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Motivations and Barriers for Using Speed Pedelecs for Daily Commuting

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Abstract: Speed pedelecs, electric bicycles that can provide pedal assistance up to 45 km/h, have seen rapid uptake over the past ten years in Flanders, Belgium, yet perceptions around motivators and barriers have not been studied and understood in detail. This paper reports on the qualitative experiences of 100 participants from 10 Flemish companies who replaced their commuting vehicle by a speed pedelec for up to three weeks. Focus groups provided data in the identification of the motivators and the barriers towards speed pedelecs in comparison to those for bicycles and pedelecs classified in nine categories. The results from the focus groups show notable differences in motivators for using speed pedelecs compared to bicycles and pedelecs—the higher available speed and range within a given timeframe, which provides the possibility of better time management. The mental benefits and the competitive aspect of commuting with a speed pedelec were identified as new motivators. The purchase cost and the perception of safety as barriers remain, with reliability, flexibility, and planning identified as new barriers.

Keywords: speed pedelecs; motivators; barriers; focus groups; e-bike; commuting; pedelec

1. Introduction

The electrification of road transportation as a strategy to reduce transport-related oil dependency, carbon dioxide (CO_2) emissions, and urban air pollution is being supported by scientists, policy makers, and industry experts [1]. Battery electric vehicles have the potential to halve the impact on climate change [2] according to Well-To-Wheels (WTW) studies based on the current EU-mix for electricity [3]. This transition to electric mobility is a step forward but also only part of the solution. The switch to electric driving would even be more beneficial with a transition to light electric vehicles (LEVs) that are easily five times more energy efficient [4] than electric vehicles (EVs). Next to this high reduction of the environmental impact, LEVs could also contribute to solving congestion problems.

For the specific case of Belgium, air quality and road congestion are considerable problems. The Flemish Environmental Agency [5] states that, for 2017, there was a downtrend regarding emissions reaching the European limit values but still exceeding the values set by the World Health Organization. According to the European Commission, maintaining or improving the level of air quality reached by discouraging car use is one of Belgium's main challenges [6]. This is a daunting objective, as the number of cars [7] and the total hours of congestion are on the rise year after year [8]. Policy-wise, the focus is to switch from combustion-engine cars to (plug-in) electric vehicles with the roll-out of basic infrastructure of 5000 charging stations, purchase premiums (up to maximum €5000) for (plug-in) electric vehicles, and tax cuts [9].

There is less emphasis on LEVs, particularly in the category of—among others—the speed pedelec, which are fast electric bicycles with motor pedal assistance limited to 45 km/h and maximum motor power of 4 kW and are, in the European Union, classified as L1e-B vehicles, subject to type testing [10]. Looking at the registration numbers (16,000 for 2015–2018 [11] and 18,000 in the last 21 months [12] before the finalization of this study in September 2019), the speed pedelec is one of the LEVs identified by the Flemish commuter as holding the most promise for commuting purposes. While the uptake of speed pedelecs is noticeable, the real potential of these higher powered and faster electric bicycles has not yet been fully studied and understood. The problem statement of this paper concerns the motivators and the barriers to use a speed pedelec for commuting compared to a pedelec (i.e., electric bicycle with motor assistance limited to 25 km/h and maximum motor power of 250 W) or a traditional bicycle and the experiences with testing a speed pedelec for commuting. In this article, pedelecs and speed pedelecs are often compared. However, when talking about both, the term electric bicycles is used. If also referring to bicycles with an electric motor where no physical effort is required to move around, e.g., by means of a throttle, the term e-bike is used.

We report on results from the 365SNEL project commissioned by the Flemish department of Environment as a part of its action plan "Clean Power for Transport" (CPT). In this project, more than 10 speed pedelecs (shown in Figure 1) from different manufacturers were deployed in several companies for multiple weeks over the course of one year. The size of the speed pedelec fleet varied throughout the year due to different arrangements with the manufacturers and defects during testing. A total of 17 speed pedelecs were used during the 365SNEL project. Figure 1 shows the most frequently deployed speed pedelecs. The project aimed to provide at least 100 users the opportunity to try out the speed pedelecs for up to three weeks at a time as a replacement commuter vehicle, covering each province in Flanders. Flanders is a region in the northern part of Belgium with a population of approximately 6.6 million inhabitants [13] (in Dutch). Flanders has both a cycling culture and a well-developed public transport network, which is already in use for commuting. Getting more commuters out of their cars and on public transport also has beneficial effects on CO_2 emissions and air quality, and the same goes (to some extent) for electric scooters and electric motorbikes; however, the focus in the study was on getting car users on a speed pedelec. For an overview of the Flemish mobility behavior, the reader is referred to [14] (in Dutch).

Figure 1. Speed pedelec fleet.

This paper focuses on the insights gained from qualitative research by means of focus groups before and after the testing period. The results in this paper provide an answer to the following research questions:

- What are the motivators and the barriers for people to consider a speed pedelec as a commuting vehicle instead of their car? How does this compare to bicycles and pedelecs?
- What is their experience with a speed pedelec as a commuting vehicle after a three weeks test period?

The structure of this paper is as follows: Section 2 discusses a review of literature on the topics of motivators and barriers towards bicycles, pedelecs, and speed pedelecs and puts forward an overview of these findings grouped into nine categories. Section 3 discusses the materials and the methods employed in this research. Section 4 highlights the results of this qualitative study, Section 5 provides an overall discussion, and Section 6 presents the conclusions.

2. Literature Review

Many studies reported already about motivators and barriers for the uptake of bicycles and pedelecs as commuter vehicles. Only a few authors mentioned speed pedelecs. This literature review starts with a discussion of the yet previously found motivators and barriers, first for bicycles and pedelecs in Section 2.1 and then specifically for speed pedelecs in Section 2.2. In Section 2.3, these motivators and barriers are organized in nine categories.

