Safety of speed-pedelecs on car lanes and bicycle paths

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Summary

The speed-pedelec is an electric powered bike with peddle assistance up to 45 km/h. In 2013 there were only 171 (RAI/BOVAG, 2016), nowadays there are already 13.000 on the road. People use them as an alternative for the car to go to their work which reduces congestion and is better for the environment
Since July 2017, the speed-pedelec falls under the category mopeds ands is no longer allowed on bicycle paths and must drive on car lanes. In the last two months, this resulted in a drop of 14% in the number of speed-pedelecs sold.

This report gives more insight in driving experiences with the speed-pedelec on bicycle paths and car lanes with the new regulations. The focus of the research is on the difference between unsafety on cycling paths and car roads, and the difference between unsafety within built-up areas and outside built-up areas.

A survey has been spread to gather experiences with the speed-pedelec from speed-pedelec cyclists and other road users. 105 people participated the survey. 75 of them were using a speed-pedelec and 30 did not. The survey was spread via fora on the internet. The participants answered questions about unsafe situations on bicycle paths and car lanes within and outside built-up areas.

The research showed that within built-up areas a lot of problems occur with the speed-pedelec. On car lanes 93% of the participants with a speed-pedelec experienced unsafe situations, 60% did often, while they only drive there sometimes. Cars are driving much faster, overtake them very close next to them, cut them off while overtaking and react negatively. Car drivers don't experience a lot of trouble with speed-pedelecs on the car lane. The mentioned they don't expect the cyclist to go so fast and the cyclists are poorly visible.
On bicycle paths, were the participants use their speed-pedelec most of the time, 65.6% of the speed-pedelec cyclists experienced unsafe situations within built-up areas, 60.7% only sometimes. 60% of the unsafe situations they experienced occurred due to other cyclist not paying attention or cycling with many next to each other. Other road users experienced it at very unpleasant and unsafe when speed-pedelecs overtook them with high speed on small cycling paths. They didn't expect them to go so fast because they didn't recognize them and they didn't hear them approaching. 21% of the unsafe situations speed-pedelec cyclists experienced on cycling paths were with cars on intersections, crossings and side streets. Cars underestimated their speed or noticed them too late.
Before 1995, 70% of the accidents with mopeds happened on intersections. In 1995 the Ministry of Infrastructure decided to move mopeds from the bicycle path to the car lane just like the speed-pedelec nowadays. This resulted in a decrease of accidents with mopeds of 70%. This was mainly a decrease of accidents on intersections. (Hagenzieker, 1995) While the mopeds were driving on the car lane, cars noticed them earlier. Because the speed of mopeds was almost as high as the speed of cars, moving the moped to car lane did not result in an increase of accidents on road sections. However, because the average speed of speed-pedelecs (32km/h) (Stelling-Konczak et al, 2017) is lower than the average speed of mopeds (44km/h) (Hagenzieker, 1994), it can't be concluded that moving the speed-pedelec to the car lane would results in the same decrease in accidents as with mopeds.

Outside built-up areas, there are no remarkable differences between the unsafe situations speed-pedelecs and other road users experienced within built-up areas. However, the participants indicated that they experienced these unsafe situations outside built-up areas on a much lower frequency.

Concluding, experiences from speed-pedelec users show that driving on the car lane is not safer than driving on the bicycle path. However, cycling with very high speeds on the bicycle paths is unsafe either. When speed-pedelecs overtake other cyclists with high speeds this can lead to unsafe situations. High speeds on bicycle paths can lead to unsafe situations on intersections with cars as well. An accident study on speed-pedelecs should show if moving the speed-pedelec to the car lane or reducing the speed of speed-pedelecs on bicycle paths would lead to a reduce in accidents.
When the speed-pedelec moved to the car lane this was based on the power it can produce. However, not all people who own a speed-pedelec can drive so fast. People who drive with 25 to 30 km/h can't be obliged to drive on car lanes where the maximum speed is 50km/h.
People with a speed-pedelec who want to drive very fast should only do this on car lanes. Increasing recognizability and campaign of Rijkswaterstaat to make car drives more aware of the fact that speed-pedelecs are allowed on the car lane should make this possible. Increasing recognizability of the speed-pedelec is also important on bicycle paths, normal cyclists should expect speeds of 30 km/h.

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1. Introduction

The invention of the E-bike, an electric powered bike made cycling a lot easier, not only for elderly people, also for people who use the bike as a way of transport to their work. No more sweating and struggling against de counterwind, just easy peddling with 25km/h. Nowadays, there is a new product on the market; the speed-pedelec. An electric bike with pedal assistance up to 45 km/h (SWOV, 2017). This super bike makes it possible for people to cover a longer distance to go to their work, distances of 20 to 30 km are not a problem. In a research from Grontmij, 115 speed-pedelec cyclists were questioned in a survey. 66% percent of them used their speed-pedelec as an alternative for the car (De Bruijne, 2016). Nowadays, there are about 13.000 speed-pedelecs registered at Rijkswaterstaat while in 2013 there were only 171 (RAI/BOVAG, 2016). This increase in the number of speed-pedelecs and the number of speed-pedelec users that use their bike as an alternative for the car, shows that the speed-pedelec has a high potential in reducing car traffic and congestion. This is better for the environment and more movement is better for people's health.

However, new regulations might lower this potential. Till January 2017 the speed-pedelec was a moped with a blue licence plate and had a maximum speed of 25 km/h. In January 2017, due to a change in European law, the speed-pedelecs were considered as mopeds with a yellow licence plate. (Raivereniging, 2017) This meant that the maximum speed and place on the road changed for the speed-pedelec. The speed-pedelec is no longer allowed on the bicycle path and must drive on the car road if there is no presence of a cycling path for cyclists and mopeds. Also, this means that the speed-pedelec is no longer allowed on cycling highways, called F-roads. Speed-pedelec users are obliged to wear a helmet and their maximum speed is 30 km/h on bicycle/moped paths within built-up areas, 40 km/h on bicycle/moped paths outside built-up areas and 45 km/h on car roads.

Since the speed-pedelecs have pedal assistance up to 45 km/h they were driving a lot faster than normal cyclists. Research showed that the average speed of speed-pedelecs on bicycle paths was 28,5 km/h (Stelling- Konczak et al., 2017). Compared to other bicycles, the average speed of normal electric bikes is 17 km/h and the average speed of conventional bicycles is 15 km/h. (Vlakveld, 2016). The differences in speed between speed-pedelecs and e-bikes and normal bikes are relatively high. However, if the new legislation is the best solution for the speed differences on the bicycle path can be doubted. When speed-pedelecs drive on car roads where the maximum speed is 50 km/h, the speed difference between them and the cars are relatively big as well. Cars overtake them with 60 km/h and the cyclist must drive between heavy vehicles. This can lead to a lot of unsafe situations for both the cyclists and car drivers. Car drivers react surprised when they see cyclists on the road and don't recognize them as car lane users. They can react negatively and speed-pedelec users experience this as very unpleasant and unsafe.

Organizations like the Dutch Fietsersbond are committed to create a safe environment for cyclists in the entire Netherlands. Therefore, they are looking for a solution to make it safer for speed-pedelecs in traffic. The Ministry of Infrastructure and the Environment requested SWOV to do a research on safety of speed-pedelecs on car roads. However, still little is known about what causes unsafe situations with speed-pedelecs and where they mainly occur. How unsafe is it to drive on bicycle paths for example?
This leads to the following main research question of this report: Is it safer to let the speed-pedelec drive on car lanes instead of bicycle paths?

The goal of this thesis is to get more insight in driving experiences with the speed-pedelec on bicycle paths and car lanes with the new regulations. The focus of the research is on the difference between unsafety on cycling paths and car roads, and the difference between unsafety within built-up areas and outside built-up areas.
To answer the research question and to achieve the goal of this report, the following sub-questions have been formulated and will be answered throughout the report.

- What are the unsafe situations that speed-pedelec users experience in traffic?
- What are the unsafe situations that other road users experience with the speed-pedelec?
- Where do most of the unsafe situations occur; bicycle path or car lane? Within or outside built-up areas?
- should the new legislation be reversed?
- What is the vision of stakeholders on speed-pedelecs?

A survey will be used to gather experiences from speed-pedelec users in traffic. To get an objective view, other road users will be questioned as well. The focus of the survey will be on the difference between unsafety on cycling paths and car roads, and on the difference between unsafety within built-up areas and outside built-up areas. Together with a literature study on speed-pedelecs, mopeds and light mopeds, the research question will be answered and some recommendations will be made.

