# Speed pedelecs for commuting – a field trial

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## Abstract

In Austria, the popularity of speed pedelecs is on the rise – both for commuting and leisure purposes. However, the fact that they are legally equivalent to mopeds has significant drawbacks, like the ban of their use on cycling infrastructure as well as the requirement for insurance, registration, and type approval. These drawbacks could restrict the potential of speed pedelecs as an alternative mode of transport for commuting, mainly as a replacement for cars. Accordingly, this paper investigates the extent to which the current legal framework in Austria restricts the potential of speed pedelecs as an alternative mode of transport for commuting and proposes alternative regulations for speed pedelecs in Austria. A comprehensive field trial with 98 participants in different regions in Austria and Switzerland was carried out to track their commute trips and gather corresponding data based on a) their usual behavior (mostly the use of cars), b) their use of pedelecs, and c) their use of speed pedelecs. To investigate safety-related aspects, speed differences between pedelecs and speed pedelecs were computed and further evaluated. In addition to this driving data, the participants were surveyed about their experiences and opinions regarding safety at four different points in time (once before, once during, and twice after the field trial). The results of the field trial showed that speed differences between pedelecs and speed pedelecs were not as large as expected and provided insights on preferred driving speed. The surveys revealed that speed pedelec riders would prefer to ride their vehicles on cycling infrastructure. They also indicated which further legal restrictions are considered useful or not. These results were used to produce suggestions for the legislation on speed pedelecs such as their use on cycling infrastructure or the need to wear a specified helmet.

Keywords: speed pedelecs, electric bicycles, speed, commuting, field study, GPS

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# 1. Introduction

In recent years, the popularity of speed pedelecs has been clearly on the rise, and the COVID-19 pandemic has intensified this development [1]. In countries like the Netherlands and Switzerland, but also in Austria, an increase in the sales of speed pedelecs can be observed – sales figures in the Netherlands doubled between 2017 and 2020 [2][3] – and more and more people are using this environmentally friendly and healthy mode of transport for commuting and leisure purposes.

In contrast to classic pedelecs, which are limited to a maximum assistance speed of 25 km/h and a maximum continuous rated power of 600 W, speed pedelecs typically have a maximum assistance speed of 45 km/h and a maximum continuous rated power of 500 to 1,000W, with the regulatory maximum set at 4,000W [4][5][6]. Based on these characteristics, speed pedelecs could extend the active commuting range (one hour commute to/from work) and allow cyclists to maintain their speed when riding uphill or facing headwinds [7]. Thus, they have a high potential as an alternative mode of transport for commuting, mainly as a replacement for cars, and especially in areas where the availability of public transport is limited.

However, in Austria speed pedelecs are legally equivalent to mopeds. This results in substantial legal differences compared to pedelecs [8]: To use a speed pedelec, a cyclist must hold a valid moped driving license and wear a motorcycle helmet. The speed pedelec itself has to be type-approved and registered for traffic and therefore requires a registration plate and third party insurance. Like mopeds, speed pedelecs are subject to recurrent vehicle inspections. Last but not least, speed pedelecs can only be ridden on the roadway, not on the bicycle infrastructure. These drawbacks and restrictions in comparison to pedelecs or conventional bicycles could deter potential users. The obligation to use the roadway, for example, leads to speed pedelecs being overtaken at high speeds in dangerous maneuvers by other motor vehicles. Accordingly, the actual use of speed pedelecs as an alternative mode of commuter transport by no means matches their potential as a replacement for cars.