2.1. Motivators and Barriers for Bicycle and Pedelecs

Motivators and barriers regarding bicycles for commuting are well defined by existing research [15–19]. Several studies have been done on the subject of pedelecs, especially on the role they could play in the overall mobility scheme. According to [20], the greatest potential to replacing cars lies in promoting pedelecs for commuting. [21] gives a similar statement. In a review of a decade of research on e-bikes, [21] divides e-bike research up into eight major sections: e-bike categories, design and performance, demographics of users, sales, user motivators and benefits, impacts on transport behavior, physical activity impact, environmental impact, and road safety. This classification inspired the development of the nine categories. Readers with an interest for a more in-depth review of the research regarding electric bicycles are encouraged to read [22].

The main advantage of pedelecs is that they can maintain speed with less effort [23]. This is also the "hidden" driver behind the motivators to use a pedelec. Increased convenience and the reduced physical exertion facilitated by a pedelec are also mentioned in the context of older adults in a region of Canada [24]. The latter also came forth in several studies [25–27]. Even though less effort is needed to reach certain speeds, some physical effort is made during e-biking, as the motor assistance operates in combination with effort by the user, as shown by [28]. The physical activity, albeit reduced, is a motivator to use a pedelec [25,29–31]. Ref. [32] also mentions that pedelecs allow users to continue to cycle against a backdrop of changing individual or household circumstances. Both [25,26] state that, besides the physical exercise, there is a mental aspect to e-biking; specifically, they highlight the feeling of being mentally free and the possibility of mentally prepping for the day ahead.

Regarding barriers towards the uptake of pedelecs for commuting, [33] states high purchase price, social stigma, and battery range. More barriers of technologic, social, and environmental kinds are weight of the pedelec, battery life, safety, and limitations of cycling infrastructure [24,32,34,35]. A Norwegian study where parents of kindergarten children were given access to different bicycle types points to a lack of packaging capacity as a barrier for pedelec uptake [35] in addition to price. Specifically, for the Flemish case, the following are mentioned: extensive commuting time, distance to the workplace, bad weather, lack of bicycle facilities at the workplace, lack of appropriate cycling infrastructure, physical constraints as a result of hilly terrain, and poor fitness level and sweating [18]. In an effort to advance the uptake of pedelecs, however, "the importance of experiencing pedelecs first hand should not be underestimated", as stated by [31]. Therefore, if the intention is to stimulate commuting with an electric two-wheeler, the possibility of testing is essential. The role of bike-sharing and especially (speed) pedelec-sharing systems is not insignificant [36]. However, the intended effect of getting car users out of their car may not occur, and pedelecs would instead be replacing traditional bicycles for commuting. Whether or not the pedelec could completely replace the bicycle, [29] states that the ones who cycle least are the most interested in buying a pedelec, which may indicate that a reduction in normal cycling is unlikely to happen, but a shift away from motorized transport or increased mobility is more likely to happen.

2.2. Motivators and Barriers for Speed Pedelecs

The availability of more motor power, higher speeds, and more sporty designs in the recently created speed pedelec category may affect the results of the above mentioned research. However, research on the motivators and the barriers of people towards the uptake of speed pedelecs for commuting is limited. It should be noted that, in literature, different terms are used to describe a speed pedelec. This might be explained by the fact that not every country makes the distinction between an e-bike and a speed pedelec. A German study points out that e-bike is a term used for a variety of vehicles, including electric bicycles and electric mopeds [37]. In an Austrian report, the term S-Pedelecs is used for an electric bicycle with a maximum speed of 45 km/h [38]. A Swiss article refers to speed pedelecs as e-bikes45 [39], and a Canadian study uses the term e-bikes for electric pedal-assist bikes up to 40 km/h. [40]. Cyclable, a large French bike retailer, states on their website the following: "In May 2018, the Union Sport Cycles, a French federation of all cycle manufacturers and traders, decided to use the following: 'speedelec' or 'speed pedelec'". They continue to give an overview of terms used in Germany, Belgium, the Netherlands, and the United Kingdom, such as S-Pedelec, Pedelec 45, E-bike 45 km/h, Speed-elec, and S-Pedelec [41]. This work uses the term "speed pedelec" as defined by Article 2.17.3 according to Belgian Law [42],

> "Any two-wheeled vehicle with pedals, excluding motorized cycles (defined in Article 2.15.3), powered by an auxiliary means of propulsion, the main purpose of which is to provide pedal assistance, the power of which is interrupted at a vehicle speed of not more than 45 km/h, and having following characteristics:
>
> - a cylinder capacity of not more than 50 cm^3 with a maximum net power output of not more than 4 kW in the case of an internal combustion engine or;
> - a maximum continuous rated power of not more than 4 kW in the case of an electric motor".

Belgian Law makes a clear distinction between the speed pedelec and the pedelec. The latter is deemed equivalent to a cycle as defined by Article 2.15.1 according to Belgian Law [42]:

> "A cycle is any vehicle with two or more wheels, propelled by means of pedals or by means of handles provided by one or more users and not equipped with a motor, such as a bicycle, a tricycle or a quadricycle.
>
> The fitting of an auxiliary electric motor with a maximum continuous rated power of 0.25 kW, whose motive power is gradually reduced and finally interrupted when the vehicle reaches a speed of 25 km/h, or earlier, if the driver stops pedaling, does not change the classification as a cycle … "

Both types of electric bicycles, pedelec and speed pedelec, are therefore seen as two different types of vehicles and should be treated separately.