In chapter 2 the Methodology of this report is discussed. Chapter 3, 4 and 5 show the results from the literature study and survey. In chapter 6 the results are discussed and conclusions are made.

2. Methodology: Literature and a Survey

2.1 Approach

To answer the research question, a survey has been spread and a literature research has been done. The speed-pedelec is still a very new concept. SWOV was the first and only institute in the Netherlands that did a research on speed-pedelecs on car lanes. Therefore, little literature is available about speed-pedelecs. The survey in this research provided more information about safety of speed-pedelecs in traffic. Furthermore, literature about mopeds, lights mopeds and e-bikes has been used to compare the speed-pedelec with other modes of transportation.

The goal of this survey was to get an objective view of speed-pedelecs in traffic. The survey should provide information to answer the following questions:
- what kind of unsafe situations occur with the speed-pedelec in traffic?
- where do these unsafe situations occur in traffic?

To get an objective view on the problems with speed-pedelecs in traffic, both speed-pedelec users and other road users have been questioned in the survey. Therefore, the structure of the survey will be as followed:

Introduction on the subject
1st question:
Do you use a speed-pedelec (yes/no)

Next, the rest of the questions depend on the answer given in the 1st question.
People who answered the first question with yes will get different questions than people who answered the question with no.
The focus of the survey is on the difference between unsafety with speed-pedelecs on bicycle paths and car lanes and on the difference between unsafety within and outside built-up areas.
In appendix A is the complete survey.

2.2 Instruments and Sources of Information

The sources used to perform the literature study are:
- Search engines on internet: e.g. google scolar, scopus
- SWOV - national scientific institute for road safety research in the Netherlands.
- External expert – Dr.ir. H. Farah

The survey has been made on the website: https://www.enquetesmaken.com
As a student, most of the features that this site offers are available. The survey can have an unlimited amount of questions, answers and participants. The survey can be opened by a link that can be spread anywhere.

2.3 Survey audience

The survey won't focus on people living in a specific area. As many people will be approached as possible. To reach this public, the following websites/companies/shops have been approached to spread the survey:

1) Fietsersbond.nl
The Fietsersbond is an organisation that stands up for the interest of cyclist in the entire Netherlands. They are committed to create more and better cycling paths for cyclist and have over 35.000 members.

2) Stromerforum.nl
This as a forum for people who are using a Stromer speed-pedelec. Stromer is one of the biggest brands in speed-pedelecs.
3) Juizz.nl
Juizz is a shop in Rotterdam, The Hague and Amsterdam that sells speed-pedelecs.
4) Elektrischefietsen.com
This website is one of the biggest forum for electric bikes in the Netherlands
5) Wereldfietser.nl
Wereldfietser is an association for and made by cyclists exchanging information about traveling by bicycle, the website has a forum as well.
6) Ouders.nl
This website has a forum with all kind of questions parents are interested in, safety on bicycles paths for their children could interest them.
7) Wegenforum.nl
This website is a forum with topics and questions about all kind of roads for cars. Speed-pedelecs on car lanes is a topic that could interest them.

Not all websites reacted or gave permission to spread the survey. The websites where the survey was spread successfully are:
- Fietersbond.nl
- Ouders.nl
- Elektrischefietsen.com
- Wegenforum.nl

3. Literature Speed-pedelec

3.1 Speed-pedelec on car lane

The speed-pedelec is still a relative new transportation mode and the number of speed-pedelecs is growing fast. When the speed-pedelec was moved to the car lane this was only based on European legislation. The speed-pedelec has an electromotor with a power of more than 0,25KW and has a maximum speed higher than 25 km/h. Therefore, the speed-pedelec falls under the category mopeds. Due to negative reactions of speed-pedelecs driving on the car lane, Provinces decided to turn the rules back. Province Gelderland decided to move the speed-pedelec from several provincial roads and allowed them to drive on nearby bicycle paths if they kept a maximum speed of 30 km/h. Rotterdam made the same decision and Utrecht and Almere are planning to do this as well.

3.2 SWOV: naturalistic-driving research

In September 2017, SWOV was the first institute who published an article with a research about speed-pedelecs driving on the car lane. (Stelling-Konczak et al., 2017) They performed a naturalistic-driving research with 29 participants for two to three weeks. The participants used a speed-pedelec to go to their work and home and had to follow the new rules. However, 23% of the driven distance during the research was on bicycle paths when they should have been driving on the car lane.
After the test period the participants received an extensive survey with questions about how they experienced driving with the speed-pedelec. The most interesting driving experiences are in figure 1 and figure 2 in chapter 3.3.

3.3 Driving experiences speed-pedelec

What is remarkable is that in every aspect driving on the bicycle/moped path is experienced more positively than driving on the car lane. Driving on the car lane is experienced as unsafe, stressful and not enjoyable. The difference between the car lane within and outside built-up areas is that driving on the car lane outside built-up areas is experienced as more efficient in terms of speed and traffic flow. Most remarkable is the difference in how safe the participants experienced driving on the different type of roads. The cycling/moped path scores very good on this question while the car lane scores very bad.

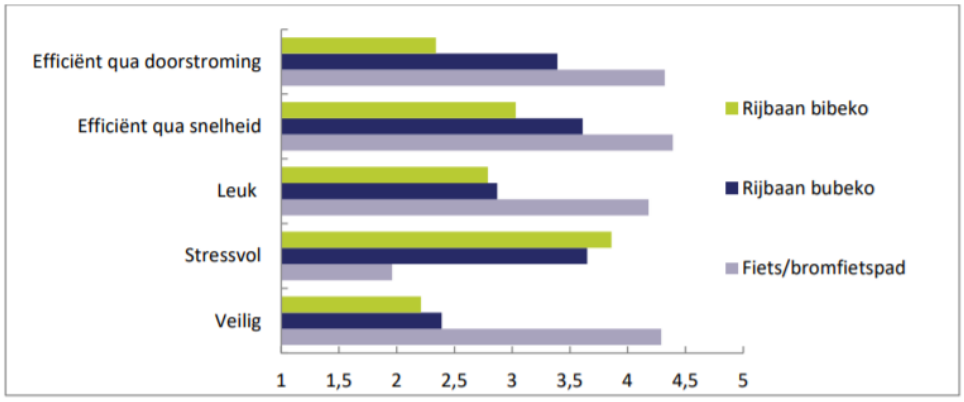

Figure 1 - Average score on five aspects (1 = absolutly not, 5 = absolutly yes) (Stelling-Konczak et al., 2017)

Figure 2 shows the results from questions about specific type of situations. Speed-pedelec users experienced the car lane as unsafe and had the feeling that other road users were suffering from their presence on the road which resulted in negative reactions. On bicycle paths the only problems that

occurred were people who noticed them lately or got scared.

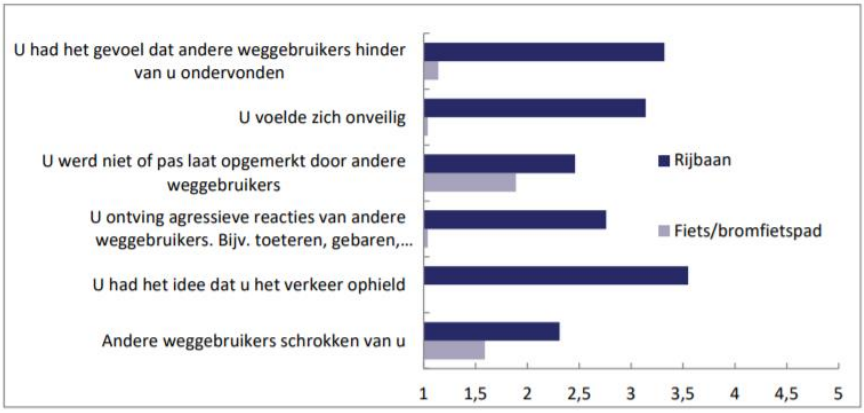

Figure 2 - Average answers on the question: how often did the following situations occur? (1 = never, 5 = (almost) never) (Stelling-Konczak et al., 2017)

3.4 Speed of speed-pedelec

During The naturalistic driving research of SWOV, the average speed of the speed-pedelec was measured on bicycle paths and car lanes. The participants of the research used two types of speed-pedelecs, one with a power of 350 W and one with a power of 500 W. The average speed of two bikes is shown in figure 3. On bicycle paths the average speed was 28.5 km/h and on car lanes the average speed was 32 km/h.