This seems all the more unfavorable given that previous studies show that the average speed of speed pedelecs – with speed being one of the important aspects for the assessment of their safety and the legal regulations – is mostly only slightly higher than the average speed of pedelecs and remains well below the maximum assistance speed of 45 km/h. In a recent study, Schleinitz et al. (2017) [9] recorded an average speed of 24.5 km/h for speed pedelecs and an average speed of 17.4 km/h for pedelecs using speed loggers and the GPS data of 9 speed pedelec riders and 48 pedelec riders in Germany. A study by Blass et al. (2019) [10] in which 101 participants rode on a 1.5 km test track in Austria with a pedelec and a speed pedelec shows an average speed of 21.4 km/h for pedelecs and 23.4 km/h for speed pedelecs. Twisk et al. (2021) [11] conducted a study with 14 pedelec riders and 20 speed pedelec riders in the Netherlands using GPS loggers and report average speeds for speed pedelecs of 28.2 km/h in urban areas and 31.4 km/h in rural areas compared to 20.1 km/h for pedelecs in urban areas and 22.2 km/h in rural areas. However, studies to date have mainly been carried out with low numbers of participants or on test tracks and most of them do not take account of customary commuting routes and conditions.

The present study investigates whether the potential of speed pedelecs as an alternative mode of commuter transport is restricted by the current legal framework in Austria and proposes alternative regulations for speed pedelecs in Austria. For this purpose, a field trial of pedelec and speed pedelec users was carried out in three different regions in Austria, Switzerland and Liechtenstein and the participants' experiences were surveyed online. Building on the results, suggestions for the legislation on speed pedelecs are derived.

# 2. Methodology

## 2.1 Participants and field trial regions

The field trial and its accompanying survey were carried out with 98 participants in three different regions in Austria, Switzerland and Liechtenstein: (1) Salzburg, representing an urban setting, (2) Eisenstadt and surroundings (Burgenland), representing smaller towns and rural areas, and (3) Wolfurt, Bludenz (in Vorarlberg), Heerbrugg (Switzerland), and Schaan (Liechtenstein) and their surrounding areas, also representing smaller towns and rural areas. The participants were all employees of various companies and government bodies in these regions, who commute daily to their place of work, mostly by car. Table 1 shows the characteristics of the participants by gender, age, and place of residence.

The majority (74%) of the 98 participants were men. 40% of the participants were 41-50 years old, 30% were 31-40 years old, and 23% were in the 51-60 age group. 88% of the participants lived in Austria and 12% lived in Switzerland (Table 1).

**Table 1: Sample characteristics of participants in the field trial and accompanying survey (n=98)**

| Characteristics | | Share |
|---|---|---|
| Gender | male | 74% |
| | female | 26% |
| Age | 20-30 years | 7% |
| | 31-40 years | 30% |
| | 41-50 years | 40% |
| | 51-60 years | 23% |
| Place of residence | Austria | 88% |
| | Switzerland | 12% |
| Total | | 100% |

## 2.2 Pedelecs and speed pedelecs

All the pedelecs and speed pedelecs used in the field trial were from the same manufacturer (Riese & Müller). The pedelec and speed pedelec models were of the same or very similar design, which was important in order to minimize possible distortions in the participants' perceptions and assessments due to different designs of the bikes. The pedelec models had a continuous rated power of 250W, and the speed pedelec models had a continuous rated power of 350W. Various models with different frame heights were selected to provide an optimal riding experience for both male and female participants.

## 2.3 Procedure

During the field study, the participants' daily trips to work were tracked over a five-week period with the help of a GPS-ready smartphone. The first week (phase 1) was used to track their customary commuting behavior (e.g. by car, public transport, or bicycle). In weeks two and three (phase 2), the participants made these trips using pedelecs, while in weeks four and five (phase 3), they did so using speed pedelecs (see Figure 1). The field trial generated a huge dataset of daily commuting routines with different modes of transport. In order to enable the analysis and investigate safety-related aspects, the speed differences between pedelecs and speed pedelecs were computed and evaluated by laying a grid of quadratic cells with a side length of 250m over the areas in which the participants had recorded trips and then calculating and comparing the average speeds for the trip segments in the cells.

To support the driving data collected, an online survey of the participants' experiences and opinions was conducted at four different points in time before, during and after the field trial, i.e. (1) before phase 1, (2) at the end of phase 2, (3) at the end of phase 3, and (4) three months after the end of phase 3. This survey contained questions on a) the process of getting used to riding the pedelec and speed pedelec, b) the perception or feeling of safety during individual riding maneuvers in the different phases, c) positive and negative aspects when riding pedelecs and speed pedelecs, and d) considerations regarding a potential purchase of a speed pedelec. Most of the questions on the accustomization process included predefined multiple-choice response options, while those on the assessment of safety used Likert scales. The survey design was based on the Health Belief Model [12].

