Accident data analyses within the Connected Motorcycle Consortium – an international overview of PTW accidents

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Abstract

The data collected by the GIDAS project in Germany, which stands for "German In-Depth Accident Study," initially served as the basis for this comprehensive analysis. GIDAS is a study focused on in-depth traffic accident data collection. The project not only gathered general information about accidents, such as the location or description of the accident site, weather conditions, and road conditions, but also conducted detailed analyses. These in-depth analyses involved evaluating several factors, including the speed at which vehicles were traveling and the permitted speed limits, potential factors influencing the cause of the accident, collision partners, lanes being used, and even existing visual obstacles.

This extensive data was then weighted based on the official statistics on road accidents in Germany to provide a well-founded statement about the overall accident situation in the country. Through this evaluation process, the accidents were categorized into eleven distinct accident scenarios. These categorized scenarios were subsequently used to create and evaluate an overview of the prevailing critical situations that typically occur prior to an accident. The study also provided a ranking of these scenarios with associated accident types within the GIDAS dataset (Table 1).

Rank scenario	Accident scenario	Accident type	Rank type
1 *(19.3%)*	Crossing Traffic	302	1 *(38.9%)*
		321	2 *(11.8%)*
		301	3 *(11.1%)*
2 *(18.4%)*	Longitudinal Traffic	601	1 *(19.6%)*
		611	2 *(14.5%)*
		623	3 *(9.0%)*
3 *(12.4%)*	Lane Change	202	1 *(34.5%)*
		631	2 *(14.7%)*
		551	3 *(6.3%)*
4 *(12.0%)*	Left Curve	101	1 *(74.2%)*
		151	2 *(10.6%)*
		121	3 *(9.4%)*
5 *(11.0%)*	Right Curve	102	1 *(62.8%)*
		122	2 *(18.5%)*
		152	3 *(12.3%)*
6 *(7.2%)*	Straight	141	1 *(88.0%)*
		183	2 *(6.3%)*
		153	3 *(2.7%)*
7 *(6.3%)*	Left Turn	211	1 *(91.5%)*
		351	2 *(5.1%)*
		352	3 *(1.8%)*
8 *(5.1%)*	U-Turn	721	1 *(64.0%)*
		722	2 *(26.3%)*
		723	3 *(8.4%)*
9 *(4.5%)*	Other/Unknown	799	1 *(13.5%)*
		199	2 *(12.0%)*
		699	3 *(8.5%)*
10 *(3.0%)*	Animals	751	1 *(97.3%)*
		752	2 *(1.4%)*
		753	3 *(1.3%)*
11 *(0.8%)*	Technical Defect	775	1 *(86.5%)*
		771	2 *(13.5%)*

Table 1 Accident scenarios and ranking in GIDAS

Similar analyses were conducted using the IGLAD (Initiative for the Global Harmonization of Accident Data) database to facilitate a comprehensive comparison between German and European accidents. This initiative, spearheaded by Daimler AG, ACEA, and various research institutes, aimed to establish a unified standard for detailed accident data. The primary advantage of this approach was the highly similar design of the database structures, which ensured consistency and comparability. Additionally, the information content of both databases was remarkably similar, further enhancing the reliability and accuracy of the comparative analyses.

Furthermore, the National Highway Traffic Safety Administration's "Crash Report Sampling System" (CRSS) database was utilized to gain insights into powered two-wheeler (PTW) accidents in the United States. CRSS, which samples police-reported accidents, helps assess the overall accident landscape, identify highway safety issues, and form the basis for safety initiatives and regulations. However, to make the data comparable with European data, a transformation of the American accident descriptions was necessary.

European analyses focus on critical situations prior to an accident, information that is only partially available in CRSS. Therefore, accidents in the CRSS database were first evaluated and assigned to scenarios outlined in Table 1. This allowed for the creation of an overview where European accidents could be compared with American ones. Both general and in-depth analyses were then conducted.

It was found that the "Crossing Traffic" and "Longitudinal Traffic" scenarios are also quite common in North America. However, driving accident scenarios such as "Left/Right Curve" and "Straight" are less frequent in CRSS compared to GIDAS, where these scenarios occur more often. The "Left Turn" scenario is frequently represented in CRSS, but it is important to note that not all accidents could be assigned to European scenarios due to the transformation, resulting in a higher proportion of "Other" scenarios. Another difference identified is the tendency for higher speeds among parties involved in PTW accidents in the CRSS database. When evaluating these differences, it is crucial to consider the criteria for including accident data, as CRSS also focuses on highway accidents. Despite these factors, a good comparison can still be made with European data in the analysis of PTW accidents.

The analysis of powered two-wheeler accidents on Japanese roads forms the final part of this study, utilizing the ITARDA (Institute for Traffic Accident Research and Data Analysis) database as the primary data source. ITARDA maintains a comprehensive database of all traffic accidents in Japan and conducts extensive studies on these incidents from various perspectives. To enable a meaningful comparison with European data, it is necessary to adapt the differentiation of accident scenarios in the ITARDA database to the European scheme. The "Crossing Traffic" scenario is also quite common in Japan, like the American data. Additionally, the "Right Turn" scenario in Japan corresponds to the "Left Turn" scenario in countries with right-hand traffic, highlighting the importance of distinguishing between right-hand and left-hand traffic in these analyses.

A more precise assessment of PTW accidents on Japanese roads and a thorough comparison with European data require an in-depth analysis, which has not yet been conducted at this stage. This future analysis will be crucial for understanding the specific dynamics and factors influencing PTW accidents in Japan and how they compare to those in Europe.

Nevertheless, the data from the GIDAS database serves as a valuable foundation for understanding the global PTW accident situation. By examining the similarities and differences in PTW accidents across various regions, this data can be instrumental in enhancing traffic behavior for PTWs worldwide. Expanding these analyses to include other regions, such as South America, Oceania, or India, can further deepen our understanding of accident patterns and sequences. This broader perspective will help to optimize PTW accident prevention and improve safety measures on a global scale.

1. Analysis of European PTW accident situation

Due to the substantial number of available and analyzable cases in the database, specific scenarios were not created for this analysis. Instead, the most frequent accident types were analyzed directly. The accident type describes the critical situation before the actual collision event. This analysis revealed that the most common critical situations across Europe are also the most frequent accident types observed in the corresponding scenarios within the GIDAS database (Figure 1).

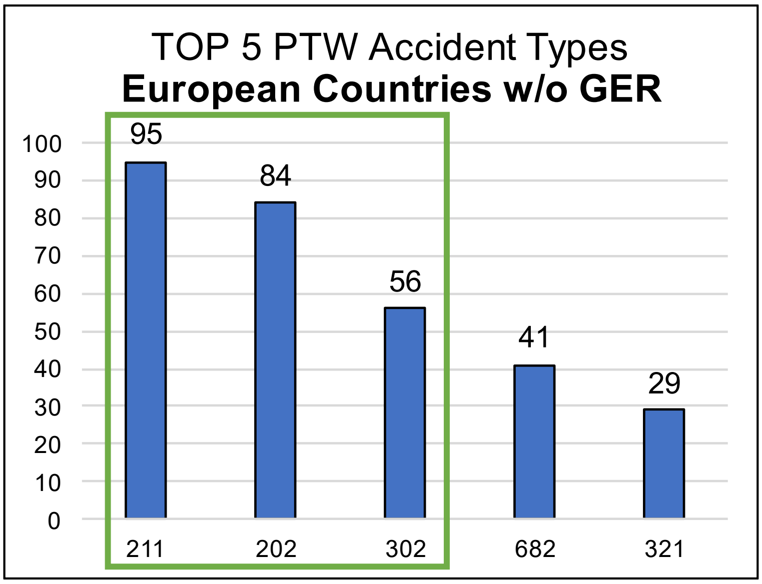


Figure 1 Top 5 PTW accident types in IGLAD

However, it is important to note that the selection of cases uploaded to the IGLAD database is determined by each participating country. The criteria for selecting these cases are not disclosed, which means that the evaluation of these accident types cannot be considered representative in terms of their ranking. This lack of transparency in case selection criteria introduces a level of uncertainty regarding the representativeness of the data.

Furthermore, the evaluation showed that the main number of cases in IGLAD came from Italy and France (if Germany is excluded from this evaluation). A closer look reveals that the main critical situations in these two countries are also similar, even in relation to Europe as a whole (Figure 2).

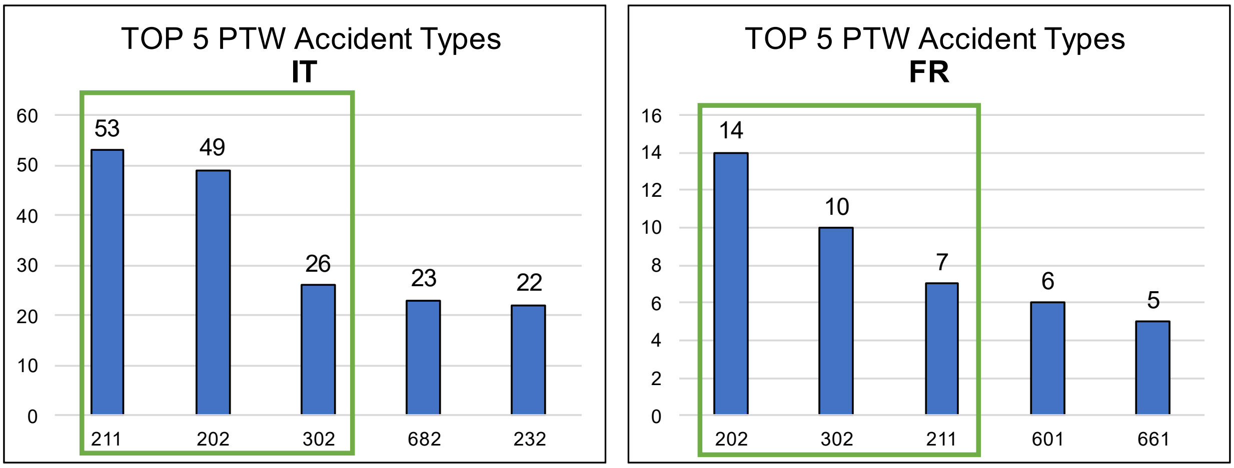


Figure 2 Top 5 PTW accident types in Italy and France

To comprehensively assess the PTW accident situation in France and Italy, official statistics from both countries were meticulously compared with the GIDAS dataset. The official statistics from France were sourced from BAAC (Bulletin d'Analyse des Accidents Corporels de la Circulation) under ONISR (Observatoire National Interministériel de la Sécurité Routière), while for Italy, the data was obtained from ACI (Automobile Club d'Italia) and ISTAT (Istituto Nazionale di Statistica).

During this comparative analysis, the first notable differences in the description of accidents became evident. In the GIDAS dataset, each accident is meticulously described with both an accident type, which details the critical situation leading up to the collision, and the nature of the accident, which describes the actual collision event. In contrast, the official statistics from France and Italy typically only provide accident scenarios without this dual categorization.

To ensure comparability of the situations, an attempt was made to reconcile these differences. The analysis revealed that while the type of accident could not be directly compared based on the official statistics, the nature of the accident could be aligned. This alignment allowed for the mapping of European accidents to the German accident history recorded in GIDAS.

The following diagrams provide a comprehensive overview of PTW accidents in the selected countries, focusing on various critical aspects. These aspects include accident severity, which categorizes the extent of injuries and fatalities; location, which identifies whether the accidents occurred in urban or rural areas; light conditions, which examine the visibility at the time of the accidents, such as daylight, dusk, or nighttime and road conditions, which consider factors like wet or dry surfaces.

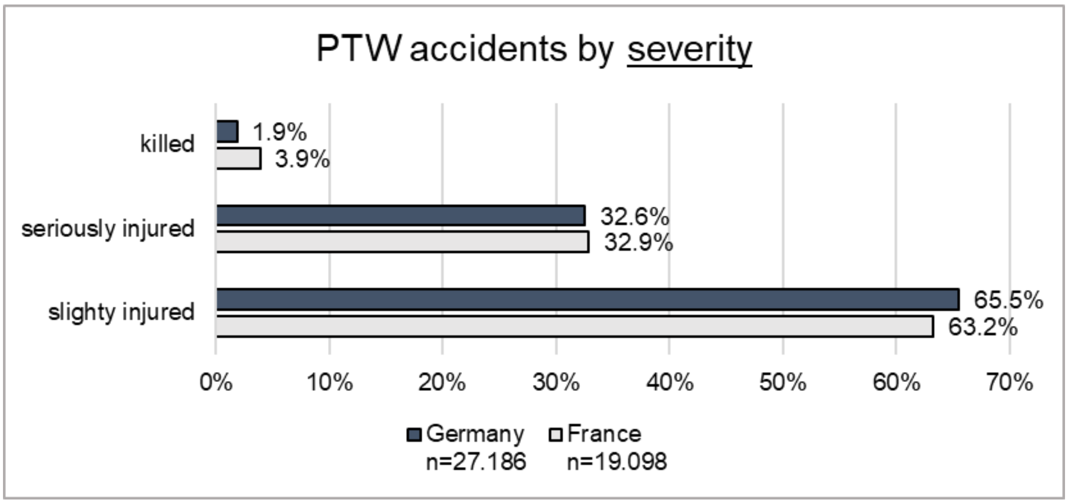


Figure 3 PTW accidents by severity (GIDAS, BAAC)

The official statistics from France indicate that a larger proportion of PTW accidents result in fatalities compared to the figures recorded in the GIDAS dataset (Figure 3).

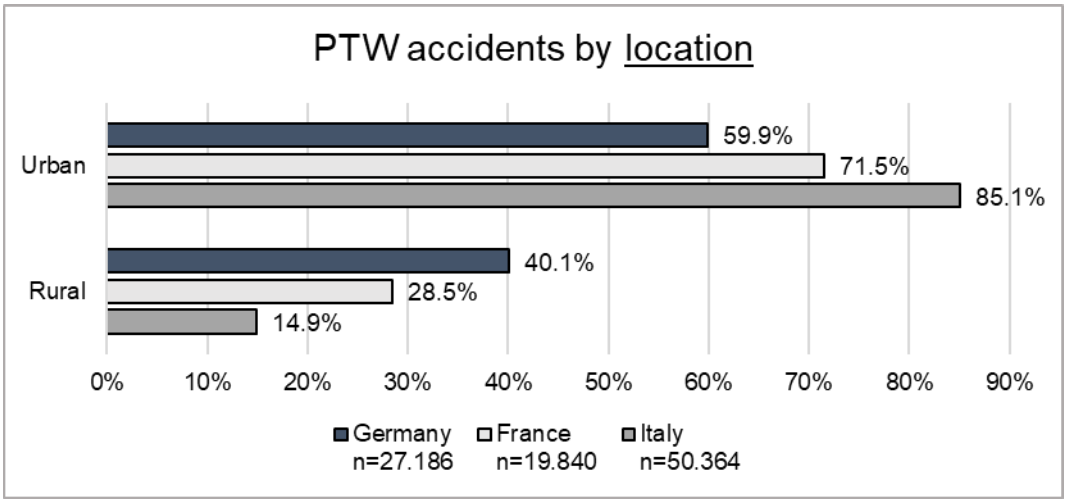


Figure 4 PTW accidents by location (GIDAS, BAAC, ISTAT)

The highest share of urban accident locations was recorded in Italy (Figure 4). This indicates that a considerable proportion of PTW accidents in Italy occur within urban areas, such as cities and towns. Urban areas often present a complex mix of road users, including pedestrians, cyclists, and diverse types of motor vehicles, which can increase the likelihood of accidents.

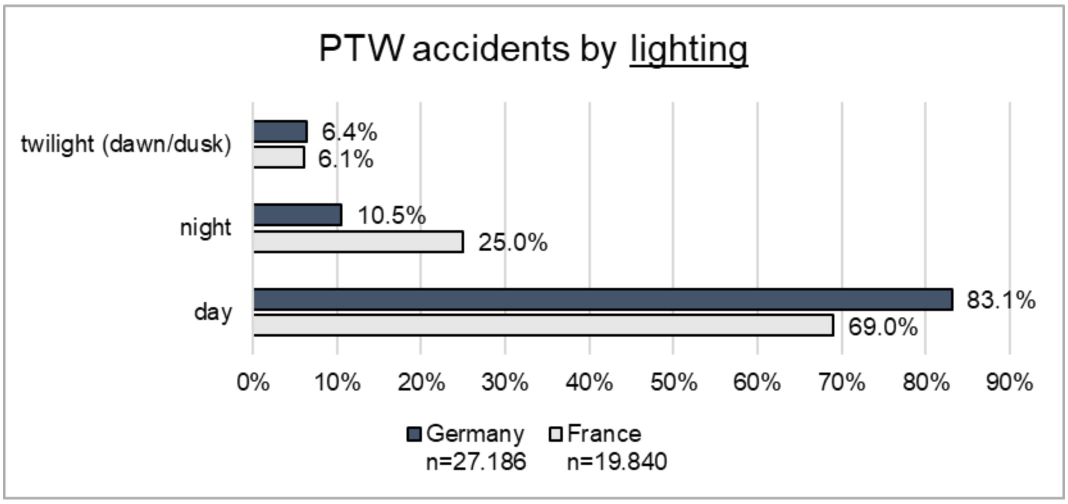


Figure 5 PTW accidents by lighting (GIDAS, BAAC)

The proportion of accidents occurring at night is significantly higher in France compared to Germany (Figure 5). This notable difference suggests that nighttime driving conditions in France may present greater risks for PTW riders.

