
# CMC Basic Specification

# Accident Analysis

## - Single Accidents

*Analysis of accident types: Left curve, Right curve and Straight based on GIDAS (German In-Depth Accident Study) database.*

## Document Information

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## Disclaimer

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# 1. Background and Objectives

To pursue the goal "improving motorcycle rider safety", CMC has studied the most frequent PTW (Powered Two-Wheeler) accident scenarios in the GIDAS (German In-Depth Accident Study) database (Figure 1). Out of those accident scenarios, Single Accidents (”Driving accidents” in Figure 1) account for 30.3% of the total of PTW accidents, which include left curve /right curve/ straight scenarios. CMC performed a study for these scenarios using the GIDAS database, which is explained in this report .
The analyses of the other accident scenarios are explained in other reports.

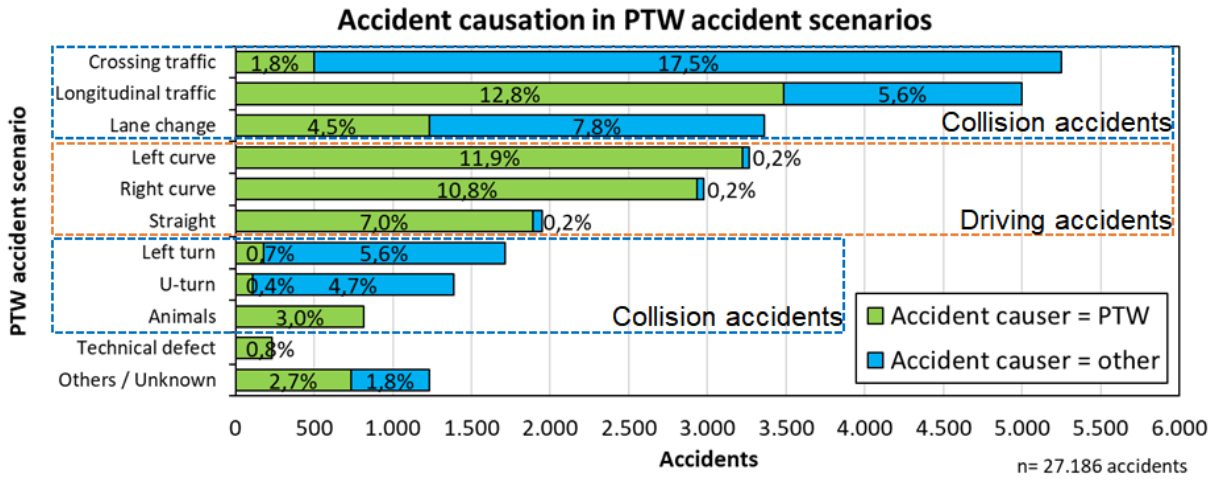


Figure 1: Accident causation in the PTW scenarios

## 2. Study structure

The study uses the GIDAS database which contains precise information about the actual accidents occurred. From the database, the following fact-based data are extracted and studied.

a) Location of the accident: rural / urban
b) Kind of traffic regulation: right of way / stop sign / traffic lights, etc.
c) Main accident causation: mis-obeyed priority / turning, etc.
d) Types of speed limitation: local limit / traffic sign, etc.
e) Maximum permitted speed: 30km/h, 50km/h etc.
f) Speed limit and distribution
g) Speed before the accident and at the time of collision
h) View obstruction
i) Used lane when encountering an accident
j) Road surface: asphalt / cobble stone / sand, etc.
k) Precipitation at the time of the accident
l) Road condition: dry / wet / snow, etc.
m) Interview result: visibility limitation
n) Interview result: overlooked / distracted, etc.
o) Interview result: misjudgement
p) Interview result: accident-avoidance possibility by other action
q) Interview result: mistakes in executing the avoidance action
r) Interview result: influence from vehicle technology
s) Interview result: influence of road condition

### Selecting the use cases for analysis

Within the selected accident scenarios, there exist more precise accident types as shown in Figure 2, Figure 3 and Figure 4 for left curve, right curve and straight accident, respectively. “participant A” in each figure represents the PTW rider who caused the accident.
Which use case to first concentrate on has been decided from the frequency of the specific use case, i.e., accident type 101 for left curve which counts for 74.2% (n=2,422) of all left curve accident types, accident type 102 for right curve which counts for 62.8% (n=1,870) of all right curve accident types and accident type 141 for straight which counts for 88.0% (n=1,714) of all straight accident types.
Considering the similarity of the accident type 101 and 102, the analysis of these types was combined as one analysis.

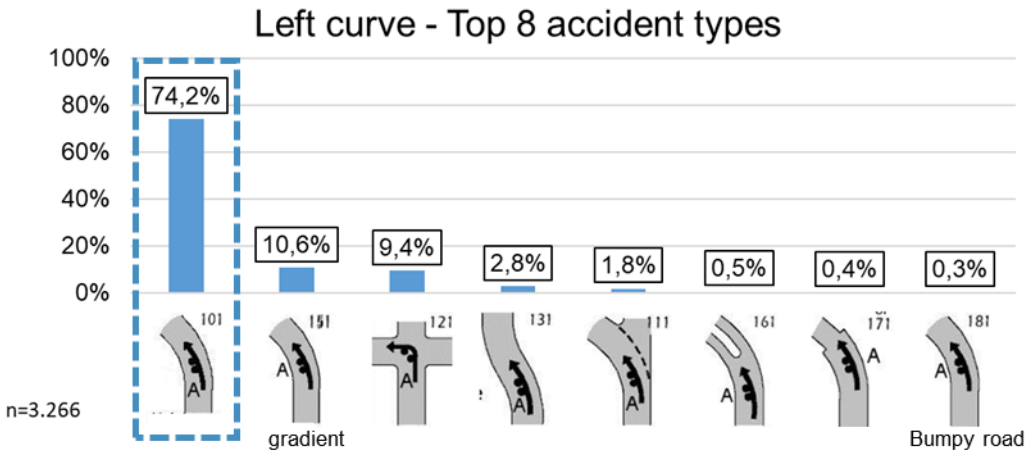


*Figure 2: Selection of left curve accident type*

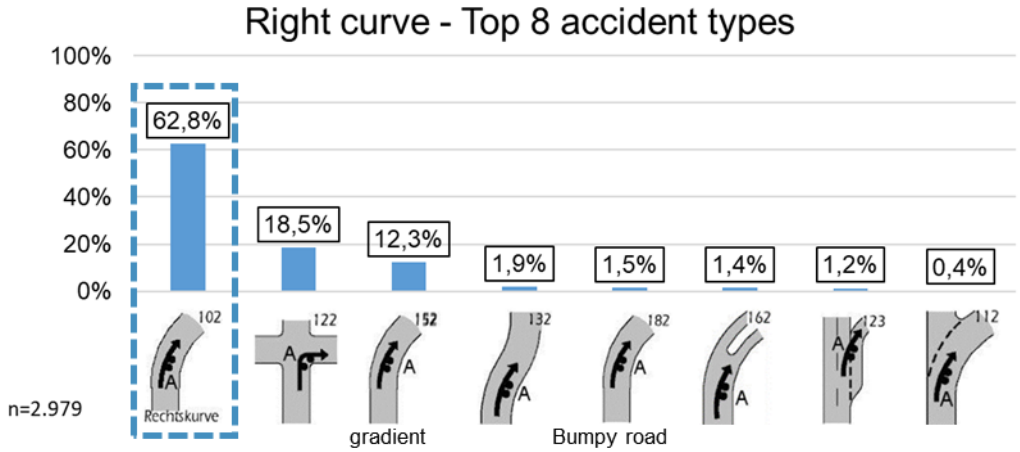


*Figure 3: Selection of right curve accident type*

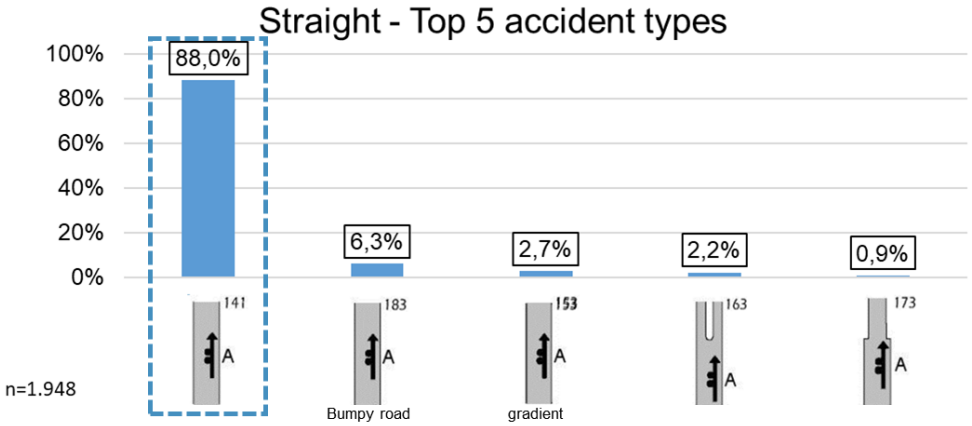


*Figure 4: Selection of straight accident type*

# 3. Use case description

### 3.1.1 Left curve accident type 101

Left curve accident type 101 is a "driving accident" caused in a left curve (Figure 5).
This means that the road user lost control of the vehicle, because the actual speed was not in line with their riding skills, or not in line with the road properties (such as its course, its transverse section, its condition, its slope, its surface etc.), or that they recognised these properties too late.


*Figure 5: Left curve accident type 101*

### 3.1.2 Right curve accident type 102

Right curve accident type 102 is a "driving accident" caused in a right curve (Figure 6).

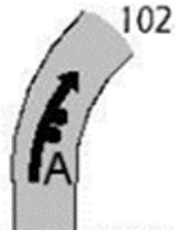


*Figure 6: Right curve accident type 102*

### 3.1.3 Straight accident type 141

Straight accident type 141 is a "driving accident" caused on a straight road (Figure 7).

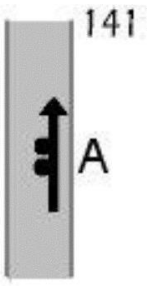


*Figure 7: Straight accident type 141*

# 4. Summary of the Analysis Results

In this chapter, a summary of the analysis results of each accident type is given. Detailed analysis results can be found in the following chapters.

## 4.1 Left / Right curve accident type 101&102

**Main findings.**

- The main reason for these accidents is the speed and the second is other mistakes made by PTW riders (5.1.3 ).
- Approximately 27% of the participants exceed the speed limit, which was 50 km/h in the majority of analysed cases. (5.1.6 )
- On average, the participants ride at 70km/h and decelerate to 52km/h before they crash (5.1.7 ).
- In most of the accidents there was no view obstruction (5.1.8 ).
- Weather condition was not identified as a major factor for the accidents, but it was raining in 7% and the road condition was damp or wet in around 16% (5.1.10 to 5.1.12 ).
- 93.2% of the accidents occur on roads that are not regulated. In 3.6% cases there was traffic regulation with right-of-way-rule and in 2.6% cases with traffic lights (5.1.2 ).

## 4.2 Straight accident type 141

**Main findings.**

- The two most frequent main causations for the accidents are the speed and other mistakes made by PTW riders (5.2.3 ).
- Approximately 23% of the participants exceed the speed limit, which was 50 km/h in the majority of analysed cases (5.2.6 ).
- On average, the participants ride at 50 km/h and decelerate to 42 km/h before they crash.(5.2.7 ).
- In most of the accidents there was no view obstruction (5.2.8 ).
- Weather condition was not identified as a major factor for the accidents, but it was raining in 19% and the road condition was damp or wet in around 33% (5.2.10 to 5.2.12 ).
- 72.2% of the accidents occur on roads that are not regulated. In 19.3% cases there was traffic regulation with traffic lights and in 6.8% cases with right-of-way-rule (5.2.2 ).