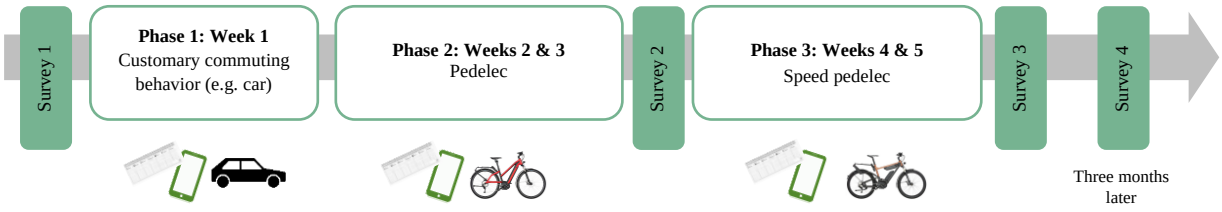


**Figure 1: Overview of the different phases in the field trial and the accompanying survey**

## 3. Analysis and Results

The results for the field study and accompanying survey described below only include data from participants who rode solely in Austria, i.e. exclude those who rode in Switzerland or Liechtenstein. This filter was set because the differences in the regulatory specifications for pedelecs and speed pedelecs (e.g., maximum power, use of bicycle infrastructure, type of helmet required, etc.) in the three countries influence the results on driving speeds and perceptions of safety. The most important difference in legal regulations concerns the use of cycling infrastructure: for speed pedelecs, the use of cycling infrastructure is prohibited in Austria, whilst in Switzerland and Liechtenstein it is obligatory [13].

### 3.1 Driving speeds of pedelecs and speed pedelecs

Table 2 shows the results for the mean driving speeds for pedelecs and speed pedelecs for all trip segments and all cells in which participants recorded trips by area, gender and field trial region. Overall, the results show that the mean speed was 23.24 km/h for pedelecs and 28.54 km/h for speed pedelecs; thus, the mean speed of speed pedelecs was 5.30 km/h higher than for pedelecs. Differences in mean speed between pedelecs and speed pedelecs were higher outside built-up areas (5.84 km/h) than in built-up areas (3.62 km/h). On average, women rode about 1 km/h slower than men both on pedelecs and speed pedelecs, and speed differences between pedelecs and speed pedelecs were only slightly higher for females (5.50 km/h) than for males (5.24 km/h). In regional terms, the difference in mean speed was lower in Burgenland (4.69 km/h) than in the other two regions (Salzburg: 5.39 km/h; Vorarlberg; 5.39 km/h).

**Table 2: Mean speed of pedelecs and speed pedelecs in Austria**

| | **Pedelec** | | **Speed pedelec** | | Difference in mean speed in km/h |
|---|---|---|---|---|---|
| | Mean speed in km/h | n | Mean speed in km/h | n | |
| Built-up areas | 22.09 | 9,946 | 25.71 | 8,828 | 3.62 |
| Outside built-up areas | 23.59 | 35,052 | 29.43 | 31,793 | 5.84 |
| Male | 23.44 | 37,100 | 28.68 | 33,637 | 5.24 |
| Female | 22.37 | 7,898 | 27.87 | 6,984 | 5.50 |
| Burgenland | 23.67 | 6,698 | 28.36 | 6,239 | 4.69 |
| Salzburg | 23.12 | 8,732 | 28.51 | 6,558 | 5.39 |
| Vorarlberg | 23.19 | 29,568 | 28.58 | 27,824 | 5.39 |
| Total | 23.24 | 44,998 | 28.54 | 40,621 | 5.30 |

### 3.2 Experiences of and opinions on riding pedelecs and speed pedelecs

The results of the survey after phase 3 (survey 3) show that the participants got used to both pedal-assisted bicycle types relatively quickly: 25% stated that they had mastered riding the speed pedelec on the first day, 66% took until the second day to do so, while 9% required slightly longer. Compared with the results for pedelecs, which 37% of the participants mastered on the first day, the process of mastering the speed pedelec took a little longer – despite the fact that they had already been riding a pedelec for the two previous weeks (see Figure 2). Additionally, participants often reported that they had to get used to speed pedelecs, i.e., that a familiarization process was needed when switching to the speed pedelec after the two-week period with the pedelec.