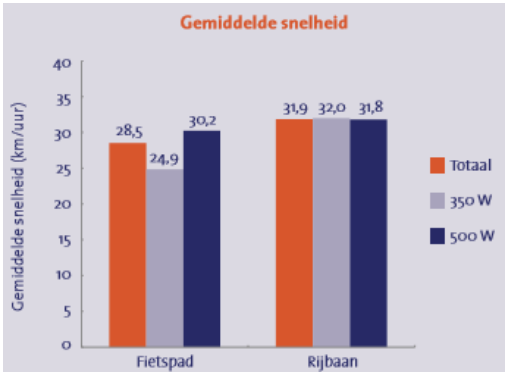

Figure 3 - Average speed on car lanes and bicycle paths (Stelling-Konczak et al., 2017)

Because of the power of the speed-pedelecs, they can drive up to 50 km/h. Figure 4 shows the average distance the participants covered for 5 different speed classes. The figure shows that on bicycle paths as well as on car lanes most of the covered distances were driven with an average speed between 30 and 40 km/h.

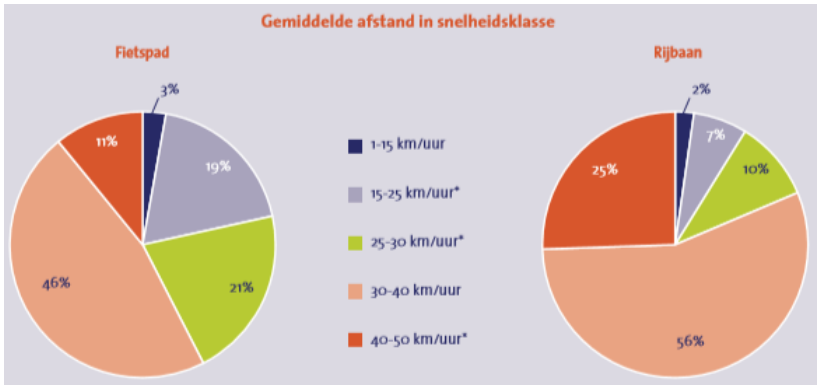

Figure 4 - Average distance covered in 5 different speed classes (Stelling-Konczak et al., 2017)

4. Survey

Research from SWOV showed that speed-pedelec users experience driving on the car lane as unsafe. The survey helped to get more insight in what kind of unsafe situations occur and how speed-pedelec users experienced driving on bicycle paths. The experience from other road users is considered as well.
The survey changed over time two times with small adjustments, these adjustments did not show a change in answers of the participants and therefore all the answers are analysed together.

The survey was online from the 23th of September till the 17th of October. There were 105 participants, 71.4% of them used a speed-pedelec.

4.1 Experiences speed-pedelec users

In chapter 4.1 and 4.2, only the experiences from speed-pedelec users are discussed.
Table 1 and figure 5 show that speed-pedelec users use their speed-pedelec most of the time on bicycle paths and only sometimes or never on car lanes. In this research no difference was made between cycling and cycling/moped paths. The difference between these two types of roads is too small to make a distinction between them in the questions in the survey.

Type of road	1 (never)		2 (sometimes)		3 (often)		4 (almost always)		Average
Cycling/moped path within built-up area	4x	5.9%	8x	11.8%	18x	26.5%	38x	55.9%	3,33
Cycling/moped path outside built-up area	-	-	3x	4.4%	20x	29.4%	45x	66.2%	3,63
Car lane within built-up area	19x	27.9%	31x	13.2%	9x	13.2%	9x	13.2%	2,10
Car lane outside built-up area	34x	50.0%	18x	25.0%	12x	17.7%	5x	7.4%	1,82

Table 1 - Answers on question: How often did you use your speed-pedelec on the following roads?

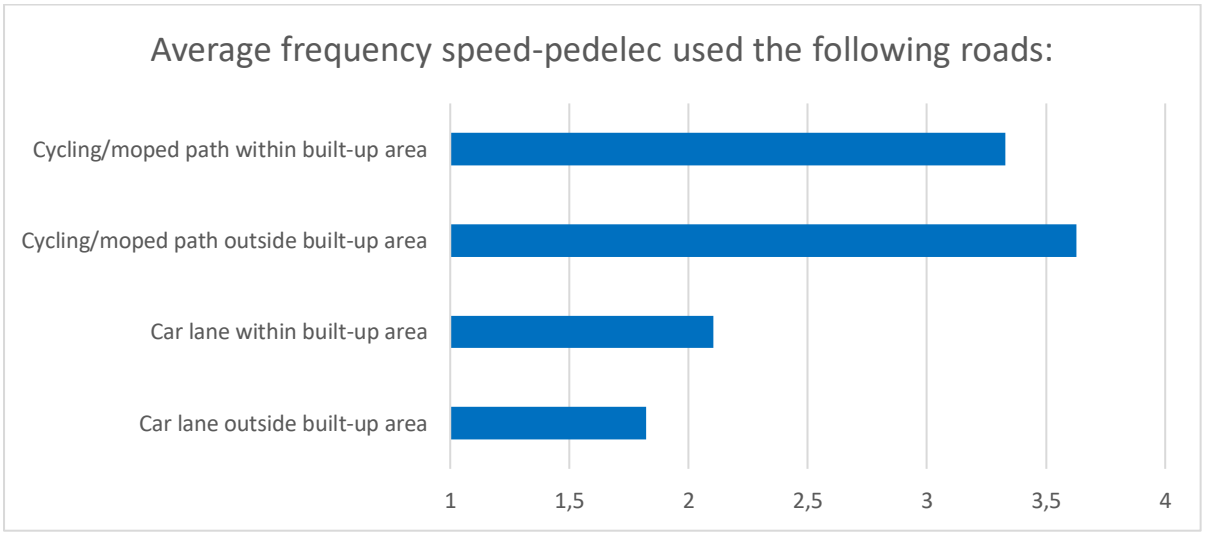

Figure 5 - Average answer on question: How often did you use your speed-pedelec on the following roads? (1 = never, 2 = sometimes, 3 = often, 4 = (almost) always)

Figure 6, 7, 8 and 9 show how many times the speed-pedelec cyclists experienced unsafe situations on bicycle/moped paths and car lanes when they were driving there. The participants could choose between never, sometimes, often and almost always.

Frequency speed-pedelec users experienced unsafe situations with other road users on bicycle/moped paths:

Within built-up areas

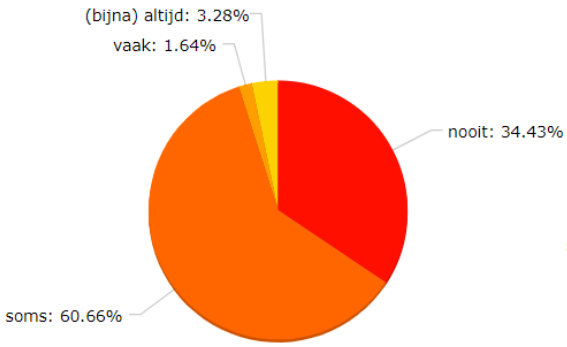

Figure 6 - answer on question: how often did you experience unsafe situations on moped/bicycle paths within built-up areas when driving there?

Outside built-up areas

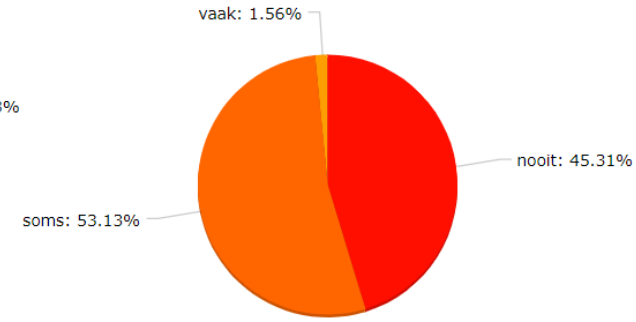

Figure 7 - answer on question: how often did you experience unsafe situations on moped/bicycle paths outside built-up areas when driving there?