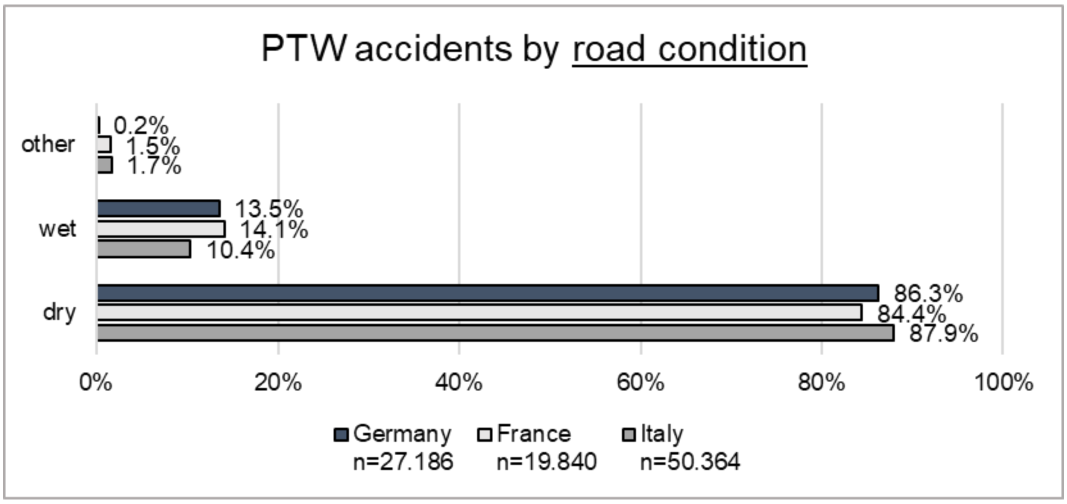


Figure 6 PTW accidents by road condition (GIDAS, BAAC, ISTAT)

Regarding road conditions, no major differences were found between the respective countries (Figure 6).

However, since the primary focus of this study was on understanding the critical situations leading to accidents, the analyses were conducted using the IGLAD (Initiative for the Global Harmonization of Accident Data) database. This approach ensured a more detailed and accurate comparison of the critical situations across different regions.

The following is an in-depth overview of the analysis of the three most frequent accident types identified in the IGLAD database (see Figure 1). This analysis is then compared with the data pertaining to the same accident types within the GIDAS database.

1.1 Accident type 211

Accident type 211, often referred to as “turning left with oncoming traffic”, involves a critical situation between a vehicle making a left turn and an oncoming vehicle traveling straight from the opposite direction. This type of accident typically occurs at intersections, junctions, or other crossing points where vehicles from different directions meet. The corresponding pictogram is shown in Figure 7.

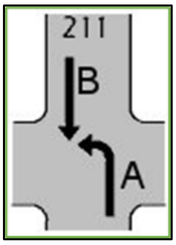


Figure 7 Pictogram of accident type 211

The analysis of the location data revealed that the proportion of urban accidents is higher in Germany compared to European countries (Figure 8). This finding indicates that a larger share of PTW accidents in Germany occur within urban environments, such as cities and towns. Urban areas are characterized by high traffic density, numerous intersections, and a diverse mix of road users, including pedestrians, cyclists, and diverse types of motor vehicles. These factors contribute to a more complex and potentially hazardous driving environment.

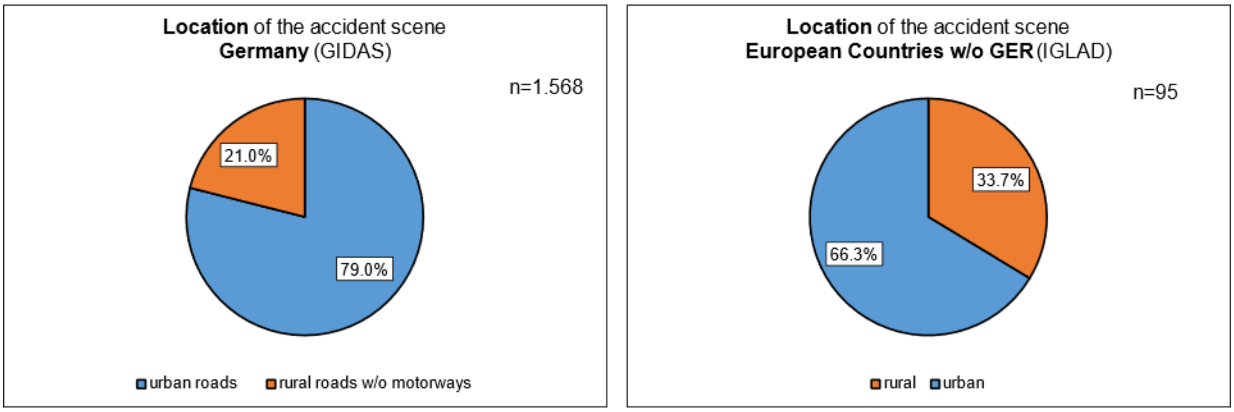


Figure 8 211: location (GIDAS, IGLAD)

The analysis of road conditions for this specific accident type revealed a striking similarity between the data sources, with both indicating that the majority of these accidents occur under dry road conditions (Figure 9). This consistency suggests that dry road surfaces are a common factor in the occurrence of these accidents, regardless of the region being studied.

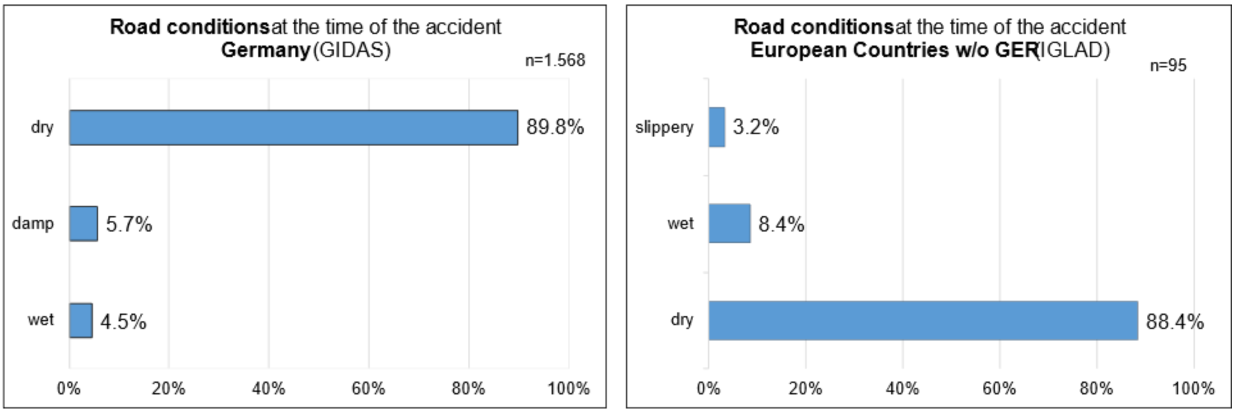


Figure 9 211: road conditions (GIDAS, IGLAD)

The evaluation of weather conditions revealed a predictable pattern: dry weather prevailed in most of the accidents analyzed (Figure 10). This result is in line with expectations, as road conditions were also dry.

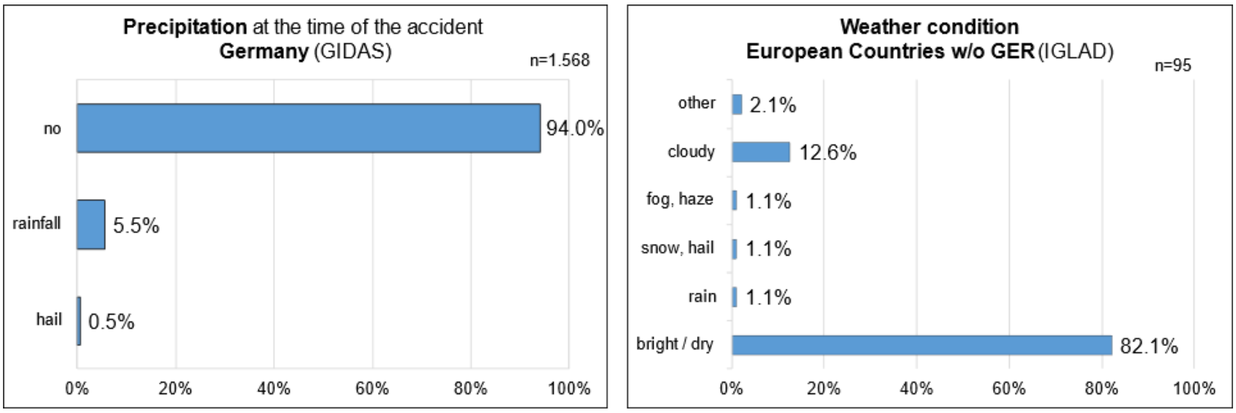


Figure 10 211: weather condition (GIDAS, IGLAD)

Figure 11and Figure 12 provide a detailed visualization of the distribution of diverse types of road users involved in PTW accidents. These diagrams illustrate the proportion of different road user categories, such as pedestrians, cyclists, car drivers, and other motor vehicle operators, who are involved in accidents with PTWs. The main differences in the accident data are observed in the case of participant A. In Germany, the share of M1 vehicles, which typically refers to passenger cars, is significantly higher for this participant. In contrast, the share of PTW users as participant A is higher in the European countries included in the analysis.

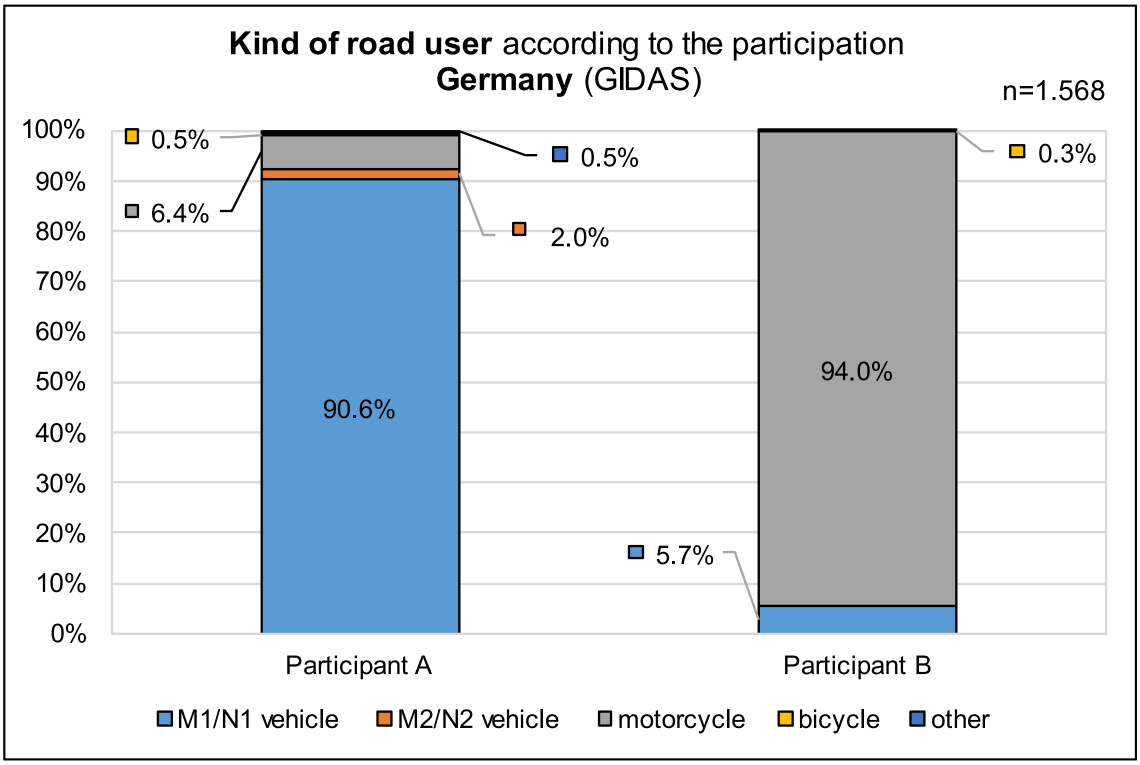


Figure 11 211: kind of road user (GIDAS)

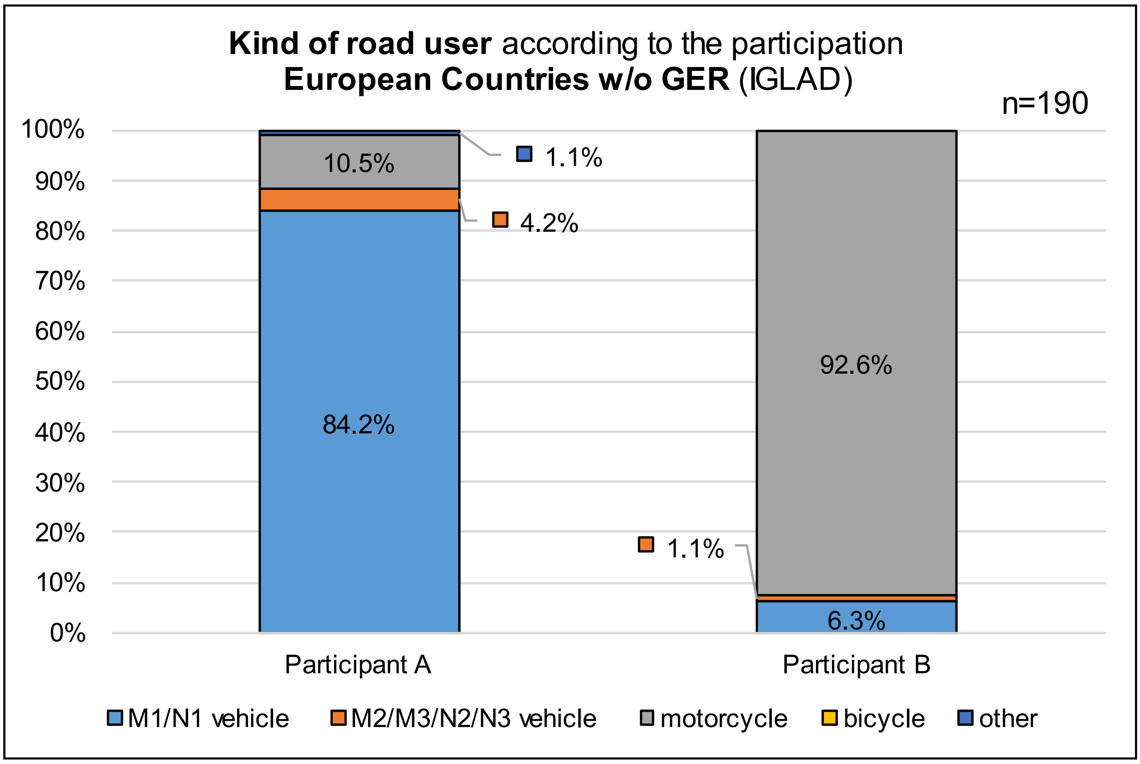


Figure 12 211: kind of road user (IGLAD)

The analysis of the initial speed for participant A showed comparable values for Germany and the European countries (Figure 13).

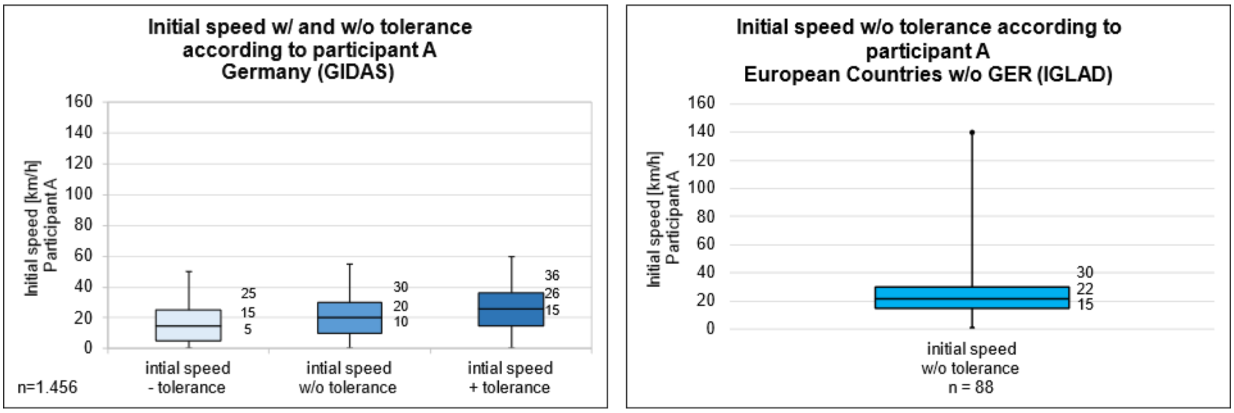


Figure 13 211: initial speed participant A (GIDAS, IGLAD)

In the case of the analysis of the initial speed for participant B, it was shown that in European countries, participant B was traveling faster than in Germany (Figure 14).

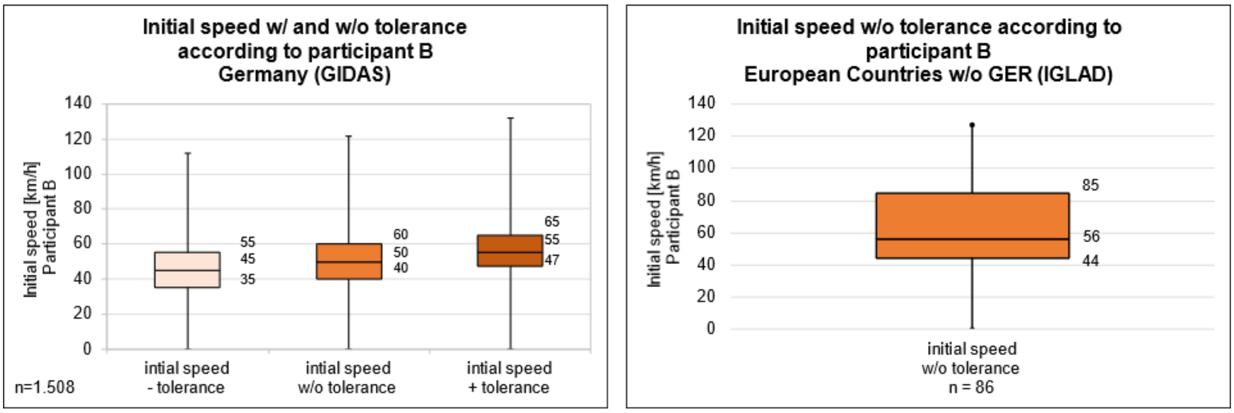


Figure 14 211: initial speed participant B (GIDAS, IGLAD)

A similar picture emerges from the analysis of the collision speeds for participants A and B (Figure 15 and Figure 16). While the collision speed for participant A is comparable, the collision speed for participant B is higher in European countries.

