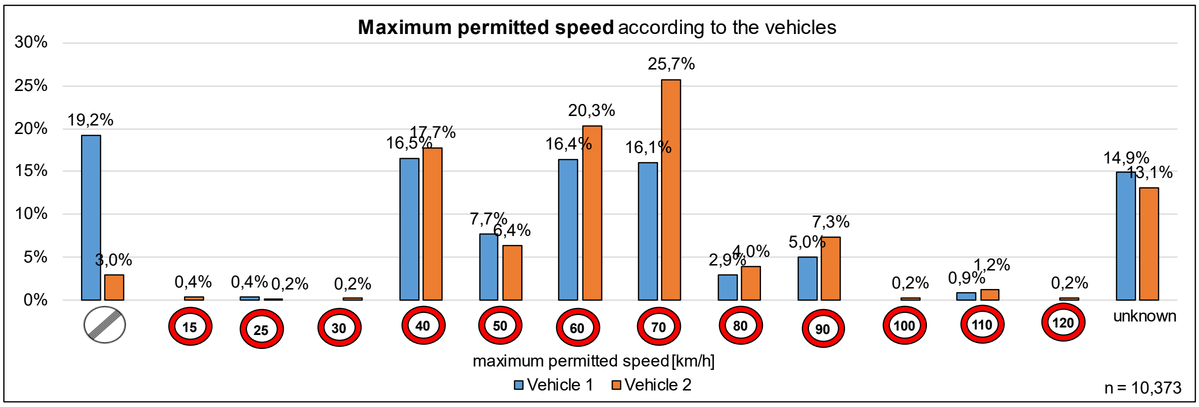



*Figure 43 CTS (CRSS) – Speed limits*

The results of the analysis of exceeding the speed limit in the Crossing Traffic Scenario in CRSS is presented in Figure 44. Exceeding the speed limit is not common in this scenario.

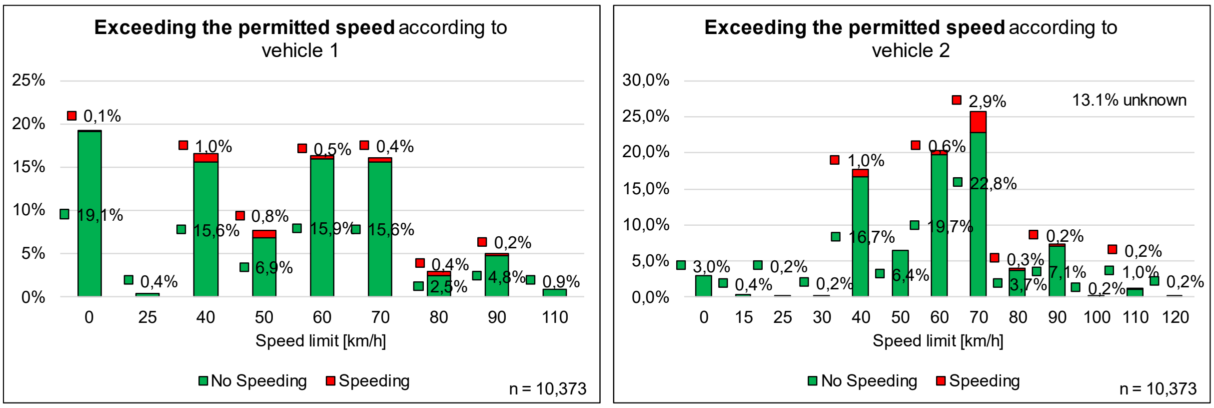



*Figure 44 CTS (CRSS) – Exceeding the speed limit*

The results of the analysis of the initial speed in the Crossing Traffic Scenario in CRSS is presented in Figure 45. The speed ranges of both vehicles are quite similar, indicating that their velocities are closely matched and there is little difference in their rates of movement.

