Data for evidence: Overcoming the problem of insufficient accident information

The example of electric bicycle accidents

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Abstract

Reliable data is necessary to test the effectiveness of measures and hence enable evidence-based measures. Availability of such data is often a barrier in itself. The aim of this project was therefore to generate data based on evidence-based analysis that function as a basis for road safety measures and analyse them to find focal points. This was done using a mixed-method-approach analysing accidents with electric bicycles (pedelecs 25). This paper deals with the first objective, presenting new, pedelec-specific categories identified with qualitative analysis. It also gives a brief overview of the quantitative analysis of these new categories. 4,198 accident descriptions were read and analysed. Qualitative analysis made it possible to create thirteen new pedelec-specific categories (with additional sub-categories) that do not exist in the standardised accident statistics to this extend. Initial results of quantitative analysis show that the majority of conflicts occur because pedelecs are not seen by others.

Keywords

Accident analysis; pedelec; electric bicycle; accident cause categorization; qualitative analysis

Introduction

Cycling is one of the oldest forms of mobility and is currently experiencing a renaissance. It supports active mobility and can have a positive influence on public health, the environment, climate and the traffic situation. Pedelecs[1] (bicycles with an electric motor supporting the user up to a speed of 25 kmph) represent a new form of active mobility and are currently enjoying great popularity as they have the same benefits as conventional bicycles and, in addition, make cycling accessible to new user groups. With the growing number of pedelecs, however, the potential for conflict also increases. Unfortunately, the majority of accidents cannot yet be analysed accordingly, as pedelec-specific characteristics are missing from the accident data. This fact in itself has already been proven as a barrier. (Panwinkler and Holz-Rau 2021)

Most accident studies focusing on pedelecs are based on police data from standardised accident forms. However, these forms were initially designed for accidents with double-track motor vehicles, in particular passenger cars. Accidents with bicycles (especially pedelecs) are difficult to categorise within this system as important information is missing. For example, “falling down” is not an accident category

[1] In this article, the term "pedelec" is used for pedelec 25 (motor may provide support with a rated continuous power of 250 W maximum and up to 25 kmph). Pedelecs with higher assistance (speed pedelecs) and vehicles with direct drive (no assistance) are excluded.

as cars normally won't do so, but for pedelec accidents, this information is fundamental. (Panwinkler and Holz-Rau 2021)

This acts as a barrier as bicycle-specific categories of accidents cannot be analysed. However, accident statistics are the most important basis for evidence-based measures in road safety work.

We therefore understand the creation of meaningful accident statistics with individual variables as a measure of targeted road safety work. This in turn serves as a basis for further evidence-based road safety measures.

Data and Method

Data and Sampling

In order to obtain more detailed information about pedelec accidents the data of the official statistics and of the accident descriptions written by the police on site have been evaluated (merging the two data sets is not permissible for data protection reasons and also not possible because both data sets have been anonymised). These were provided by the German polices as a special data set. It included 6,253 accidents with pedelecs from 2016 and 2017, covering 68 % of all police recorded pedelec accidents in this period. Preliminary research showed that this data was distributed similarly to the total of all pedelec accidents across the core indicators and could therefore be considered representative. (Panwinkler and Holz-Rau 2021)

The first comprehensive evaluation of the data of the official accident statistics of accidents involving pedelecs and their differences to accidents involving conventional bicycles (Panwinkler and Holz-Rau 2019) showed in particular that the proportion of pedelec single accidents is significantly higher than that of conventional bicycles. In addition, single accidents of pedelecs were significantly more severe than single accidents of conventional bicycles. Since other, pedelec-specific categories were suspected for single accidents, single accidents of pedelecs were evaluated separately in another project and published as a separate paper (Panwinkler and Holz-Rau 2021). Therefore, the 4,196 accidents with two or more road users (involving at least one pedelec) were selected from the original data set to investigate whether there are pedelec-specific categories of accidents.

Method

The first objective of the project was to define new, pedelec-specific characteristics that describe the pedelec accident, based on the raw data and in particular the free text descriptions of the accidents. The second objective was to analyse these newly created categories and to show which categories are common in pedelec accidents and which are common in accident with serious injuries of pedelec users. This paper deals with the first objective and shows how new, pedelec-specific categories can be identified. It also gives a brief overview of the quantitative analysis of these new categories. A more detailed analysis of the frequencies and expected accident severities of these newly described accident categories will be published in a separate paper.

The following procedure was chosen to identify new, pedelec specific categories:

1. The new categories were defined on the basis of a comprehensive literature analysis and are thus intended to cover all pedelec-specific aspects of accidents.
2. First screening: The data were sorted according to different characteristics in order to get an overview of the contents. A part of the texts was read by several experts.
3. Drafting of the new features: Based on the first screening, previous findings and the findings from the literature as well as presumed focal points (especially on the basis of the official characteristic "accident type"), a first draft of the new characteristics was created in a brainstorming session.