# 5. Analysis results (detailed)

## 5.1 Left / Right curve accident type 101&102

### 5.1.1 a) Location of the accident

The majority of PTW accidents in left / right curves occurred on rural roads which accounts for 72.4% of overall 101&102 type (Figure 8).

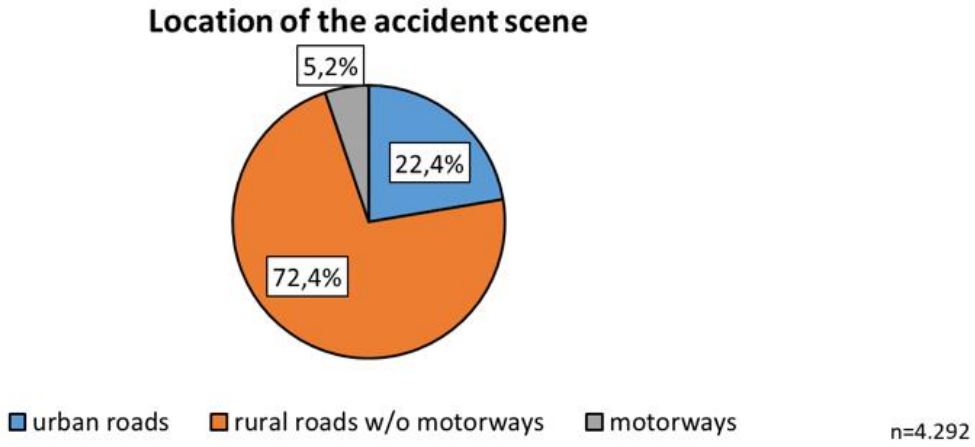


*Figure 8: Location of the accident (101&102)*

### 5.1.2 b) Kind of traffic regulation

The majority (93.2%) of PTW accidents according to the accident type 101&102 are not regulated (Figure 9). In 6.8% of the cases, traffic regulation takes place, e.g. right-of-way-rule (3.6%) or traffic lights (2.6%).

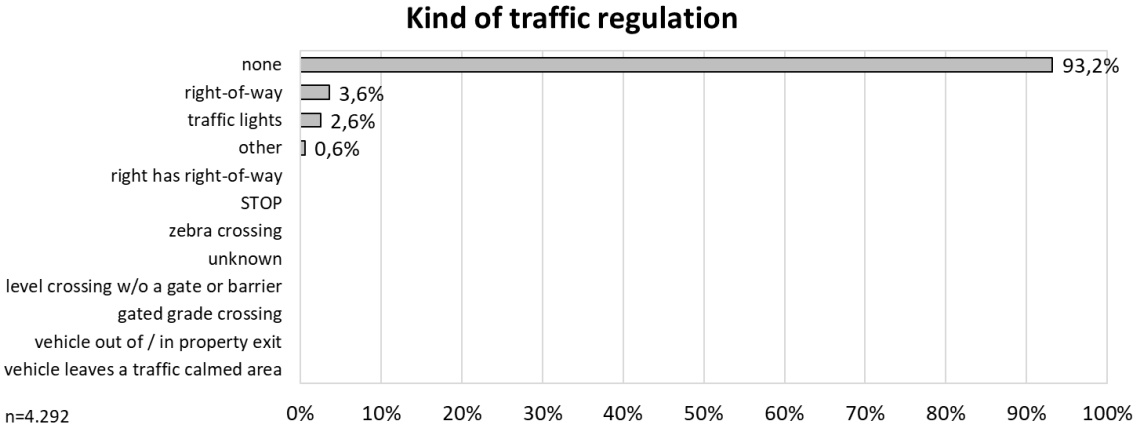


*Figure 9: Kind of traffic regulation (101&102)*

### 5.1.3 c) Main accident causation

The causation of the accidents is studied and shown in Figure 10 and Figure 11. The main reason for the accident was the speed.

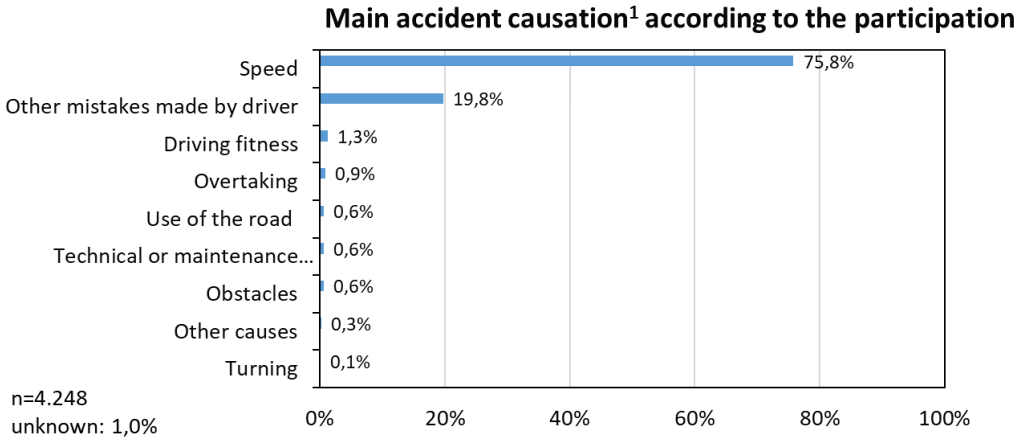


*Figure 10: Main accident causation (101&102)*

1: The police and also the technical investigation units in GIDAS have to assign a main accident causer with one main accident causation in each accident.

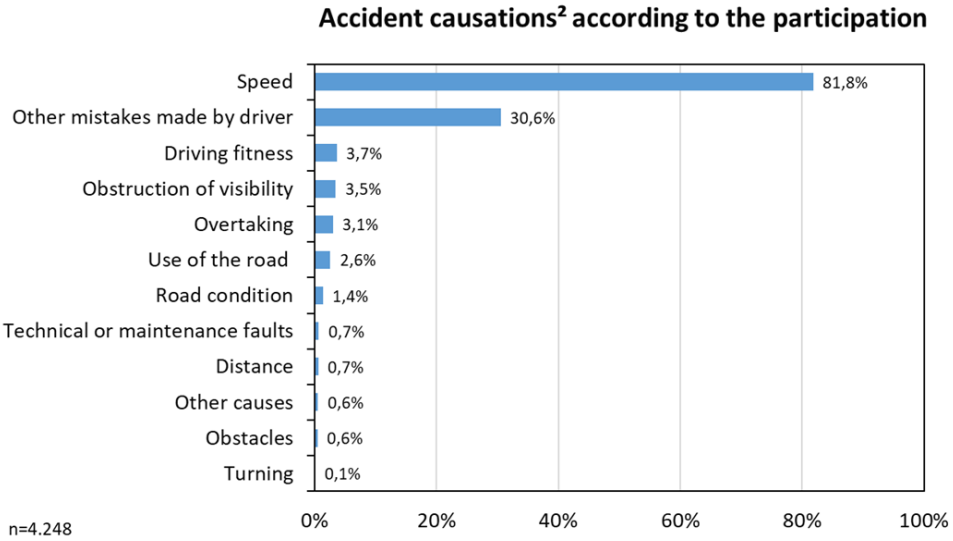


*Figure 11: Accident causations (101&102)*

2: The police and the technical investigation units in GIDAS can assign up to 3 accident causations for each accident participant. Consequently, one accident can have several accident causes depending on the participant and so the sum of the accident causations is ≥100%.

### 5.1.4 d) Types of speed limitation

What provides the speed limit to the participant is shown in Figure 12. In more than 50% of the cases, the speed limit is provided by local traffic rules and in 38% of the cases by traffic signs.

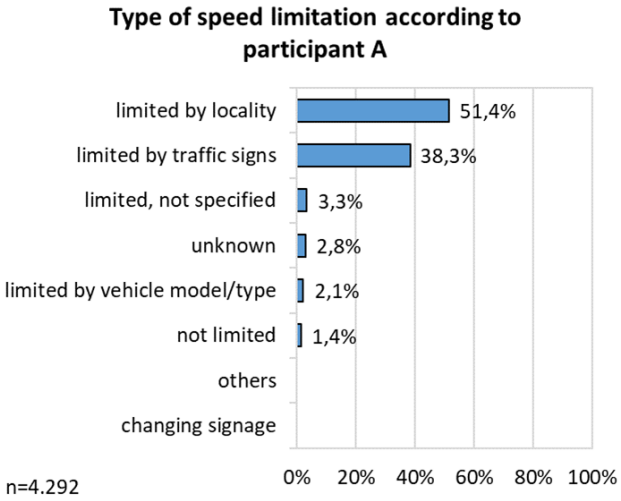


*Figure 12: Types of speed limitation (101&102)*

### 5.1.5 e) Maximum permitted speed

Maximum permitted speed on the accident site is shown in Figure 13. The most frequent permitted speed is 100 km/h. This is in line with Figure 8, that indicates that 44% of accidents occurred at rural roads.

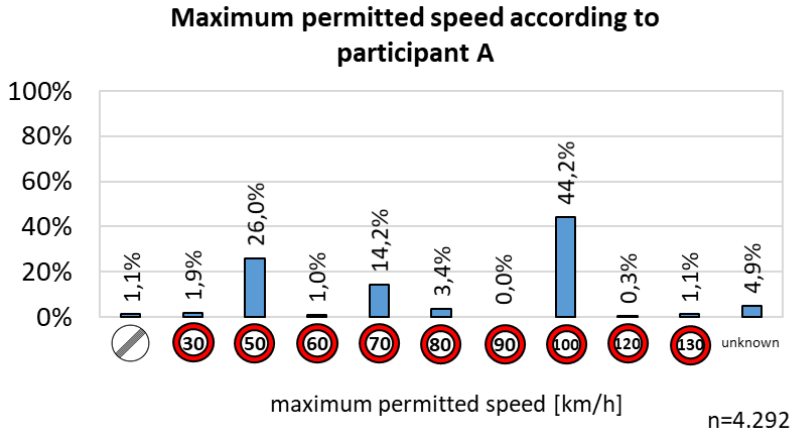


*Figure 13: Maximum permitted speed (101&102)*

### 5.1.6 f) Speed limit and distribution

Figure 14 shows the percentage of participants exceeding the applicable speed limit. Approximately 27% of PTW riders exceeded the speed limit. The majority of cases exceeding the speed limit occurred at a permitted speed of 50 km/h.

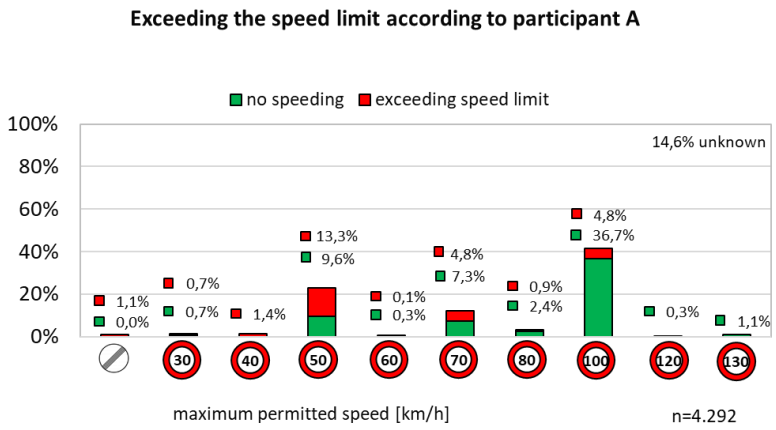


*Figure 14: Exceeding Speed limit (101&102)*

Figure 15 shows the distribution of how much the participants exceeded the allowable speed for each given speed limit before causing accident.