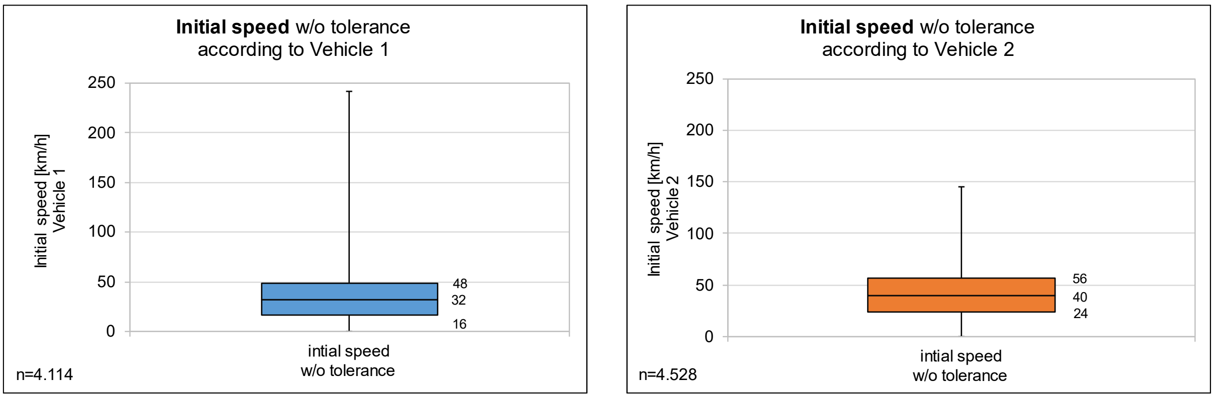
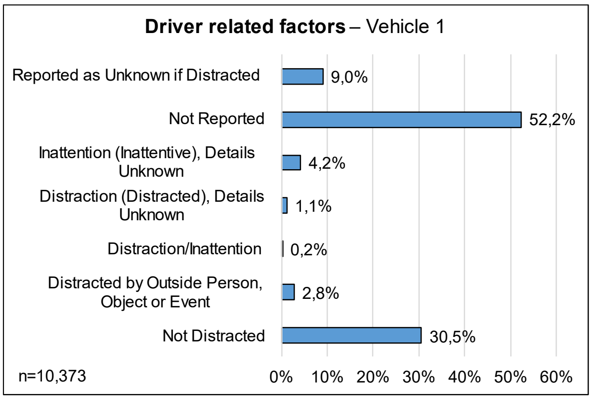



*Figure 45 CTS (CRSS) – Initial speed*

The analysis of driver related factors in the Crossing Traffic Scenario in CRSS is presented in Figure 46. This indicates that in most incidents, there were no specific issues attributed to the behaviour or condition of the driver of vehicle 1 and vehicle 2.



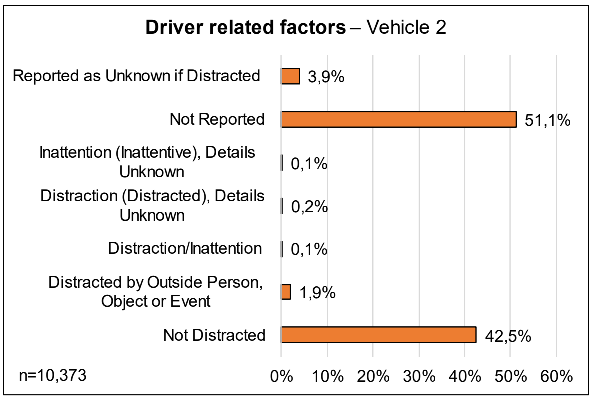
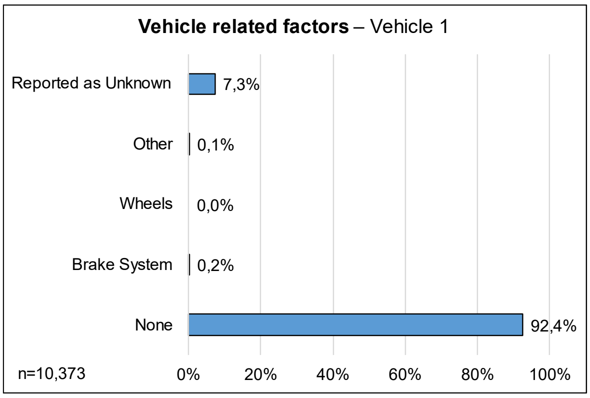




*Figure 46 CTS (CRSS) – Driver related factors*

The analysis of vehicle related factors in the Crossing Traffic Scenario in CRSS is presented in Figure 47. According to the diagrams, the influence of vehicle-related factors is less than 1 % for vehicle 1 and for vehicle 2. Vehicle-related influences are therefore the exception in this scenario.



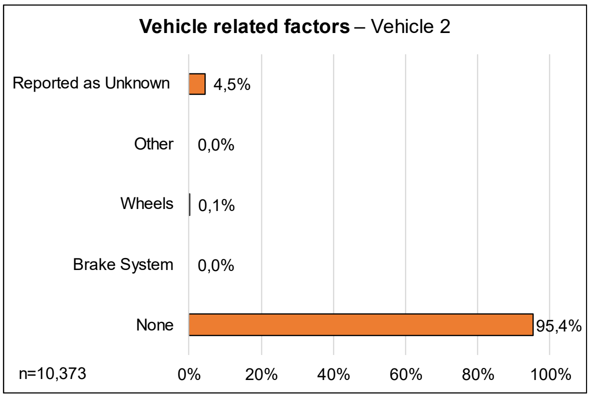




*Figure 47 CTS (CRSS) – Vehicle related factors*

## 5.3 Left Turn Traffic Scenario

The results of the analysis of the accident scene location and the kind of road users in the Left Turn Traffic Scenario (LEFTS) in CRSS are presented in Figure 48. As illustrated in the diagram, around three quarters of the location in the Left Turn Traffic Scenario is situated in urban areas. The distribution of those involved in these critical situations predominantly includes M1/N1 vehicles and motorcycles. Other types of participants are less frequently involved in this scenario.