Frequency speed-pedelec users experienced unsafe situations with other road users on car lanes:

Within built-up areas

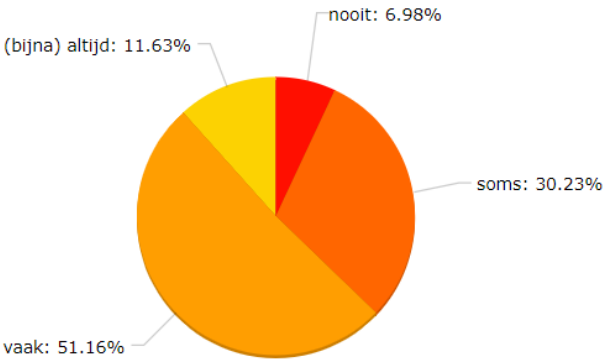

Figure 6 - answer on question: how often did you experience unsafe situations on car lanes within built-up areas when driving there?

Outside built-up areas

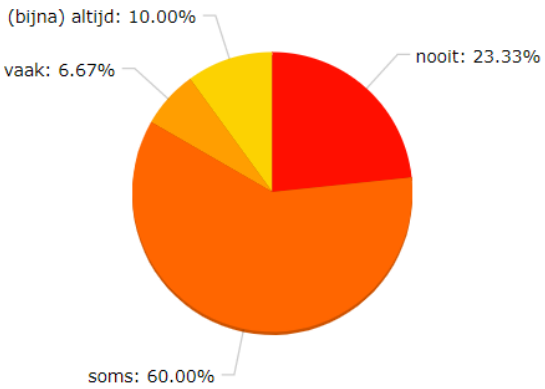

Figure 9 - answer on question: how often did you experience unsafe situations on car lanes outside built-up areas when driving there?

On car lanes within built-up areas most speed-pedelec users experienced unsafe situations with other road users, 93% did. Least people experienced unsafe situations on bicycle/moped paths outside built-up areas, 45,3% never experienced unsafe situations.

Figure 10 shows the average frequency speed-pedelec users experienced unsafe situations with other road users of the four different roads. Speed-pedelec users experience unsafe situations most frequent on car lanes, especially on car lanes within built-up areas.

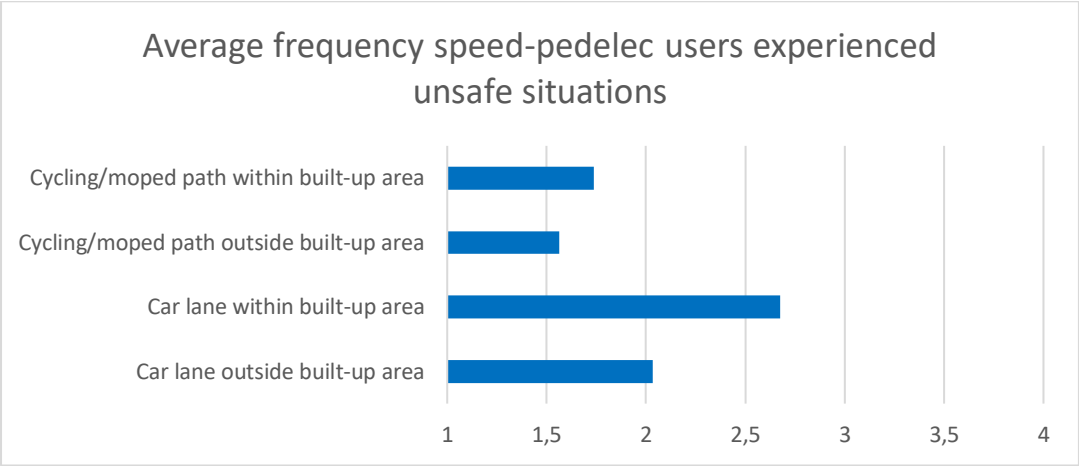

Figure 10 - Average answer on question: How often did you experience unsafe situations on the following roads when driving there? (1 = never, 2 = sometimes, 3 = often, 4 = (almost) always)

4.2 Unsafe situations speed-pedelec users

In the text below is described what kind of unsafe situations speed-pedelec users experienced.
In appendix B is a table with unsafe situations the participants mentioned.

Bicycle/moped path within built-up area.

The biggest cause for unsafe situations on bicycle paths within built-up areas were other cyclists using their phone or listening to music and not paying attention, 40 % of the participants mentioned this. Another 20% of the participants mentioned that people cycling with many next to each other on small cycling paths could lead to unsafe situations with oncoming cyclists or cyclist they were overtaking. Another significant cause for unsafety, 20.9% of the participants mentioned it, were cars who didn't expect the speed-pedelec to go so fast, they underestimated their speed and noticed them too late on intersections, crossings, side streets and round abounds.
Other unsafe situations occurred due to swerving cyclists and pedestrians with dogs on cycling paths.

Bicycle/moped path outside built-up area.

Outside built-up areas cars were responsible for most of the unsafe situations. 25% of the participants mentioned that unsafe situations occurred due to cars who noticed them too late at intersections, side streets and crossings. What speed-pedelec cyclists didn't mention on bicycle paths within built-up areas were mopeds. Outside built-up areas, 21.9% of the participants mentioned they experienced unsafe situations with mopeds. Cycling paths were narrow and this lead to dangerous situations while mopeds were overtaking them, the mirrors of mopeds and speed-pedelecs next to each other leave little room for errors. Another 18.8% of the participants mentioned to experience unsafe situations with other cyclists who were using their phone and another 12.5% mentioned unsafe situations with people cycling with many next to each other.

Car lane within built-up area.

On car lanes within built-up areas there were two main causes for unsafe situations. 63.9% of the speed-pedelec cyclists experienced unsafe situations with cars who overtook them with high speed very close next to them or cut them off while overtaking. Cars drove very close behind the cyclists and wanted to overtake when this was nearly not possible. On roads where the maximum speed was 30 km/h and speed-pedelecs were driving this speed, cars still wanted to overtake them.
50% of the participants experienced unsafe situations due to aggressive behaviour from car drivers. Car drivers didn't accept the speed-pedelecs on the car lane and honked and shouted towards the cyclists.
Other unsafe situations speed-pedelec users experienced arose when they didn't get priority at round abounds or when their speed reduced to much when climbing a hill or driving with counterwind.

Car lane outside built-up area.

Outside built-up areas speed-pedelec cyclists experienced the same unsafe situations as in built-up areas. However, only 9.1% received aggressive reactions from car drivers. The main cause for unsafety was cars who overtook them with very high speeds or cars who cut them off, 50% experienced this.

4.3 Experiences other road users

Chapter 4.3 and 4.4, only the experiences of other road users with speed-pedelecs are discussed. The structure of this chapter is the same as chapter 4.1 and 4.2.

There are only 13.000 speed-pedelecs in the Netherlands. Therefore, people don't come across one very often. Especially on car lanes, only few participants saw one. Table 2 and figure 11 show how many times people came across a speed-pedelec on the different roads. On bicycle/moped paths the participants came across a speed-pedelec most often.

Type of road	1 (never)		2 (sometimes)		3 (often)		4 (almost always)		Average
Cycling/moped path within built-up area	4x	17.4%	14x	60.9%	3x	13.0%	2x	8.7%	2,13
Cycling/moped path outside built-up area	4x	17.4%	13x	56.5%	6x	26.1%	-	-	2,09
Car lane within built-up area	11x	47.8%	9x	39.1%	3x	13.0%	-	-	1,65
Car lane outside built-up area	13x	56.5%	8x	34.8%	1x	4.4%	1x	4.4%	1,57

Table 2 - Answers on question: How often did you encounter a speed-pedelec on the following roads?