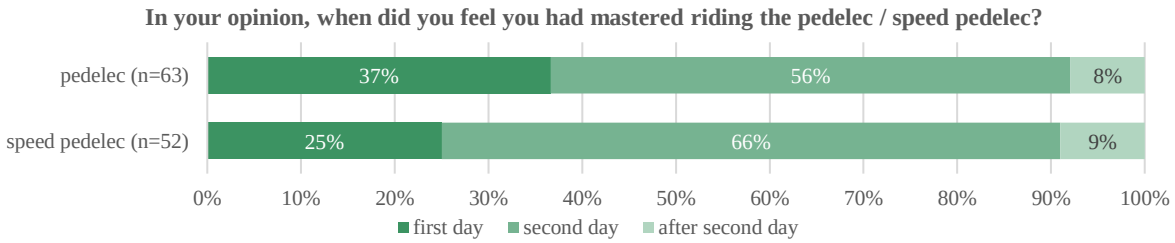


**Figure 2: Length of time required to master riding the pedelec (n=63) and speed pedelec (n=52)**

Most of the participants described their overall feeling of safety (i.e., of being in control of the vehicle) during the various riding maneuvers (starting, accelerating, braking, riding bends and turning) as good for both pedelecs and speed pedelecs, with higher percentages for feeling very safe when starting and accelerating (pedelec: 86%, speed

pedelec: 81%) and lower percentages for riding bends and turning (pedelec: 59%, speed pedelec: 62%). For starting and accelerating maneuvers, a higher share of participants felt very safe when riding the pedelec compared to the speed pedelec, while the opposite was the case in braking situations and when riding bends or turning. However, for riding bends or turning, 2% of the participants reported that they felt very unsafe when using the speed pedelec, whereas none of them felt very unsafe during other riding maneuvers on either speed pedelecs or pedelecs (see Figure 3).

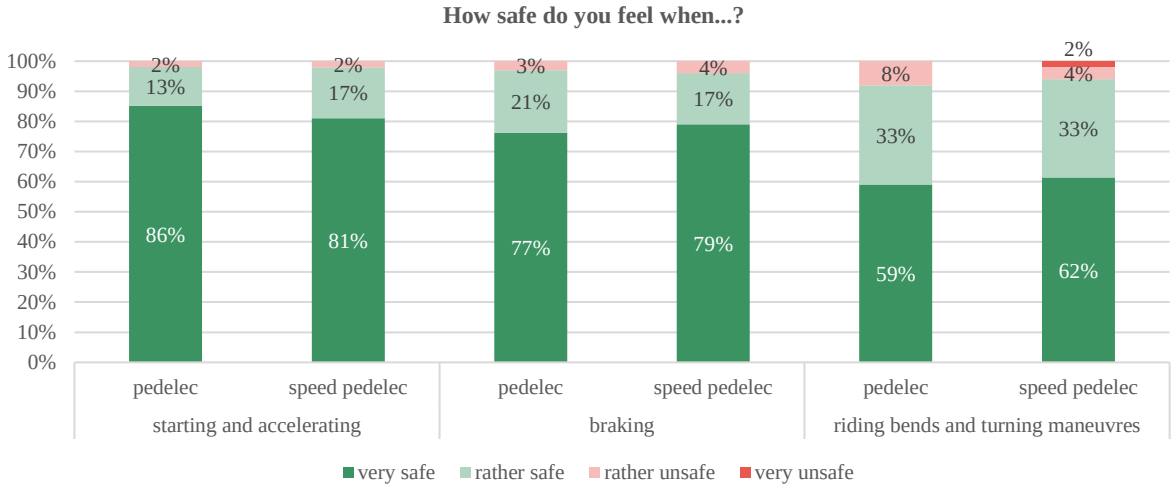


**Figure 3: Feeling of safety for pedelecs (n=63) and speed pedelecs (n=52) for different riding situations**

Regarding the statement 'I'm able to ride safely in all situations', a higher percentage of participants (75%) felt they were in control in all situations when riding a pedelec than was the case for riding a speed pedelec (64%). For speed pedelecs, a small share of participants (2%) even disagreed with the statement, whereas none of them did so with respect to using a pedelec (see Figure 4).