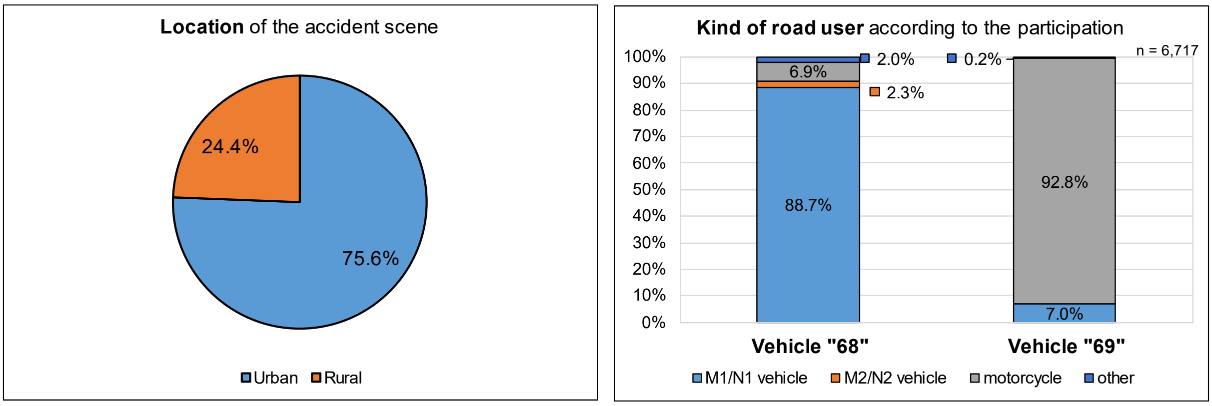



*Figure 48 LEFTS (CRSS) – Location and Kind of road user*

The results of the analysis of the type of intersection and the accident scene in the Left Turn Traffic Scenarios in CRSS are presented in Figure 49. As illustrated in the diagram, around three quarters of the accident scenes were intersections. All cases in this scenario involve a right-of-way situation.

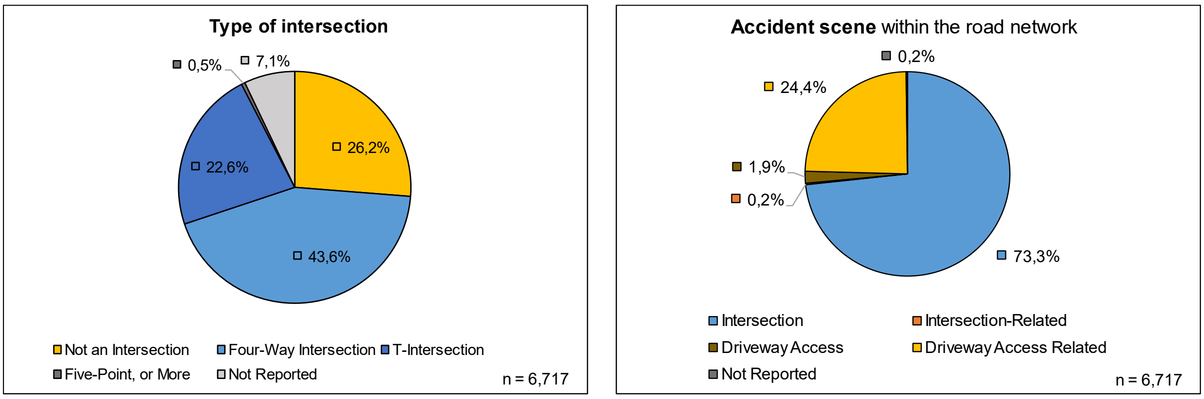



*Figure 49 LEFTS (CRSS) – Type of intersection and Accident scene*

The results of the analysis of the lighting and weather condition in the Left Turn Traffic Scenario are presented in Figure 50. The analysis of the lighting conditions indicates that critical situations in the Left Turn Traffic Scenario predominantly occur during daylight hours, accounting for 64 % of the cases. In another 25 % of the cases, it was dark, but the area was illuminated by streetlamps or similar lighting sources. This means that in 89 % of the cases, adequate lighting conditions were present. A similar pattern emerges when examining weather conditions. In 83 % of the cases, clear weather conditions were recorded, while 8 % of the cases noted “cloudy” conditions. Only 2 % of the cases involved rain, suggesting that dry road conditions were prevalent in the majority of incidents.