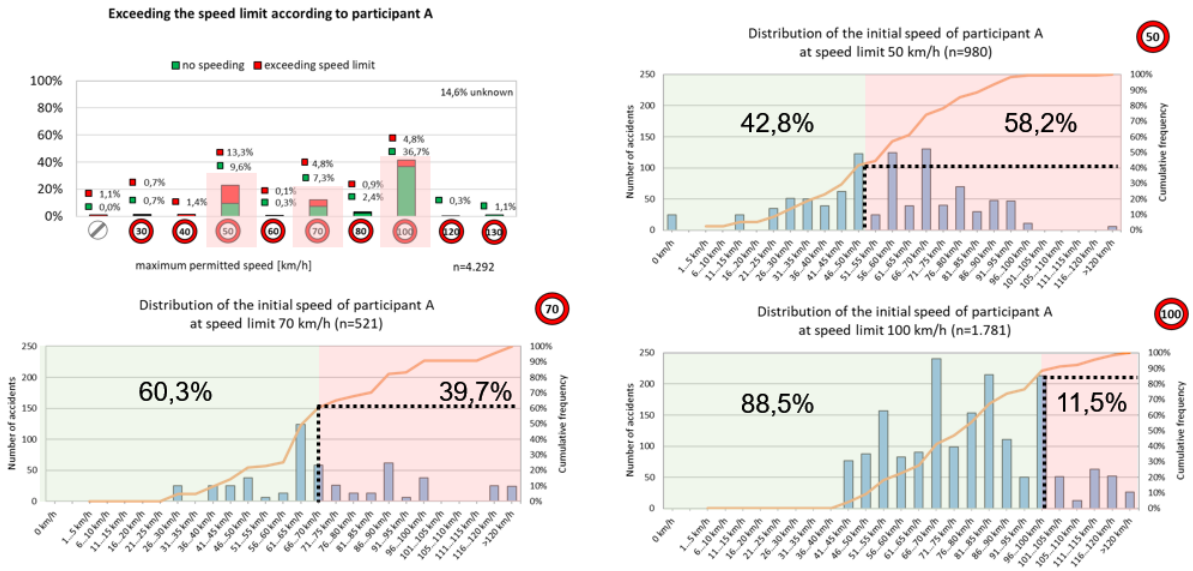


*Figure 15: Speed distribution (101&102)*

### 5.1.7 g) Speed before the accident and at the time of crash

Figure 16 shows the initial speed of the participants. The median of the average initial speed of the participants is 70 km/h.

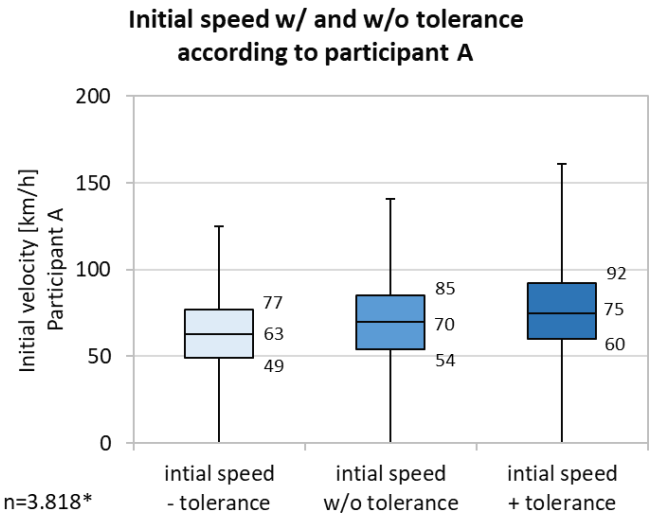


*Figure 16: Initial speed (101&102)*

Figure 17 shows the collision speed of the participants. Comparing the initial speed in Figure 16 and the collision speed in Figure 17, the plots show that in the median scenario, participants ride at 70 km/h initially and decelerate to 52 km/h before crashing.

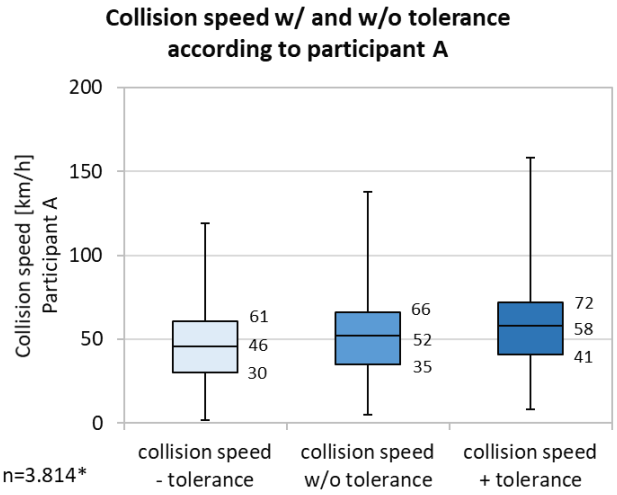


Figure 16Figure 17

*Figure 17: Collision speed (101&102)*

### 5.1.8 h) View obstruction

Figure 18 and Figure 19 show existence of view obstructions and the types of obstruction respectively. It can be seen that around 94% of the cases had no view obstructions and the rest with permanent obstruction, e.g., buildings.

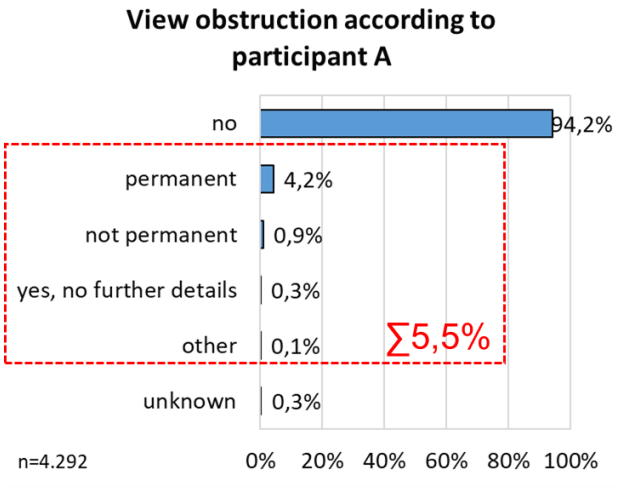


*Figure 18: View obstructions (101&102)*

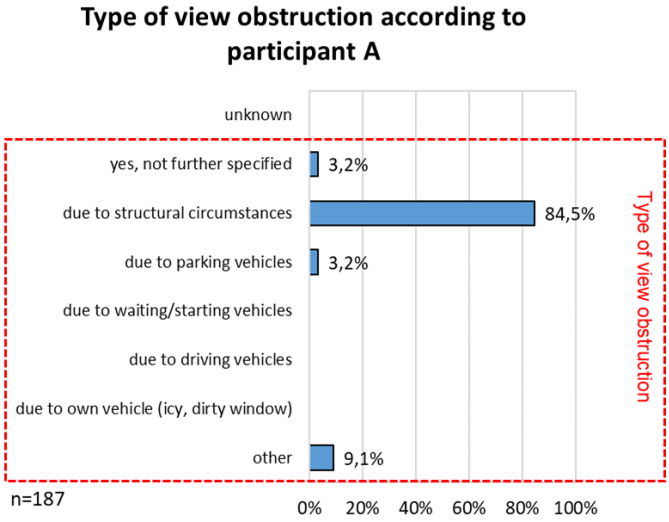


*Figure 19: Type of view obstruction (101&102)*

### 5.1.9 i) Used lane when encountering an accident

Figure 20 shows which lane the participants took when encountering an accident. The majority of this Left / Right curve accident scenario participants were driving at a tow-lane road.

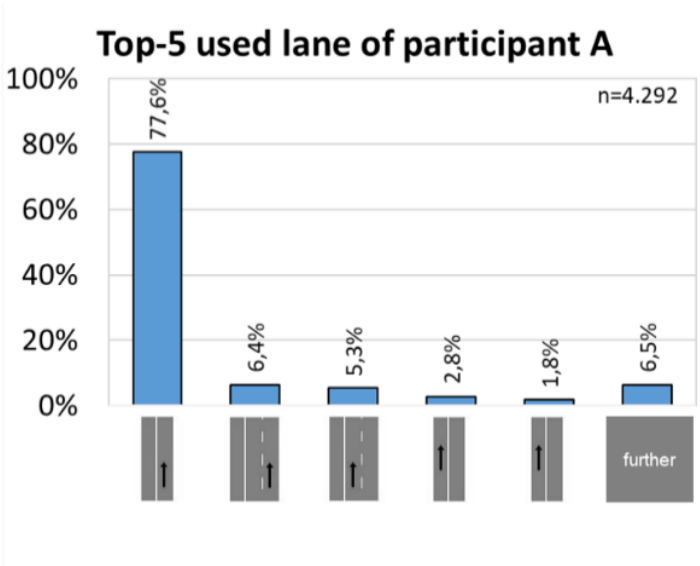


*Figure 20: Used lane at an accident (101&102)*

### 5.1.10 j) Road surface

Figure 21 shows which kind of road surface it was when encountering the accident. It can be seen that almost all the accidents happened on asphalt.

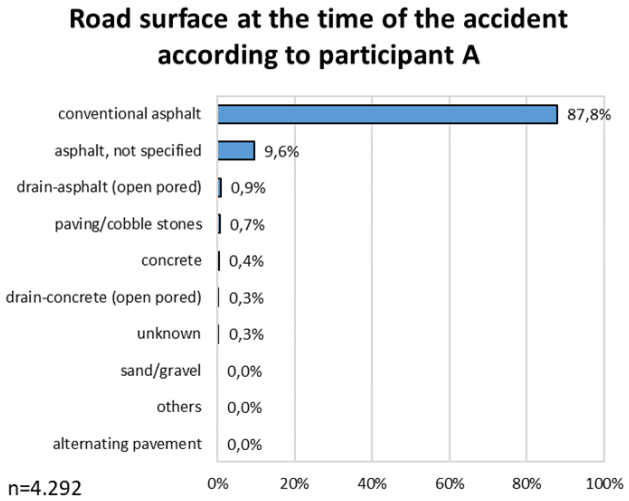


*Figure 21: Road surface (101&102)*

### 5.1.11 k) Precipitation at the time of the accident

Figure 22 shows precipitation at the time of the accident. In most accidents there was no precipitation. In 7% of the accidents it was raining.