4. Partitioning of the accident data: Subsequently, the entire data set was divided between two experts. For this purpose, all cases were sorted by accident type and federal state and then randomly assigned.
5. Quality assurance: For quality assurance, 5 % of the cases were drawn and assigned to both experts in order to subsequently be able to quantify differences in categorisation.
6. Categorisation: All cases were read and assigned to the respective new characteristics, whereby multiple entries were also possible. In the first days, there were daily discussion rounds to evaluate the characteristics. On the basis of these, the draft of the characteristics was revised several times and new expressions of individual characteristics or additional characteristics were inserted or deleted. At the end of the test phase, the systematology of the new categories was fixed. Cases that had already been read were added to the revised categorisation if necessary, and cases that had not yet been read were categorised.
7. Merging the data sets: Once all cases had been read and categorised accordingly, the two datasets were merged back into one dataset. Table 1 gives an overview of the data set including the categories. For better readability, the table has been grouped into blocks. The individual row blocks each provide information on a topic as well as on different subcategories of the topic. Row block 1 has a special position: the block does not contain any causes of accidents, but the traffic area on which the pedelec was located during the conflict. A distinction is made as to whether a pedestrian or bicycle traffic facility was present and whether this was separated from the carriageway (and several additional items of information). The resulting categories were again checked for plausibility and completeness. Subsequently, all accidents of the dataset were assigned to one or more categories.

In contrast to the official definition, the new definitions are interpreted more broadly. Although even in the official statistics, presumptions of the police officers would suffice as reasons for some variables (e.g. causes of the accident), in practice, mostly officially verifiable evidence is usually categorised here. In contrast, the classification in the new categories was rather based on the long-term expertise of the two researchers regarding relevant accident factors.

To illustrate this process and the need for new categories, the following two accident text descriptions have been translated. Both accidents describe conflicts of a pedelec with a motor vehicle in which a fall occurred without the pedelec touching the other road user. This category does not exist in the official statistics and was therefore newly created in our categorisation. We also created the two subcategories “Falling due to evasive manoeuvres” or “Falling due to problems with brakes or braking”. Each of the following two texts describes one of the two subcategories.

“The driver of the electric bicycle (road user 02) swerved to the right at a narrow spot to avoid a collision with the oncoming passenger car (road user 01). Road user 02 fell in this process. He sustained serious injuries to his left foot. There was no collision with the car. The driver of the car continued his journey although, according to the cyclist, he must have noticed the accident.” (Accident number 21837, own translation). Accident was categorised to our new category no. 10 “Falling without collision” and its sub-category “Falling due to evasive manoeuvres”.

“Road user 01 is cycling on the cycle path [...], he is considering overtaking a bicycle (road user 02) (with a child trailer) [...] in front of him. The cyclist in front of him looks over his shoulder because he wants to turn [...]. This irritated road user 01 (who had not yet started to overtake) and he braked hard. Road user 01 falls and is slightly injured.” (Accident number 21729, own translation). Accident was categorised to our new category no. 10 “Falling without collision” and its sub-category “Falling due to problems with brakes or braking”.

Of course, both accidents are also categorised according to the official system, which enables an analysis of the accidents. However, the examples show that the new categories enable a more in-depth, pedelec-specific analysis.

Results

In total, thirteen new, pedelec-specific accident categories have been defined. These are mostly subdivided into further sub-categories. In addition to the twelve new accident categories describing accident causes, an additional new category (with subcategories) has been defined, describing the area of the road used by pedelec during conflict. Table 1 shows these categories, as well as the number of assigned accidents and their severity (number of pedelec users fatally or seriously injured per 1,000 accidents involving a pedelec).

The analysis of this data set shows that the most frequent conflicts are those in which the pedelec is overlooked by a motor vehicle or bicycle (58.4% of all accidents in the data set) (the pedelec mostly approached from the right), in which the road users involved (mostly opponents) disregarded the right of way (31.3%) or in which the road users involved (more often the opponents) kept too small safety distance or misjudged the space required (24.5%).

In about three quarters (75.3%) of all accidents, the pedelec user is not mainly responsible. However, the severity of accidents with a pedelec as the main responsible road user is significantly higher.

The highest accident severity was seen in conflicts when the pedelec user violated red light, when pedelec users did not give a hand signal when changing direction or this was too short or not recognisable, when pedelecs users disregarded the right of way or when the pedelec got stuck on an obstacle or touched it.

For almost half (45.7%) of all accidents in the data set, it was noted that the pedelec was riding on a pedestrian and/or cycle facility during conflict, and the severity of accidents was significantly lower than for accidents on the carriageway.

Conclusion

Pedelecs are still a new vehicle type and a specific accident analysis is still pending, as the official accident statistics do not include pedelec-specific accident categories. To analyse this problem, a mixed-method approach was used. For this purpose, 4,196 accident descriptions were read and analysed. The qualitative analysis made it possible to create thirteen new pedelec-specific categories (with additional subcategories) that do not exist in the standardised accident statistics to this extend. Initial results of the quantitative analysis of accidents with two or more road users show that the majority of conflicts occur because pedelecs are not seen by other road users.