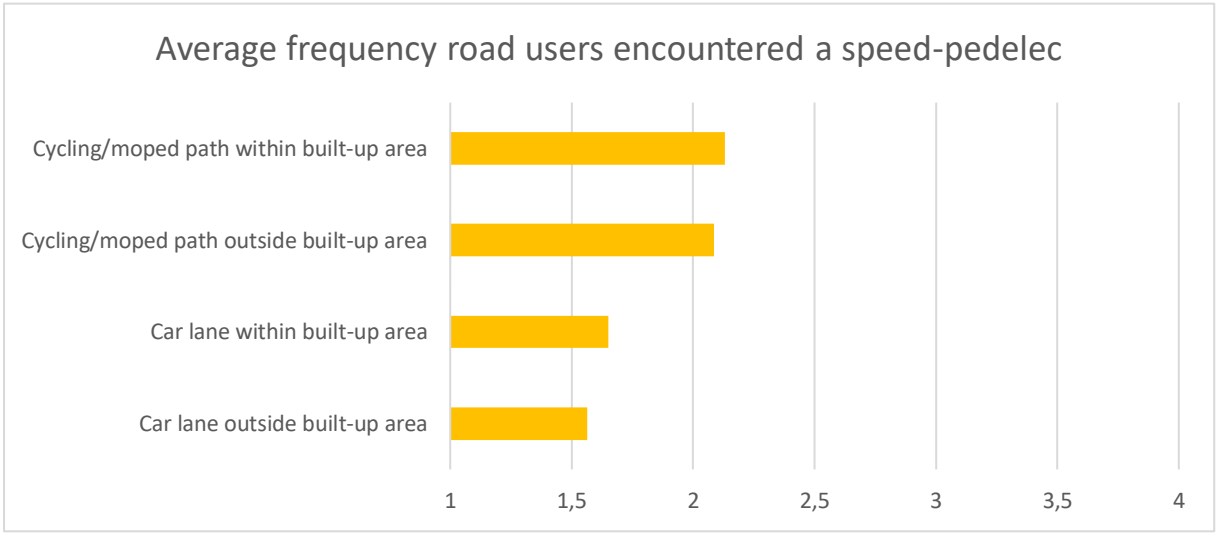

Figure 11 - Average answer on question: How often did you encounter a speed-pedelec on the following roads? (1 = never, 2 = sometimes, 3 = often, 4 = (almost) always)

Figure 12, 13, 14 and 15 show how many times road users experienced unsafe situations with speed-pedelecs on bicycle paths and car lanes. The participants could choose between never, sometimes, often and almost always.

Frequency other road users experienced unsafe situations with speed-pedelec cyclists on cycling/moped paths:

Within built-up areas

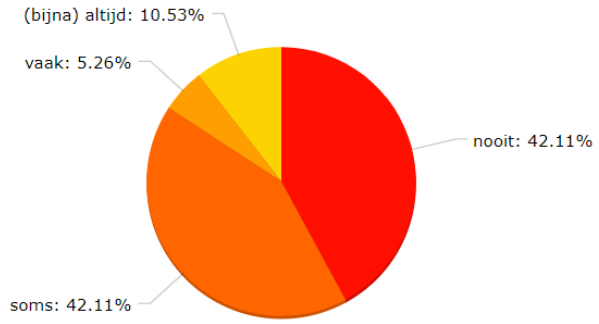

Figure 12 - answer on question: how often did you experience unsafe situations on moped/bicycle paths within built-up areas when you encountered a speed-pedelec?

Outside built-up areas

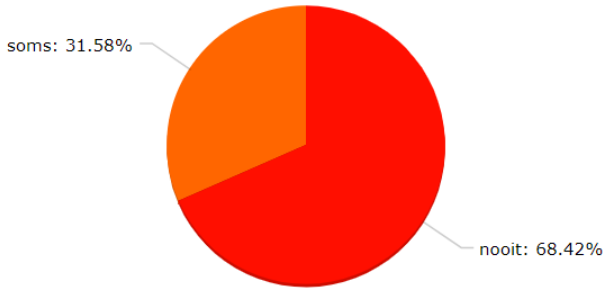

Figure 13 - answer on question: how often did you experience unsafe situations on moped/bicycle paths outside built-up areas when you encountered a speed-pedelec?

Frequency other road users experienced unsafe situations with speed-pedelec cyclists on car lanes:

Within built-up areas

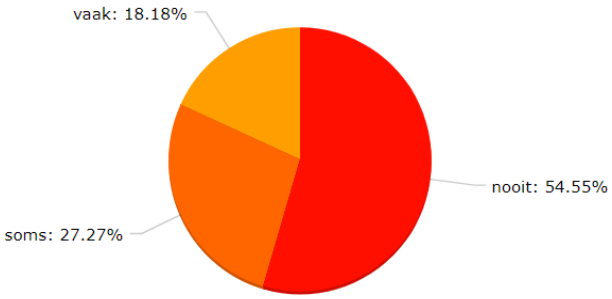

Figure 14 - answer on question: how often did you experience unsafe situations on car lanes within built-up areas when you encountered a speed-pedelec?

Outside built-up areas

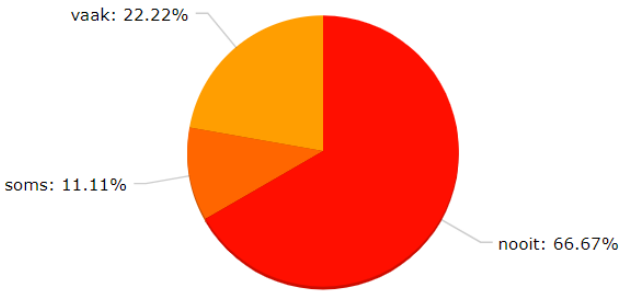

Figure 15 - answer on question: how often did you experience unsafe situations on car lanes outside built-up when you encountered a speed-pedelec?

On bicycle paths within built-up areas most of the road users experienced unsafe situations with speed-pedelecs, 57,89% experienced unsafe situations. Outside built-up areas on cycling/moped paths as well as on car lanes, 67% never experience unsafe situations.

Figure 16 shows the average frequency other road users experienced unsafe situations with speed-pedelecs. On average road users experienced most frequent unsafe situations with speed-pedelec on bicycle/moped paths within built-up areas. Outside built-up areas two third never experienced unsafe situations. However, the people that did experience unsafe situations experienced these situations more frequent on car lanes then on moped/bicycle paths.

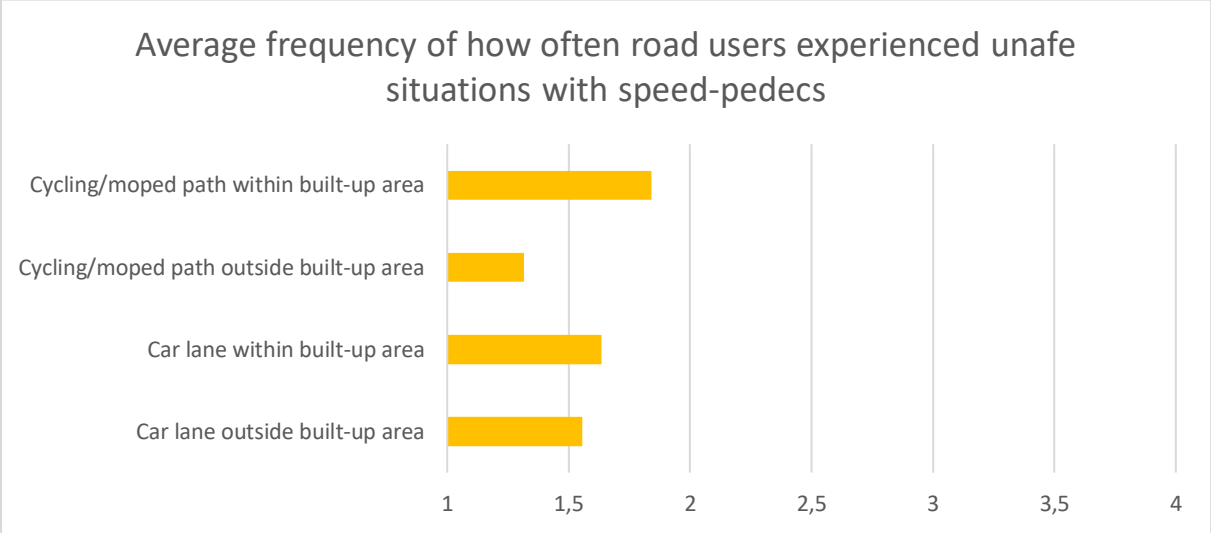

Figure 16 - Average answer on question: How often did you experience unsafe situations when you encountered a speed-pedelec on the following roads? (1 = never, 2 = sometimes, 3 = often, 4 = (almost) always)

4.4 Unsafe situations other road users

In the text below is described what kind of unsafe situations road users experienced with speed-pedelecs.
In Appendix B is a table with unsafe situations the participants mentioned.

Bicycle/moped path within and outside built-up areas.

Within built-up areas 70% of the participants experienced unsafe situations because the speed-pedelec cyclists overtook them with high speeds very close next to them, they didn't hear them approaching and cycling paths were often very small and bumpy. 33% of the participants mentioned that they experienced unsafe situations because they didn't recognize the cyclists as speed-pedelec cyclists, they look the same as normal cyclists. Therefore, they didn't expect them to go so fast. Outside built-up areas people experienced the same unsafe situations, speed-pedelecs overtook them with high speeds and risky overtaking manoeuvres.