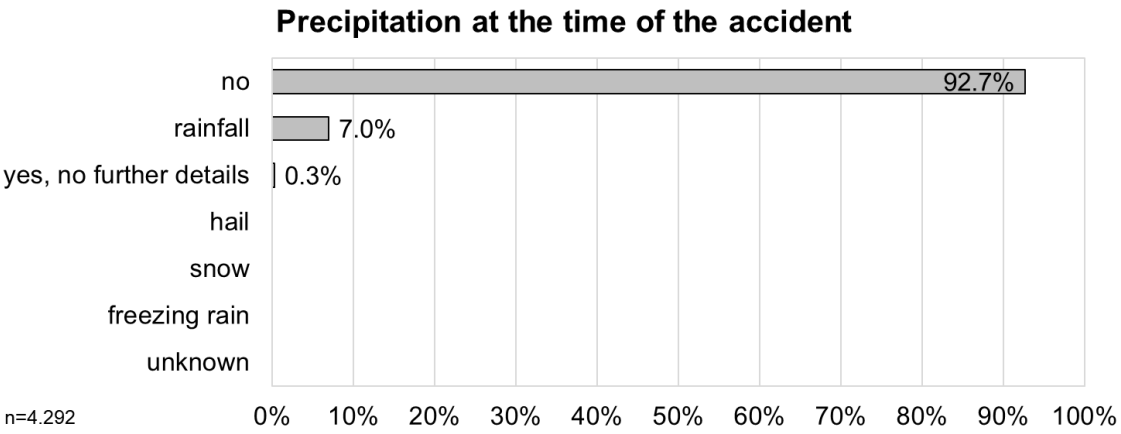


*Figure 22: Precipitation (101&102)*

### 5.1.12 l) Road condition

Figure 23 shows the road condition at the time of the accident. From the figure, it can be observed that in around 80% of accidents there was a dry road surface which would allow full brake performance. In around 16% of accidents the road surface was damp or wet.

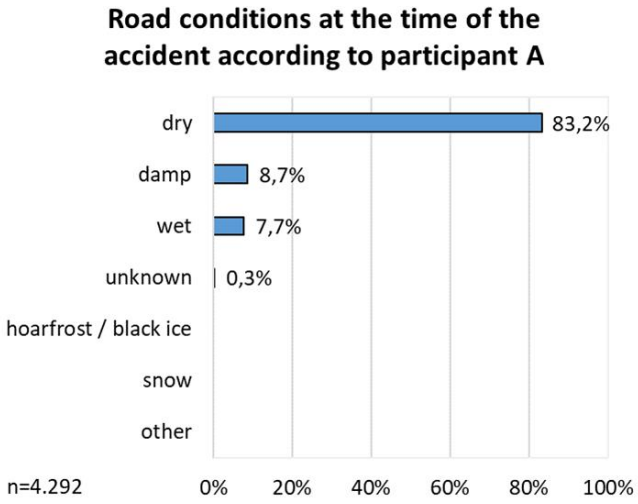


*Figure 23: Road condition (101&102)*

### 5.1.13 m) Interview result: visibility / audibility limitation

Figure 24 shows the participant interview results about visibility and audibility limitations. Out of those who answered "yes" or "no", (so taking out the unknown cases), only 5.4% (=2.5/(2.5+43.9)x100) of the participants reported that visibility or audibility was limited at the time of accident.

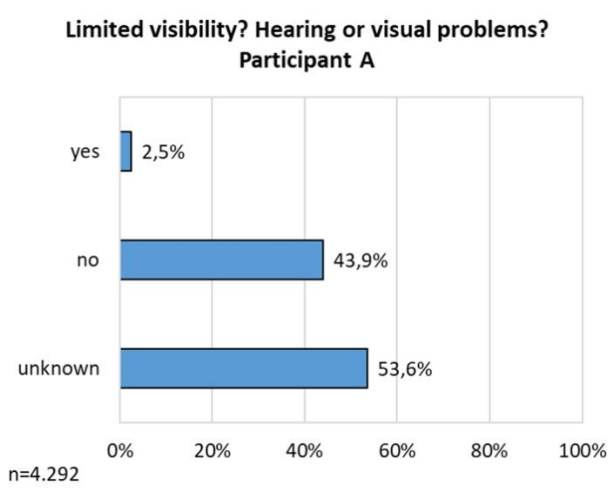


*Figure 24: Interview - visibility / audibility limitation (101&102)*

### 5.1.14 n) Interview result: overlooked / distracted, etc.

Figure 25 エラー! 参照元が見つかりません。 shows the participant interview results whether they overlooked important information or if they were distracted. In 10.4% (=4.5 /(4.5+38.7)x100) of the known cases, the interviewed riders report overlooking or distraction. Figure 26 エラー! 参照元が見つかりません。 shows further insight into those “yes” cases. Among them, 22.1% stated that they were influenced by conditions like being tired or not concentrated, or alcohol, drugs, or medication at the time of the accident and 12.3% stated stress or hurry.

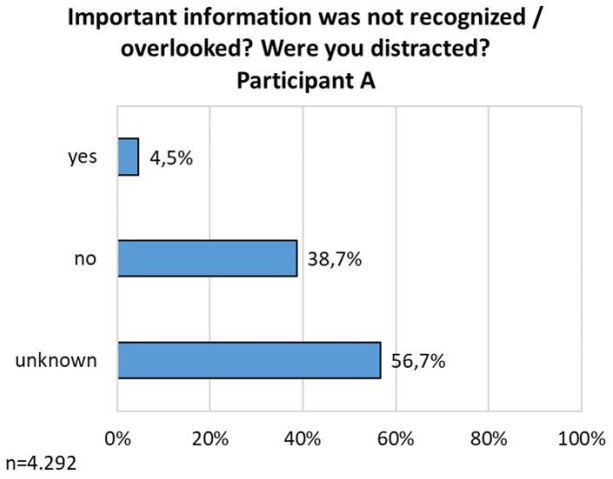


*Figure 25: Interview - overlooked / distracted (101&102)*

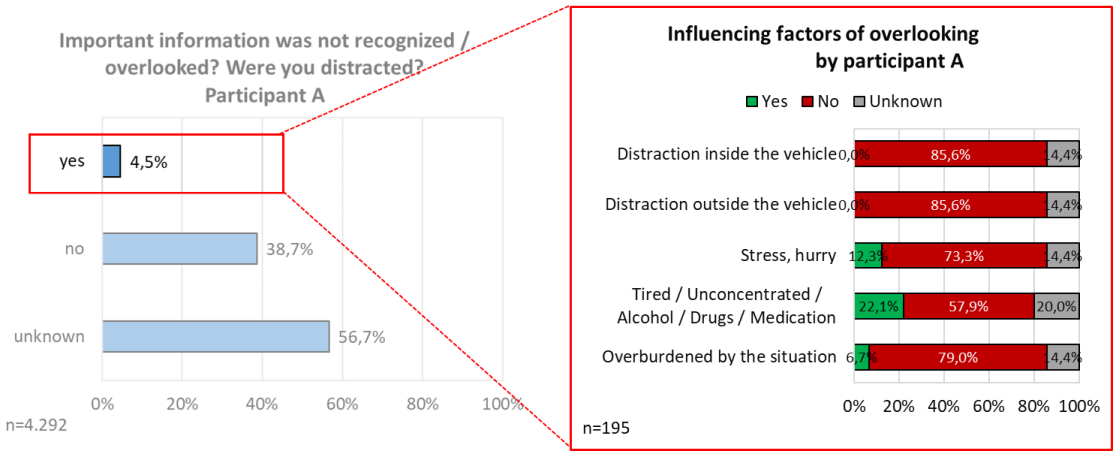


*Figure 26: Interview – Influencing factors for overlooking (101&102)*

### 5.1.15 o) Interview result: misjudgement

Figure 27 shows interview results of the participants whether they misjudged the situation or not. In 61% (=25.9/(25.9+16.5)x100) of the known cases, the participants report they have misjudged the situation.

Figure 28 shows further insight into the influencing factors of the participants, who answered that they misjudged the situation or course of events. This chart shows that the most frequent reason was a misjudgment of the own vehicle speed / distance (94.9%).

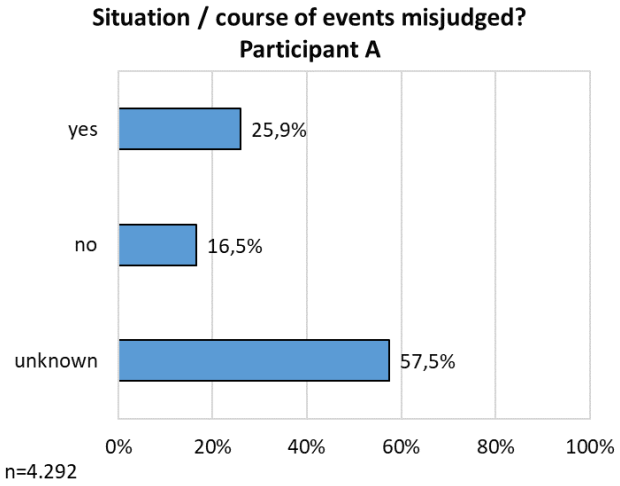


*Figure 27: Interview - Misjudgement (101&102)*

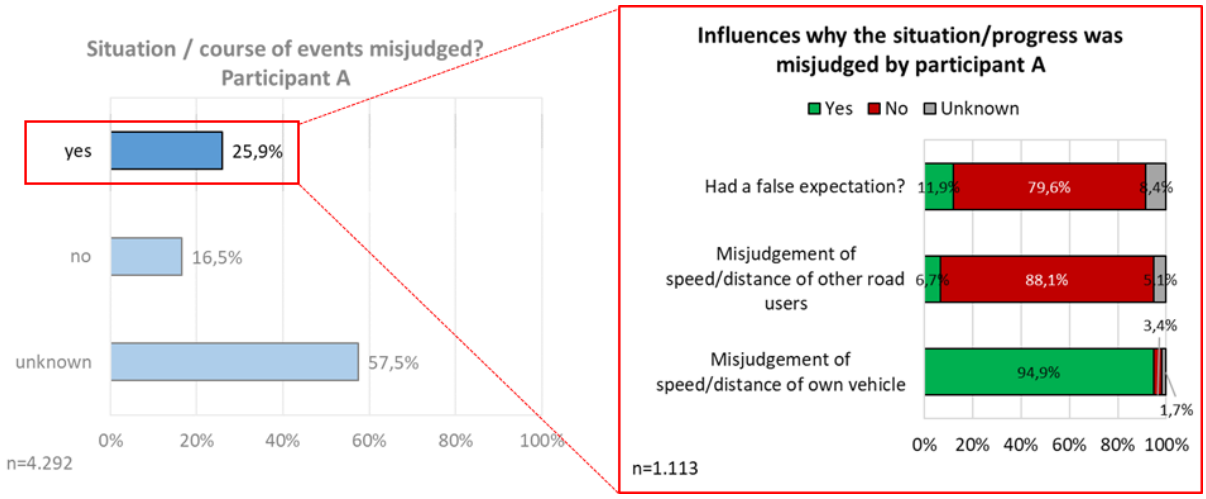


*Figure 28: Interview – Influences why misjudged (101&102)*

### 5.1.16 p) Interview result: accident-avoidance possibility by other action

Figure 29 shows the participant interview results whether the accident would have been possible to be avoided by some other reaction / action. Comparing the number of participants answering "yes" to "no", the ratio of "no" is much higher. In 80% (= 33.2/(33.2+8.5)x100) of the known cases, the accident seemed to be difficult to be avoided with other actions taken.