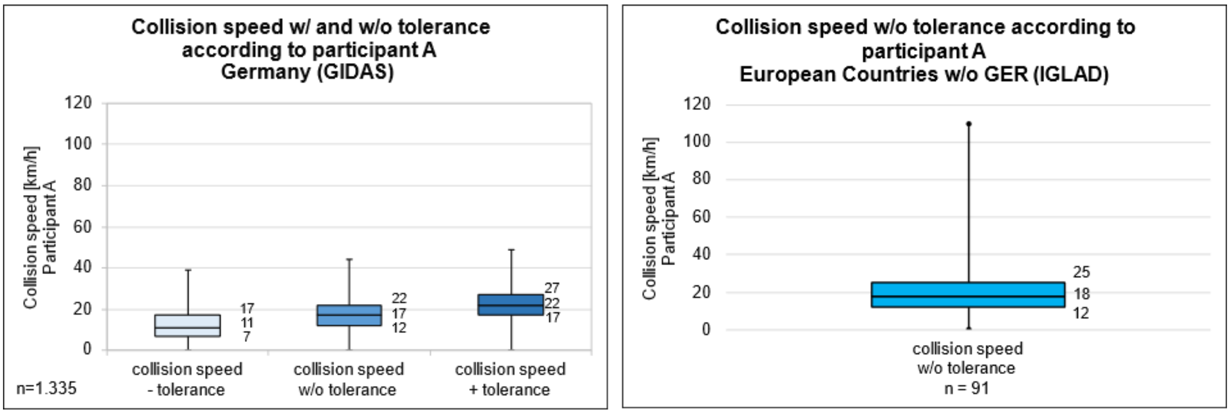


Figure 15 211: collision speed participant A (GIDAS, IGLAD)

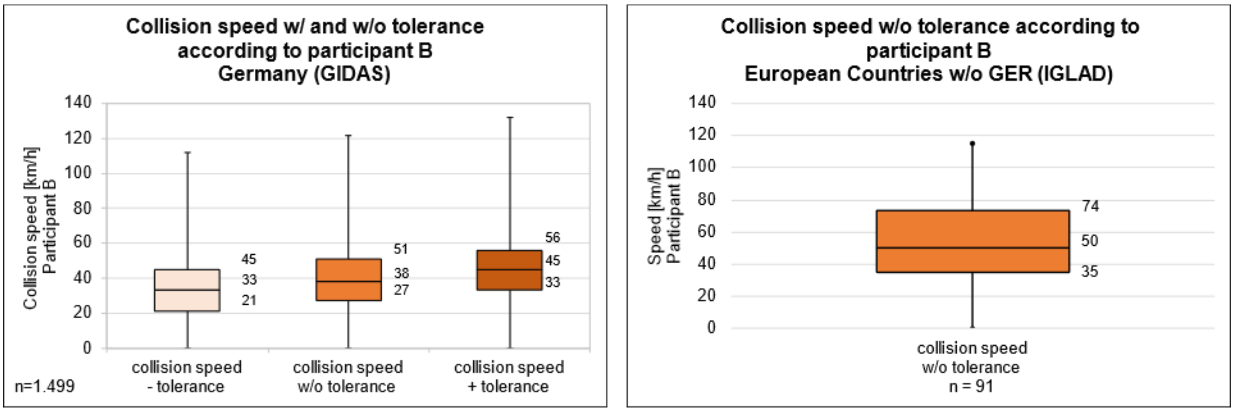


Figure 16 211: collision speed participant B (GIDAS, IGLAD)

1.2 Accident type 202

Accident type 202, classified as “turning left with following traffic,” describes a specific scenario where a vehicle (Participant A) is making a left turn and is followed by another vehicle (Participant B) that is either following or overtaking Participant A on its left side. This type of accident is particularly common at intersections or junctions where vehicles are required to navigate turns amidst ongoing traffic. The corresponding pictogram is shown in Figure 17.

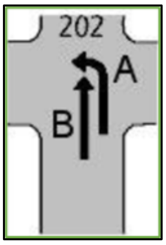


Figure 17 Pictogram accident type 202

The analysis of the location data revealed that the proportion of urban accidents is significantly higher in the European countries compared to Germany (Figure 18). Understanding the prevalence of urban accidents is crucial for developing targeted safety measures. Efforts to improve urban road safety could include enhancing traffic management systems, improving road infrastructure, and implementing stricter enforcement of traffic laws. Measures such as dedicated PTW lanes, better signage, and public awareness campaigns about safe riding practices can also contribute to reducing the number of accidents in urban areas.

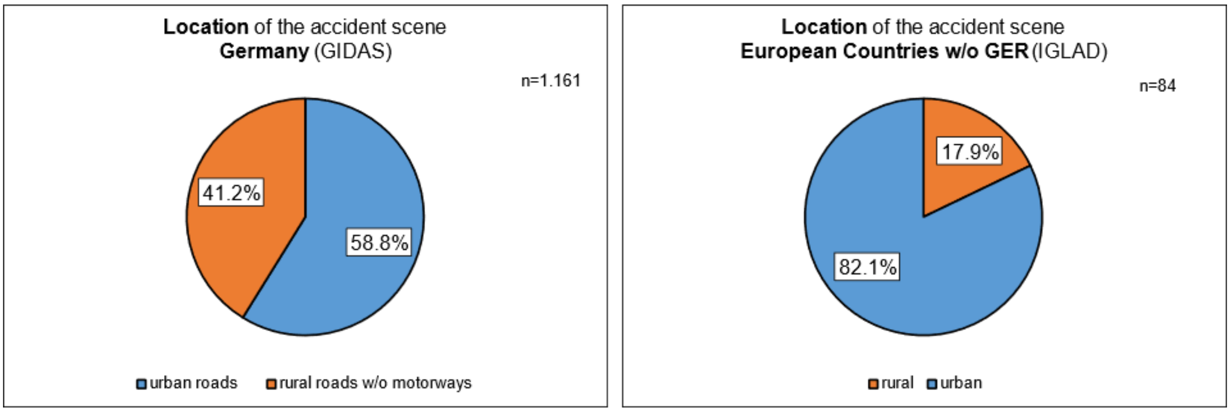


Figure 18 202: location (GIDAS, IGLAD)

The analysis of road conditions for this specific accident type revealed a striking similarity between the data sources, with both indicating that the majority of these accidents occur under dry road conditions (Figure 19). This consistency suggests that dry road surfaces are a common factor in the occurrence of these accidents, regardless of the region being studied.

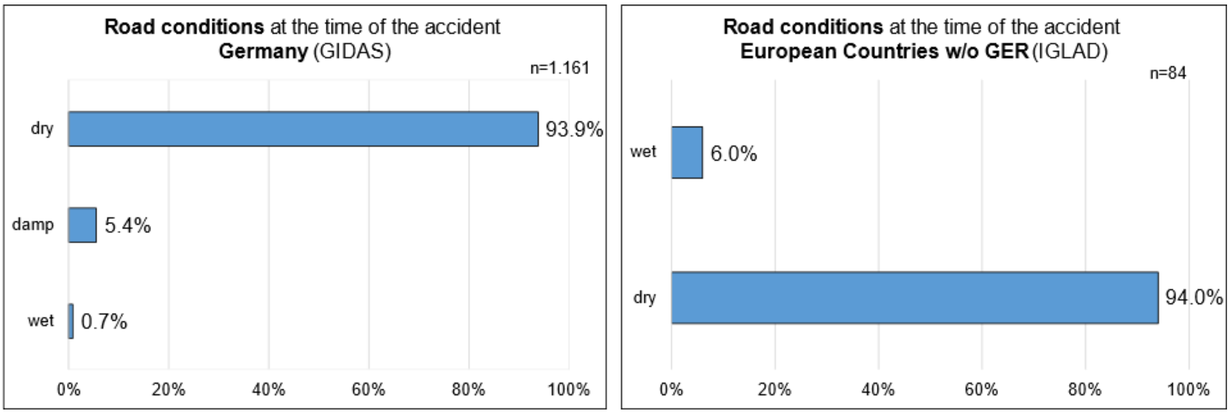


Figure 19 202: road conditions (GIDAS, IGLAD)

The evaluation of weather conditions revealed a predictable pattern: dry weather prevailed in most of the accidents analyzed (Figure 20). This result is in line with expectations, as road conditions were also dry.

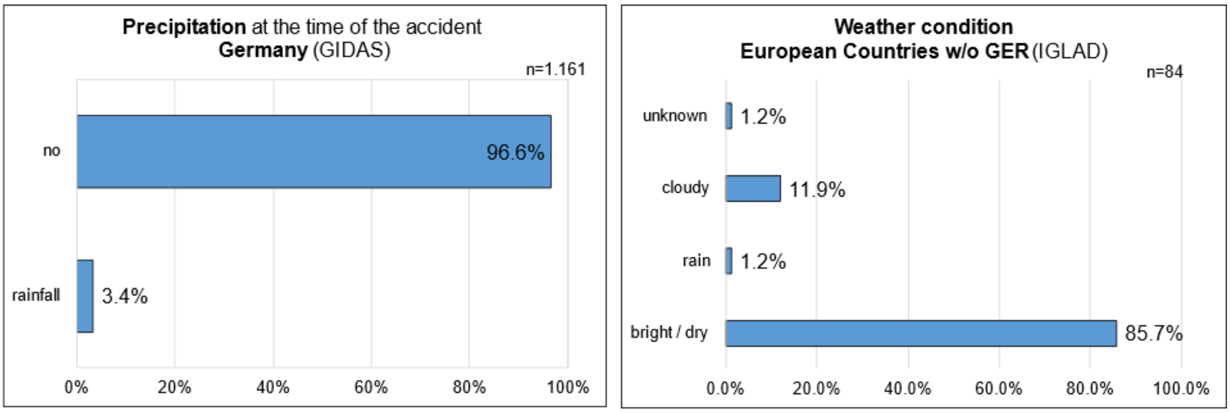


Figure 20 202: weather condition (GIDAS, IGLAD)

Figure 21 and Figure 22 provide a detailed visualization of the distribution of diverse types of road users involved in PTW accidents. The main differences in the accident data are observed in the case of participant B. In the European countries, the share of M1/N1 vehicles is significantly higher for this participant.

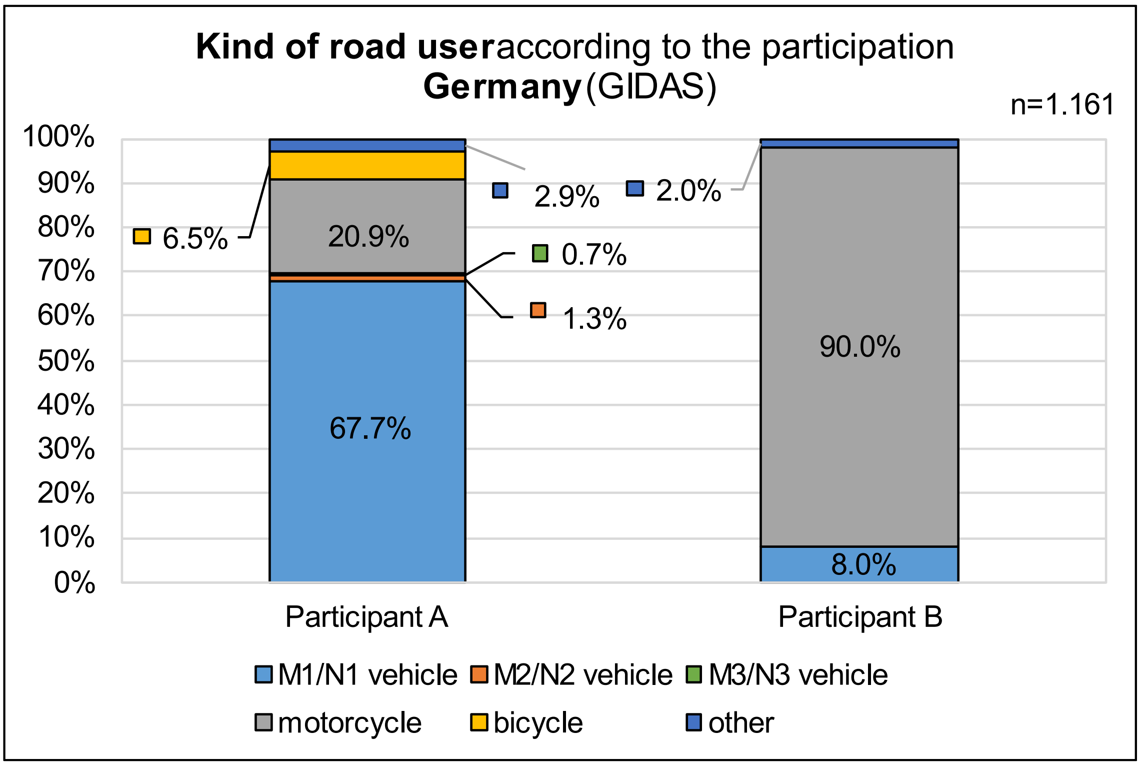


Figure 21 202: kind of road user (GIDAS)

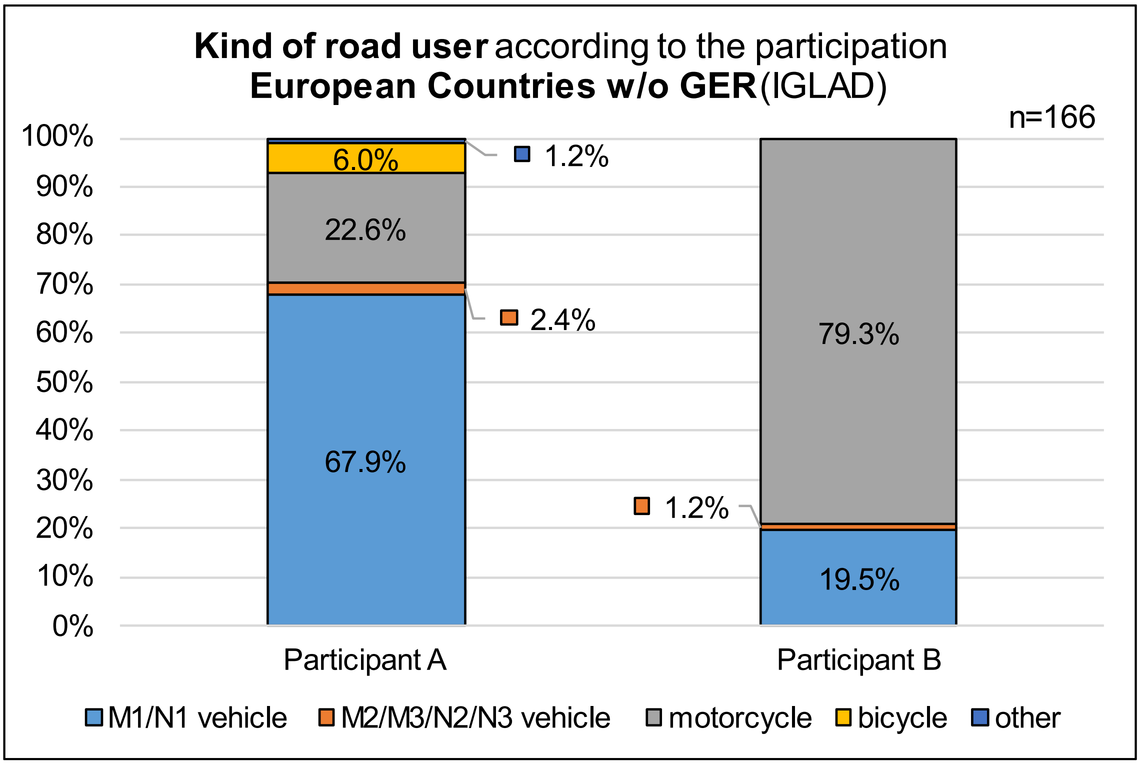


Figure 22 202: kind of road user (IGLAD)

The analysis of the initial speed for participant A showed comparable values for Germany and the European countries with a tendency to higher speeds in GIDAS (Figure 23).

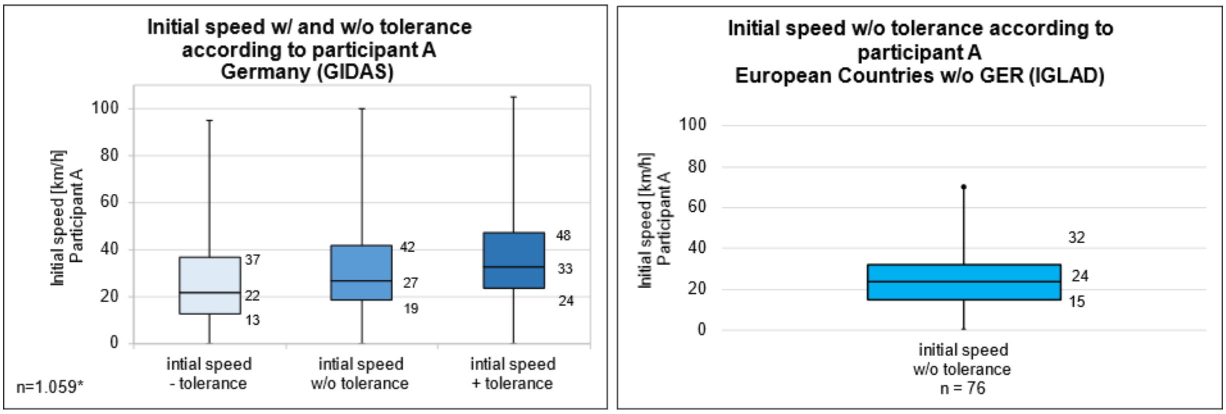


Figure 23 202: initial speed participant A (GIDAS, IGLAD)

In the case of the analysis of the initial speed for participant B, it was shown that in GIDAS, participant B was traveling faster than in the European countries (Figure 24).

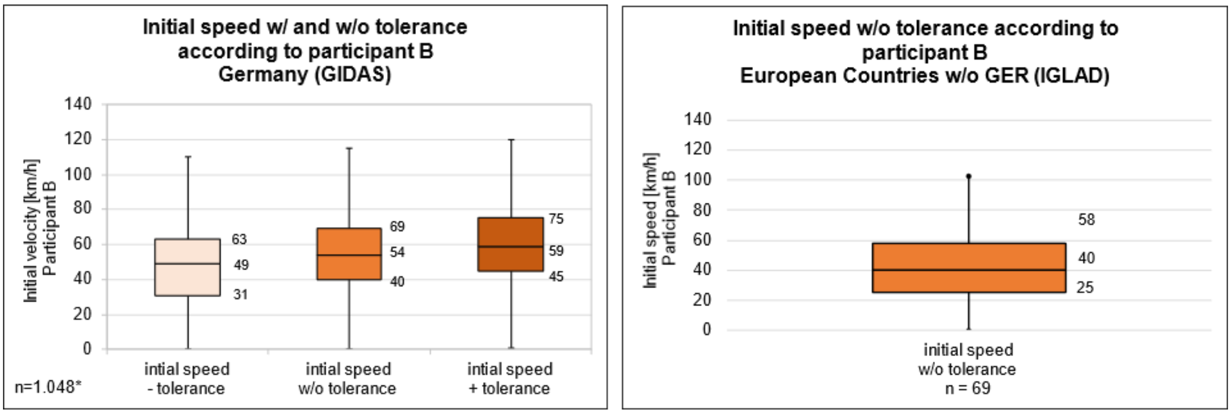


Figure 24 202: initial speed participant B (GIDAS, IGLAD)

A similar picture emerges from the analysis of the collision speeds for participants A and B (Figure 25 and Figure 26). While the collision speed for participant A is comparable, the collision speed for participant B tends to be higher in Germany.