Car lane within and outside built-up areas.

The few participants who encountered problems with speed-pedelecs on the car lane mentioned three types of unsafe situations. They don't expect the speed-pedelec to go so fast, it is difficult to overtake them when they go relatively fast and they are very vulnerable. Also, they were poorly visibility, especially in the dark. A participant mentioned that he himself never experiences unsafe situations with speed-pedelecs on car lanes. The unsafe situations he encountered occurred due to the behaviour of other car drivers.

5. Literature: Mopeds and Light mopeds

From January 2017 till July 2017, speed-pedelec owners could decide to use a yellow or blue licence plate and use their speed-pedelec as a moped or light moped. Since July 2017 every speed-pedelec is considered as a moped with a yellow licence plate which means it is no longer allowed to drive on bicycle paths. Therefore, it can be useful to take a deeper look at mopeds and light mopeds and how these vehicles perform in traffic.

5.1 Accident study Mopeds

Before 1999 mopeds were driving on bicycle paths and were not allowed to drive on car lanes. But in 1999 the Ministry of Transport announced that Municipalities could decide to move mopeds to the car lane. The reason for this decision came after a research of SWOV. In 1991 the Ministry of Transport asked SWOV to investigate if it was safer to let mopeds drive on car lanes.
In this research there was a test- and control area. In the test area, mopeds were no longer allowed on bicycle paths within built-up areas and in the control area mopeds could stay on the bicycle path. In both areas an accident study was performed. (Hagenzieker, 1993)

Figure 17 shows that there was a significant decrease of accidents with mopeds in the test area. The number of injury accidents decreased with 70%. The trend in injury accidents of other bicycles and other accidents were not significant. In the control areas, there was only a decrease in injury accidents with mopeds of 20%.

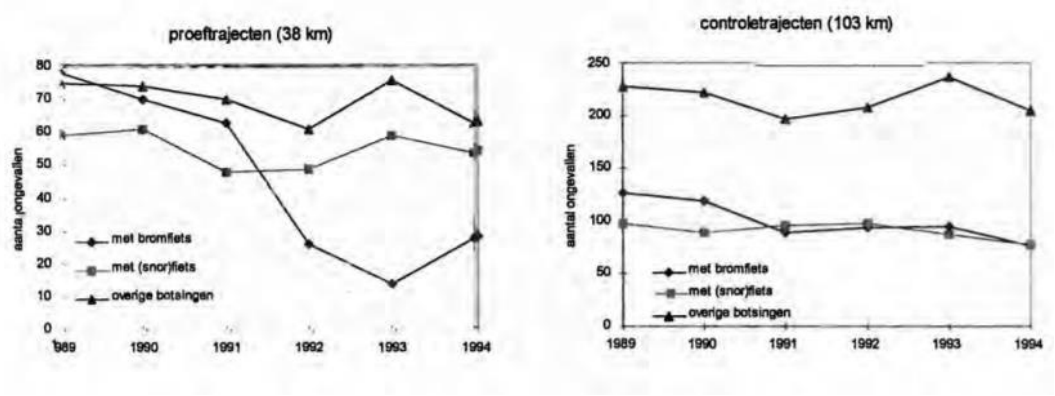

Figure 17 - Number of accidents in the test and control areas each year (Hagenzieker, 1995)

1994 shows an increase in accidents with mopeds. However, it is not known if this is a coincidence or that is shows that the impact of the rule was decreasing.

Figure 18 makes a difference between the type of accidents of mopeds. When developments of different modes of traffic are considered, e.g. the rise in number of bicycles, the accidents between moped and bicycle shows the biggest relative decrease in the test area. This decrease is quite logical because mopeds were not driving on bicycle paths anymore.

As can be seen in the figure 18 the biggest actual decrease in accidents, it the decrease in accidents between mopeds and motor vehicles. This is mainly due to a decrease in accidents on intersections.

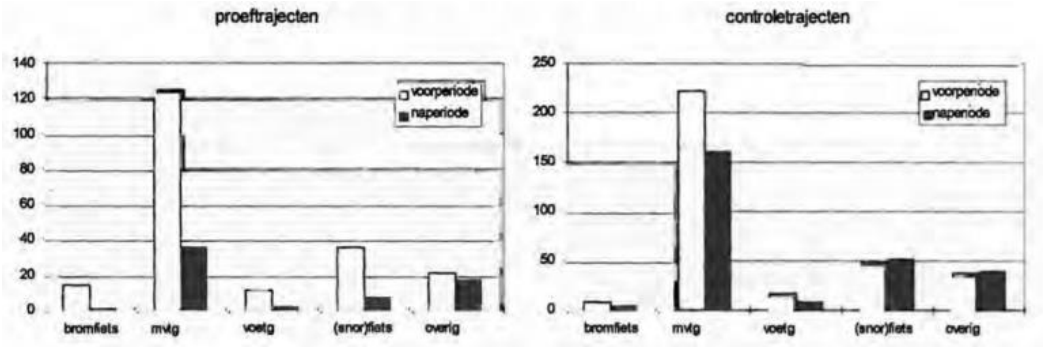

Figure 18 - Number of accidents with mopeds in test and control areas before and after the research (Hagenzieker 1995)

Before the mopeds were driving on the car lanes, 70% of all accidents took place on intersections. While the mopeds were driving on the car lane, they were better visible for car drivers and car drivers noticed them earlier.
Figure 19 shows the decrease of accidents on intersections in the test and control area.

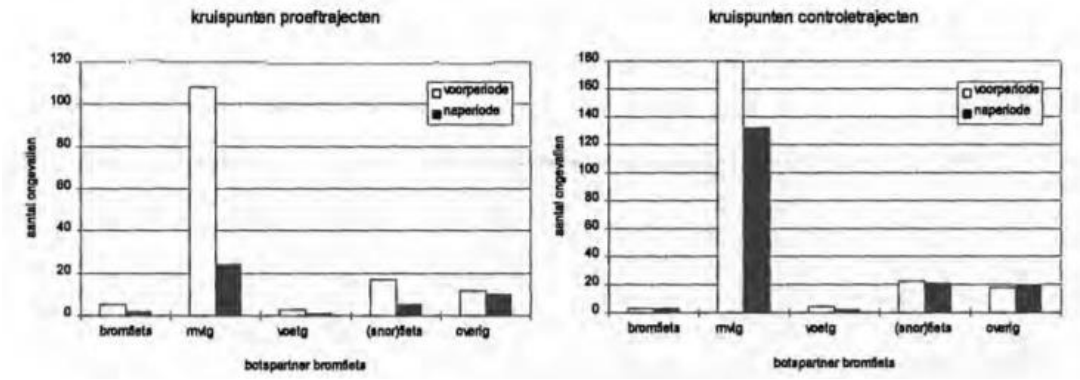

Figure 19 - Number of accidents with mopeds on intersections in the test and control area before and after the research (Hagenzieker, 1995)

When the mopeds were driving on the car lane, you might expect an increase in number of accidents on road sections with cars. But the research showed that on road sections there was a decrease in accidents as well. The biggest decrease of accidents on road sections was the number of accidents between mopeds and slow mopeds.

This research showed a significant decrease in accidents with mopeds. Therefore, SWOV recommended mopeds to drive on car lanes.

5.2 Speed-pedelec vs. Moped

Nowadays most of the accidents with mopeds are not registered, this also counts for speed-pedelecs. There is no list yet of the number of accidents with speed-pedelecs. The number of accidents with speed-pedelecs before and after the new legislation can't be compared.
However, the survey showed that 20.9% of the participants with a speed-pedelec experienced unsafe situations with cars on intersections while they were driving on the bicycle path. These are similar problems mopeds experienced with cars when they were driving on the bicycle path; cars underestimated their speed or noticed them too late.

However, the speed-pedelec differs from the moped. In the research of M.P. Hagenzieker, the average speed of the mopeds on carriage ways was 44-45 km/h while the average speed of other traffic was 49-50 km/h. The speed of the mopeds was almost the same as the speed of the cars (Hagenzieker,

1994) .In the research of SWOV, the average speed of speed-pedelecs on car lanes was 32 km/h. This is a difference of almost 20 km/h with other traffic and a difference of almost 15 km/ with mopeds. On road sections there was no increase in accidents with mopeds but for speed-pedelecs this is not known.