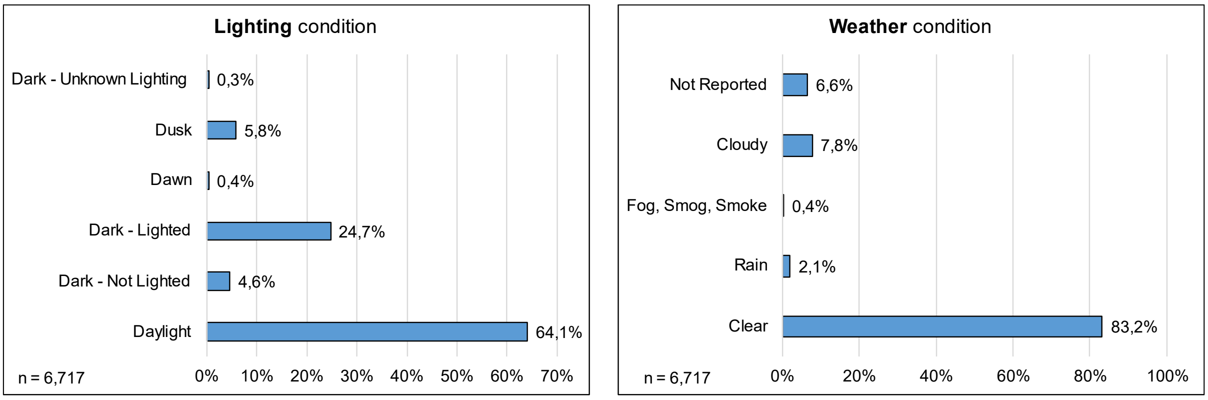



*Figure 50 LEFTS (CRSS) – Lighting and Weather condition*

Figure 51 provides an overview of the prevailing speed limits for the Left Turn Traffic Scenario in CRSS. The most common speed limits observed in this scenario ranged between 60 km/h and 70 km/h.

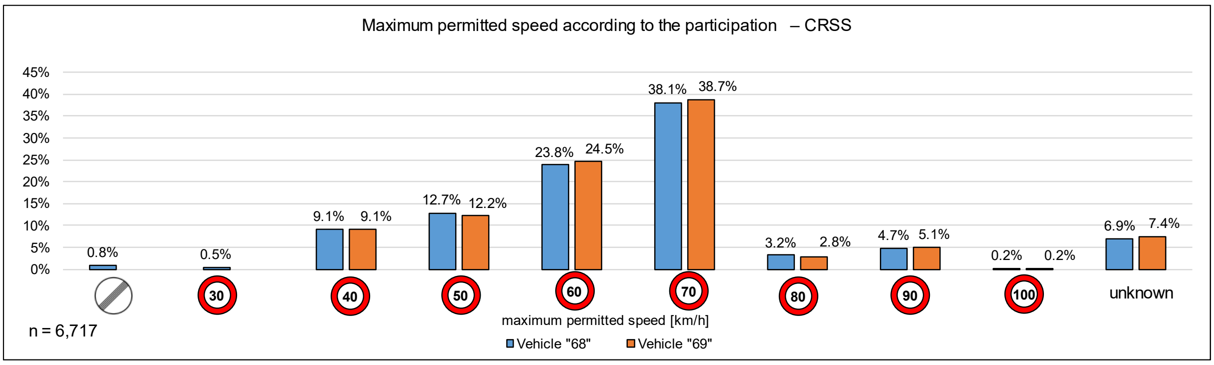



*Figure 51 LEFTS (CRSS) – Speed limits*

The results of the analysis of exceeding the speed limit in the Left Turn Traffic Scenario in CRSS are presented in Figure 52. A comparison of the speed limits with the recorded speeds driven reveals that only one of the two parties involved in the critical situation had exceeded the speed limit. The diagrams provide a clear illustration of this trend, showing that in the few cases of speeding, it was vehicle “69” (the vehicle driving straight) that had surpassed the prevailing speed limits, whereas vehicle “68” (the vehicle turning left) generally adhered to the speed regulations due to the waiting obligation.