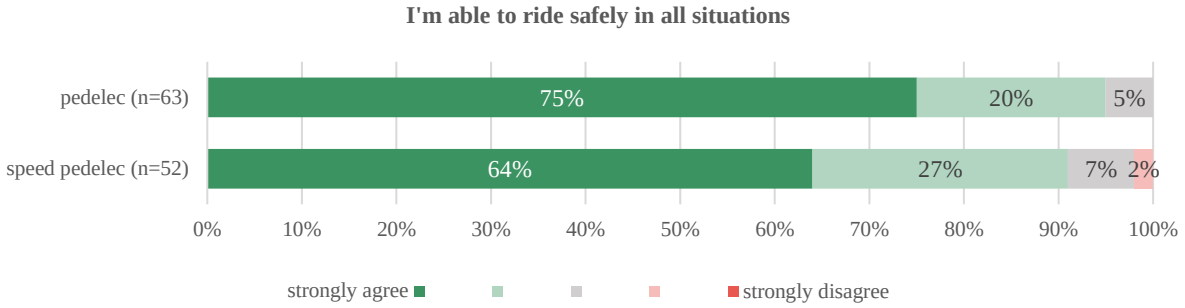


**Figure 4: Agreement with the statement "I'm able to ride safely in all situations" for pedelecs (n=63) and speed pedelecs (n=52)**

With regard to positive and negative aspects of riding a speed pedelec, 89% of the participants assessed the higher driving speed positively, while 81% viewed the speed pedelec itself as positive. The most negative aspect was the fact that riders of speed pedelecs are prohibited from using the bicycle infrastructure (85%), followed by the obligation to ride on the roadway (81%), the weight of the speed pedelec (54%), and the dependency on the weather (52%). 44% of the participants also considered the requirement to have a registration plate as negative (see Figure 5).