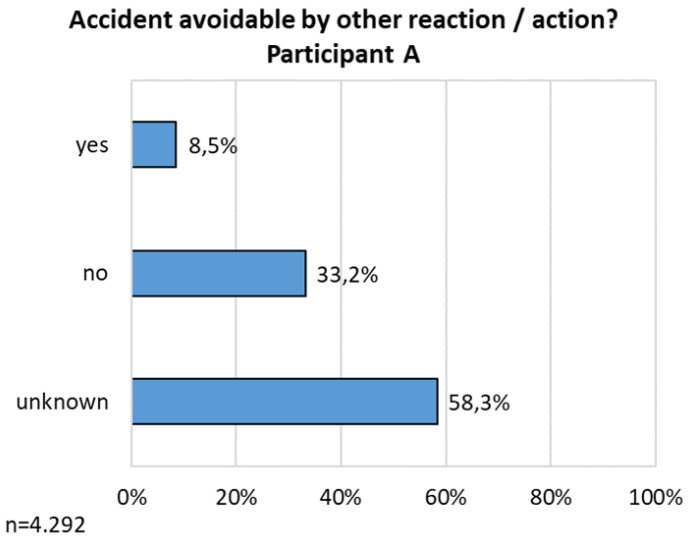


*Figure 29: Interview - Accident avoidance possibility (101&102)*

### 5.1.17 q) Interview result: mistakes in executing the avoidance action

Figure 30 shows the participant interview results about difficulties / mistakes in taking the planned action. Comparing the number of participants answering "yes" to "no", the ratio of "no" is much higher. In 87% (= 36.7/(5.6+36.7)x100) of the known cases, the planned action was not difficult or mistaken to execute.

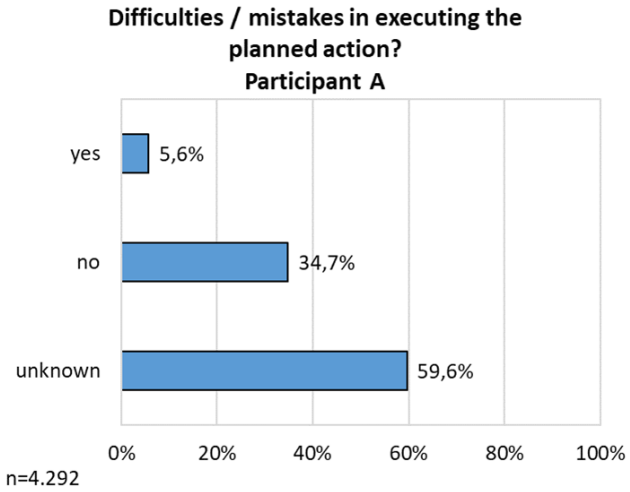


*Figure 30 Interview - Mistakes in avoidance action (101&102)*

### 5.1.18 r) Interview result: influence from vehicle technology

Figure 31 shows the interview results of the participants about any influence of the vehicle technology. This query is asking whether the participants had difficulty in operating a certain function provided by the vehicle or were distracted by any function on the vehicle. The ratio of participants answering "no" is much higher than those answering "yes" meaning that there was little influence by the vehicle technology leading to an accident.

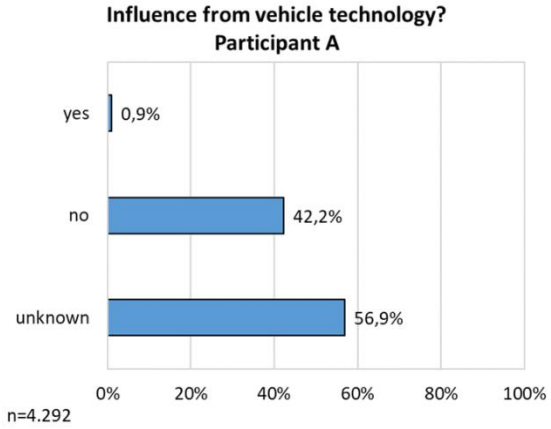


*Figure 31: Interview - Influence from vehicle technology (101&102)*

### 5.1.19 s) Interview result: influence from the condition of the road

Figure 32 shows the participant interview results about any influence from the condition of the road. The ratio of participants answering "no" is higher than those answering "yes", but in 20% (= 8.8/(8.8+35.8)x100 ) of the known cases the interviewed participants answered yes.

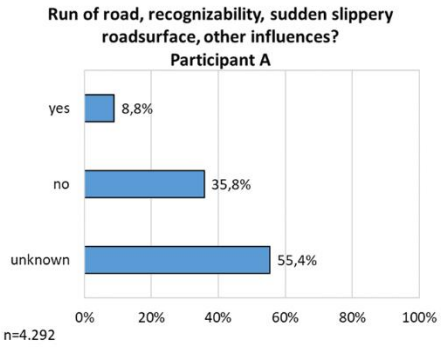


*Figure 32: Interview - Influence of road condition (101&102)*

## 5.2 Straight accident type 141 analysis

### 5.2.1 a) Location of the accident

The majority of PTW accidents for straight road accident types occurred on urban roads which accounts for 57.4% of the accident type 141 (Figure 33).

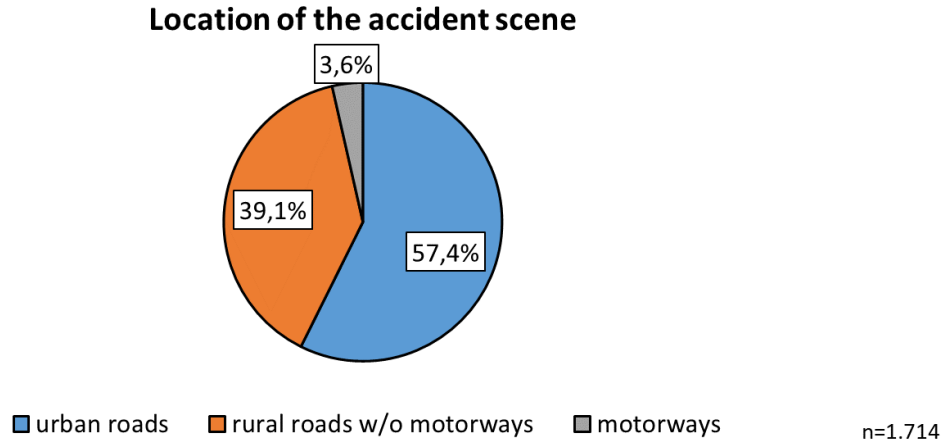


*Figure 33: Location of the accident (141)*

### 5.2.2 b) Kind of traffic regulation

The majority (72.2%) of PTW accidents according to accident type 141 occur on roads that are not regulated (Figure 34). In 19.3% there was traffic regulation with traffic lights and in 6.8% with right-of-way-rule.

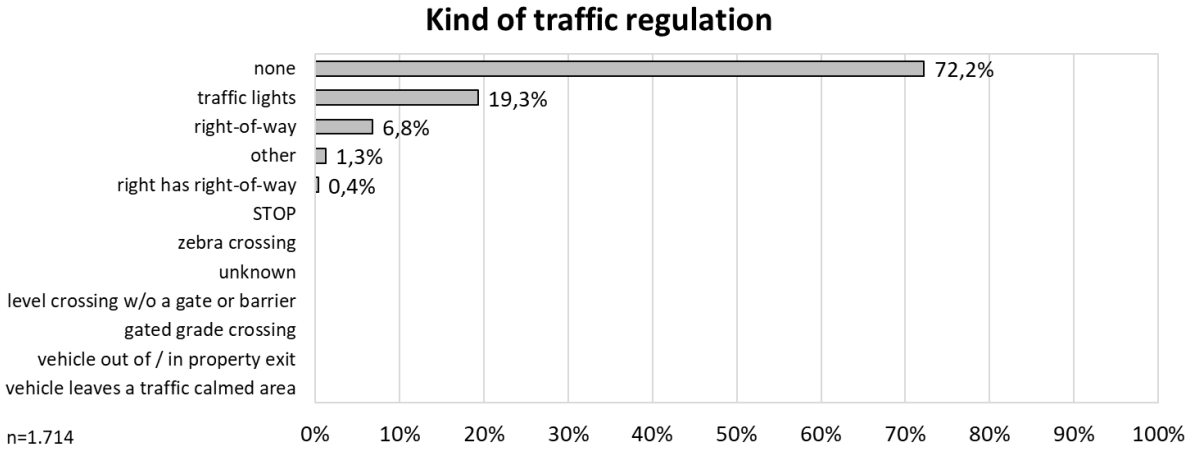


*Figure 34: Kind of traffic regulation (141)*

### 5.2.3 c) Main accident causation

The causation of the accidents is studied and shown in Figure 35 and Figure 36. From the figures, it can be seen that the two most frequent main accident causations for accident type 141 are "Speed" and "Other mistakes made by driver".

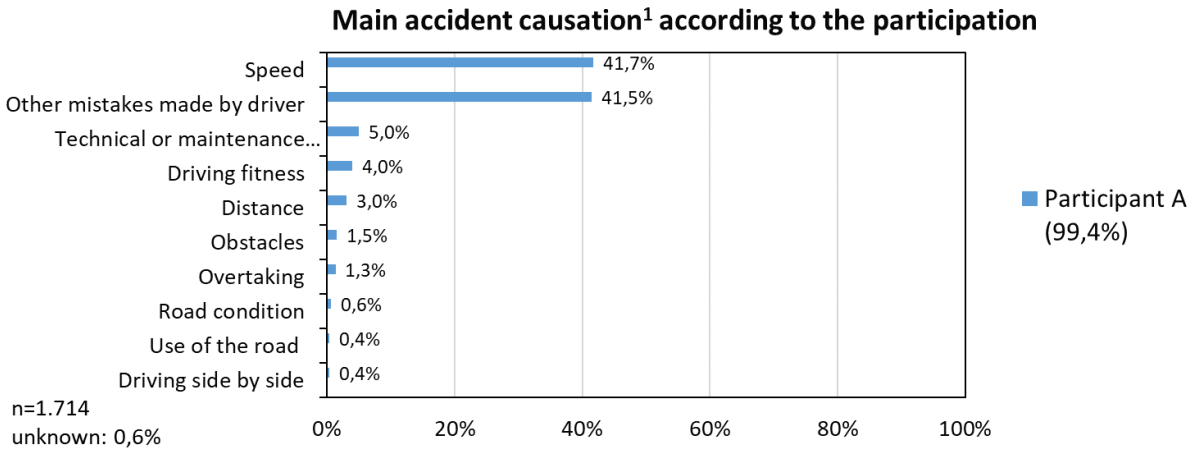


*Figure 35: Main accident causation (141)*

1: The police and also the technical investigation units in GIDAS have to assign a main accident causer with one main accident causation in each accident.