With the help of the new categories, it was possible to take a closer look at this problem. For example, pedelecs are often not seen because they have given no or only a poor hand signal when turning. In addition, pedelec accidents often happen because of right-of-way violations or too little distance, both also often caused by overlooking the pedelec. Better visibility of pedelecs therefore appears to be a priority. On the other hand, the highest accident severities were found to be related to pedelec user errors (red light violation, poor hand signal, disregarding the right of way or getting stuck on an obstacle). Raising awareness among pedelec users therefore seems to be a second priority. Finally, accidents on cycling facilities were significantly less severe, which highlights the expansion of safe cycling infrastructure as a third priority. The results provide pedelec-specific information This information can be used as a basis for analysing whether new requirements/measures for road safety work are needed because of the new type of vehicle (pedelec).

Tables

Table 1: New, pedelec specific categories

Sample dat set: accidents with personal injury involving two or more road users (including at least one pedelec) in the period 2016-2017

Block	categories / sub-categories	Number of accidents	number of pedelec users injured…				accident severity*
			total	fatally	seriously	slightly	
0	total	4,196	3,958	52	921	2,985	232
1	Traffic area used by pedelec before collision:						
1	Walking/cycling facility (GRVA)	1,919	1,803	14	371	1,418	201
1	GRVA structurally separated: footway	220	196	3	32	161	159
1	GRVA structurally separated: cycle path	1,042	990	7	202	781	201
1	GRVA struc. sep.: shared foot- & cycle path	439	409	1	96	312	221
1	GRVA on carriageway: cycle lane	218	208	3	41	164	202
1	Road lane (without cycling facility)	2,277	2,155	38	550	1,567	258
1	Addition: on cycle facility in wrong direction	282	260	1	38	221	138
1	Addition: GRVA (was free for both directions)	498	469	4	88	377	185
2	Distance too short**	1,028	932	7	257	668	257
2	Pedelec	470	399	1	123	275	264
2	Opponent	683	640	6	156	478	237
3	Pedelec driving error: stuck/touched…	306	265	2	73	190	245
3	Motor vehicle	82	78	1	19	58	244
3	Bicycle/Pedelec	166	145	0	42	103	253
3	Pedestrian	44	28	1	6	21	159
3	Obstacle/other	14	14	0	6	8	429
4	Conflict with parked motor vehicle**	260	253	0	44	209	169
4	Motor vehicle opening door ("dooring")	132	129	0	24	105	182
4	Motor vehicle manoeuvring in/out parking space	110	107	0	15	92	136
4	Motor vehicle on cycle lane	26	25	0	5	20	192
5	Violating red light**	78	74	1	29	44	385
5	Pedelec	50	46	0	23	23	460
5	Opponent	32	31	1	7	23	250
6	Disregarded right of way	1,313	1,259	18	301	940	243
6	Pedelec	286	274	16	108	150	434
6	Opponent	1,027	985	2	193	790	190
7	Conflict with animals	62	60	0	19	41	306
8	Motor vehicle/bicycle overlooks pedelec	2,451	2,376	17	430	1,929	182
8	Pedelec from left	518	504	4	105	395	210
8	Pedelec from right	741	715	5	119	591	167
8	Pedelec from rear right (blind spot)	293	288	3	58	227	208
8	Pedelec from rear left (blind spot)	178	172	0	29	143	163
8	Pedelec from opposite direction	464	448	3	85	360	190
8	Pedelec from unclear direction	257	249	2	34	213	140
9	Carelessness of pedelec user**	377	359	7	130	222	363
9	Overlooked	198	184	4	73	107	389
9	Mobile phone	3	2	0	0	2	.
9	Others	235	233	6	75	152	345
10	Falling without collision**	354	338	2	45	291	133
10	Falling due to evasive manoeuvres	152	141	1	21	119	145
10	Falling due to problems with brakes or braking	213	208	1	24	183	117
11	Poor hand signal	81	73	3	35	35	469
12	Cut curve**	132	123	1	30	92	235
12	Pedelec	45	41	0	14	27	311
12	Opponent	89	82	1	16	65	191
12	Cut after overtaking	124	119	3	30	86	266
12	Pedelec	18	13	0	4	9	222
12	Opponent	106	106	3	26	77	274
12	Pedelec lane change	76	72	2	20	50	289
12	Pedelec lane crossing	76	73	5	25	43	395
12	Motor vehicle crossing cycle lane	5	5	0	2	3	.
13	Roundabout	130	125	1	30	94	238
13	Property entrance (garage driveway, etc.)	596	577	4	83	490	146

*Accident severity: fatally and seriously injured pedelec users per 1,000 accidents involving a pedelec. No calculation of accident severity if less than: 10

** Multiple answers possible

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