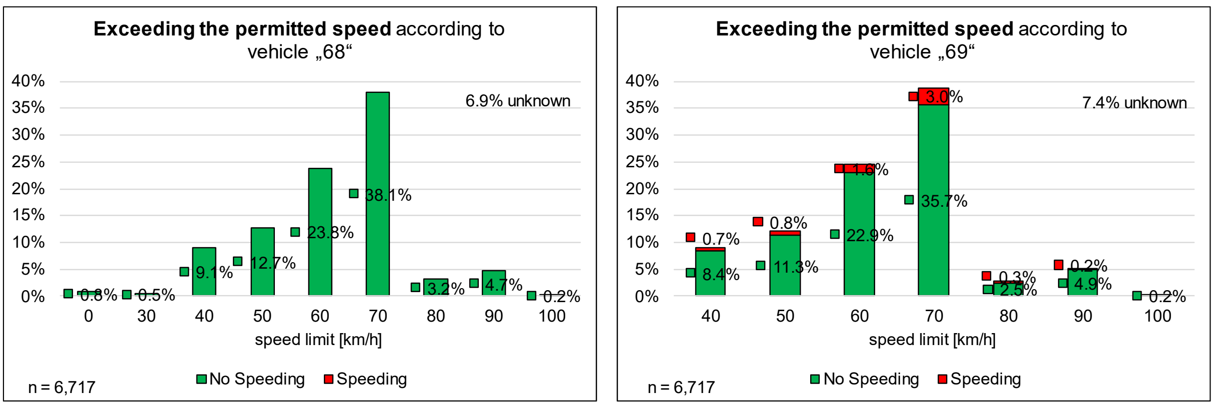
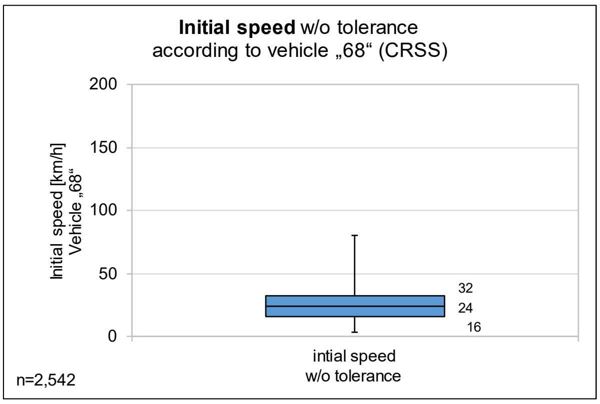



*Figure 52 LEFTS (CRSS) – Exceeding the speed limit*

The result of the analysis of the initial speed in the Left Turn Traffic Scenario in CRSS is presented in Figure 53. It can be observed that significantly higher speeds were registered for vehicle “69”. This is in line with the waiting obligation for vehicle “68”, who therefore drives more slowly.



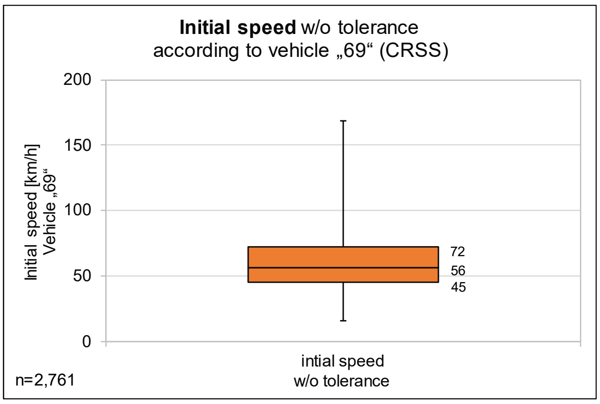
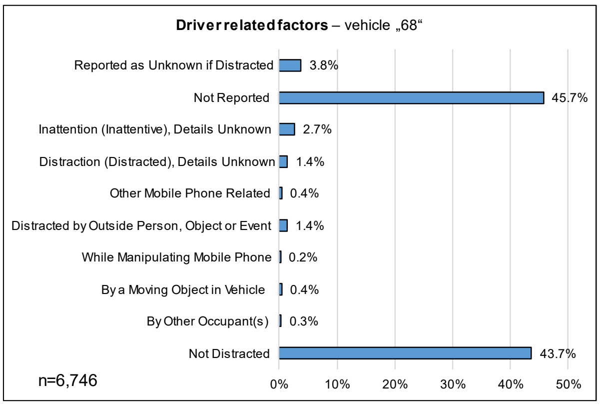




*Figure 53 LEFTS (CRSS) – Initial speed*

The analysis of driver related factors in the Left Turn Traffic Scenario in CRSS is presented in Figure 54. For vehicle “68”, no driver related factors were recorded in 93 % of the cases. This indicates that in the vast majority of incidents, there were no specific issues attributed to the behaviour or condition of the driver of vehicle “68”. For vehicle “69”, this value is even higher, at 99 %.