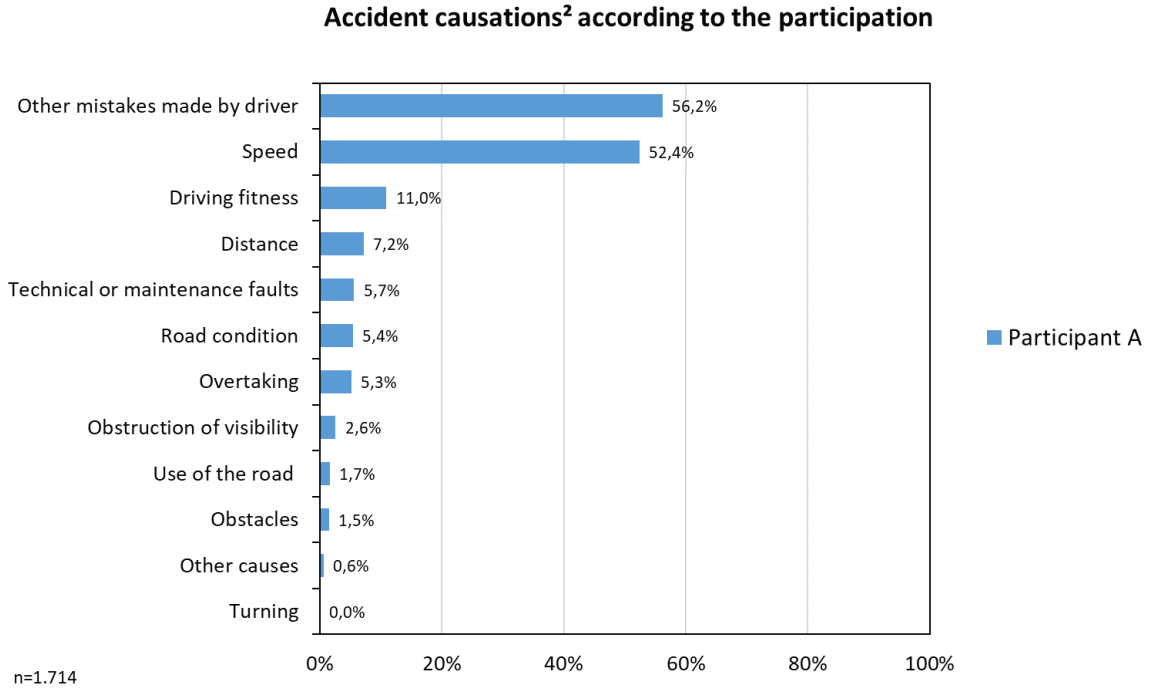


*Figure 36: Accident causations (141)*

2: The police and the technical investigation units in GIDAS can assign up to 3 accident causations for each accident participant. Consequently, one accident can have several accident causes depending on the participant and so the sum of the accident causations is ≥100%.

### 5.2.4 d) Types of speed limitation: local limit / traffic sign, etc.

What provides the speed limit to the participant is shown in Figure 37. In the majority of cases, the speed limit is provided by local traffic rules and secondly, by traffic signs.

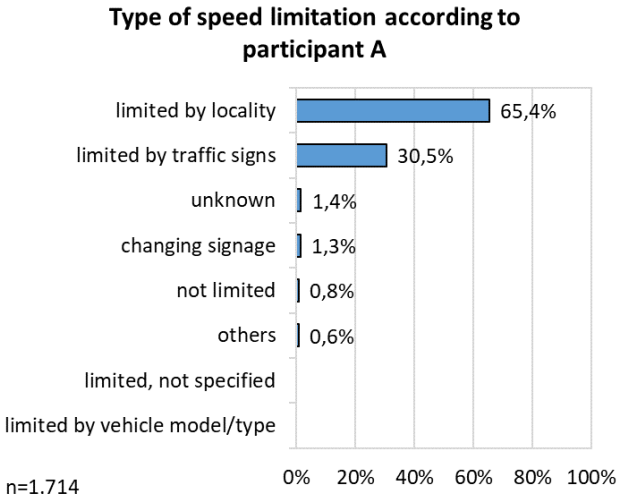


*Figure 37: Types of speed limitation for the participants (141)*

### 5.2.5 e) Maximum permitted speed

The maximum permitted speed on the accident site is shown in Figure 38. The most frequent maximum permitted speed is 50 km/h. This is in line with Figure 33, that shows that around 54% of accidents occurred at urban roads.

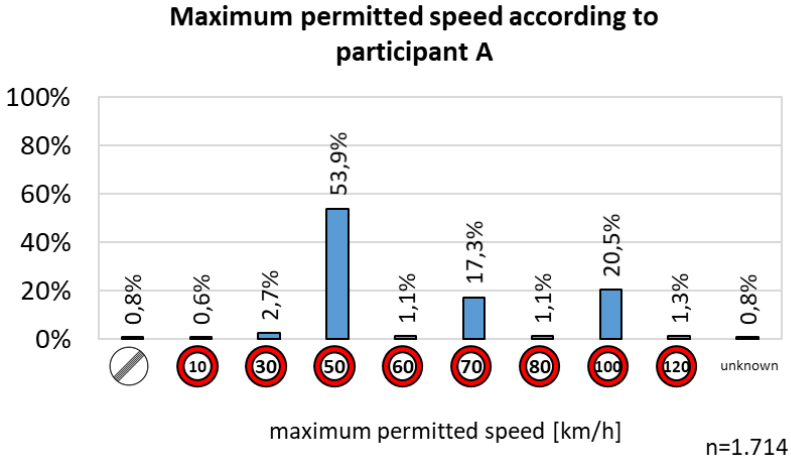


*Figure 38: Maximum permitted speed (141)*

### 5.2.6 f) Speed limit and distribution

Figure 39 shows the percentage of participants exceeding the applicable speed limit. Approximately 23% of PTW riders exceed the speed limit. The majority of exceeding the speed limit occurs at 50 km/h.

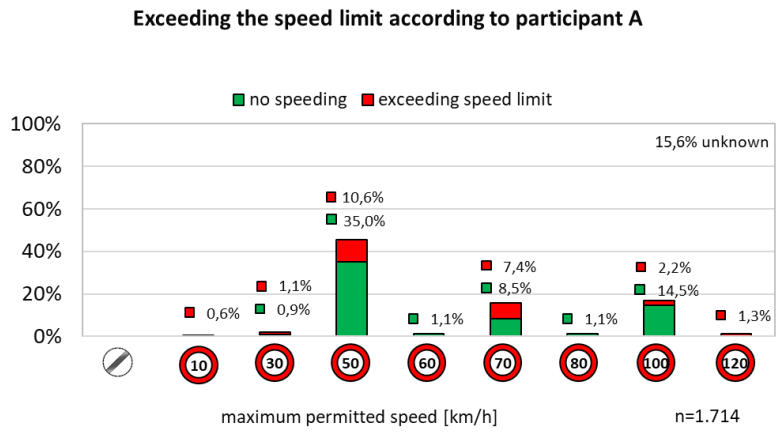


*Figure 39: Exceeding speed limit (141)*

Figure 40 shows the distribution of how much the participants exceeded the allowable speed for each given speed limit before the accident.

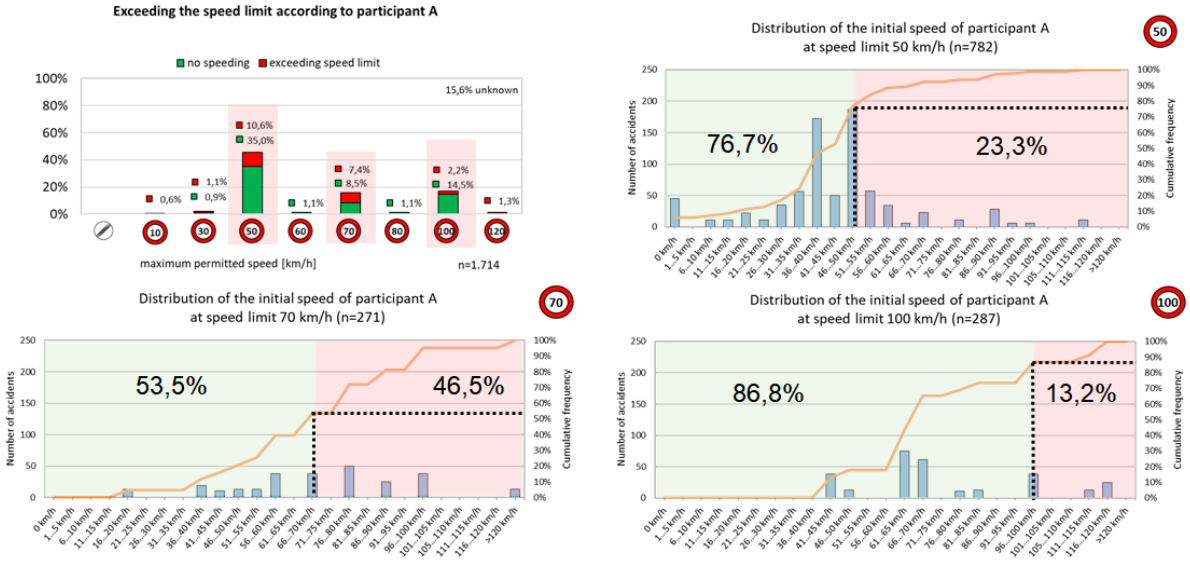


*Figure 40: Speed distribution (141)*

### 5.2.7 g) Speed before the accident and at the time of crash

Figure 41 shows the initial speed of the participants. The median of the average initial speed of the participants is 50 km/h.

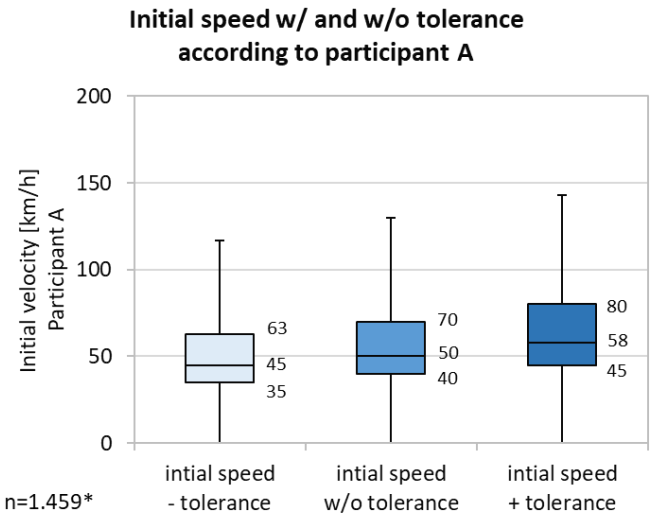


*Figure 41: Initial speed of participants (141)*

Figure 42 shows the colliding speed of the participants. The median of the average collision speed of the participants is 42 km/h.

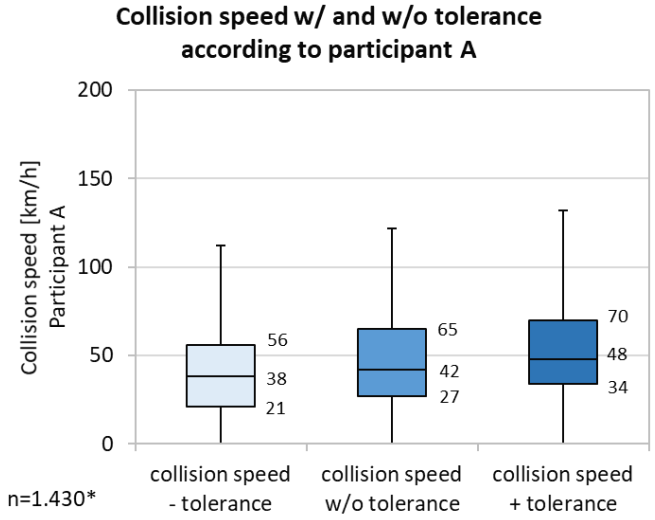


*Figure 42: Collision speed of participants (141)*

### 5.2.8 h) View obstruction

Figure 43 and Figure 44 show existence of view obstructions and the types of obstruction respectively. It can be seen that almost 98% of the cases had no view obstructions and approximately 2% of the participants were affected in sight by mostly permanent view obstructions.