Bearing this in mind, a summary is given of the relevant research on the topic of speed pedelecs known to us. A Dutch naturalistic study of the Foundation for Scientific Research on Road Safety (Stichting Wetenschappelijk Onderzoek Verkeersveiligheid, SWOV) compares the behavior of users of conventional bicycles and speed pedelecs with the conclusion that speed pedelec users ride faster and brake more and harder [43]. Further research conducted by SWOV concludes that there are differences in speed behavior between speed pedelec users as well as variation in the position users choose on the road, as the users do not always feel safe on the road [44]. The German Naturalistic Cycling Study (GNCS) includes speed pedelecs (n = 9) in their study and reports that longer distances are traveled and users travel at a higher speed overall on all surfaces compared to pedelecs [37]. This conclusion is confirmed by an Austrian study where the speed differences between bicycles and bicycles with electric support was investigated [45]. Previous research published about the study design of GNCS included safety tests done with speed pedelecs [46]. A Belgian naturalistic cycling study states that preliminary results show that varying cruising speeds are linked to the difference in maximum continuous rated power provided by the electric motor [47]. The potential for speed pedelecs to achieve a modal shift is slightly touched upon in [48]. This study shows the potential time gain as a motivator, and price is identified as a major barrier for uptake as a result of surveys among users. A Canadian temporal qualitative study of novice riders that provided electric bicycles with a maximum speed of 40 km/h to 25 test persons for everyday use during a period of three years states the following: "Prevailing themes discussed include the types of trips e-bikes are typically used for, are implications for physical activity, prospects for enabling a modal shift away from cars and encouraging multi-modal transit, and limitations (e.g., battery restrictions, heavy weight, lack of infrastructure, fear of theft, winter weather, etc.)" [40]. However, [40] does not make a clear distinction between pedelecs and speed pedelecs, as is the case in Belgium shown in the previous paragraph. A North American survey of electric bicycle owners states that 20.1% of their respondents were in possession of a speed pedelec but makes no further distinction in their conclusions [49]. A Swiss study reports on the vehicle crashes with electrical bicycles in Switzerland and includes speed pedelecs in their study [39]. Last but not least, the possible effects of rules of conduct for speed pedelecs in the Netherlands are studied in [50]. The study concludes that the scenario where speed pedelecs can choose between the bicycle path and the road dependent on the speed is most favorable in terms of the following topics: environment, air and noise, congestion, public health, and traffic safety. It is, however, not easier to enforce the rules in comparison with the current situation, where they are not allowed on the bicycle path but are allowed on the bicycle/motorcycle path and road [51].

2.3. Overview of Nine Categories

With all the aforementioned papers taken into consideration, the motivators (Mot) and the barriers (Bar) towards bicycles, pedelecs, and speed pedelecs for commute can be bundled into nine overall categories, which are each a collection of different subcategories and find their origin in literature as shown in Table 1. The subcategories are not included in Table 1 to maintain a clear overview. However, to be comprehensive, the subcategories are described in the following section.

The first category, *Properties*, refers to all properties related to the vehicle (i.e., brakes, battery, ease of use, lights, pedal assist, recognizability, tires, weight, accessories, and reliability). The second category refers to the environmental impact of a two-wheeler as a commuting vehicle, such as associated CO_2 emissions and particulate matters (PM_{10}, $PM_{2.5}$ and Ultra Fine Particles) [5]. The category *Geographical conditions* is an umbrella term for all geographical contextual variables, for example, geography (terrain and distance) and weather conditions (high temperatures, rain, wind, and snow). *Personal mobility* refers to all aspects related to time management (time gain, predictability, comparability, planning, and flexibility) and (choice of) route. *Cost of ownership* refers to the total cost of ownership as it is in [52]—the purchase cost of the vehicle but also the operational costs (i.e., charging costs) and the non-operational costs (i.e., battery pack, maintenance, leasing, fines) for the electric bicycles. The category of *Traffic safety*, on the other hand, can be divided into the following categories: infrastructure, visibility, conflicts, and legislative knowledge of the user and others. The aspects of stigma, social contacts with others, and social status were combined in the category *Social interactions*. The category *Speed* refers to the speed at which the vehicle can be ridden. Last but not least is the category *Physical effect and mental health*, which is obviously dividable into two aspects—mental health (enjoyment, clear head/fresh feeling and added attention) and physical effect (sweat, exercise, and physical condition).

Table 1. Overview motivators/barriers on bicycles, pedelecs, and speed pedelecs.

Topics	Bicycle		Pedelec		Speed Pedelec	
	Mot	Bar	Mot	Bar	Mot	Bar
Properties	.	.	[23,29]	[24,33–35]	.	[40]
Environmental impact	[15]	.	[18,20,21]	.	[40]	.
Geographical conditions	.	[15,48]	[24,26,29]	[18,30]	[47,48]	[40]
Personal mobility	.	[15,19,48]	[32,53]	[35]	[47]	.
Cost of ownership	.	.	.	[29,32,33]	.	[48]
Traffic safety	.	[15,16,19,48]	.	[24,32,34,35]	.	[40]
Social interaction	.	.	.	[24,32,33]	.	.
Speed	.	.	.	.	[47,48]	.
Physical effect and mental health	[15,17]	[15]	[24,25,29–31]	.	.	.

It can be concluded that the motivators and the barriers towards the use of speed pedelecs for commuting were not yet systematically tested in regard to the identified categories. Further research is therefore needed to more clearly define the motivators and the barriers towards speed pedelecs (i.e., a fast electric bicycle with motor pedal assistance limited to 45 km/h and maximum motor power of 4 kW, which, in the European Union, is classified as an L1e-B vehicle, subject to type testing [10]). The defined categories are used in this paper for further qualitative data analysis.

3. Materials and Methods

A qualitative approach was adopted to answer our aforementioned research questions. This paper focuses on the insights gained from the focus groups, which were conducted during the 365SNEL project. The methodology applied throughout the project is explained in detail in [54]. During the period of October 2018 until September 2019, ten testing periods in 10 different companies were undertaken with a break in July and August 2019. Table 2 provides an overview of the sector, the location, and the number of employees from participating companies. Furthermore, the table gives insight to the response rate and the number of people who participated in the focus groups and in the testing period.