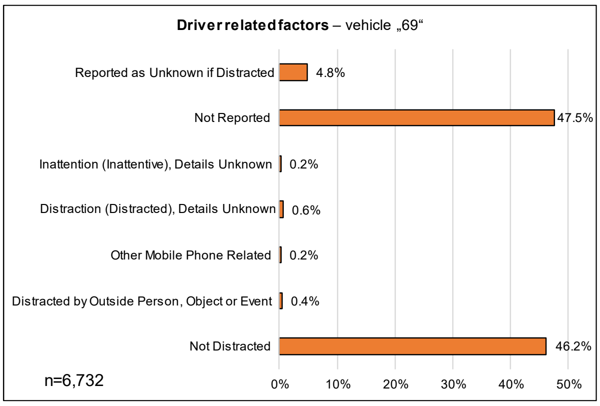




*Figure 54 LEFTS (CRSS) – Driver related factors*

The analysis of vehicle related factors in the Left Turn Traffic Scenario in CRSS is presented in Figure 55. According to the diagrams, the influence of vehicle-related factors is less than 2 % for the vehicles involved. Vehicle-related influences are therefore the exception in this scenario.

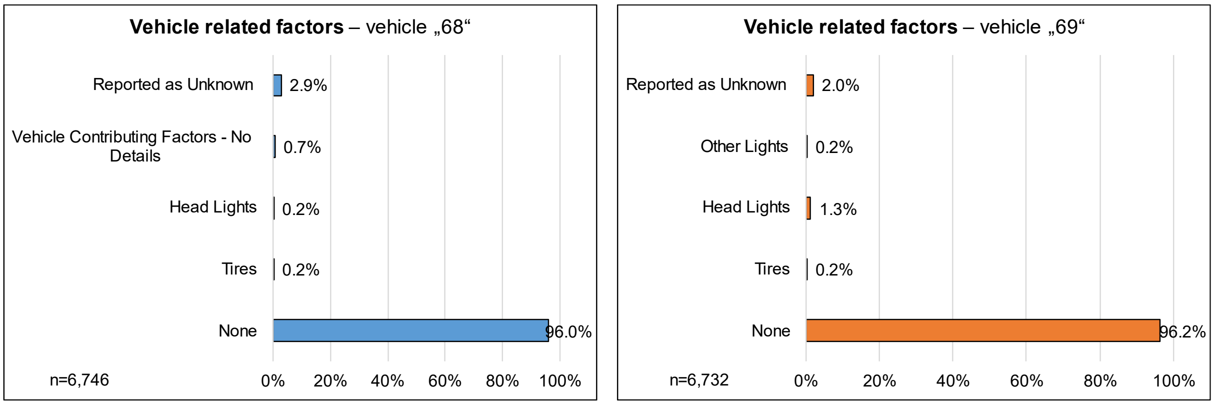



*Figure 55 LEFTS (CRSS) – Vehicle related factors*

# 6. Conclusion

Following a thorough analysis of PTW accidents in the US using the CRSS (Crash Report Sampling System) database, and a detailed comparison of these accidents with those occurring in Germany using the GIDAS (German In-Depth Accident Study) database, an extensive overview of their comparability is now provided. Through this overview, we aim to enhance our understanding of PTW accidents and improve safety measures for riders in both the US and Germany.

Specifically, the scenarios shown in this report were compared with selected critical situations from these scenarios in GIDAS. The following statements can be made about the comparability of the American and German data with regard to the variables examined. First of all, the differences between CRSS and GIDAS in the structure of the database and the coding of the information must be highlighted. In CRSS, the Crash Type describes both the critical situation and the actual collision, whereas in GIDAS, the Accident Type only describes the critical situation. Consequently, the Crash Type in CRSS is assigned to each vehicle, while the Accident Type in GIDAS provides an overall description of the parties involved in the critical situation. Another difference is that CRSS does not assign a main accident causer, whereas in GIDAS, Participant A usually refers to the main accident causer. Finally, in CRSS, only motorized vehicles are designated as involved parties, whereas in GIDAS, all persons involved in the accident are considered involved parties, including pedestrians and cyclists who were not motorized.