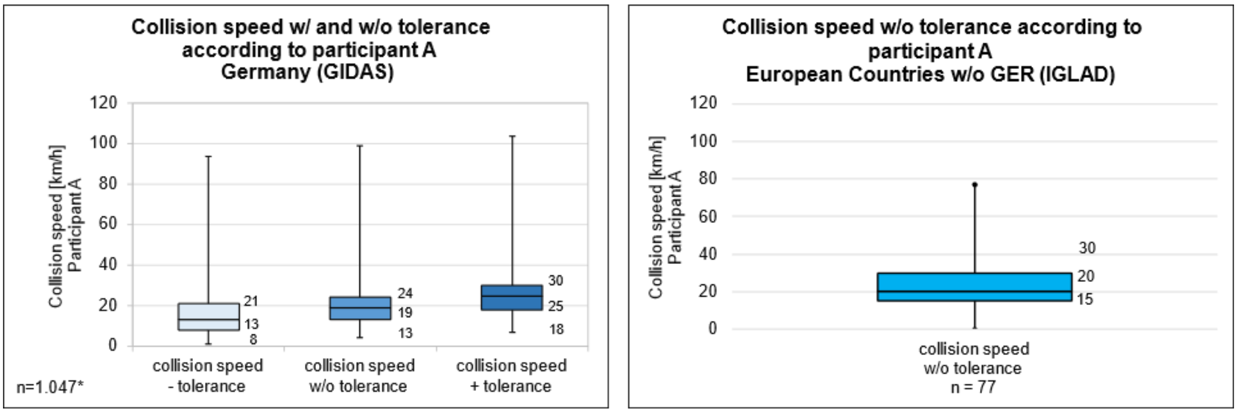


Figure 25 202: collision speed participant A (GIDAS, IGLAD)

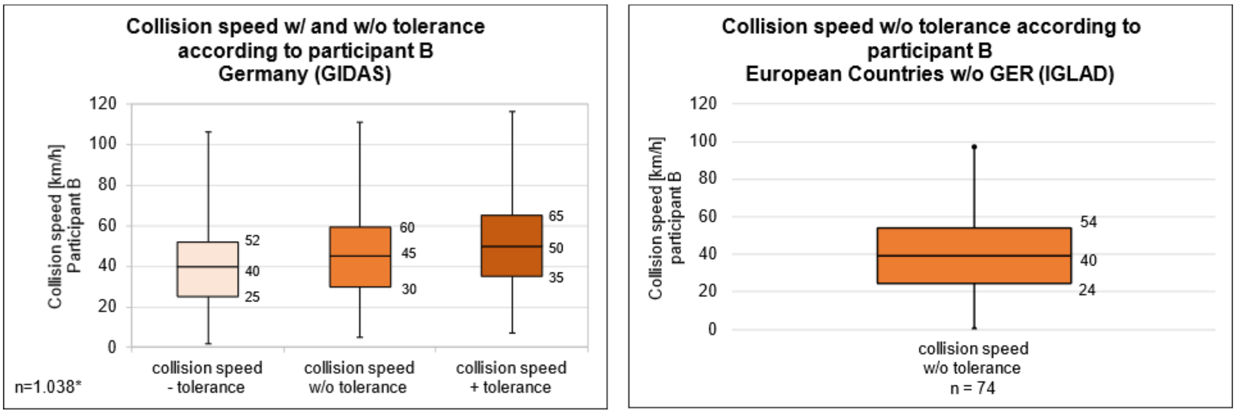


Figure 26 202: collision speed participant B (GIDAS, IGLAD)

1.3 Accident type 302

Accident type 302, known as “turning left with straight priority road from the left,” involves a situation where a vehicle (Participant A) is attempting a left turn while another vehicle (Participant B) is traveling straight on the priority road from the left. The corresponding pictogram is shown in Figure 27.

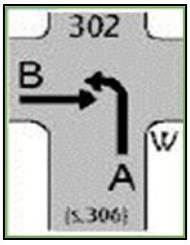
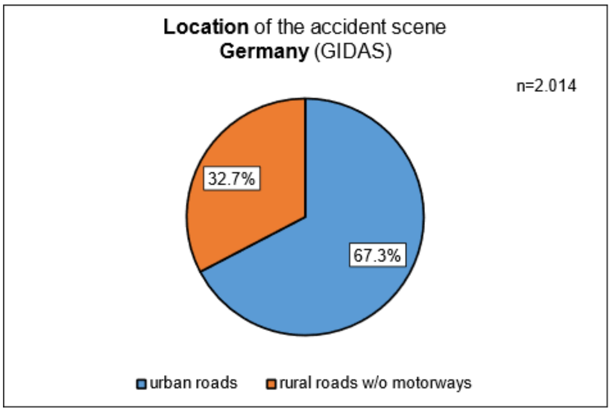


Figure 27 Pictogram of accident type 302

The analysis of the location data revealed that the proportion of urban and rural accidents is very similar in Germany and the European countries (Figure 28).



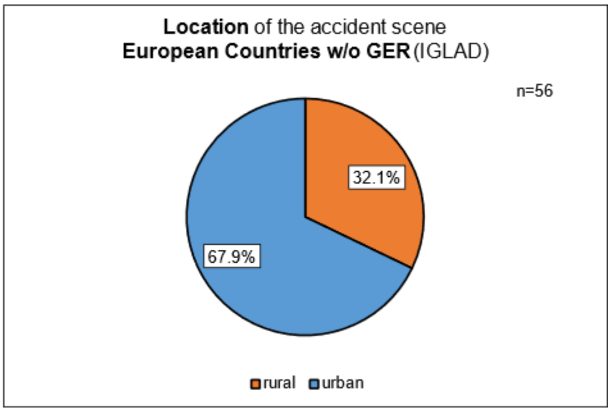
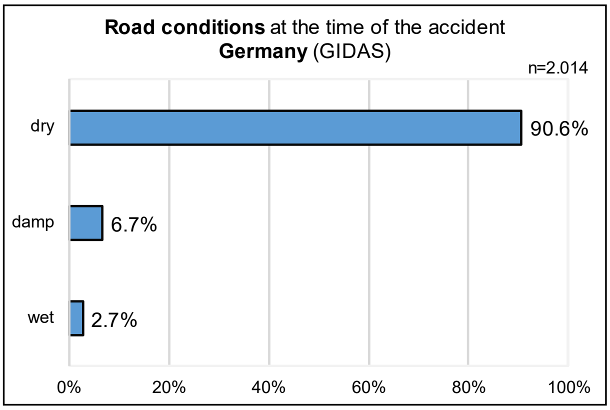


Figure 28 302: location (GIDAS, IGLAD)

The analysis of road conditions for this specific accident type revealed a striking similarity between the data sources, with both indicating that the majority of these accidents occur under dry road conditions (Figure 29). This consistency suggests that dry road surfaces are a common factor in the occurrence of these accidents, regardless of the region being studied.



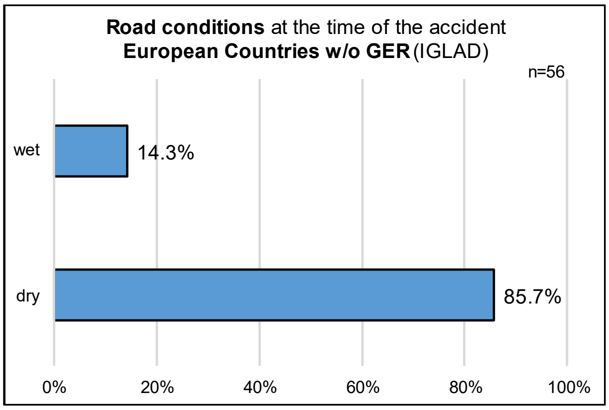


Figure 29 302: road conditions (GIDAS, IGLAD)

The evaluation of weather conditions revealed a predictable pattern: dry weather prevailed in most of the accidents analyzed (Figure 30). This result is in line with expectations, as road conditions were also dry.

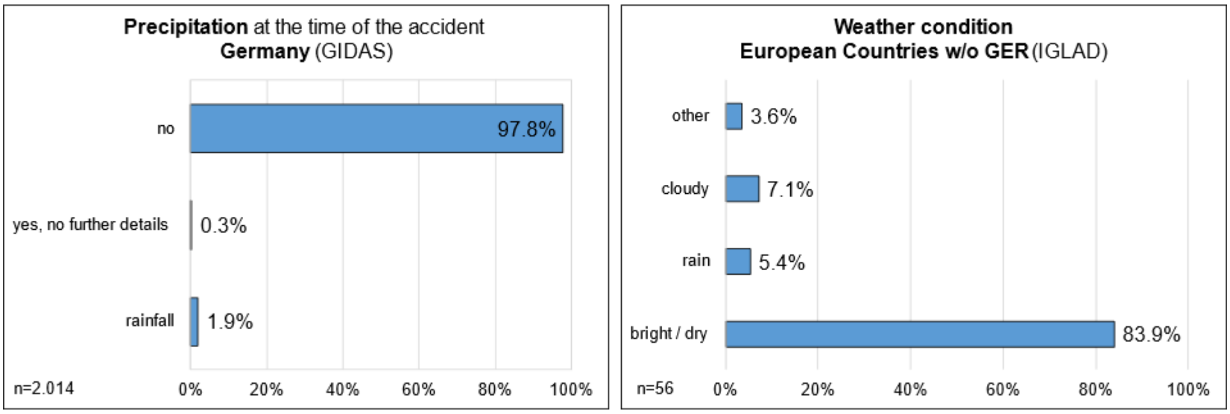


Figure 30 302: weather condition (GIDAS, IGLAD)

Figure 31 and Figure 32 provide a detailed visualization of the distribution of diverse types of road users involved in PTW accidents. In Germany, the share of M1/N1 vehicles is higher for participant A. On the other hand, the share of M1/N1 vehicles as participant B is significantly higher in the European countries. This could mean that in Germany, in this particular situation, the M1/N1 vehicle was required to wait in many cases due to traffic regulations. In contrast, in the European countries, the distribution of responsibility is more balanced. Here, the PTW was occasionally also required to wait.

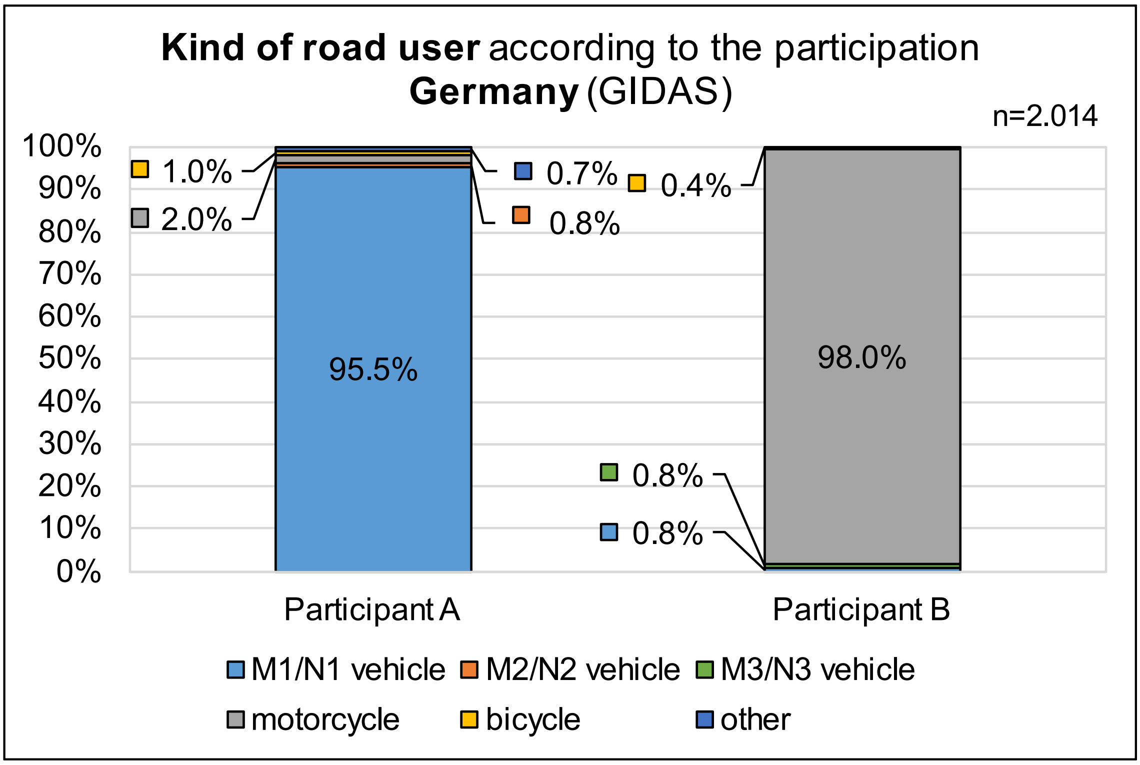


Figure 31 302: kind of road user (GIDAS)

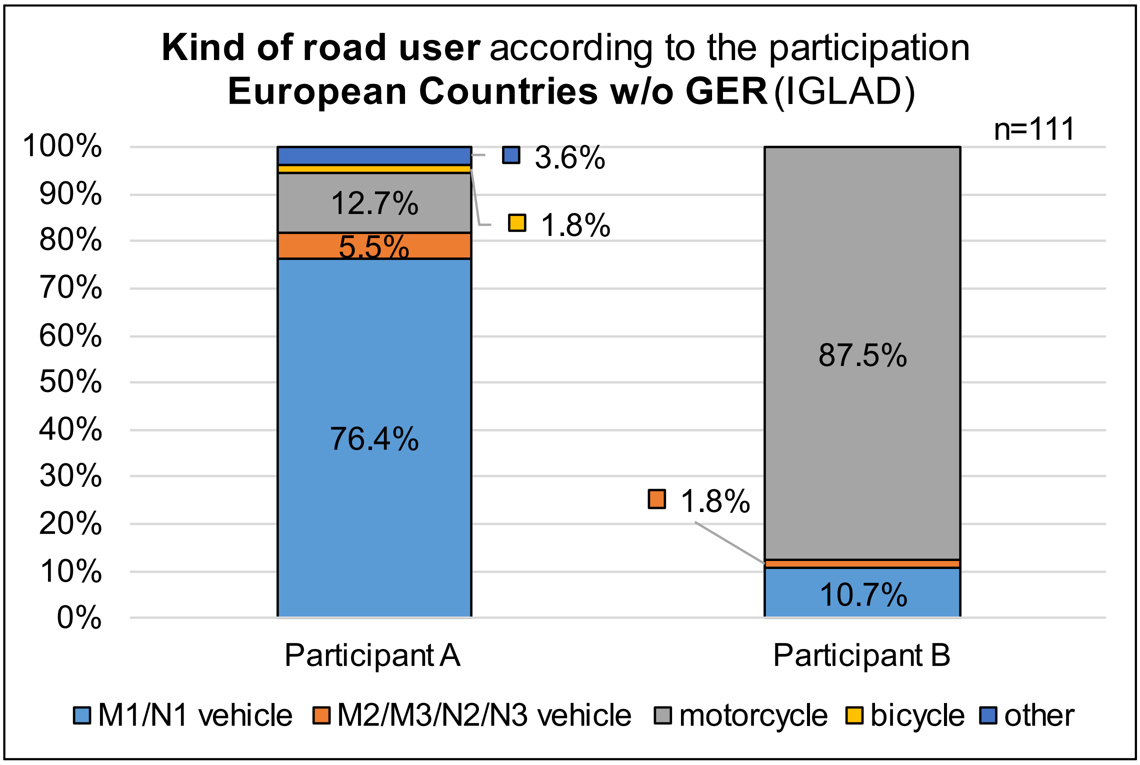
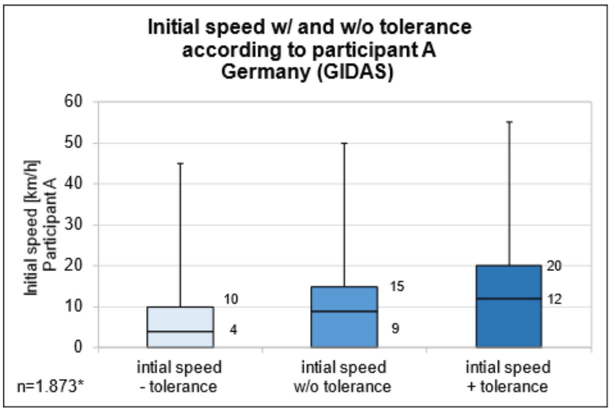


Figure 32 302: kind of road user (IGLAD)

The analysis of the initial speed for participant A and B showed comparable values for Germany and the European countries (Figure 33 and Figure 34).