In all participating companies, an in-depth interview was held with the mobility manager or a human resources (HR) representative to provide contextual information. The potential users were invited to take part in the project after an invitation to participate in the testing project was sent out throughout their company with participation on a voluntary basis. A tailored approach was taken for companies depending on size, which ranged from using an internal recruitment mail to sending out an E-newsletter or person-to-person communication and recruitment. Where possible, a sample of 10 to 15 persons was selected by the researcher from the group of respondents. The composition of the sample was weighted by age and gender with preferences for novice speed pedelec users, for full-time working employees, and for those with a commuting distance between 15 and 35 km. Previous experience from the researchers identified these to likely be the prime distances for speed pedelecs, as this range was too long for (e-)bikes and yet could provide a benefit compared to other modes of transport [4] (Dutch). Due to the lack of volunteers in Companies 2 and 4, the sample was equal to the number of respondents. In the specific case of Company 2, there were less participants than available speed pedelecs. The aim of the sample weighting was to find participants for whom a speed pedelec could potentially be a meaningful substitute or replacement for their car, which was required for the commuting distance, yet who had little prior experience with speed pedelecs. Low response numbers made it not always possible to select car users, and thus a limited amount of bike, pedelec, car poolers, or public transport users were selected. From a technology adoption perspective, the sampling aimed to exclude early adopters but instead aimed for the majority of potential users of speed pedelecs [55].

Table 2. Overview participating companies.

Overview	Company 1	Company 2	Company 3	Company 4	Company 5
Sector	Health	Commercial	Public	Commercial	Commercial
Location	North-West Brussels	Outskirts of Kortrijk	Brussels centre close to train station	Municipality close to Antwerp	Municipality close to Turnhout
Employees	+3000	±20	+100	±20	+1000
Respondents	112	7	34	11	178
Participants entry focus group	13	7	12	11	19
Participants testing period	12	7	11	11	11
Overview	**Company 6**	**Company 7**	**Company 8**	**Company 9**	**Company 10**
Sector	Education	Commercial	Commercial	Education	Research
Location	Outskirts of Hasselt	North Brussels	Outskirts of Ghent	Port of Zeebrugge	Municipality close to Ghent
Employees	+100	+100	+100	+20	+100
Respondents	61	39	15	14	49
Participants entry focus group	13	14	11	13	13
Participants testing period	11	11	10	10	12

For all the companies, the selected persons were invited to take part in a focus group of one hour or more. Each focus group started with a presentation about the objective of the study. Each participant was provided with a consent form for participation in the project, which covered audio recordings in the focus groups and (voluntary) logging of speed pedelecs rides using GPS via the RunKeeper App [56].

The researcher moderated each focus group guided by a pre-composed topic guide. By starting each focus group with the following statement: "Please introduce yourself briefly by stating your name, the extent of the commuting distance and how you came to your work today", the researcher got a starting point for subsequent questions. By first putting the focus on motivators to use current modes of transport and barriers leading to the non-use of other modes of transport, the conversation was steered towards biking. Through funneling, the conversation was narrowed down from regular bicycle to electric bicycles and finally to speed pedelecs. Taking into account the availability of the speed pedelecs (as not all sizes and models were available for use in the project), a final selection of the participants was made after the entry focus group. After the testing period, an exit focus group served to gather important qualitative data on user experiences and changes in attitude, if any.

In total, 12 entry focus groups (with one additional focus group in both Company 3 and Company 5) and 10 exit focus groups were conducted, of which 21 audio recordings were later transcribed verbatim and analyzed by the researcher using NVivo12 Plus (QSR International (UK) Limited, Cheshire, UK) [57]. One audio recording of Company 4 was lost due to technical failure. Thematic analysis was used to inductively code the transcribed focus groups guided by the phases proposed by [58]. As stated by [59], theoretical saturation was mostly reached after 10 to 12 interviews and thus reached by the number of participating companies. For privacy reasons, transcripts cannot be disclosed, as they may lead to the identification of participants.

4. Results

First, the general responses received from the recruitment survey are discussed. Subsequently, the themes discussed during both the entry and the exit focus groups are discussed.

4.1. Statistics of Recruitment Survey

For the ten companies, a total of 520 respondents out of > 5000 staff members showed their interest by filling in the recruitment survey, with 64% male and 36% female respondents. Table 3 shows statistics of specific characteristics of this group. These include age, commuting distance, and average hours of exercise/week. Besides gender, working full-time (80.6%), and preferably having no former experience with speed pedelecs (89.8%), the characteristics presented in Table 3 were used as selection criteria for the focus groups.

Table 3. General recruitment survey responses.

Characteristics	**Age**		**Commuting Distance (km)**		**Average Hours of Exercise/ Week (h)** [1]	
Group	**Recruitment**	**Focus Group**	**Recruitment**	**Focus Group**	**Recruitment**	**Focus Group**
Mean	41.32	40.91	21.57	22.63	6.01	5.39
Median	41	40	20	22	4	4
Standard deviation	8.42	8.15	9.32	6.83	3.88	3.53
Maximum	63	63	80	63	35	35
Minimum	22	22	2	3	0	0

[1] Average hours of exercise/week (h) was neither a selection criterion nor was it further specified in the survey. It includes any type of physical activity, (e.g., commuting by bike). It is included in the table to give a clear overview of the participants.

A large group of respondents (82.9%) share their life with a partner, and 71.2% of that group have a car (petrol or diesel) available for commuting. When looking at the available modes of transport to get to work, 86% of respondents have a car at their disposal. Following second, third, and fourth are bicycles (67.9% availability), public transport (35% availability), and electric bicycles (18.6% availability). Other modes of transport are carpooling, hybrid/electric cars, motorcycles (petrol or diesel), and walking. A total of 60.1% of the respondents use their car often or always to go to work, and = 28.8% of respondents never take a bike to go to work, in contrast with 27.5% who bike to work every day or almost every day. This number is almost double the 14.6% of commuters mentioned in a Flemish research on travel behavior of 2016–2017 [60], which can be explained by the fact that companies participated voluntarily in the 365SNEL project and companies were thus self-selecting for a cycling-minded workforce. In total, 63.1% of the respondents had some experience with electric vehicles in general, and only 40.4% of the respondents had never ridden an electric bicycle, while 17.1% of respondents had experience with a speed pedelec. Over 90% of the respondents found that the first contact with electric bicycles was pleasant, comfortable, safe, and made them feel confident. From the 520 respondents, 126 were selected to participate in 12 focus groups following the selection criteria mentioned above. Out of the 126 participants in the focus groups, 106 were selected for testing, 91 participated in the exit surveys, and 15 participants could not attend the exit focus groups.