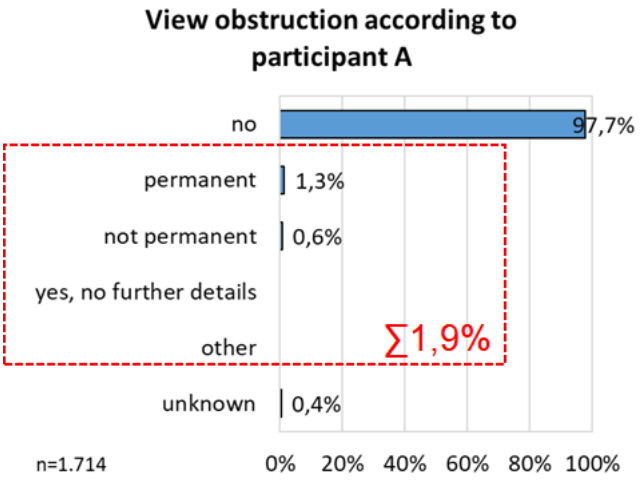


*Figure 43: View obstructions (141)*

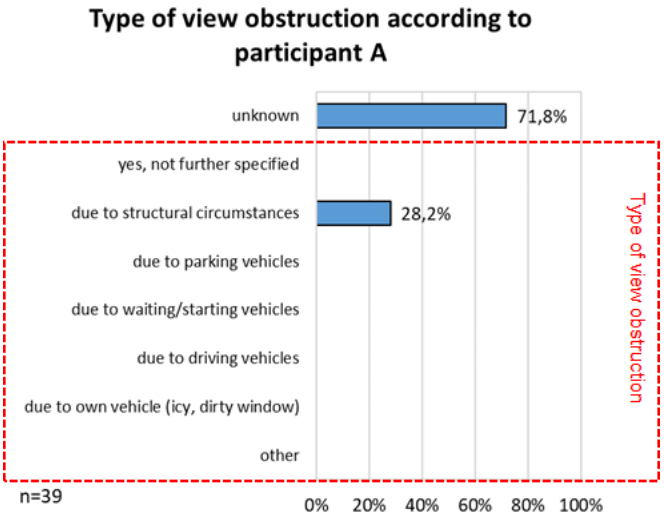


*Figure 44: Type of view obstruction (141)*

### 5.2.9 i) Used lane when encountering an accident

Figure 45 shows which lane the participants took when encountering an accident. The most common situation is driving at a two-lane road (55.8%).

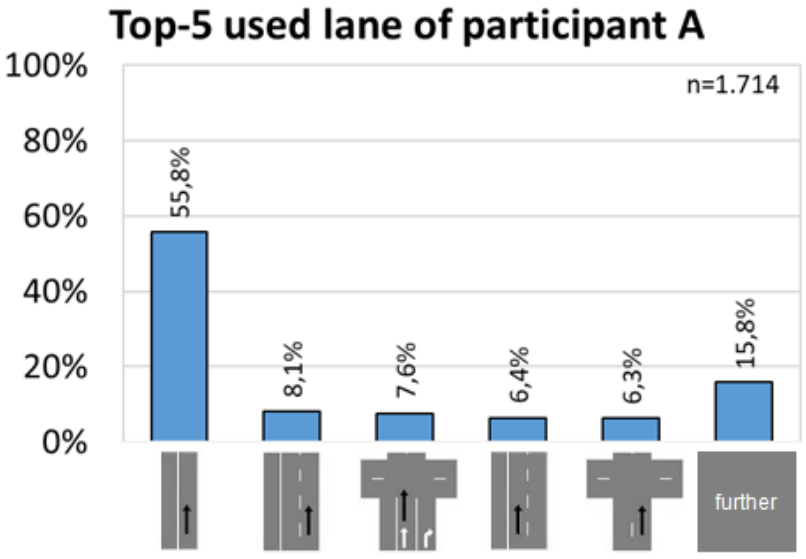


*Figure 45: Used lane at an accident (141)*

### 5.2.10 j) Road surface

Figure 46 shows which kind of road surface it was when encountering the accident. The majority of straight accident type 141 participants were driving at a conventional asphalt road.

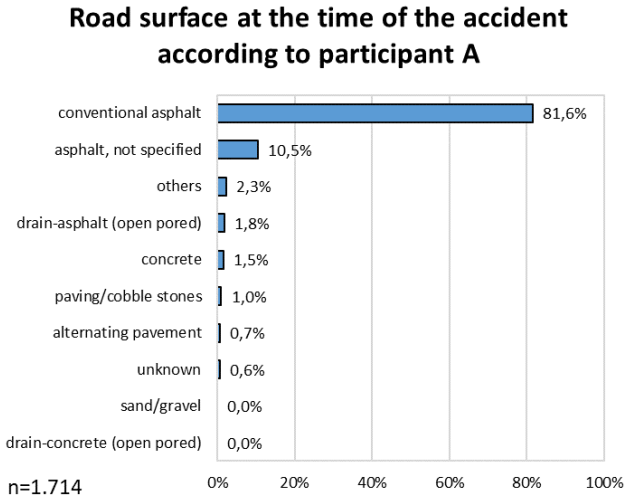


*Figure 46: Road surface (141)*

### 5.2.11 k) Precipitation at the time of the accident

Figure 47 shows precipitation at the time of the accident. In most cases there was no precipitation at all and in 19% of the cases it was raining.

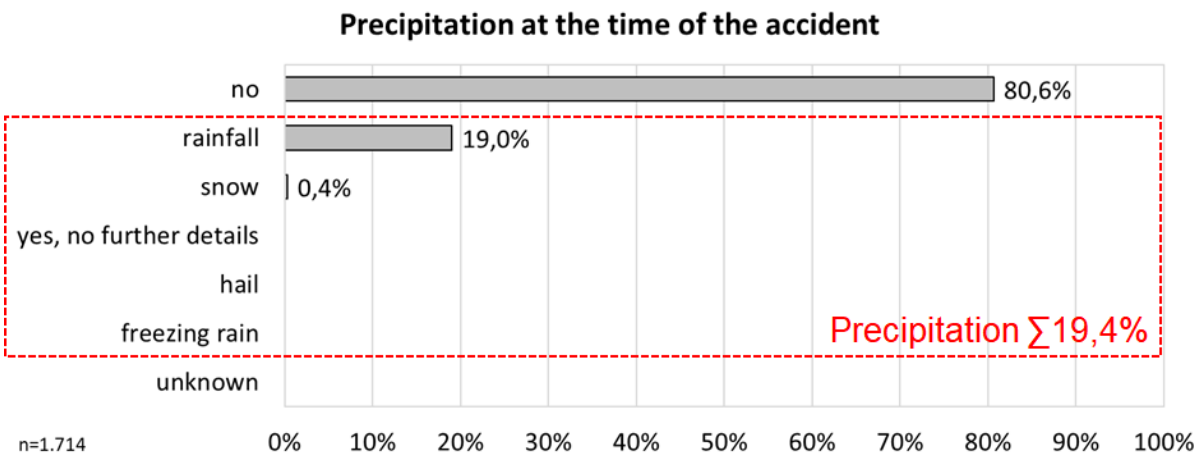


*Figure 47: Precipitation (141)*

### 5.2.12 l) Road condition

Figure 48 shows the road condition at the time of the accident. Most accidents happened on a dry road surface but in 32.6% of cases it was wet or damp.

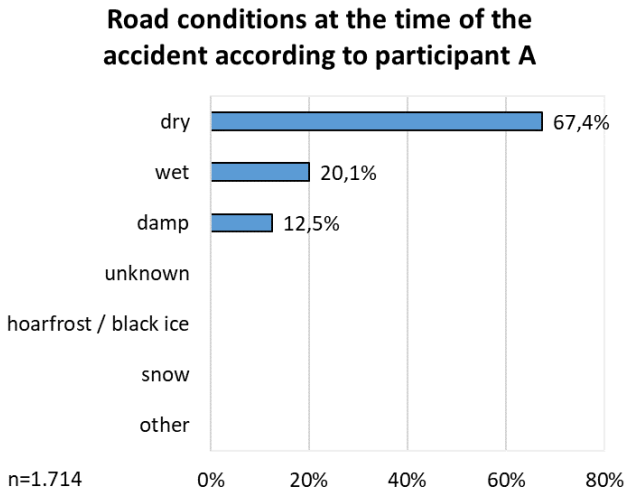


*Figure 48: Road condition (141)*

### 5.2.13 m) Interview result: visibility / audibility limitation

Figure 49 shows the interview results of the participants about visibility and audibility limitations. In 12% (=4.4/(4.4+32.2)x100) of the known cases, the participants reported that visibility or audibility was limited at the time of accident.

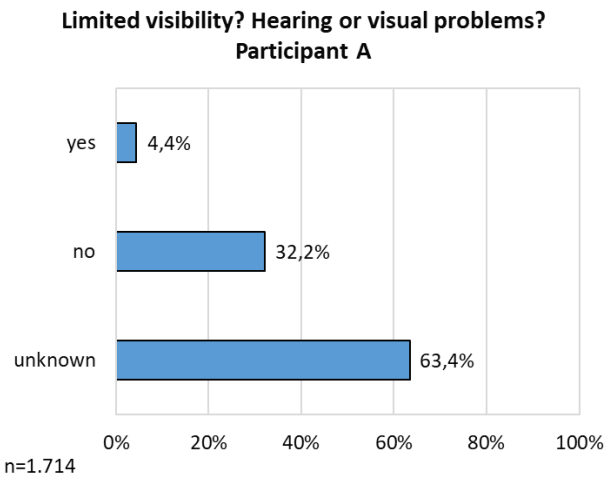


*Figure 49: Interview - visibility limitation (141)*

### 5.2.14 n) Interview result: overlooked / distracted, etc.

Figure 50 shows the participant interview results whether they overlooked important information or were distracted. The figure shows that in 15% (=5.0 /(5.0+28.3)x100) of the known cases the interviewed riders report overlooking or distraction.
Figure 51 shows further insight into those “yes” cases. Among them, 33.7% stated that they were influenced by conditions like being tired or not concentrated, or alcohol, drugs, or medication at the time of the accident and 19.8% stated they were overburdened by the situation.

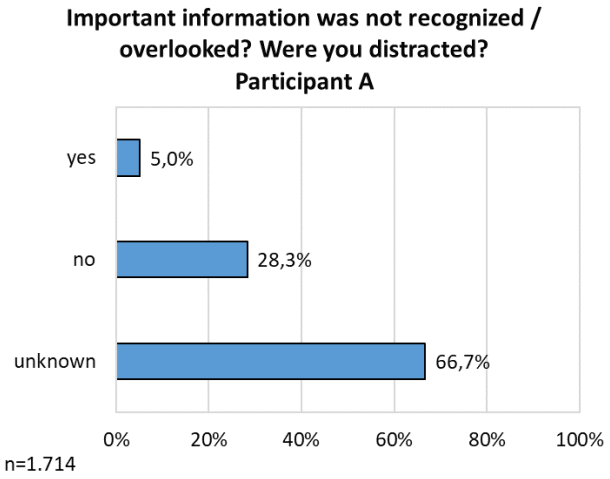


*Figure 50: Interview - overlooked / distracted (141)*

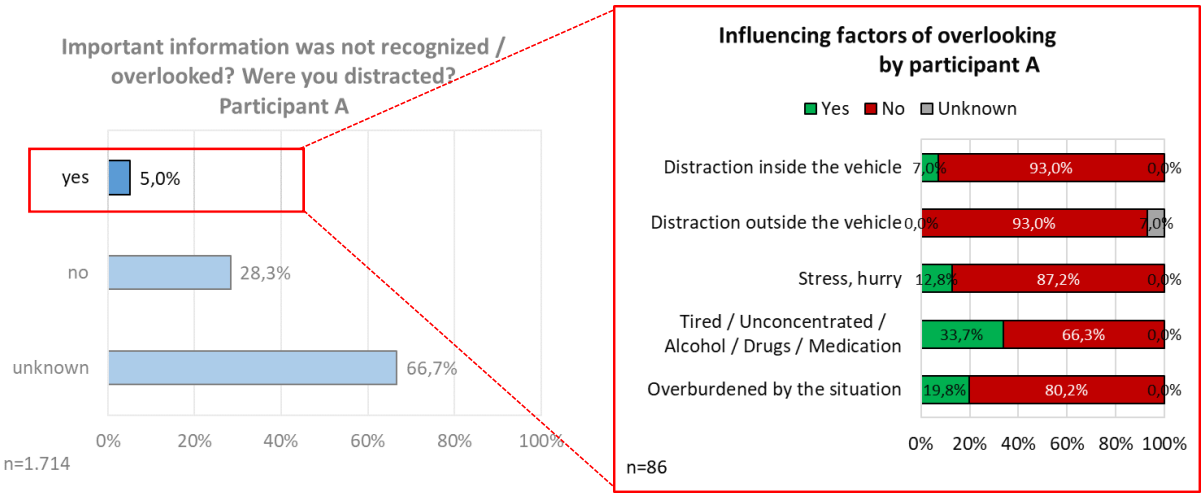


*Figure 51: Interview - Influencing factor for overlooking (141)*

### 5.2.15 o) Interview result: misjudgement

Figure 52 shows the participant interview results whether they misjudged the situation or not. In 48% (= 15.7/(15.7+17.3)x100) of the known cases, the participants report they have not misjudged the situation.