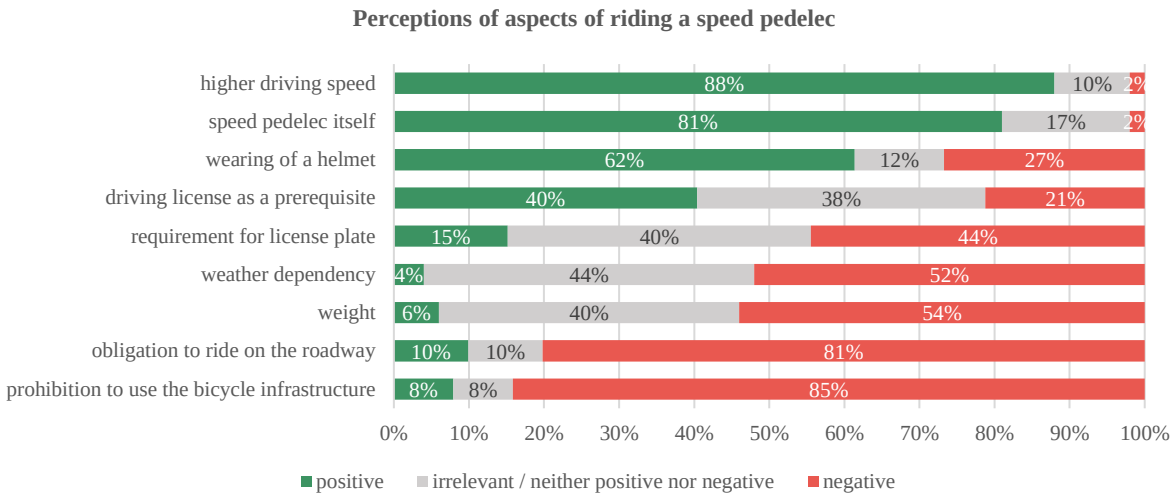


**Figure 5: Perceptions of aspects of riding a speed pedelec (n=52)**

Regarding a potential purchase of a speed pedelec in the future, the majority of the participants (86%) stated that they were not planning to buy a speed pedelec; only 3% stated that they were planning to do so. However, about two thirds (66%) of the participants who were not planning to buy a speed pedelec would change their decision if the use of the bicycle infrastructure was not prohibited, while 40% would change their decision if there was no obligation to use a motorcycle helmet (see Figure 6).

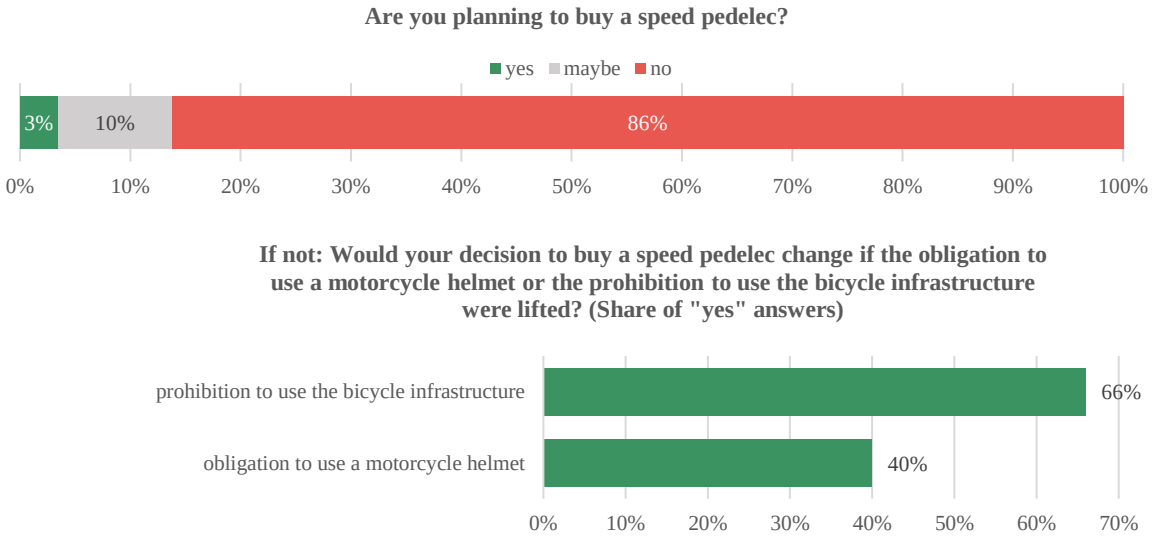


**Figure 6: Potential purchase of a speed pedelec (top, n=58) and share of participants who are not planning to do so but would change their decision if the obligation to use a motorcycle helmet/prohibition to use the bicycle infrastructure were lifted (bottom, n= 50)**

## 4. Discussion

Speed pedelecs have the potential to increase the radius that can be actively covered on a commute and allow riders to maintain their speed when riding uphill or facing headwinds. They thus have a high potential as an alternative mode of transport for commuting, mainly as a replacement for cars. However, the current legal framework in Austria treats speed pedelecs (in contrast to pedelecs) as mopeds, which entails the obligation to

comply with provisions such as the wearing of a motorcycle helmet or the prohibition to use bicycle infrastructure, which could restrict this potential.

The results of the survey indicate that participants considered being prohibited from using the cycling infrastructure – and thus being obliged to ride on the roadway – to be the most negative aspect when riding speed pedelecs. The requirement to hold a moped driving license or wear a motorcycle helmet to use speed pedelecs was not perceived to be predominantly negative. With regard to potential plans to buy a speed pedelec in the near future, the majority of participants did not plan to do so, although two thirds of them would possibly change their decision if the prohibition to use the bicycle infrastructure was lifted. This indicates that this aspect seems to restrict the use of speed pedelecs in Austria.