4.2. Focus Group before the Testing Period

As discussed previously, the motivators and the barriers found in literature are summarized by nine categories in Table 1. Throughout the 12 entry focus groups, different topics emerged, mostly aligning with the topics found in literature, represented in Table 1. However, some categories from literature were not discussed in the focus groups while other additional topics were. Table 4 gives an overview of these similarities and differences. The table consists of three major columns—bicycle, pedelec, and speed pedelec—each with their motivators (Mot) and barriers (Bar). If a category is mentioned in literature for the respective motivator or barrier and the respective vehicle, it is indicated by a grey background, similar to Table 1. A dot (●) indicates that a certain category was touched upon for a certain vehicle during the focus groups. The size of the dot indicates the importance and the frequency of the topic. When not mentioned during the focus groups, a dash (-) is used.

Table 4. Overview of motivators/barriers for bicycles, pedelecs, and speed pedelecs.

Topics	Before					
	Bicycle		Pedelec		Speed Pedelec	
	Mot	Bar	Mot	Bar	Mot	Bar
Properties	-	-	●	●	●	•
Environmental impact	●	-	•	-	●	-
Geographical conditions	-	●	•	-	•	•
Personal mobility	•	•	•	-	●	•
Cost of ownership	-	-	-	-	•	●
Traffic safety	-	•	-	•	-	●
Social interaction	-	-	-	-	-	-
Speed	-	-	-	●	●	●
Physical effect and mental health	●	•	•	-	●	-

In the following sections, the elements of the table are presented column by column in order of importance.

4.2.1. Motivations and Barriers for Bicycles before the Testing Period

In this section, first the motivations and then the barriers for bicycles for commuting are discussed. Almost all of the participants used or tried to use a bicycle as a commuting vehicle, thus the motivations and the barriers mentioned below are based on user experience. Quotes of the participants are included when appropriate. The participants are characterized by a person specific number, their gender, their age, and their commuting distance (in km).

Physical Effect and Mental Health

The main motivator to cycle to work for the participants is that you can exercise while going to work. The time previously lost by sitting in the car is put to good use. This reason is especially important to participants with a sedentary occupation but also for participants with children who have difficulties finding time for exercise beside work and family duties.

" . . . Yes, I like to do sports and I have less time for that. So that is an opportunity to do sports . . . "

Test person 124, male, age 40, 33 km

Another implication of biking to work is the mental clarity after exercising—having a clear head to start either work or private life. Although there is (as of yet) no scientific consensus, moderate exertion is considered as mostly pleasurable [53] and was perceived as such by participants.

" . . . I feel wonderful when I get to work. My head is completely empty when I get home . . . "

Test person 47, female, age 37, 23 km

The feeling after moderate exertion leads to the following motivators: enjoyment and being outside. For some participants, mostly those who already attempted to commute by bike, riding their bike is seen as a pleasant mode of transportation, something that is enjoyable. It is a moment for themselves, where they can relax but also truly immerse themselves in their surroundings, especially when the weather is nice.

" ... Yes, it is also a means of transport and transportation, but a pleasant transport ... "

Test person 123, male, age 34, 24 km

" ... For me this is also the great motivator to take the bike: to be outside. For me, that is very relaxing ... "

Test person 72, male, age 35, 24 km

" ... You are much more aware of your surroundings compared to the car ... On the bike you can stop for a picture of a very nice sunset, while you missed it in the car ... "

Test person 44, female, age 31, 22 km

Environmental Impact

Less frequently mentioned but nonetheless relevant for some is the environmental aspect. By taking their bicycle to work, some participants aim to reduce their carbon footprint. For others, however, not polluting the environment is a nice bonus that comes with commuting by bike.

" ... And also because it's ecological. The bike is a conscious choice, not to save time ... "

Test person 49, male, age 41, 17 km

" ... If it helps for the environment, that is good. Hey, I'm not against the environment. But it's not from that conviction that I commute by bike ... "

Test person 110, male, age 55, 5 km

Personal Mobility

Lastly, for some participants, the bike is their fastest way of getting to work. When plagued by traffic jams or a bad public transport connection, the bike might not only be faster, but is also a "predictable" (consistent travel time) alternative.

" ... I forgot to mention that for me the bike is the fastest way to get here. For me, that is an incentive to get here by bike ... "

Test person 31, male, age 51, 19 km

Geographical Conditions

As there are motivators, there are also barriers that ensure that people do not use their bicycles for commuting. First and foremost, all things related to weather conditions—wind, rain, and hot/cold temperatures—ensure that commuters do not take their bike to work. In particular, wind makes it so that the effort to reach the destination has to increase, resulting in fatigue and excessive sweating on top of the fatigue and sweating that already would occur as a result of the commuting distance. Both results were not pursued by participants. Dependent on the type of work (e.g., dress code), showering and specialized clothing is thus required, which consequently brings with it preparations and loss of time.

" ... I do come by bike once in a while, but not often actually. This is mainly due to the hassle. Showering and putting the clothes ready and also the time (required) actually."

Test person 121, male, age 54, 24 km

" ... I didn't like the idea of the regular bike, then also the showering, changing clothing scenario. It takes extra time and that is just not doable with an ordinary bike ... "

Test person 10, male, age 56, 17 km

" ... I used to go on a MTB and then I have to change clothes here, take a shower because I have been sweating. We can save time there ... "

Test person 74, female, age 48, 24 km

Others indicated that the distance to travel is just too far, the terrain is hilly, and the current infrastructure is in such a state that a safe and pleasant commute is not an option.