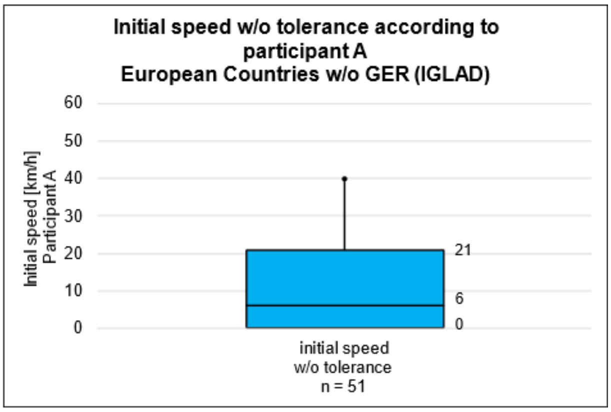
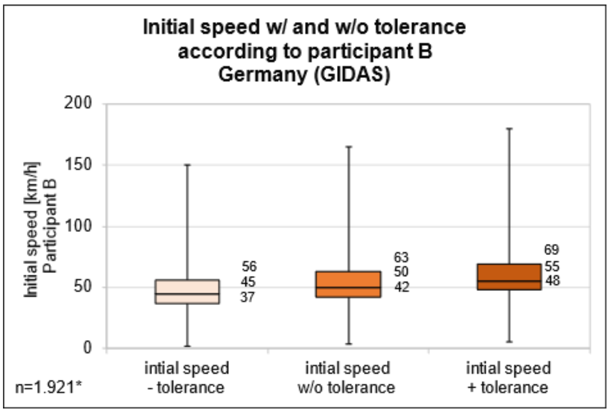


Figure 33 302: initial speed participant A (GIDAS, IGLAD)



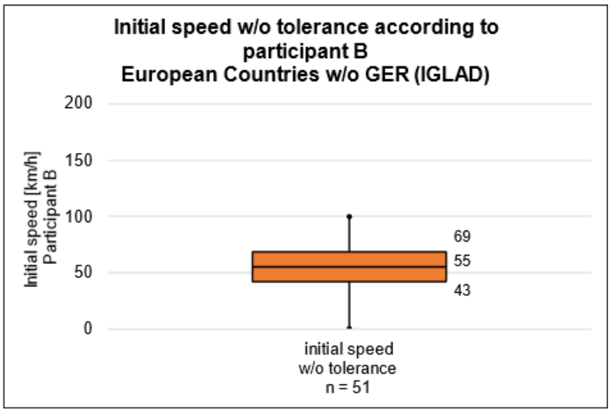


Figure 34 302: initial speed participant B (GIDAS, IGLAD)

A similar picture emerges from the analysis of the collision speeds for participants A and B (Figure 35 and Figure 36). The collision speed shows comparable values for both datasets, with a tendency to higher speeds for participant B in IGLAD.

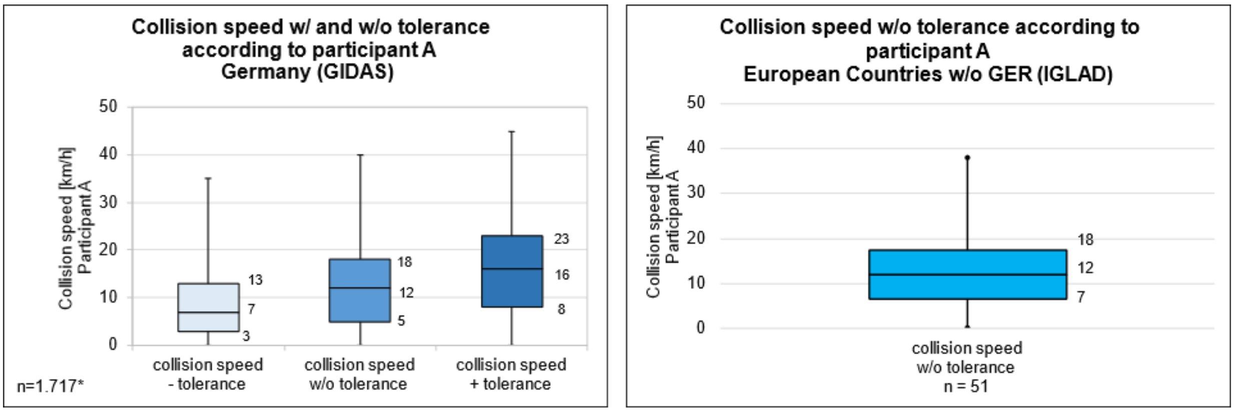


Figure 35 302: collision speed participant A (GIDAS, IGLAD)

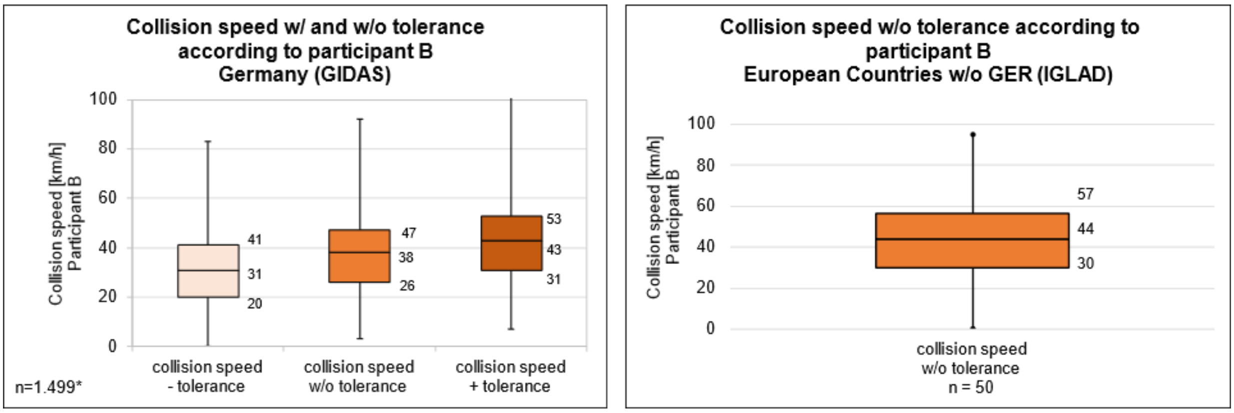


Figure 36 302: collision speed participant B (GIDAS, IGLAD)

1.4 Summary / Conclusion

The top three accident types are consistently the same in Italy, France and the European countries considered (with data from IGLAD), indicating similar traffic patterns and issues across these regions. For accident type 211, the initial speed is notably higher in IGLAD for participant B, and the collision speed is also higher in IGLAD for participant B. This suggests that vehicles involved in these accidents in IGLAD tend to be traveling faster both before and at the moment of collision. Despite these differences, a good comparison to German data is feasible, providing valuable insights into accident dynamics. In the case of accident type 202, there are more rural accident scenes recorded in GIDAS, which could reflect different driving conditions and road types compared to urban areas. Participant B has a higher share of M1/N1 vehicles in IGLAD. The initial speed tends to be higher for participant A in GIDAS, and the initial speed for participant B is also higher in GIDAS. Additionally, the collision speed tends to be higher for participant B in GIDAS. These factors suggest that accidents in GIDAS might involve higher speeds overall. Nevertheless, a good comparison to German data is feasible, allowing for a comprehensive understanding of these accidents. For accident type 302, there is a higher share of M1/N1 vehicles for participant A in GIDAS, while there is a higher share of M1/N1 vehicles for participant B in IGLAD. This indicates a variation in the types of vehicles involved in these accidents between the two datasets. Despite these differences, a good comparison to German data is feasible, providing a clear picture of how these accidents occur and the factors involved.

The evaluation of the IGLAD data and its comparison with the GIDAS data reveal many similarities, indicating consistent patterns across both datasets. However, to fully understand the nuances and specific differences between these datasets, an in-depth analysis is recommended. This detailed examination would help identify any subtle variations and provide a clearer picture of the accident dynamics. Taking these individual differences into account, the GIDAS data can serve as a valuable starting point for making statements about PTW accidents in Europe. This approach ensures that the unique characteristics of each dataset are considered, leading to more accurate and effective conclusions.

2. Analysis of US PTW accident situation

Based on the approach of comparing German accident data with European accident data, a similar methodology was applied to North American accident data. This comparative analysis aimed to identify patterns and insights across different regions. One significant advantage of analyzing European accident data using the International Road Traffic and Accident Database (IGLAD) was the uniformity in accident descriptions. The descriptions of accidents in terms of type and nature are consistent, which facilitates a more straightforward comparison. Both IGLAD and the German In-Depth Accident Study (GIDAS) databases contain standardized and identical descriptions of critical situations, ensuring that the data is comparable and reliable. This standardization is crucial for conducting accurate and meaningful analyses, as it eliminates discrepancies that might arise from differing terminologies or classification systems.

However, the description of an accident sequence using predefined codes in North America with the Crash Report Sampling System (CRSS) differs significantly from the European approach. In CRSS, for example, there is no clear and distinct description of a critical situation. Instead, the coding system known as “Crash Type” is used, which encompasses both the critical situation and the actual collision event. This dual-purpose coding presents a challenge for studies that require a clear delineation of critical situations.

For the purposes of this study, the critical situation was a crucial element. Therefore, it was necessary to map these North American crash types to the European accident types. This mapping process was not straightforward due to the distinct levels of detail and information content in the two coding systems. The European system, with its standardized and detailed descriptions, allows for a more granular analysis of critical situations. In contrast, the CRSS coding merges the critical situation with the collision, making it difficult to isolate and compare individual critical situations directly (Figure 37).

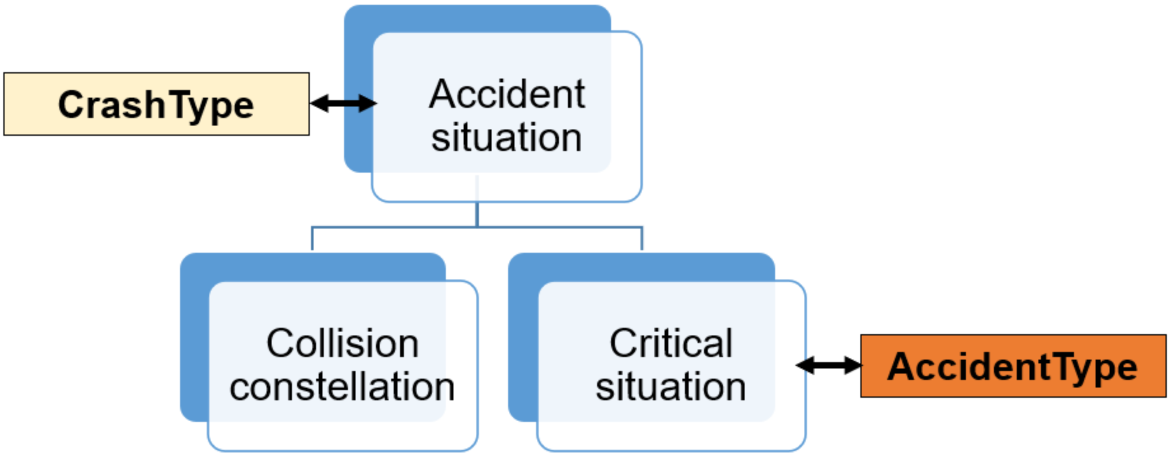


Figure 37 Differences between crash type and accident type

The “level” at which Accident Type and Crash Type are assigned also differs between GIDAS and CRSS. In GIDAS, the Accident Type is assigned at a broader level (Accident Level), encompassing both parties involved in the accident (Figure 38). This means that the Accident Type provides a unified description of the accident scenario, considering the interaction between all involved entities.

In contrast, the Crash Type in CRSS is assigned at a more granular, vehicle-specific level (Vehicle Level) (Figure 38). Each vehicle involved in a common accident is assigned its own Crash Type, reflecting the specific circumstances and dynamics from the perspective of that particular vehicle.

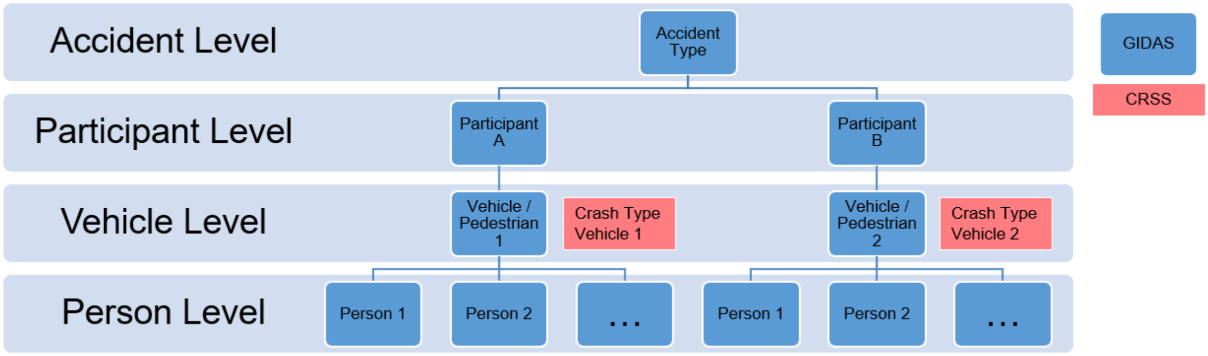


Figure 38 Categorization of crash type and accident type

As a result, the study could only derive and compare broader “accident scenarios” rather than individual critical situations. This meant that while a direct comparison of specific critical situations was not feasible, the overall accident scenarios could still be analyzed and compared. This approach provided valuable insights, albeit at a higher level of abstraction. The differences between CRSS and the German In-Depth Accident Study (GIDAS) are briefly summarized in Table 2.

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
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 2 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 European data. The following image (Figure 39) illustrates this outcome, highlighting the increased presence of unknown scenarios within the CRSS dataset. This visualization underscores the difficulties in achieving a one-to-one mapping between the two systems due to their differing structures and levels of detail.

By acknowledging these limitations, the study provides a more nuanced understanding of the data comparison process. It emphasizes the importance of considering these unknown scenarios when interpreting the results, as they represent a sizable portion of the CRSS data that could not be directly aligned with the European accident scenarios.

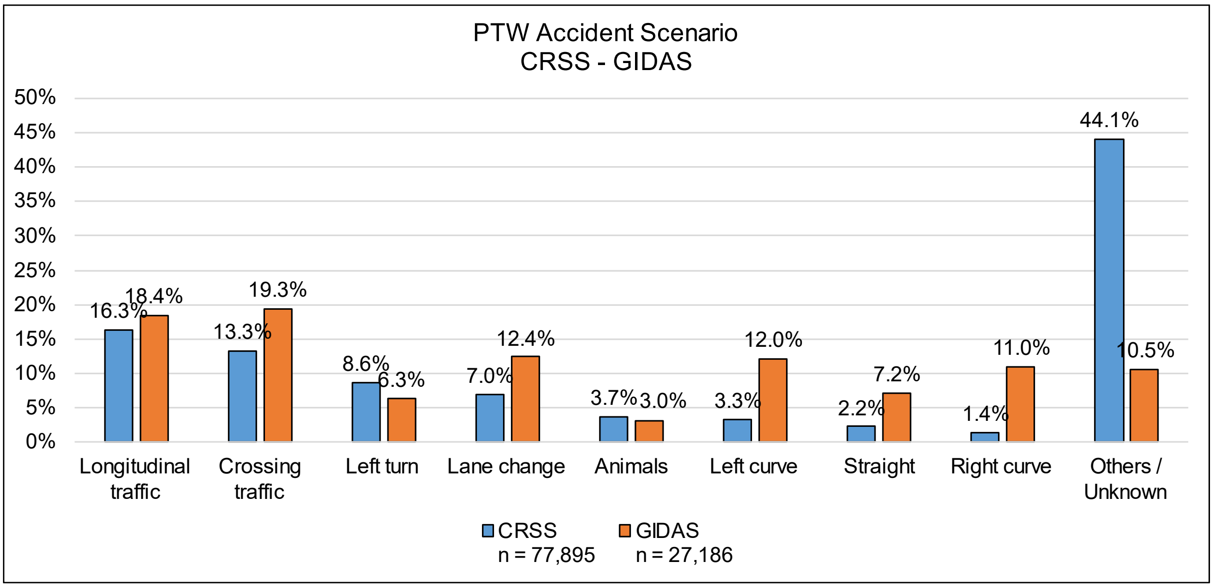


Figure 39 Comparison of accident scenarios in GIDAS and CRSS

The following ranking of the top four scenarios in the respective data sets thus emerges for the scenarios (Table 3). This ranking provides a clear comparison of the most common accident scenarios identified in both the German and North American 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 3 Ranking of accident scenarios in GIDAS and CRSS

In North America, 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, whereas it is ranked seventh in GIDAS. This discrepancy indicates regional variations in accident patterns, which could be influenced by differences in road design, traffic regulations, or driver behavior.

As illustrated in the accompanying image (Figure 39), 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 North American 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” also differs between CRSS and GIDAS. In GIDAS, these accidents typically involve a vehicle losing control. In contrast, CRSS defines “driving 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 how these situations are categorized but also the variations in their underlying definitions. These differences can significantly impact the analysis and understanding of accident data, emphasizing the need for careful interpretation when comparing datasets from different regions.

2.1 Longitudinal Traffic Scenario

After categorizing the crash types into the defined scenarios, the three most frequent scenarios were thoroughly analyzed: 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 utilized. 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.

The accident types illustrated in Figure 40 account for 24% of the total critical situations in the Longitudinal Traffic Scenario 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.

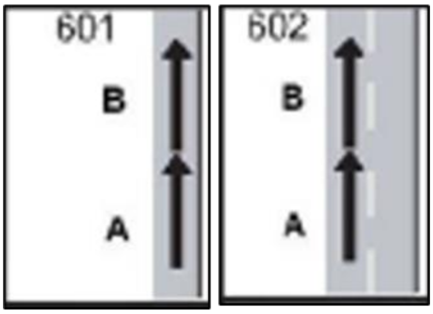


Figure 40 Pictograms of accident types 601 and 602

The crash types illustrated in Figure 41 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.

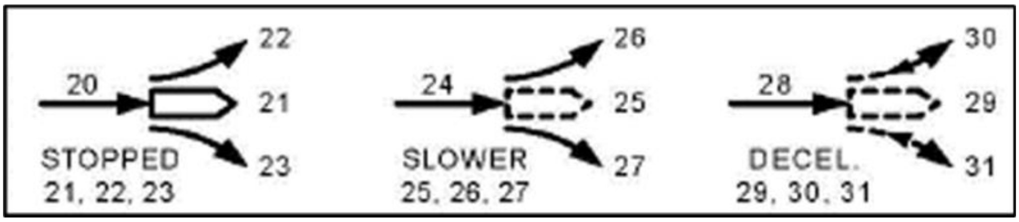


Figure 41 Pictograms of "longitudinal" crash types

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 critical situations in GIDAS (Figure 42), there is a noticeable higher proportion of urban locations in the CRSS dataset. 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 41. In the CRSS dataset, intersections appear to be a more common scene for accidents.