The evaluations of the location show good comparability across the scenarios. However, a tendency towards a more urban location can be seen in the Longitudinal Traffic Scenario in CRSS.
The evaluations of the accident scene and the weather conditions were also comparable for each scenario with the German data. This indicates that environmental factors play a similar role in both regions, contributing to the occurrence of accidents in comparable ways.
The respective parties involved in the accidents can only be compared with difficulty between CRSS and GIDAS, since the description of the kind of road users in CRSS is at the vehicle level and in GIDAS at the participant level. This highlights the challenges in comparing data

from diverse sources and underscores the importance of standardised definitions and classifications. The Left Turn Scenario is an exception here. Due to the definition of this scenario, it was possible to conduct a direct comparison.
When looking at speed limits, it was found that the CRSS data tend to show higher limits for PTW accidents than the German data. However, this is partly because CRSS focuses on highway accidents. The examination of the initial speeds revealed some differences, especially in the Longitudinal Traffic Scenario and the Crossing Traffic Scenario. In the Crossing Traffic Scenario, the discrepancy in speeds between the vehicles involved is particularly striking. The difference between the speeds of the parties involved in GIDAS is significantly higher than the difference in speed of the parties involved in CRSS. This can partly be attributed to the fact that the critical situations in the Crossing Traffic Scenario in GIDAS are often described by the fact that one of the parties involved has a waiting obligation. This detail is not available in CRSS. Therefore, the Crossing Traffic Scenario may vary in terms of vehicle dynamics between the US and Germany. The speed difference between participants in the Longitudinal Traffic Scenario in CRSS also significantly contrasts with that in GIDAS. In CRSS, the median speed of vehicle 2 is 0 km/h, indicating a stationary vehicle. The need for technology support to inform participants of the existence of oncoming participants or warn participants of a possible rear end collision highlighted in previous CMC reports is also evident in the CRSS data. Specifically, the speed differences between the two participants in CRSS emphasise the necessity for such technology, particularly concerning stationary or slow-moving vehicles.
Neither data source indicates that contributing factors have an influence at the accident level. The evaluation of driver distraction while driving also shows a similar picture in both data sources, since the data does not show any influence. This suggests that while driver distraction is a recognised issue, its documentation and perceived impact may vary between regions. Previous CMC reports have shown that even with good visibility and no distractions, PTWs were still often overlooked. Consequently, the CRSS data also underscores the strong need for technology support to mitigate accidents.

Overall, these comparisons highlight the importance of understanding regional differences in accident data and the need for careful interpretation when comparing datasets from different regions. By acknowledging these differences, we can better tailor safety measures and interventions to address the specific needs and conditions of each region.
Additionally, the analyses also demonstrate that the PTW accident situation in the US can be transferred to the German accident situation, albeit with some limitations. This suggests that the GIDAS data is a valuable source for making informed statements and deriving effective measures. The similarities in accident patterns and contributing factors between the two regions highlight the relevance of GIDAS data. Consequently, this data can be instrumental in developing targeted safety measures and policies to mitigate such accidents.

## Abbreviations

| | |
|---|---|
| CMC | Connected Motorcycle Consortium |
| CRSS | Crash Report Sampling System |
| CTS | Crossing Traffic Scenario |
| GIDAS | German In-Depth Accident Study |
| LEFTS | Let Turn Scenario |
| LTS | Longitudinal Traffic Scenario |
| US | United States |
| UTYP | Unfalltyp (accident type) |
| PCM | Pre-Crash-Matrix |
| PTW | Powered Two-Wheeler |