5.3 Light mopeds

As with mopeds, most of the accidents with light mopeds happen on intersections and most of the times it is an accident between a light moped and a car. Therefore, moving the light moped to the car lane seems to be a solution to reduce injury accidents.
However, light mopeds have just like speed-pedelecs a much lower average speed. The maximum speed of light mopeds is 25 km/h. Therefore, SWOV stated it will only be possible if the road has a maximum speed of 30 km/h. (Dr. R.J. Davidse et al, 2017)

6. Discussion and Conclusion

6.1 Discussion

This study showed that speed-pedelec users mainly experienced unsafe situations on car lanes. Within built-up areas 93% of the speed-pedelec users experienced unsafe situations. Compared to other roads, speed-pedelec users experienced unsafe situations more often on car lanes within built-up areas than on other roads.
However, other road users did not mainly experience unsafe with speed-pedelecs on car lanes. From the other road users, 57.89% experienced unsafe situations with speed-pedelecs on bicycle/moped paths within built-up areas. Compared to other roads, they experienced unsafe situations more often on moped/bicycle paths within built-up areas than on other roads.
Therefore, according to other road users, it is safer if the speed-pedelec drives on the car lane but according to speed-pedelec users, the speed-pedelec is safer on moped/bicycle paths. There is no place in traffic for the speed-pedelec where it is safer for all road users.
However, when you compare the percentage of speed-pedelec users with other road users that experienced unsafe situations and when you compare the frequency at which speed-pedelec users and other road users experienced unsafe situations, the results show that biggest problems are with speed-pedelecs on car lanes.
On car lanes the difference in speed between speed-pedelecs and cars can be relatively high resulting in unsafe situations. This is probably the reason that speed-pedelec cyclists prefer to use their speed-pedelec on bicycle/moped paths.

Speed-pedelec users mostly experienced unsafe situations on car lanes but driving on bicycle/moped paths is not considered to be completely safe either.
The unsafe situations they experienced on bicycle/moped paths with other cyclists indicate that cycling with high speeds is not possible and not safe. Other Cyclists do not pay attention or cycle with many next to each other which can lead to unsafe situations when speed-pedelecs overtake them. Other cyclists experienced it as unsafe and unpleasant when speed-pedelecs overtook them with high speeds. Cyclist didn't hear them approaching, didn't recognize them as speed-pedelecs and didn't expect them to go this fast.
The unsafe situations speed-pedelec users experienced on bicycle/moped paths with car drivers were mainly located at intersections. Car drivers underestimated their speed or noticed them too late. It can be very useful the compare these situations with mopeds.
When mopeds were moved to the car lane in 1999 this led to a decrease of accidents of 70%, mainly due to a decrease of accidents on intersections. Cars noticed the mopeds earlier and had more time to react. However, on road sections there was no increase in accidents with mopeds, the average speed of mopeds (45km/h) was almost the same as the average speed of cars (49 km/h). Speed-pedelecs can reach these speeds as well, but the average speed of speed-pedelecs on car lanes is much lower, only 32 km/h. Not all owners of a speed-pedelec can reach such high speeds, especially when driving with counterwind. Because the average speed of speed-pedelecs is lower than mopeds, it can't be concluded that moving the speed-pedelec from the bicycle path to the car lane leads to a decrease in accidents on intersections and not to an increase in accidents on road sections. A study about accidents with speed-pedelecs is needed to conclude this.

Differences in speed between speed-pedelecs and other road users cause a lot of unsafe situations. However, recognisability plays an important role in a lot of situations. Speed-pedelecs look just like normal bicycles. Therefore, people accept them on bicycle paths but car drivers don't accept them on car lanes.

Because speed-pedelecs look just like normal cyclists, people underestimate their speed. Car drivers underestimate their speed when overtaking and other cyclists don't expect a 'cyclist' to go so fast.

Roads outside built-up areas seem to be the safest place for speed-pedelecs, especially bicycle/moped paths. However, the only reason for this seems to be that these roads are quieter than roads within built-up areas. The unsafe situations people experienced outside built-up areas are similar to the unsafe situations they experienced within built-up areas but people experienced these unsafe situations less often.

Important to mention is that the experiences of other road users with speed-pedelecs is only based on few participants in the survey. On car lanes only eleven people encountered a speed-pedelec within built-up areas and only nine people encountered one outside built-up areas. On bicycle paths more participants encountered a speed-pedelec but it is still a small group of 19 participants. Therefore, the results from other road users is only an indication of how they experienced speed-pedelecs in traffic.

6.2. Conclusion

Experiences from speed-pedelec users show that driving on the car lane is not safer than driving on the bicycle path. Driving on the car lane can lead to a lot of unsafe situations. Cars overtake them with very high speeds, cut them off and don't accept them on the car lane. Provinces and Municipalities want to reverse the rules already.
However, cycling with very high speed on the bicycle paths is unsafe either. Other cyclists don't pay attention and often cycle with many next to each other. Other cyclists experience is as very unpleasant and unsafe when speed-pedelecs overtake them with high speeds on small bicycle paths. Cyclist don't hear them approaching, don't recognize them as speed-pedelecs and don't expect them to go so fast.
High speeds on bicycle paths can lead to unsafe situations on intersections with cars as well. An accident study on speed-pedelecs should show if moving the speed-pedelec to the car lane or reducing the speed of speed-pedelecs on bicycle paths would lead to a reduce in accidents.
The speed-pedelec was moved to the car lane based on the power it can produce. However, not all people who own a speed-pedelec can drive so fast. People who drive with 25 to 30 km/h can't be obliged to drive on car lanes where the maximum speed is 50km/h and cars drive 60km/h. Using a speed-pedelec instead of a car should be stimulated but it prevents people from buying a speed-pedelec knowing they must use it on car lanes as well.
People with a speed-pedelec who want to drive very fast should only do this on car lanes. Increasing recognizability and campaign of Rijkswaterstaat to make car drives more aware of the fact that speed-pedelecs are allowed on the car lane should make this possible. Increasing recognizability of the speed-pedelec is also important on bicycle path, normal cyclists should expect speeds of 30 km/h.

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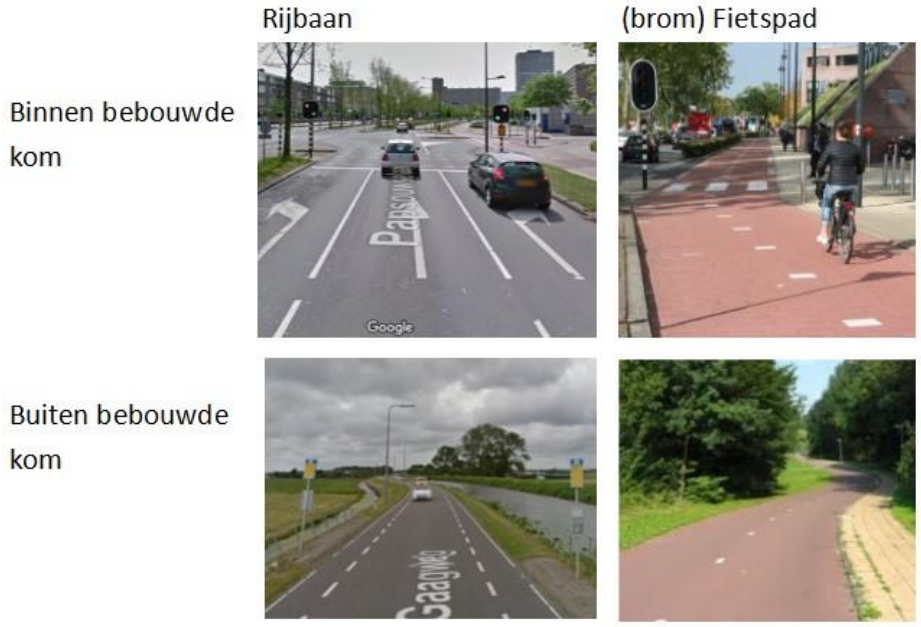
8. Appendices

Appendix A : Survey questions

This appendix shows the questions that were presented in the survey. The answer on the first question determines which questions were asked to the participant.

1) Do you use a speed-pedelec:
yes/no

2) can you indicate how often you use your speed-pedelec on the following roads:



	Never	Sometimes	Often	(almost) always
Cycling/scooter path within built-up areas				
Cycling/scooter path within built-up areas				
Car road within built-up areas				
Car road outside built-up areas				

3) Do you ever experience unsafe situations with other road users on cycling/scooter paths within built-up areas
Never/sometimes /often/(almost) always

If sometimes or more often →

> 4) Could you explain what kind of situations this are and in what kind of traffic situations you experience this?
> *For example a situation where the bicycle path (design/surface) was not suited for speed-pedelecs, an accident that occurred or unsafe experiences with other road users.*
> …….