" ... Weather conditions affect me much less. It's really just the distance. By bike, it would take me 2 or 2.5 h to get here. So we're not going to do that ... "

Test person 35, male, age 36, 43 km

Others

Finally, less recurring barriers are a lack of flexibility compared to a car, less baggage capacity, the reliability of the vehicle, and limited physical abilities.

4.2.2. Motivations and Barriers for Pedelecs before the Testing Period

In this section, first the motivations and then the barriers for pedelecs for commuting are discussed. Most of the participants had already come into contact with a pedelec, and a small number used a pedelec as a commuting vehicle, thus the motivations and the barriers mentioned below are partially based on user experience. The quotes of participants are presented in the same manner as before.

Properties

Pedelecs with a pedal assisted maximum speed of 25 km/h can remove certain barriers associated with bicycles. As shown in literature, distance, (hilly) terrain, limiting physical abilities, and sweat (with subsequent time loss) could partly be overcome. Although the added electrical pedal assist could suggest a decrease of the physical effort, research showed that e-cycling also has the ability to increase physical fitness, as longer distances are more likely to be traveled [28].

" ... It takes me about as long electrically as it would take me to get there with the car (with no traffic). With the car you are always held up somewhere. I just like it, you're outside, you have some movement ... "

Test person 71, female, age 43, 15 km

" ... I came here with it (pedelec) last year, that's kind of cool. You're not that tired. You're less sweaty ... "

Test person 106, male, age 46, 11 km

The added benefits of pedal-assist, such as time gain, provide motivation to use a pedelec for commuting. Nonetheless, the benefits bring with it some drawbacks, which are perceived as barriers for the uptake.

Speed

The first barrier is the maximum assisted speed of the pedelec—25 km/h is seen by participants as too low a speed for (semi-) trained cyclists, especially those who regularly ride a racing bike and consider the maximum of 25 km/h an easy to reach restriction by medium effort and see the discontinuation of the pedal-assist at that point as something unfortunate.

" ... I always ride a little over 25, so when you go above that with the pedelec, it starts to get a bit tricky. I find that an unpleasant feeling."

Test person 32, male, age 51, 19 km

" ... up to 25, 26 km/h, then the support stops and it's a 23 kg bike. Yes, compared to a racing bike, I am faster with a racing bike than with an electric one ... "

Test person 98, male, age 42, 40 km

In the "Pedelec Promotion" scenario stated by a German study [61], a maximum speed of 30 km/h is suggested as an evolution for 2030. Such proposals correspond to what some participants convey in the entry focus groups.

> *" ... I think that's a pity with an electric bike, that it's so divided, 25 vs. 45 km/h ... I would really go for a bike where you keep your support and then you ride 30 or 35 km/h ... "*
>
> Test person 96, male, age 30, 37 km

Others

Other possible concerns or barriers specific for pedelecs are related to the electric components regarding the battery, in particular the range, and the availability of nearby repair shops. Aforementioned statements and occurring motivators/barriers towards bicycles and pedelecs are largely aligned to what has been published previously.

4.2.3. Motivations and Barriers for Speed Pedelecs before Testing Period

Given one of the selection criteria to participate in the 365SNEL project was little or no speed pedelec experience, the motivations and the barriers of the participants to take up a speed pedelec for commuting were assumptions by them and were not based on actual user experience. Therefore, the motivations and the barriers identified at the pre-testing focus group stage are preconceptions by the participants. First the motivators and then the barriers are described in the following sections.

Speed

An essential and differentiating part of speed pedelecs is their maximum motor assisted speed of 45 km/h. The advantage of going faster without deceleration due to wind and thus covering more distance in less time, preferably with no excessive exertion, is seen as a benefit of speed pedelecs by participants. This also raises concerns due to a lack of experience with those speeds and the possible effects. The speed pedelec enables commutes that were impossible with either a bicycle or pedelec before due to terrain or distance. It was noticeable that most participants, especially those who had not yet come into contact with a speed pedelec or its user, were focused on the 45 km/h as an achievable average speed, their cruising speed (defined in [62]) as it were. However, in reality, not all speed pedelecs are able to reach a speed of 45 km/h, and neither is it a common cruising speed [62]. The maximum speed is dependent on level of assistance, motor power, and pedal power input delivered by the user. The possibility of traveling at speeds lower than the maximum speed limit was frequently overlooked.

> *" ... I'm not a hero on a regular bike, so I think 45 km/h or 40 km/h, I'm never going to dare to do that."*
>
> Test person 11, female, aged 43, 30 km

> *" ... There's a maximum of 45 (km/h). That's the maximum (speed) you want to reach ... "*
>
> Test person 94, male, age 35, 20 km

> *" ... I think it's (the speed pedelec) going to drive 45 (km/h) anyway ... "*
>
> Test person 115, male, age 47, 21 km

Personal Mobility

In specifying their motivation to participate, time management was the most frequently occurring theme covered by the overarching theme of mobility. Within the concept of time management, the following three categories can be identified: time gain, arrival time predictability, and comparable travel time. Firstly, the commuters were curious about what was possible with a speed pedelec, e.g., how much time could be gained compared to their previous mode of transport. That time gain could be obtained in different ways. First and foremost, the higher estimated average speed, not needing to shower after the commute, avoiding traffic, and a shorter route are other ways of gaining time in the overall commute.

> *" ... Also saving time again. I may be going home at a later time, but I won't have to take a shower like I used to, with the regular bike I will have to take a shower as soon as I get home and immediately when I get to work ... "*
>
> Test person 7, male aged 30, 25 km

> *" ... Now, what am I doing right now? I just start earlier, at a quarter to 6 I leave by car, then I am here at 5 past 6, then I am here in 20 min, then a car is easy of course. But of course I would rather start again at 7 o'clock, but that means that it takes an hour and a half by car and therefore that the bike becomes interesting when it has a higher speed ... "*
>
> Test person 13, male, aged 41, 18 km

> *" ... The distance I have to do from home to work, in the morning it's traffic jam. In all possible directions, no matter how I ride, I am stuck and that frustrates me endlessly. The route has silted up in less than 3 years. It has completely turned 180°. It's become like that bit by bit, but now I'm really tired of it ... "*
>
> Test person 16, female, aged 57, 10 km

Secondly, the entry focus groups showed that, for some participants, being able to predict the duration of their commute and the consistency of that duration was key. The speed pedelec provided them with an arrival time predictability [53] they lost with their previous commuting vehicle.