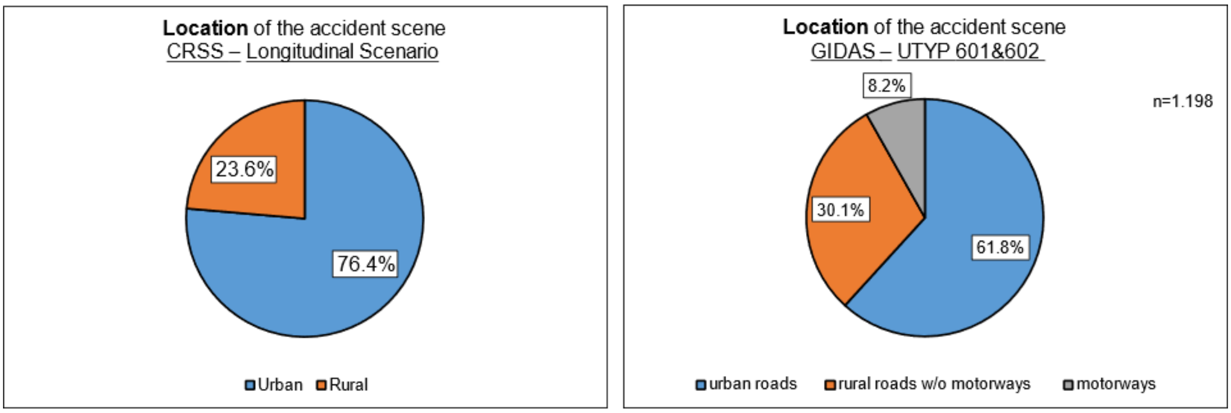


Figure 42 Longitudinal Scenario: location (GIDAS, CRSS)

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 (Figure 43). This finding underscores the importance of considering the specific context and location of accidents when analyzing and comparing different datasets.

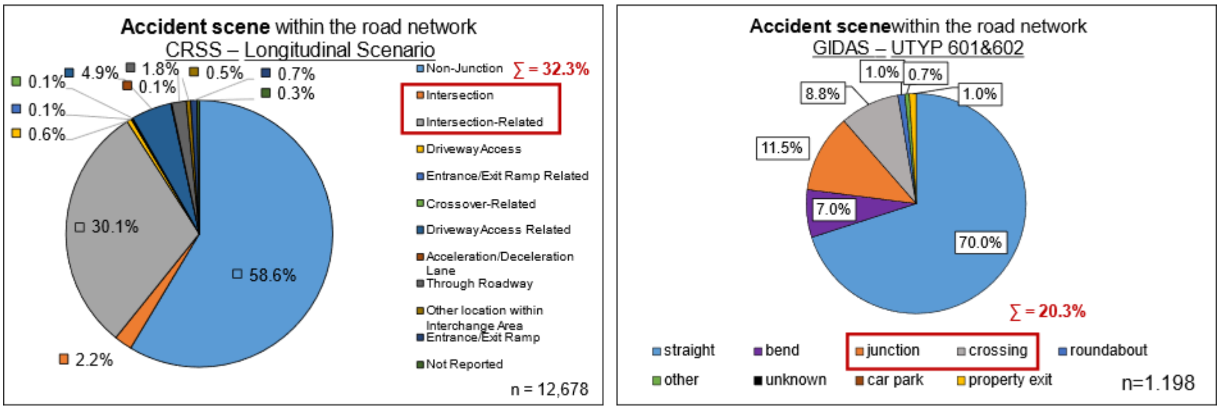


Figure 43 Longitudinal Scenario: accident scene (GIDAS, CRSS)

The evaluation of weather conditions revealed that most accidents in the Longitudinal Traffic Scenario within CRSS occurred under clear weather conditions (Figure 44). This finding indicates that most accidents happened when visibility was good and there were no adverse weather factors influencing the driving environment.

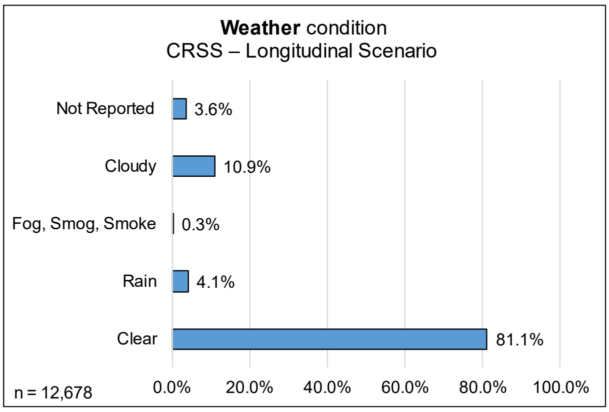


Figure 44 Longitudinal Scenario: weather condition (CRSS)

For a more comprehensive understanding, a comparison with the evaluation of precipitation in the GIDAS dataset is useful (Figure 45). This comparison helps classify and contextualize the findings from both datasets. 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.

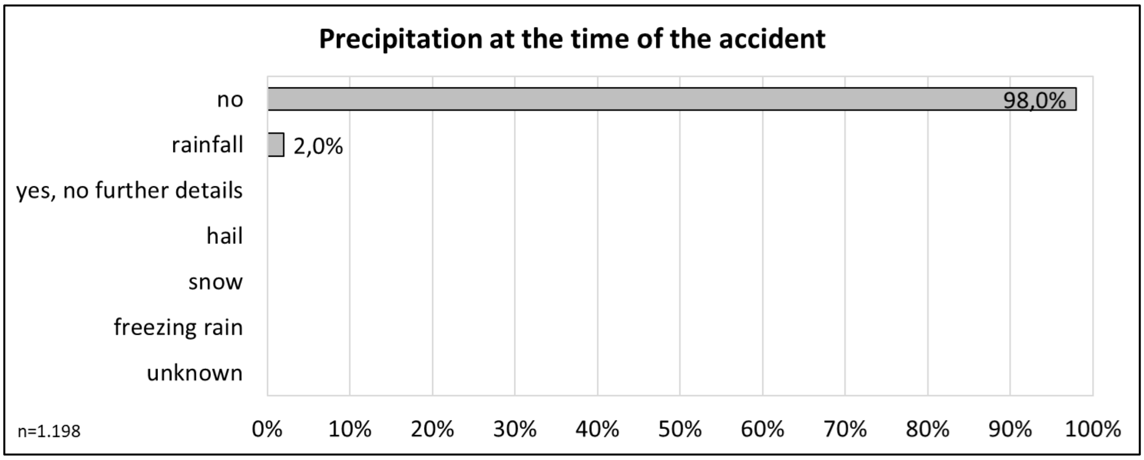


Figure 45 Longitudinal Scenario: precipitation (GIDAS)

The evaluation of the kind of road user in this scenario is shown in Figure 46 for CRSS and in Figure 47 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 categorization 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.

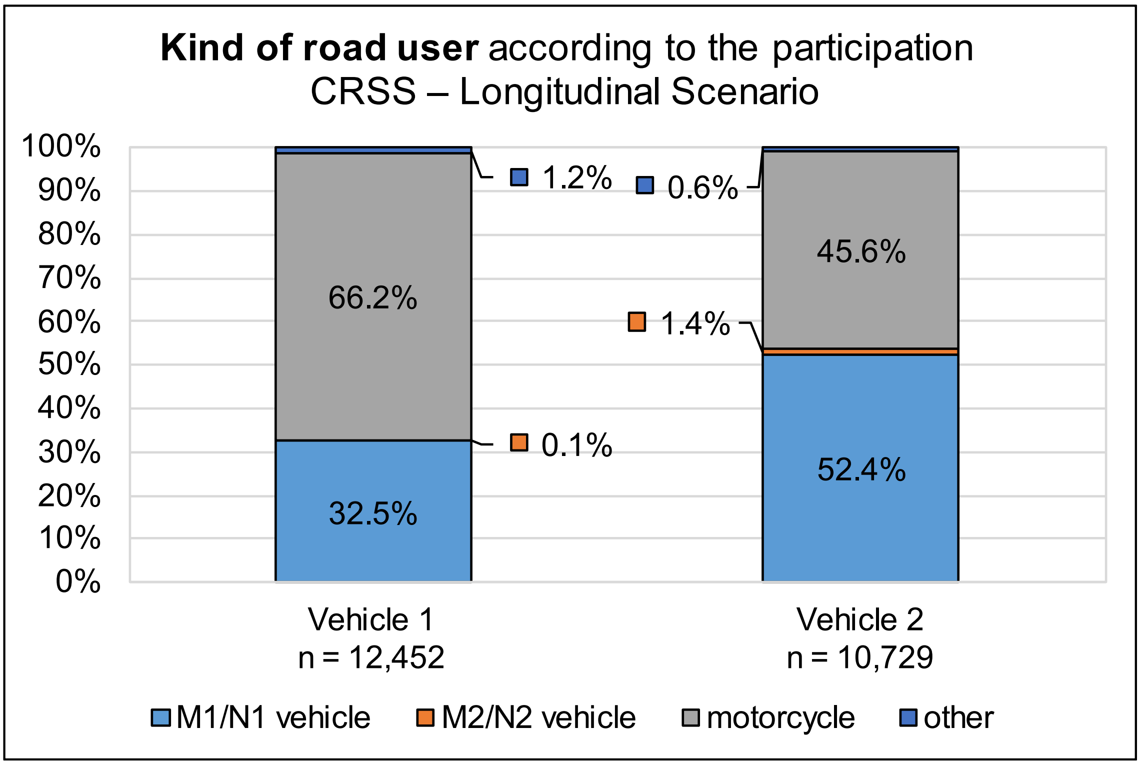


Figure 46 Longitudinal Scenario: kind of road user (CRSS)

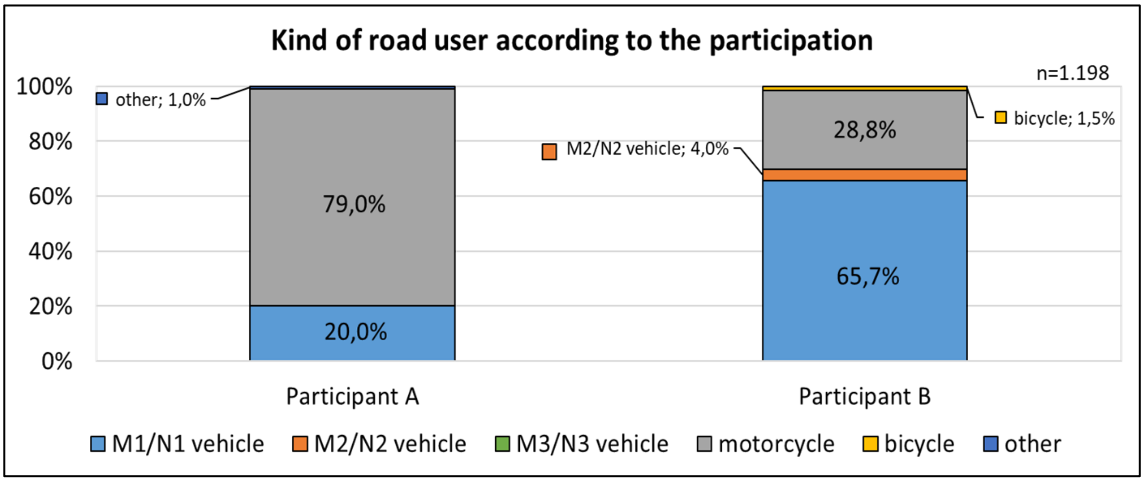


Figure 47 Longitudinal Scenario: kind of road user (GIDAS)

The analysis of the initial speed of the vehicles in the Crash Report Sampling System (CRSS) reveals significant differences in the speeds of the two vehicles involved in accidents (Figure 48). 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.

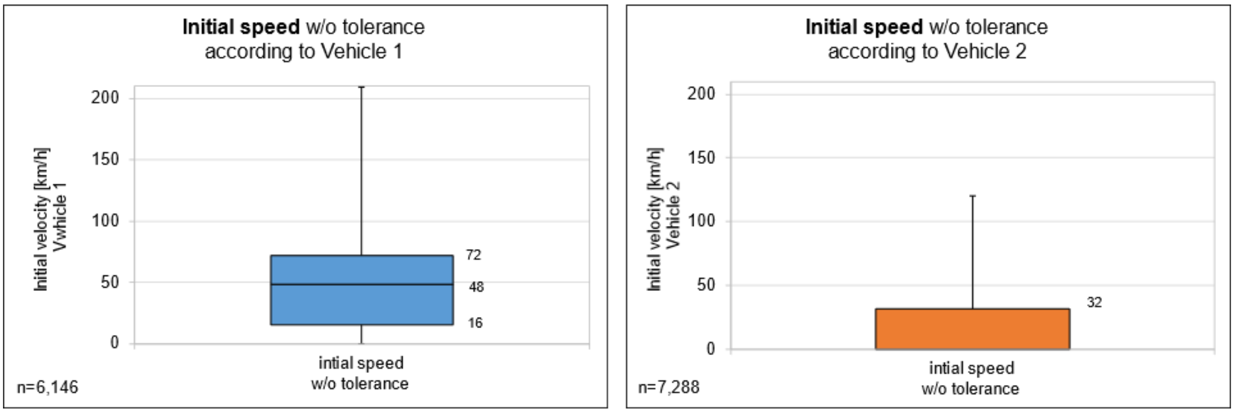


Figure 48 Longitudinal Scenario: initial speed (CRSS)

By contrast, the speeds of the participants in the GIDAS dataset are much closer together (Figure 49). 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.

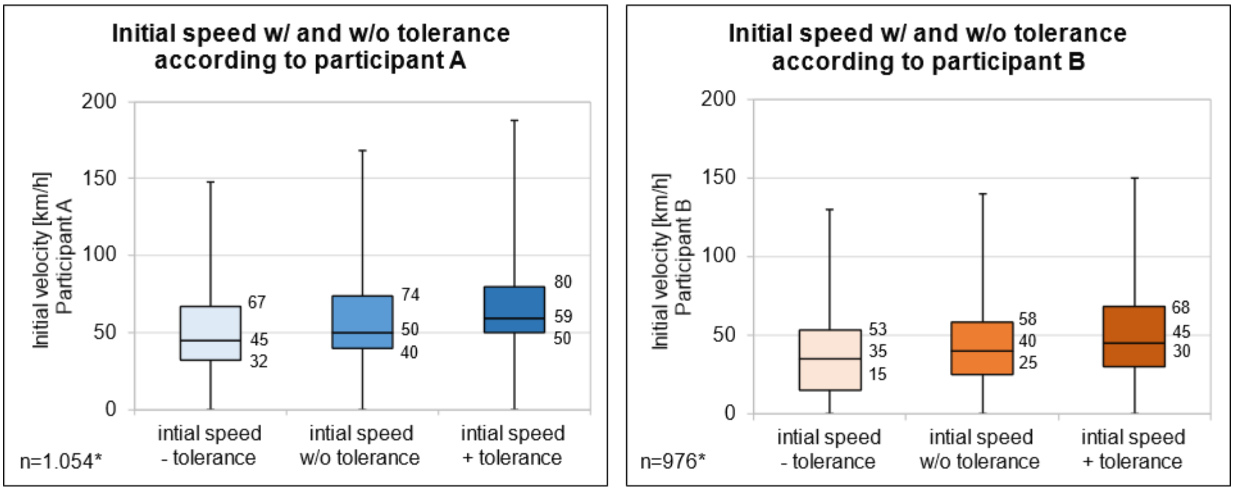


Figure 49 Longitudinal Scenario: initial speed (GIDAS)

2.2 Crossing Traffic Scenario

The accident type illustrated in Figure 50 account for 40% of the total critical situations in the Crossing Traffic Scenario within GIDAS. This substantial proportion highlights the prevalence and importance of this specific accident type within the Crossing Traffic Scenario in GIDAS.

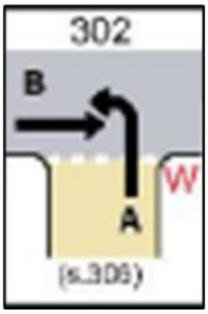


Figure 50 Pictogram of accident type 302

The crash types illustrated in Figure 51 account for 36% of the Crossing Traffic Scenario in CRSS. This underscores the prevalence of this crash type within the Crossing Traffic Scenario in CRSS.

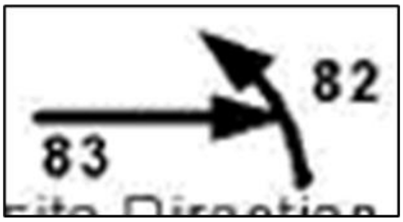


Figure 51 Pictogram of "crossing" crash types

The evaluation of the location data reveals a comparable distribution of urban and rural areas across both data sources (Figure 52). Specifically, in both GIDAS and CRSS, the proportion of rural locations is around 30%. However, it is noteworthy that GIDAS exhibits a slightly higher percentage of rural locations compared to CRSS.

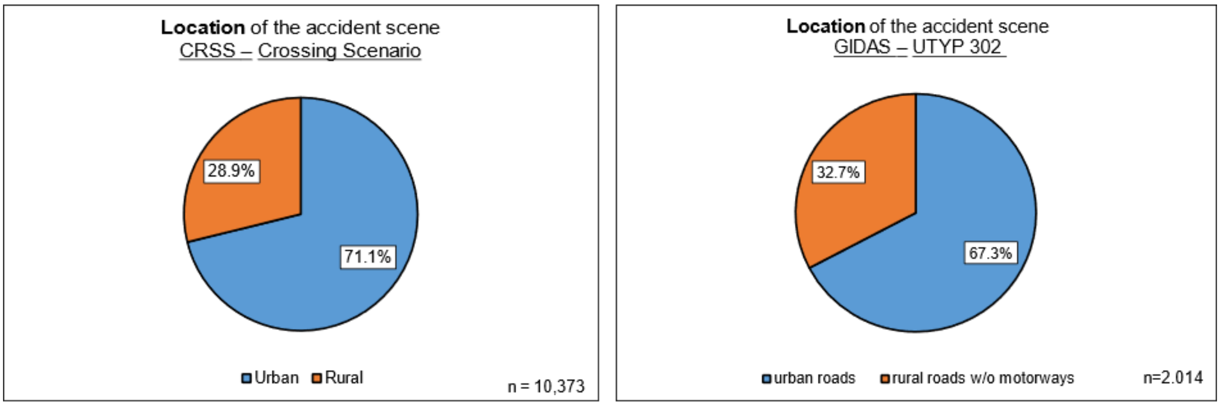


Figure 52 Crossing Scenario: location (GIDAS, CRSS)

The analysis of the accident scene data reveals a consistent pattern across both data sources (Figure 53). Specifically, CRSS indicates that approximately 77% of accidents occur at intersections. In comparison, GIDAS reports a slightly higher intersection share of around 83%.