5) Do you ever experience unsafe situations with other road users on cycling/scooter paths outside built-up areas
Never/sometimes /often/(almost) always

If sometimes or more often →

> 6) Could you explain what kind of situations this are and in what kind of traffic situations you experience this?
> *For example a situation where the bicycle path (design/surface) was not suited for speed-pedelecs, an accident that occurred or unsafe experiences with other road users*
> …….

7) Do you ever experience unsafe situations with other road users on car roads within built-up areas
Never/sometimes//often/(almost) always

If sometimes or more often →

> 8) Could you explain what kind of situations this are and in what kind of traffic situations you experience this?
> *For example a situation where the road (design/surface) was not suited for speed-pedelecs, an accident that occurred or unsafe experiences with other road users*
> …….

9) Do you ever experience unsafe situations with other road users on car roads outside built-up areas
Never/sometimes//often/(almost) always

If sometimes or more often →

> 10) Could you explain what kind of situations this are and in what kind of traffic situations you experience this?
> *For example a situation where the road (design/surface) was not suited for speed-pedelecs, an accident that occurred or unsafe experiences with other road users*
> …….

11) Do you think that changes need to be made on the current infrastructure to make it safer for speed-pedelec cyclists?
Completely disagree/disagree /agree/completely agree

1) Do you use a speed-pedelec:
yes/no

2) can you indicate how often you come across a speed-pedelec on the following roads:

	Rijbaan	(brom) Fietspad
Binnen bebouwde kom		
Buiten bebouwde kom		

	Never	Sometimes	Often	(almost) always
Cycling/scooter path within built-up areas				
Cycling/scooter path within built-up areas				
Car road within built-up areas				
Car road outside built-up areas				

3) Do you ever experience unsafe situations with speed-pedelec cyclists on <u>cycling/scooter paths within built-up areas</u>
Never/sometimes//often/(almost) always

If sometimes or more often →

4) Could you explain what kind of situations this are and in what kind of traffic situations you experience this?
For example a situation where the bicycle path (design/surface) was not suited for speed-pedelecs, an accident that occurred or other unsafe experiences with speed-pedelec cyclists
…….

5) Do you ever experience unsafe situations with speed-pedelec cyclists on cycling/scooter paths outside built-up areas
Never/sometimes//often/(almost) always

If sometimes or more often →

> 6) Could you explain what kind of situations this are and in what kind of traffic situations you experience this?
> *For example a situation where the bicycle path (design/surface) was not suited for speed-pedelecs, an accident that occurred or other unsafe experiences with speed-pedelec cyclists*
> …….

7) Do you ever experience unsafe situations with speed-pedelec cyclists on car roads within built-up areas
Never/sometimes//often/(almost) always

If sometimes or more often →

> 8) Could you explain what kind of situations this are and in what kind of traffic situations you experience this?
> *For example a situation where the road (design/surface) was not suited for speed-pedelecs, an accident that occurred or other unsafe experiences with speed-pedelec cyclists*
> …….

9) Do you ever experience unsafe situations with speed-pedelec cyclists on car roads outside built-up areas
Never/sometimes//often/(almost) always

If sometimes or more often →

> 10) Could you explain what kind of situations this are and in what kind of traffic situations you experience this?
> *For example a situation where the road (design/surface) was not suited for speed-pedelecs, an accident that occurred or other unsafe experiences with speed-pedelec cyclists*
> …….

11) Do you think that changes need to be made on the current infrastructure to make it safer for speed-pedelec cyclists and other road users?
Completely disagree/disagree /agree/completely agree

Appendix B: Unsafe situations mentioned in Survey

This appendix shows the unsafe situations the participants from the survey mentioned. Some participants mentioned multiple unsafe situations.

Unsafe situations experienced by speed-pedelec users

The list below shows unsafe situations speed-pedelec users experienced on moped/bicycle paths within built-up areas. Unsafe situations mentioned less than 3 times are not shown.

Number of participants: 43

Situation	Mentioned	%
Cyclists using their phone (apping/calling)	11x	25.6%
Cars who don't expect speed-pedelecs to drive so fast. They underestimate the speed or notice them too late. Unsafe situations occur at: roundabouts, side streets, crossing traffic, turning cars	9x	20.9%
Cyclists cycling with many next to each other (both directions), cycling path is too narrow, mirrors of speed-pedelec make the bike quite wide	9x	20.9%
People cycling with headphones	6x	14%
Swerving cyclists	4x	9.3%
Pedestrians and dogs on cycling path	4x	9.3%

The list below shows unsafe situations speed-pedelec users experienced on moped/bicycle paths outside built-up areas. Unsafe situations mentioned less than 3 times are not shown

Number of participants: 32

Situation	Mentioned	%
Cars who don't expect speed-pedelecs to drive so fast. They underestimate the speed or notice them too late. Unsafe situations occur at: roundabouts, side streets, crossing traffic, turning cars	8x	25.0%
Mopeds overtaking with high speed, cycling path is too narrow, especially with two mirrors next to each other	7x	21.9%
Cyclist using their phone (apping/cycling)	6x	18.8%
People cycling with many next to each other, cycling path is too narrow	4x	12.5%

The list below shows unsafe situations speed-pedelec users experienced on car lanes within built-up areas. Unsafe situations mentioned less than 2 times are not shown

Number of participants: 36

Situation	Mentioned	%
Cars who cut you off or overtake with high speed very close next to you	23x	63.9%
Aggressive behaviour / incomprehension of other road users	18x	50.0%
Cars who drive very close behind you	4x	11.1%
Bus/truck who push you of the road at corners	2x	5.6%
Don't get priority at round abounds	2x	5.6%
When driving on a hill or driving with counter wind, speed reduces and speed difference becomes too big.	2x	5.6%

The list below shows unsafe situations speed-pedelec users experienced on car lanes outside built-up areas. Unsafe situations mentioned less than 2 times are not shown.

Number of participants: 22

Situation	Mentioned	%
Cars who cut you off or overtake with high speed very close next to you	11x	50.0%
Aggressive behaviour / incomprehension of other road users	2x	9.1%
Don't get priority (at confined spaces e.g.)	2x	9.1%
When driving on a hill or driving with counter wind, speed reduces and speed difference becomes too big.	2x	9.1%

Unsafe situations experienced by other road users

The list below shows unsafe situations road users experienced with speed-pedelecs on moped/bicycle paths within built-up areas. All mentioned situations are shown.

Number of participants: 10

Situation	Mentioned	%
You don't hear them approaching and they overtake with high speeds close next to you	5x	50.0%
You don't expect them to drive so fast because you don't recognize them as speed-pedelecs, they look the same as normal cyclists. Also you don't expect them to drive faster than mopeds with a blue licence plate	3x	30.0%
Cycling paths are too narrow and bumpy, not comfortable when they pass by.	2x	20.0%
They don't look around when overtaking with high speed	1x	10.0%

The list below shows unsafe situations road users experienced with speed-pedelecs on moped/bicycle paths outside built-up areas. All mentioned situations are shown.

Number of participants: 5

Situation	Mentioned	%
They drive too fast and you don't expect them to drive so fast	2x	40%
On T-junctions, you can't estimate how fast they go	1x	20%
In your mirrors, you can't estimate how fast they go	1x	20%
Cycling paths for two directions are too small, dangerous when they are overtaking	1x	20%

The list below shows unsafe situations road users experienced with speed-pedelecs on car lanes within built-up areas. All mentioned situations are shown.

Number of participants: 3

Situation	Mentioned
You don't expect them to drive so fast	2x
Remark from participant: the speed-pedelec cyclist don't cause unsafe situations. Car drivers create unsafe situations because they don't accept them on the car lane. Himself, he does never experience unsafe situations with speed-pedelecs on car lanes, only unsafe situations due to behaviour of other car drivers.	1x

The list below shows unsafe situations road users experienced with speed-pedelecs on car lanes outside built-up areas. All mentioned situations are shown.

Number of participants: 3

Situation	Mentioned
Speed-pedelecs drive on the middle of the road, are vulnerable and therefore difficult to overtake without driving through the berm	1x
The speed-pedelec is poorly visible	1x
Same as inside built-up areas: only unsafe situations due to behaviour of other car drivers.	1x