The results of the field trial indicate that the mean speed for speed pedelecs (28.54 km/h) was higher than for pedelecs (23.24 km/h) but – in line with previous studies [9][10][11] – that these speeds were far lower than the maximum assistance speed of 45 km/h. However, especially outside of built-up areas – where there were fewer intersections and traffic signals, and the participants had to brake and accelerate less often and had more opportunities to use pedal assist over 25 km/h – the mean speed for speed pedelecs reached 29.43 km/h and the difference in mean speed between pedelecs and speed pedelecs (5.84 km/h) was higher than in built-up areas (3.62 km/h).

In such cases, the difference between the driving speeds of speed pedelecs and pedelecs was also higher than in previous studies like the one by Blass et al. (2019) [10], where the participants only used the speed pedelecs on a test circuit. Nevertheless, the differences were lower than in the study by Twisk et al. (2021) [11], who reported differences in average speed between pedelecs and speed pedelecs of 8.1 km/h in urban areas and 9.2 km/h in non-urban areas. Furthermore, the mean driving speeds for pedelecs and speed pedelecs measured in our field study were both higher than those reported in the studies by Schleinitz et al. (2017) [9] and Blass et al. (2019) [10], which might be due to the fact that our participants were all commuters and not a mix of user groups. Similarly, although Twisk et al. (2021) [11] also included commuters in their study, they in fact even reported higher average speeds for pedelecs and speed pedelecs both for urban and non-urban areas. However, this might result from the fact that the speed pedelecs in their study could use the bicycle infrastructure, which is mostly of a higher quality in the Netherlands than in Austria. Nevertheless, other studies such as the one by Lienhop et al. (2015) [14] have also shown that the driving speeds of bicycle commuters are in general considerably higher than those of other cyclist groups.

Another aspect that should be considered is that the results of the survey indicate that pedelecs and speed pedelecs differ slightly in their riding characteristics. The feeling of safety during the individual riding maneuvers (starting, accelerating, braking, riding bends and turning maneuvers) was good for most participants; however, some still did not feel completely safe even after two weeks with the speed pedelec. Therefore, introductory training would be recommended in order to quickly and safely master the speed pedelec.

## 5. Conclusions

This paper investigated whether the potential of speed pedelecs to provide an alternative mode of transport for commuting is restricted by the current legal framework in Austria. For this purpose, a field study was carried out with commuters using speed pedelecs to travel to and from work and accompanied by a survey of their perceptions of their safety. The results show overall that the prohibition of the use of speed pedelecs on bicycle infrastructure seems to be an aspect that restricts their use for commuting and thus their potential as a replacement for cars. Other legal requirements were not perceived as negative. In addition, the results regarding driving speeds indicate that the corresponding differences between pedelecs and speed pedelecs were not as large as expected, although they were higher outside built-up areas.

Building on these results and to foster the use of speed pedelecs as an alternative to cars for commuters and increase their safety, we recommend opening up the cycling infrastructure to speed pedelecs but only under certain conditions. These should ensure on the one hand that the riders of conventional bicycles are protected from faster speed pedelec riders and on the other hand increase the safety of speed pedelec riders on those occasions where they cannot ride safely on the roadway. The recommendation to open up the cycling infrastructure applies in particular for built-up areas, where speed pedelecs should be allowed to use cycle lanes, multipurpose lanes as well as separate, well-developed cycle paths. However, the width of the cycle path, the volume of cycle traffic, and the speed of motor vehicles must also be taken into account. Nevertheless, the possibility of opening up the cycling infrastructure to speed pedelecs outside of built-up areas should also be considered on a case-by-case basis and with due consideration to various safety parameters. Based on the results of this study, a general opening up

of cycling infrastructure to speed pedelecs – as is the case in Switzerland – is not recommended for Austria, as the speed differences between speed pedelecs, pedelecs, and conventional bicycles – especially outside of built-up areas – are too high.

## 6. Acknowledgment

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