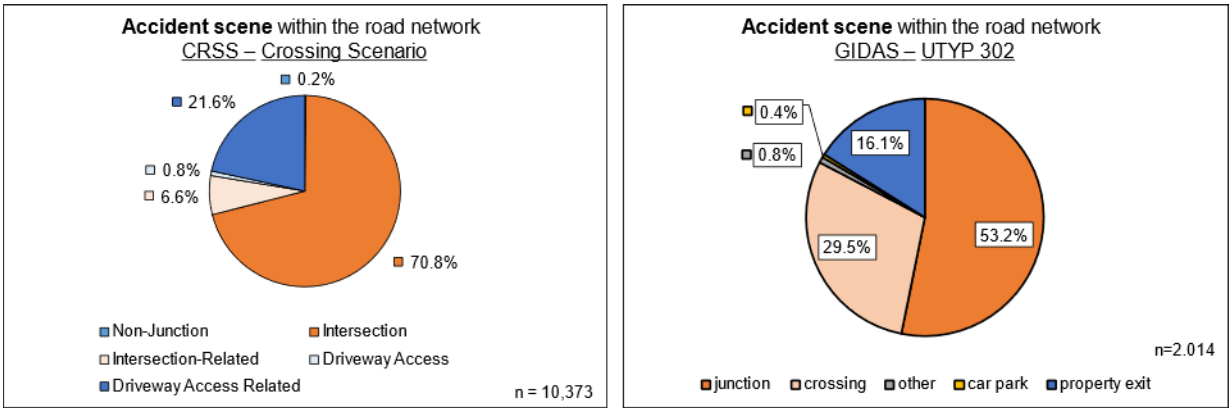


Figure 53 Crossing Scenario: accident scene (GIDAS, CRSS)

The evaluation of weather conditions revealed that most accidents in the Crossing Traffic Scenario within CRSS occurred under clear weather conditions (Figure 54). This finding indicates that most accidents happened when visibility was good and there were no adverse weather factors influencing the driving environment.

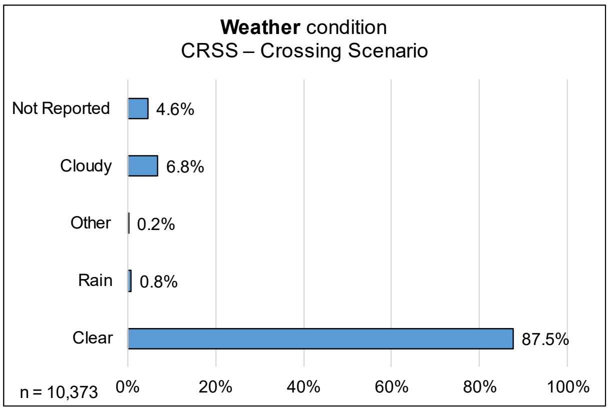


Figure 54 Crossing Scenario: weather condition (CRSS)

For a more comprehensive understanding, a comparison with the evaluation of precipitation in the GIDAS dataset is useful (Figure 55). This comparison helps classify and contextualize the findings from both datasets. 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.

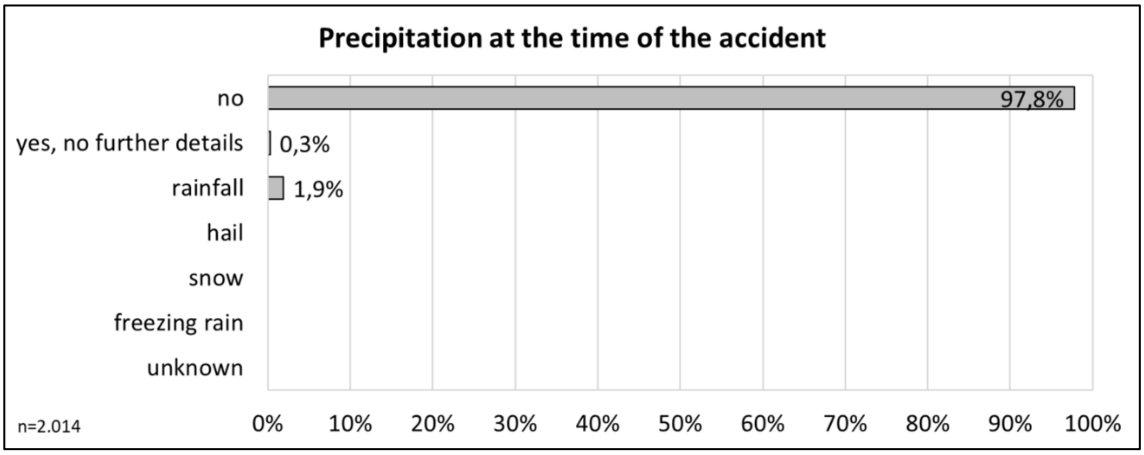


Figure 55 Crossing Scenario: precipitation (GIDAS)

The evaluation of the kind of road user in this scenario is shown in Figure 56 for CRSS and in Figure 57 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 categorization 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.

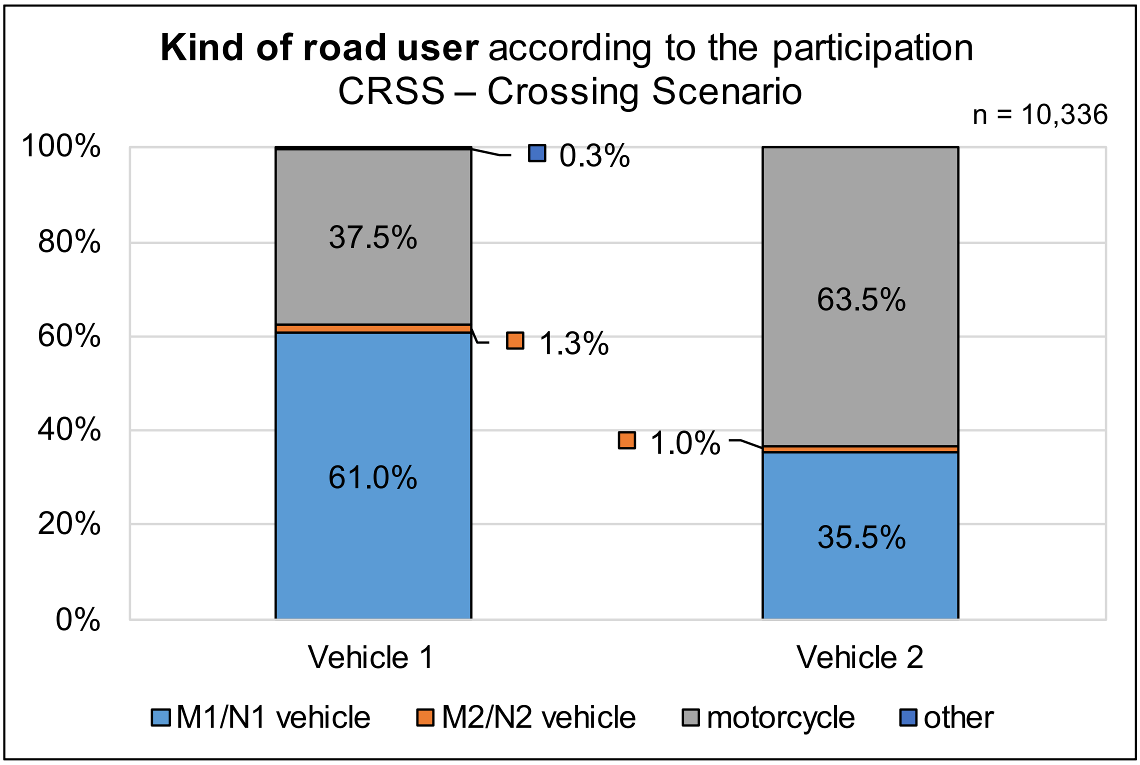


Figure 56 Crossing Scenario: kind of road user (CRSS)

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.

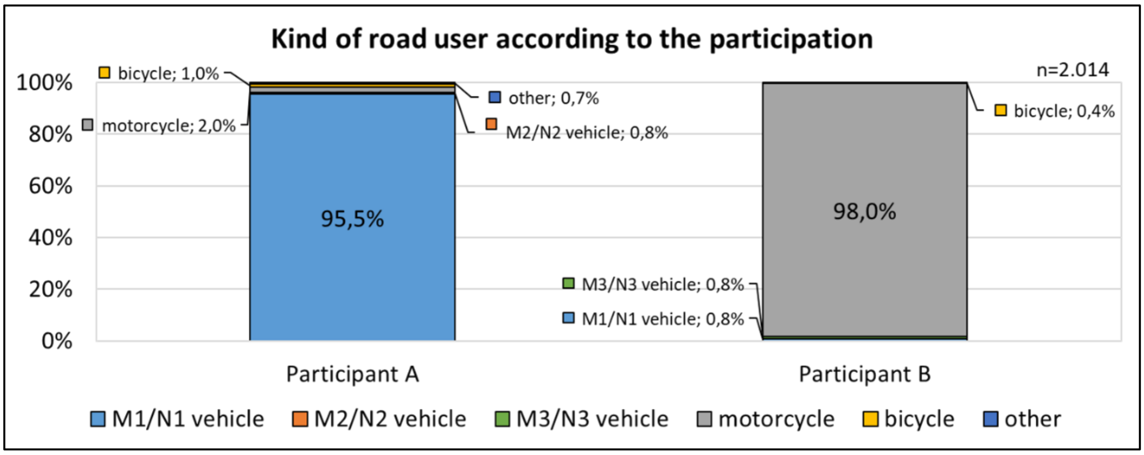


Figure 57 Crossing Scenario: kind of road user (GIDAS)

The initial speed of the two vehicles in CRSS data falls within a similar range of values, indicating a consistent pattern (Figure 58).

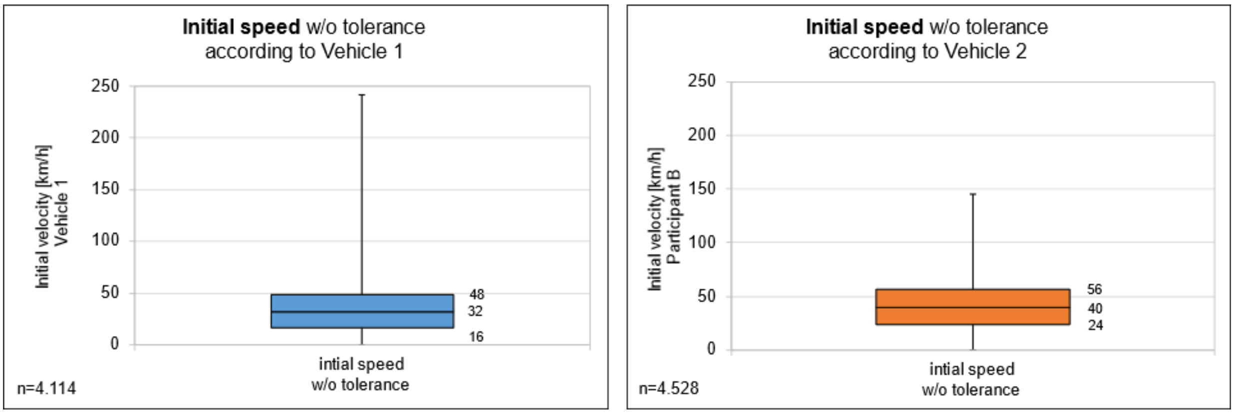


Figure 58 Crossing Scenario: initial speed (CRSS)

However, when evaluating the initial speed in GIDAS for accident type 302, significant differences in the range of values are observed (Figure 59). 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.

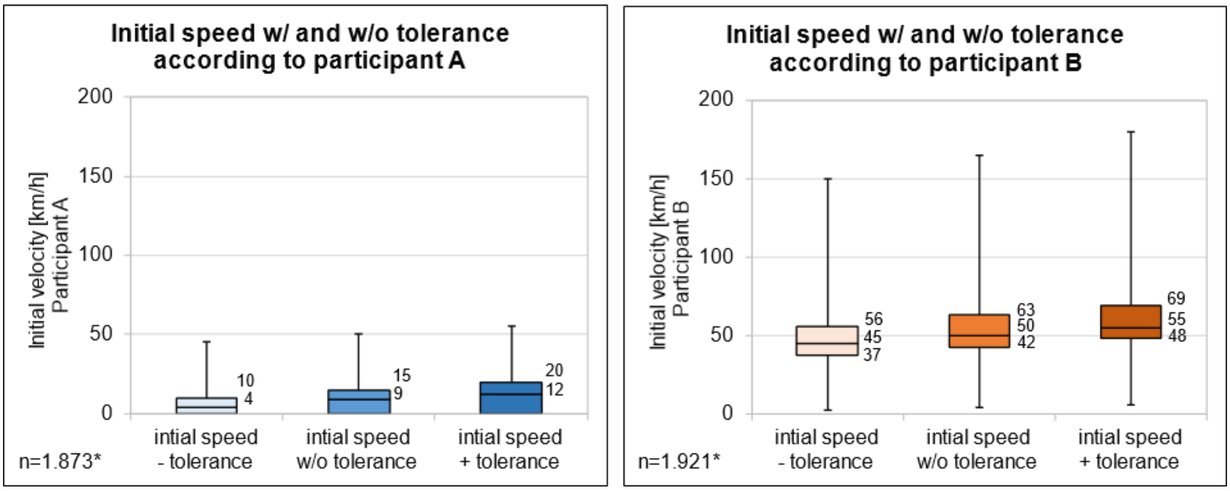


Figure 59 Crossing Scenario: initial speed (GIDAS)

2.3 Left Turn Scenario

The accident type illustrated in Figure 60 account for 92% of the total critical situations in the Left Turn Scenario within GIDAS. This substantial proportion highlights the prevalence and importance of this specific accident type within the Left Turn Scenario in GIDAS.

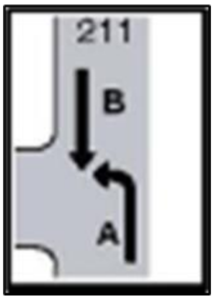


Figure 60 Pictogram of accident type 211

The crash type illustrated in Figure 61 account for 100% of the Left Turn Scenario in CRSS. This underscores the prevalence of this crash type 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 61 Pictogram of "left turn" crash types

The evaluation of the location data reveals a comparable ratio of urban and rural locations across both data sources (Figure 62). Specifically, in both GIDAS and CRSS, the proportion of urban locations range between 21% and 25%. This indicates a consistent representation of urban areas in both datasets.

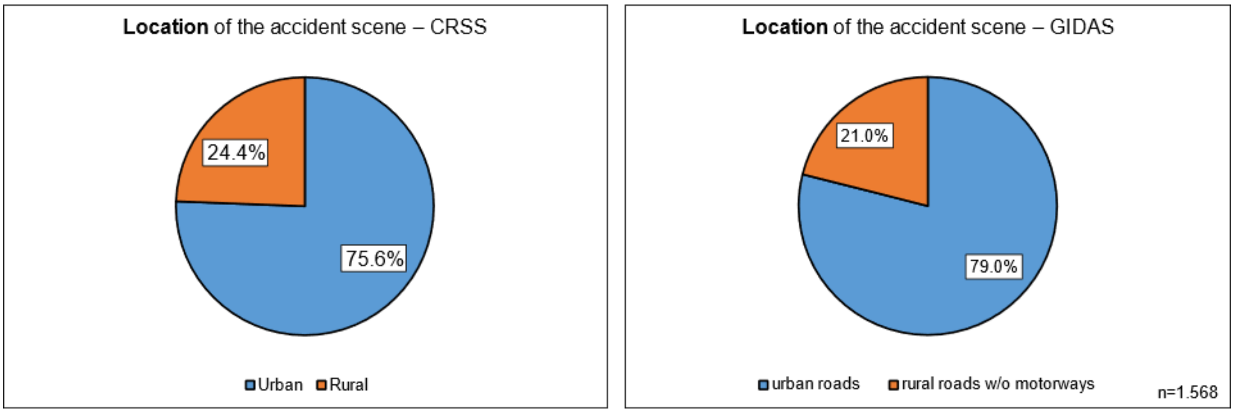


Figure 62 Left Turn Scenario: location (GIDAS, CRSS)

The analysis of the accident scene data reveals a consistent pattern across both data sources (Figure 63). Specifically, CRSS indicates that approximately 74% of accidents occur at intersections. In comparison, GIDAS reports a slightly higher intersection share of around 79%.

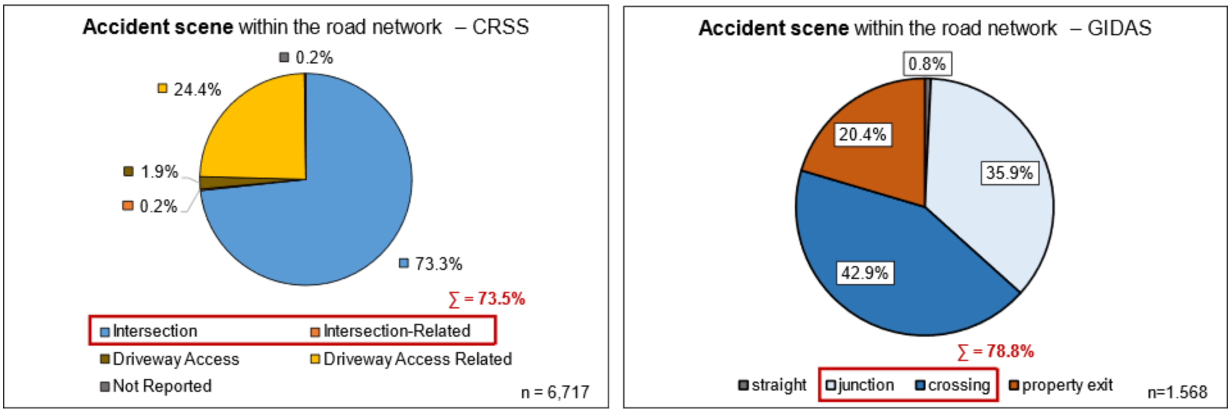


Figure 63 Left Turn Scenario: accident scene (GIDAS, CRSS)

The evaluation of the kind of road user in this scenario is shown in Figure 64 for CRSS and in Figure 65 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.