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# Annex A

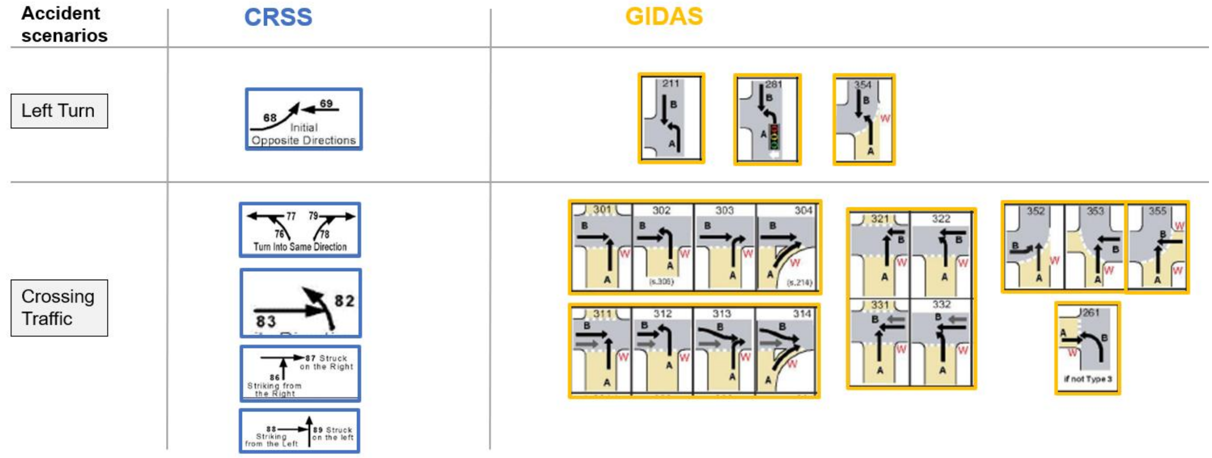


*Figure 56 Left Turn / Crossing Traffic – Accident/Crash Types GIDAS/CRSS*

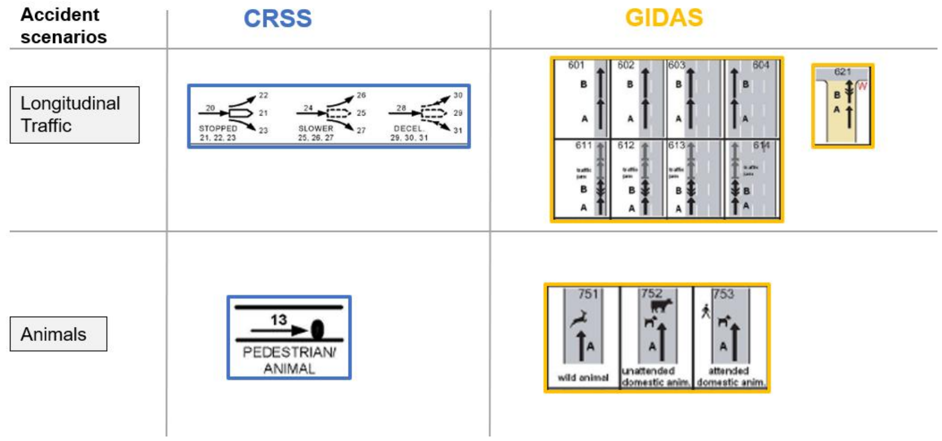


*Figure 57 Longitudinal Traffic / Animals – Accident/Crash Types GIDAS/CRSS*

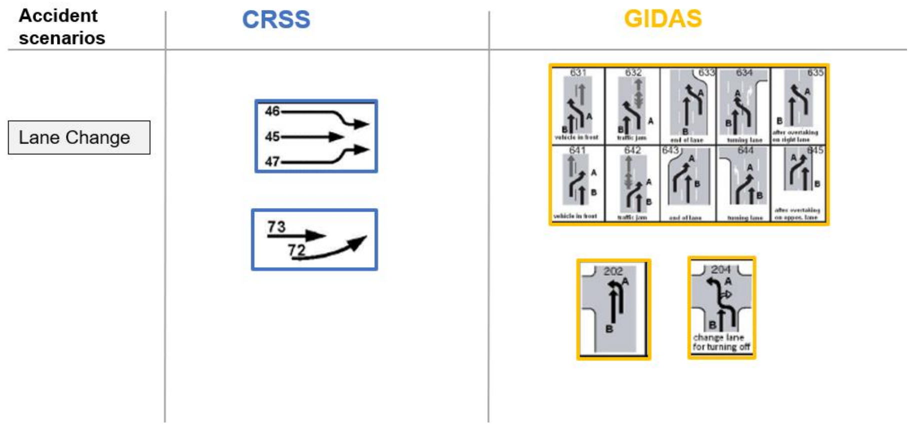


*Figure 58 Lane Change – Accident/Crash Types GIDAS/CRSS*

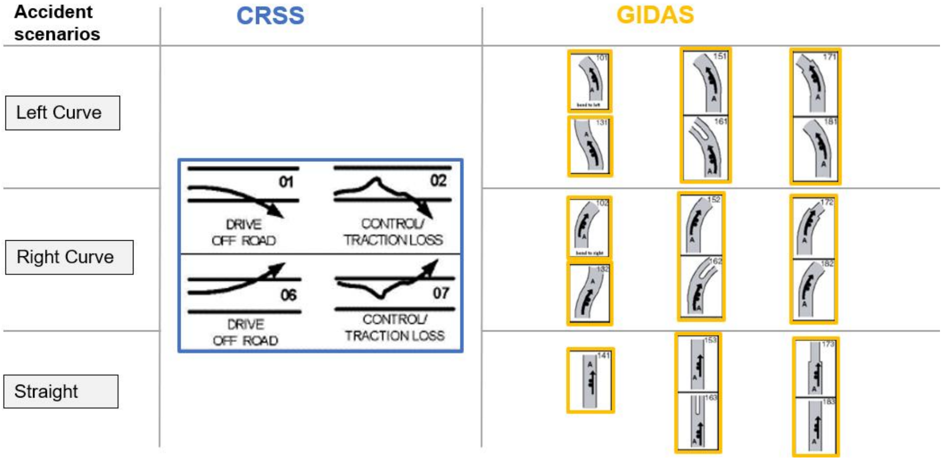


*Figure 59 Left, Right Curve / Straight – Accident/Crash Types GIDAS/CRSS*