> *" ... I hope to have more predictability of my time because it's just, now I don't know if I'm going to be able to cook at home ... "*
>
> Test person 5, female, aged 35, 22 km

Lastly, the travel time should be comparable to the existing travel time. For some participants, it was clear that a shorter travel time is just not an option, in most cases due to a large commuting distance. In that case, the assumption that the speed pedelec takes about as long as the previous mode of transport justified considering a speed pedelec as a future mode of transport.

> *" ... I hope to see that I am here at the same time as the car, if necessary a few extra minutes ... "*
>
> Test person 66, male, aged 34, 21 km.

Physical Effect and Mental Effect

A third motivator for participants (mostly car users) was the expectation that their physical condition would heavily improve, especially since they used a car to commute and would exercise, for example, one hour per day instead of sitting in their car for one hour per day. Understandably, trained cyclists who used their bike for commuting stated that commuting by speed pedelec would not improve their physique.

> *" ... moving around for 2 h a day, even if it's not very intensive. That should have an effect on your body ... "*
>
> Test person 44, female, age 40, 33 km.

Environmental Impact

A fourth motivator was a desire to leave the car for the sake of the environment.

> *" ... the environment, the fact that you don't drive your polluting car to work again ... "*
>
> Test person 74, female, age 48, 24 km

" ... It's better for the environment than coming by car ... "

Test person 27, female, age 48, 16 km

" ... And I want an alternative to come to work because that car, that's not going to last anyway. And that (speed pedelec) is a super alternative! So I think it's nice and new way, also to persuade people who are not cyclists to switch to something better for the environment ... "

Test person 122, female, age 31, 12 km

Cost of Ownership

When considering a speed pedelec as a future commuting vehicle, a significant barrier is the price of the vehicles [49], especially the stark difference in price compared to pedelecs.

" ... I've already seen prices and think it's quite pricey ... "

Test person 45, female, age 38, 20 km

" ... And I've actually already thought about buying a speed pedelec. But then I thought that it's a hefty investment ... "

Test person 67, male, age 29, 25 km

Yet, there were some who were already calculating how much they could save in costs of fuel, insurance, and maintenance by replacing their car with a speed pedelec. Some already counted on a leasing program to avoid the high purchase cost or took cycle reimbursement into account during a return on investment calculation. The latter initiatives were certainly seen as a motivators.

" ... Yeah, financially. If you can leave your car at home, it's quite a sum of money in gasoline every month ... "

Test person 108, male, age 48, 21 km

Traffic Safety

Second to cost of ownership is traffic safety as a barrier for uptake of speed pedelecs. Concerns towards safety largely relate to a lack of experience with high speeds on a two-wheeler, negative traffic experiences, and not being recognized in traffic. Due to insufficient knowledge of traffic regulations for speed pedelecs, discussion arose among participants about where a speed pedelec should be driving—on the bicycle paths or on the road. Based on their experience as cyclists in traffic, most of the participants recognized that a two-wheeler on the Belgian roads is vulnerable. Largely thanks to ribbon development, Belgian bicycle paths in most cases are close to housing and adjacent driveways, which can lead to traffic conflicts. Keeping in mind the assumption that 45 km/h was a possible cruising speed, participants found it dangerous to share a bicycle path with others traveling at much lower speeds. Riding on the road was seen by those same participants as possibly conflict-inducing with cars. Combined with a perceived limited recognizability in traffic (over half of the participants found it hard to recognize a speed pedelec in traffic or named characteristics not unique to a speed pedelec, i.e., helmet, dark colors, heavy frame, and mirror), participants were concerned for their safety. Suggestions for a common identification returned in several focus groups.

" ... Yes, I have a concern with the safety actually, because with the car, you have that big stuff around you, you feel safe. But with the speed pedelec, 45 km/h is quite a big speed. If anything goes wrong ... "

Test person 77, male, age 44, 34 km

" ... But I don't know the difference between a speed pedelec and a regular pedelec. I just don't know ... "

Test person 27, female, age 48, 16 km

Others

Other barriers—similar to those of bicycles and pedelecs—were identified as a lack of appropriate infrastructure, weather conditions (in particular, rain and snow), battery range, stationing problems, and reduced flexibility compared to a car.

4.3. Focus Groups after the Testing Period

After three weeks of the test period, the participants returned for a final focus group. During these focus groups, participants were asked how they had experienced the three weeks of commuting with a speed pedelec. The findings from these focus groups are described below following this structure: general sentiments after the testing period, similarities in motivations and barriers towards speed pedelecs, changes in motivations and barriers towards speed pedelecs, and other insights gained as a result of a focus group after three weeks of testing. Table 5 presents the similarities and the changes in motivations and barriers towards speed pedelecs after a testing period of three weeks.

Table 5. Overview similarities/changes in motivators/barriers.

Overview	Motivators	Barriers
Similarities	Environmental impact	Cost of ownership
	Personal mobility	Traffic safety
	Physical effort	Geographical conditions
	Properties	
Changes	Mental health	Properties
	Traffic safety	Social interaction
	Competiveness	Personal mobility

4.3.1. General Sentiment after the Testing Period

" … Very cool, very nice to do! … A very nice experience … For me, it had been predominantly positive! … I really enjoyed it, I thought it was very positive … It has been a pleasant experience … In general, very positive … I liked it very much … Yes, it was very positive! … I was actually very happy from day one … I only have a positive experience! … Generally I liked it … I've arrived at work and left work every day with a smile on my face … I found it to be very enjoyable … I cycled every day and with a lot of enthusiasm … I found it very enjoyable … "

For a large part, as is shown in the statements above, the general sentiment after the testing period was positive. To be exact, from a total of 91 focus group participants, 54 indicated that they had a positive feeling when commuting with a speed pedelec, 12 participants indicated that, although they largely enjoyed the commute, a speed pedelec is not necessary for their trajectory, 11 were neither convinced nor unconvinced, four were not happy with the commute, two did not indicate what they felt, and eight were lost with the lost recording. Fifteen participants did not attend the exit focus group.