Figure 53 shows further insight into the “yes” cases. This chart shows that the most frequent reason was a misjudgment of the own vehicle speed / distance (81.4%).

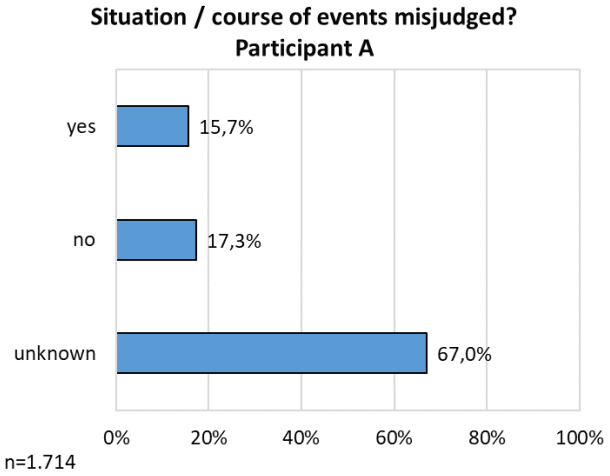


*Figure 52: Interview - Misjudgement (141)*

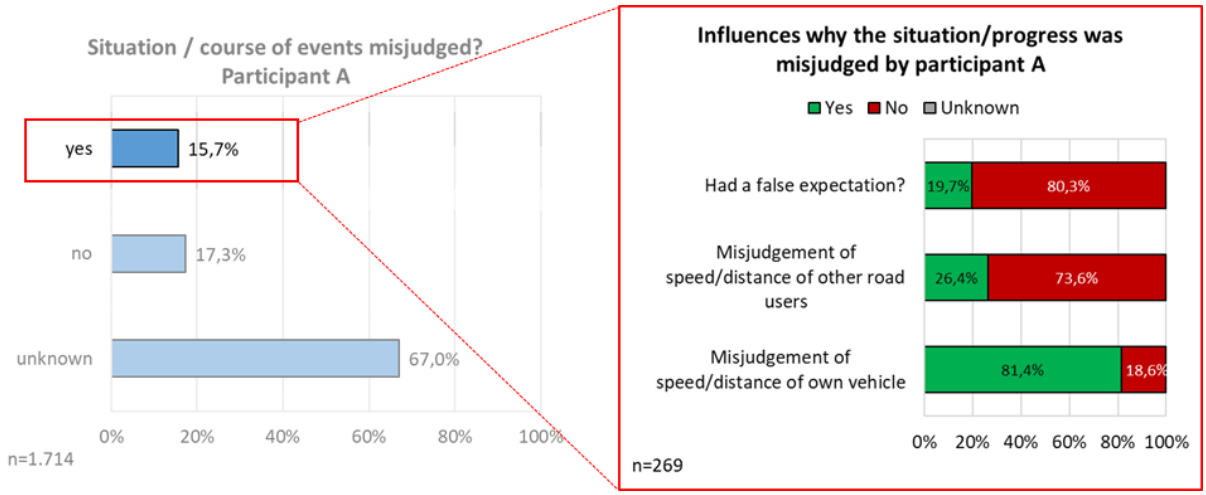


*Figure 53: Interview – Influences why misjudged (141)*

### 5.2.16 p) Interview result: accident-avoidance possibility by other action

Figure 54 shows the interview results of the participants whether the accident was possible to be avoided by some other reaction / action. In 26% (= 8.4/(8.4+23.9)x100) of the known cases the participants answered the accidents was avoidable by taking other actions and in 74% the participants answered not.

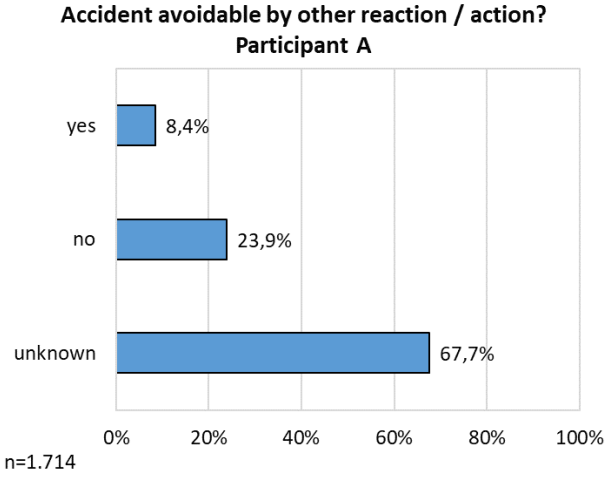


*Figure 54: Interview - Accident avoidance possibility (141)*

### 5.2.17 q) Interview result: mistakes in executing the avoidance action

Figure 55 shows the participant interview results about difficulties / mistakes in taking the planned action. In 27% (= 8.8/(8.8+23.6)x100) of the known cases there were difficulties or mistakes in executing the planned action, and in 73% cases not.

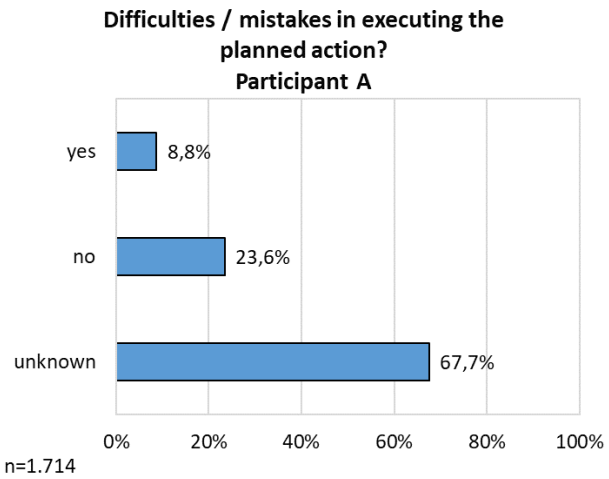


*Figure 55: Interview - Mistakes in avoidance action (141)*

### 5.2.18 r) Interview result: influence from vehicle technology

Figure 56 shows the participant interview results about any influence of the vehicle technology. This query is asking whether the participants had difficulty in operating a certain function provided by the vehicle or were distracted by any function on the vehicle. The figure shows that the majority of the participants were not influenced by the vehicle technology.

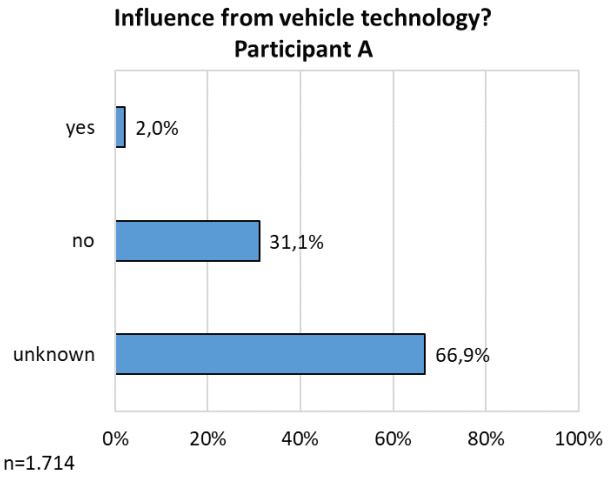


*Figure 56: Interview - Influence from vehicle technology (141)*

### 5.2.19 s) Interview result: influence from the condition of the road

Figure 57 shows the participant interview results about any influence from the condition of the road. The ratio of participants answering "no" are higher than those answering "yes", but in 29% (= 10.9/(10.9+26.8)x100) of the known cases, the participants report they were affected by conditions of the road such as run of road, recognizability, unexpected slippery road surface and so on.

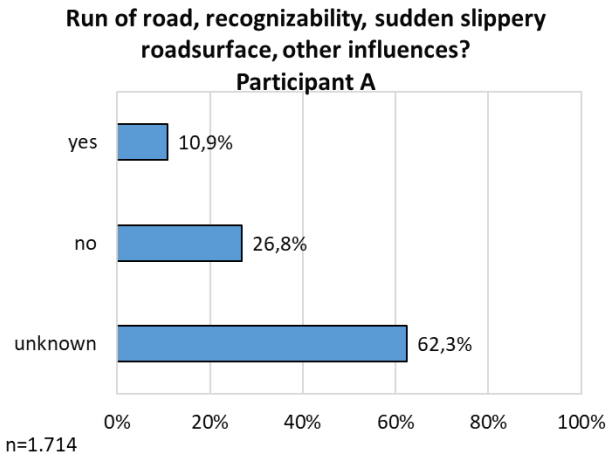


*Figure 57: Interview - Influence of road condition (141)*

## 6. Conclusion

CMC analysed Single Accidents type 101 for left curve, type 102 for right curve, and type 141 for straight, for the future improvement of motorcycle rider safety with technology.
A total of 19 potential influencing factors of Single Accidents a) to s) were reported.
From the analysis, an important outcome is that the two most frequent main causations for the accidents were the speed and other mistakes made by PTW riders. In the accident type 101 and 102, the share of PTW riders who exceeded the speed limit of the road is approximately 27% while the rate of “speed” in the accident causation is 75.8%. In the accident type 141, the share of PTW riders who exceeded the speed limit of the road is approximately 23% while the rate of “speed” in the accident causation is 41.7%. That means there is an important share of accidents where speed was considered a contributing factor despite the fact that the actual speed limit of the road was not exceeded. Looking at their interview results, in the accident type 101 and 102, 61% of the riders who answered clearly, made mistakes and 94.9% of them misjudged speed or distance of their own vehicle, and in the accident type 141, 48% of the riders who answered clearly, made mistakes and 81.4% of them misjudged the speed or distance of their own vehicle.
Weather condition was not identified as a major contributing factor for the accidents. Yet, accidents in the rain, on the damp or on wet roads were observed in a relatively high rate. In the accident type 141, it was raining in 19% and the road condition was damp or wet in around 33%.

## Abbreviations

| | |
|---|---|
| CMC | Connected Motorcycle Consortium |
| GIDAS | German In-Depth Accident Study |
| PTW | Powered Two-Wheeler |