As a result of the comprehensive analysis, it becomes evident that in both GIDAS and CRSS, participant A, which refers to the party turning left across the driving line of participant B, 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 and motorcycles for participant B across both data sources provides valuable insights into the dynamics of such accidents.

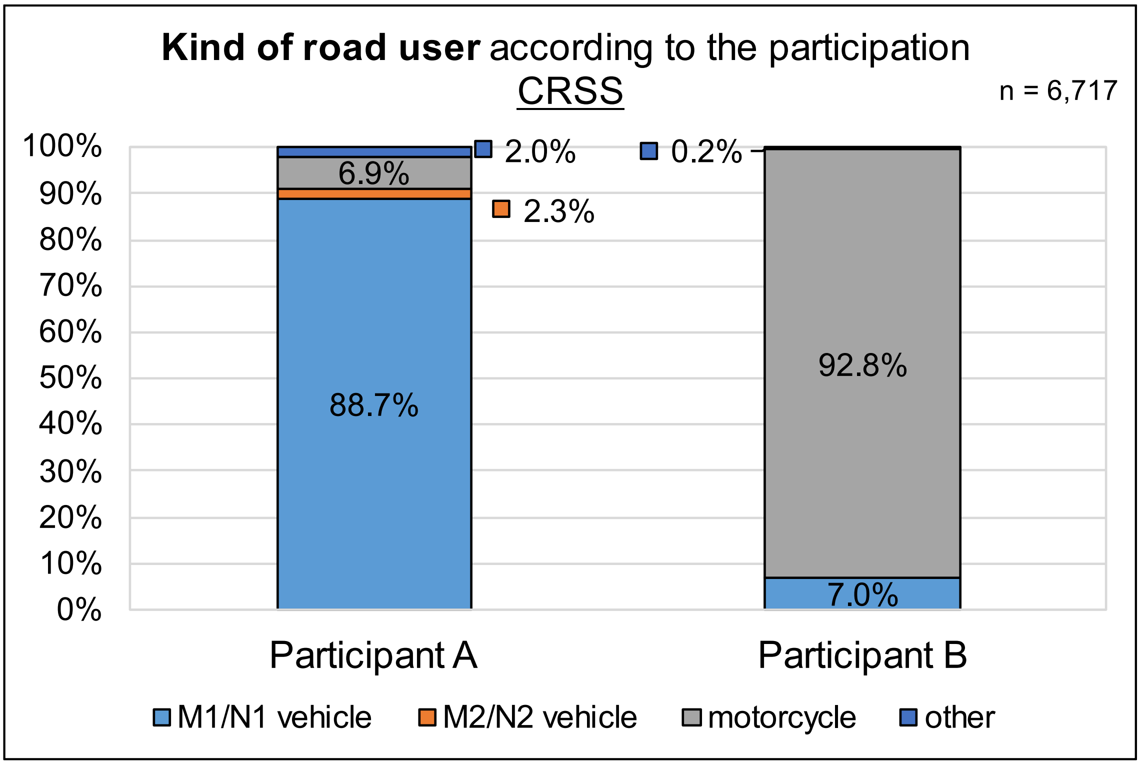


Figure 64 Left Turn Scenario: kind of road user (CRSS)

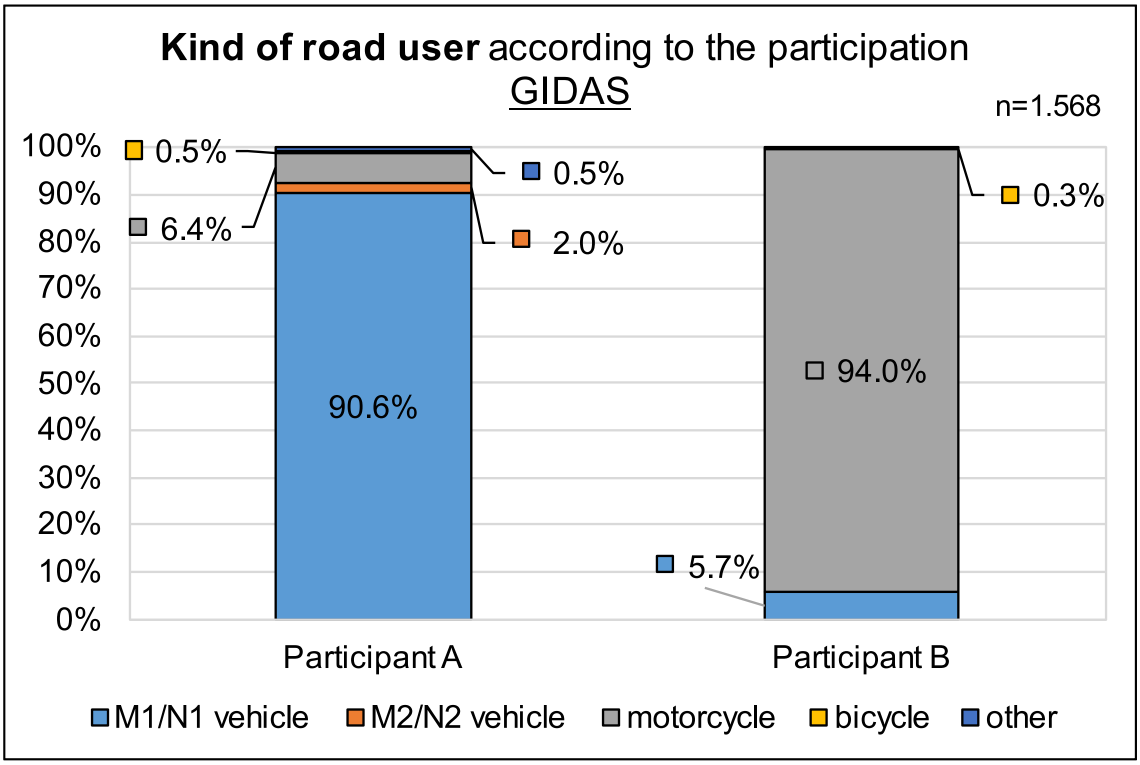


Figure 65 Left Turn Scenario: kind of road user (GIDAS)

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 66). This finding indicates that most accidents happened when visibility was good and there were no adverse weather factors influencing the driving environment.

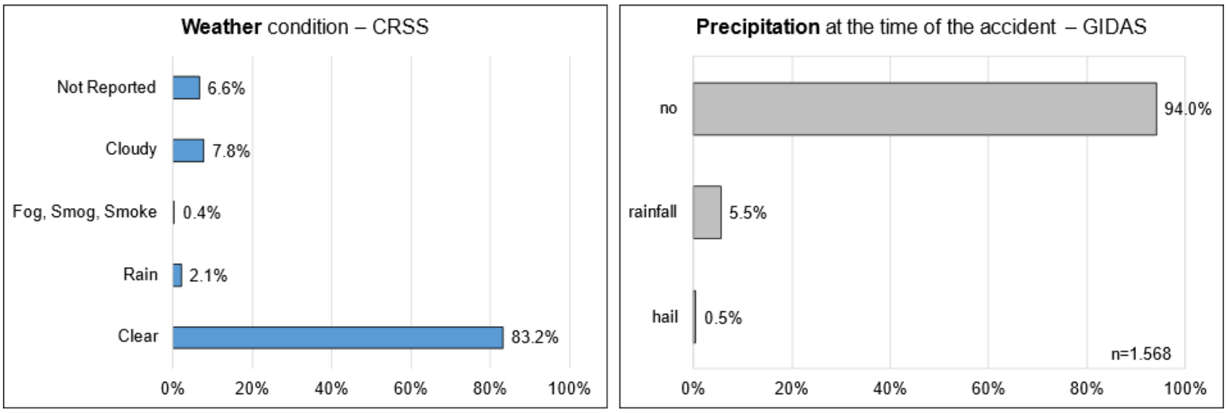


Figure 66 Left Turn Scenario: weather condition (GIDAS, CRSS)

The analysis of the initial speed for participant A showed comparable values for Germany and the US (Figure 67).

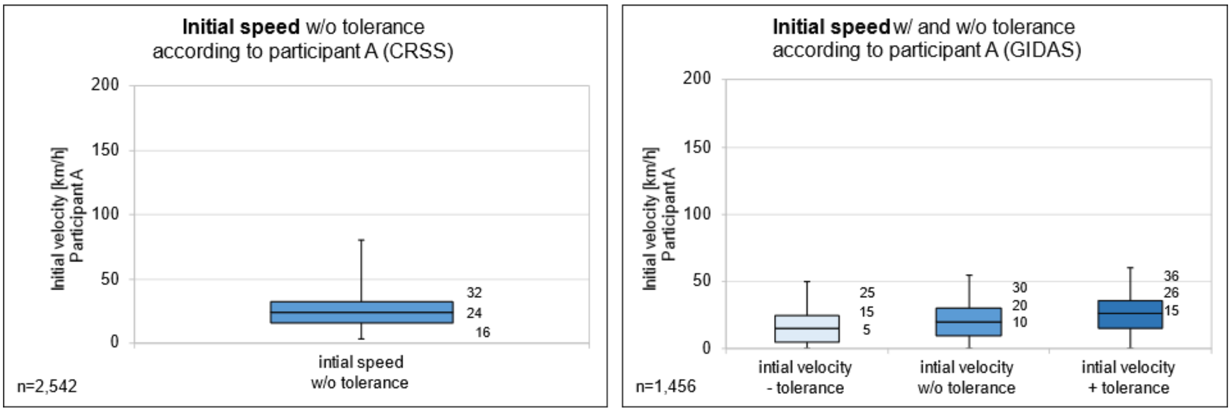


Figure 67 Left Turn Scenario: initial speed participant A (GIDAS, CRSS)

In the case of the analysis of the initial speed for participant B, it was shown that in CRSS, participant B was traveling faster than in GIDAS (Figure 68). One notable commonality between the two data sources, GIDAS and CRSS, is the observation that participant B was traveling at a higher speed than participant A.

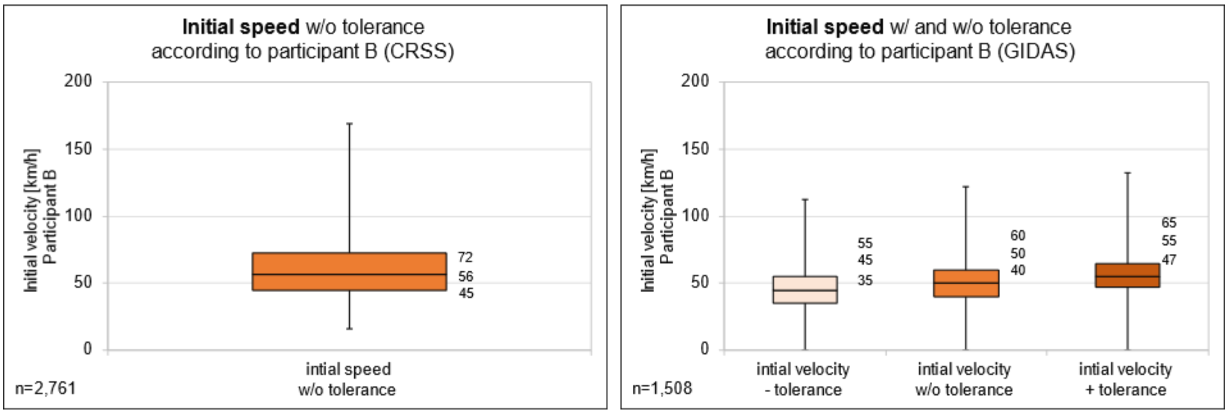


Figure 68 Left Turn Scenario: initial speed participant B (GIDAS, CRSS)

2.4 Summary / Conclusion

In the Longitudinal Traffic Scenario within CRSS, 24% of 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 categorization 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 emphasizes 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 categorization between the two datasets. CRSS distinguishes parties based on vehicle types, while GIDAS categorizes them at the participant level. CRSS data shows a balanced distribution of vehicle types in crossing accidents. In contrast, 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 a consistent pattern. 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 21% and 25%. 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, the party turning left across the driving line of participant B, 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. These findings highlight the importance of understanding the specific roles and behaviors of different vehicle types in left-turn scenarios. The analysis of the initial speed for participant A shows comparable values for Germany and the US. However, for participant B, it was shown that in CRSS, participant B was traveling faster than in GIDAS. 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. The differences in initial speeds and the specific roles of vehicles in left-turn scenarios provide valuable insights into the factors influencing these accidents.

A direct comparison of critical situations before an accident was not feasible between GIDAS and CRSS due to the different categorization 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 categorization of accident scenarios. Based on this categorization, 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. For the left turn scenario, a direct comparison was possible. The differences in this scenario can be directly attributed to the accident events in these two regions.

When comparing the German PTW accident data with the North American PTW accident data, clear similarities and differences were observed, similar to the comparison with the European PTW accident data. Once these similarities and differences have been identified, the GIDAS data can serve as a starting point for understanding the North American accident situation. This approach highlights the importance of recognizing and addressing the differences in data categorization and classification to enable meaningful comparisons.

3. Analysis of Japan PTW accident situation

An in-depth analysis of Japanese PTW accidents is not yet complete. However, the accident types in the ITARDA database have been examined and categorized (Figure 69). These accident types have not yet been divided into the defined accident scenarios, but their descriptions are remarkably similar to those scenarios, providing an initial classification of Japanese accident occurrences.

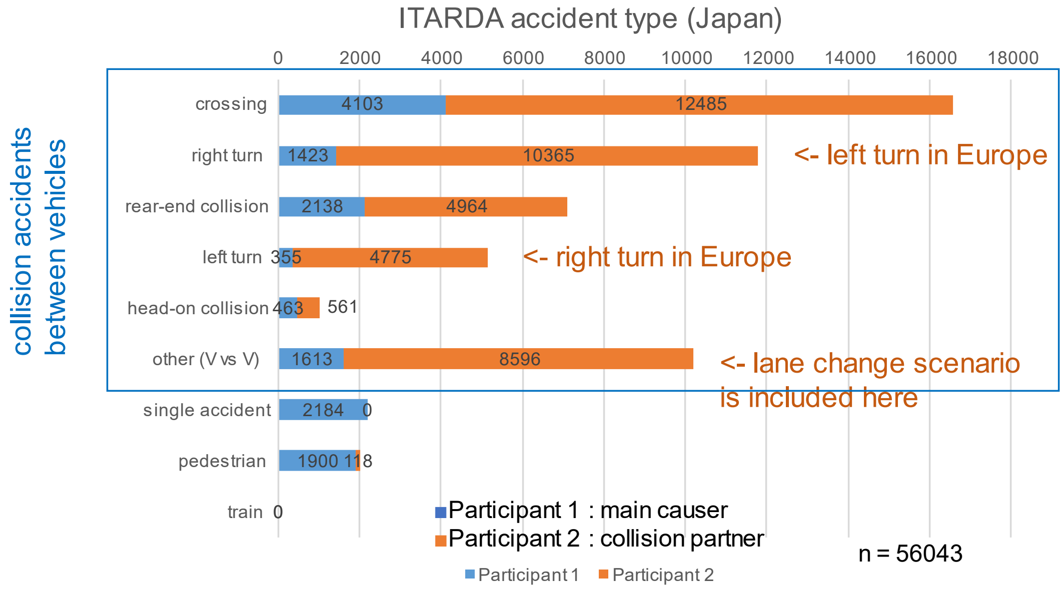


Figure 69 Accident types in Japan (ITARDA)

Like CRSS, the categorization of accidents in ITARDA differs from GIDAS. For instance, head-on collisions and rear-end collisions are grouped together in the GIDAS “longitudinal traffic” scenario. When considering “right turn” and “left turn” scenarios, it is important to note that Japan has left-hand traffic, which means the “left turn” scenario in ITARDA corresponds to the “right turn” scenario in right-hand traffic countries. A glance at the distribution of scenarios reveals differences in accident occurences between Japan and Germany. For example, the number of single accidents, classified as “driving accidents” in GIDAS, is significantly lower in Japan than in Germany.

An in-depth analysis of Japanese accidents is currently being conducted with the help of ITARDA to provide a well-founded understanding of Japanese accident occurences and how they can be classified within the GIDAS framework. Preliminary findings suggest that the “Crossing Traffic Scenario,” the “Longitudinal Traffic Scenario” and the “Left Turn Scenario” are the most common accident scenarios in Japan, similar to the CRSS data. Understanding the exact similarities and differences with GIDAS data will allow the European data to serve as a valuable starting point for further analysis.

4. Summary / Conclusion

The evaluation of the German PTW accident situation in the GIDAS database served as the foundational starting point for the in-depth analysis of PTW accidents. GIDAS provides a wealth of valuable data that allows for a detailed analysis of each accident. This includes a precise distinction between the critical situation leading up to the accident and the description of the actual collision. The database contains comprehensive information about the location, weather, and road conditions at the time of the accident. It also includes details about the exact critical situation, the initial and collision speeds of the various parties involved, the speed limits in force, factors that may have contributed to the accident and any driver distractions or obstructions to visibility.

The comparison of GIDAS data with IGLAD data was straightforward, as both data sources use the same framework for describing accidents. However, for the comparison with CRSS data, it was necessary to first establish a common basis for comparison. This involved transforming the American accident descriptions to align with the European scheme. Once this basis was created, defined accident scenarios could be compared. This comparison revealed many similarities, as well as some differences in the accident events. The most similarities in accidents are primarily found in the location, weather, and road conditions. Additionally, most accidents can be categorized into specific accident scenarios, which means that another common feature is the descriptions of individual situations. The distribution of the parties involved in an accident is also similar in many cases, indicating patterns in who is typically involved. However, there are notable differences, often related to the speeds at which vehicles are driven. It's important to remember that some data sources have their own specific focus; for example, CRSS concentrates on highway accidents. This focus can influence the type of data collected and the insights derived from it. These insights provide a solid foundation for further analysis and conclusions regarding CRSS and GIDAS data.

The same procedure is being applied to the ITARDA data from Japan. Due to differences in the understanding and categorization of accident descriptions, the accident scenarios must be adapted for the Japanese data. This process will allow for the identification of similarities and differences in PTW accident occurrences between GIDAS and ITARDA. By systematically transferring and comparing these scenarios, researchers can gain a comprehensive understanding of PTW accidents across different regions, contributing to improved traffic safety measures worldwide.

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