4.3.2. Similarities in Motivations and Barriers after Test Period

Environmental Impact, Physical Effort, and Properties

After the testing period, most of the motivations from before the test period still stood. The speed pedelec was still considered as more environmentally friendly than a car, the higher achievable speed limit was still an inherent driver to use a speed pedelec, and with it there was the possibility to cover more ground more quickly and with less influence from wind or terrain.

" … I did like the fact that I had the support during headwind. Because that makes it unpleasant to come with a bicycle … I didn't have that anymore … "

Test person 103, female, age 38, 8 km

Personal Mobility

Better time management also remained as a main motivator to participants to commute with the speed pedelec. Some mentioned that they had actually gained time. Others who before thought they would save time on their commute actually had a comparable commuting time that was only slightly longer compared to their previous mode of transport. This was, in most cases, not considered a problem, as participants note that their commute with a speed pedelec made it possible to make up lost time, because they were exercising while going to work instead of sitting in their car.

"I normally drive the car, 45 min, now (with the speed pedelec) it's 55 min. So I've lost some time now … That's not such a problem in itself, because you've been moving … "

Test person 75, male, age 35, 18 km

Before the testing period, a small number of participants were hoping for a more predictable travel time, which, after the test period, proved to be a great advantage for a much larger number of participants, although it was unexpected.

" … With me also the experience of always a fixed time from home to here. I did not have to get up earlier or leave earlier or something. It all fitted in perfectly with the timing … "

Test person 4, male, age 25, 20 km

" … Now my travel time was really one hour, whenever I left … "

Test person 89, female, age 40, 26 km

Cost of Ownership

As with the motivators, some barriers remained the same after the test period. First off, price remained the main barrier.

" … I'm considering buying one but still find it pricey … "

Test person 121, male, age 54, 24 km

" … I think it's too much money … "

Test person 19, male, age 54, 8 km

" … I do think about it (buying a speed pedelec), but I still find it very expensive … "

Test person 69, female, age 35, 23 km

According to the participants, financial cycle reimbursement (now maximum 0.24 €/km [63]), group purchases, multi-day testing session, and leasing formulas are initiatives that can be set up in order to further motivate employees to consider a speed pedelec as a commuting vehicle and not be stopped by a steep purchase price. Other suggested company initiatives were a permanent testing fleet within a leasing formula, electric bicycle friendly parking infrastructure, and (semi-) permanent bicycle repair capabilities nearby the work location.

Traffic Safety

A second barrier was the perceived safety of a speed pedelec. As with the price, this remained a barrier, although for different reasons. Participants felt unsafe when they came into frequent contact with other road users, who were often unaware of the road regulations around speed pedelecs, via roundabouts, crossings, and adjacent drive ways, or when they were sometimes forced by the road regulations to drive on poor (bicycle) infrastructure.

" ... In terms of dangerous situations, you think about that, every time that you might come into conflict with someone else. Especially when there are side-roads on those roads ... "

Test person 23, female, age 56, 22 km

" ... They drove me off the road. It was an older gentlemen, who pushed me off the road with his car. 'You have to ride on the bike path', he said ... "

Test person 108, male, age 48, 21 km

" ... I have one time that I was cycling on a street with speed limit 50, that I saw a car (driver) make some gestures. People don't know, nobody knows the regulation ... "

Test person 51, female, age 34, 20 km

Participants indicated that the improvement of general road regulation knowledge for all road users was important to feel more safe in traffic. They would feel more safe if they would fully be accepted as a road or a bicycle path user by the other road users. The need to improve the infrastructure was also stated during almost all focus groups.

Geographical Conditions

A third barrier that remained after three weeks of testing was the weather. The participants who enjoyed commuting by speed pedelec stated that, with the correct accessories, weather influences such as wind, rain, and cold temperature could successfully be countered. However, they also stated that, at the point of departure, if it would rain or be slippery due to freezing temperatures, they would not be inclined to commute by speed pedelec and would prefer their car instead.

" ... I was afraid to cycle in the cold, but because the clothes we got, I was not cold. I was pleasantly surprised by that! ... "

Test person 51, female, age 34, 20 km

" ... I am hesitating to buy one, partly because I'm not going to use it that often in the winter, I think it's a bit dangerous ... "

Test person 69, female, age 35, 23 km

" ... I think when it's freezing all the time, that (riding a speed pedelec) is dangerous ... "

Test person 19, male, age 54, 8 km

4.3.3. Changes in Motivations and Barriers after Test Period

After three weeks of test driving, certain motivations and barriers changed compared to before the test period.

Traffic Safety

Views on safety changed slightly. Some participants reported feeling pretty safe because of the weight and the fat tires of their speed pedelec, while others felt more safe with the route they could choose due to the legislative nature of the speed pedelec between the bicycle path and the road. In Belgium, when the speed limit is 50 km/h or below, speed pedelecs are allowed to ride on the road or the bicycle paths if the right signs (D7 sign or equivalents) are in place. When the speed limit is 70 km/h, they are obliged to ride on the bicycle path if available and if the right signs are in place. When no bicycle path is available, the speed pedelecs cannot ride on that particular road. They must continue on foot, if possible. In most other cases, the speed pedelec is not allowed. Speed pedelecs should also always adhere to the speed limits. For a more detailed description of the traffic regulations, the reader is referred to [64] (in Dutch). By switching between bicycle infrastructure and roads, the participants were able to determine for themselves what the safest option was.

“ . . . Since my speed pedelec didn’t go that fast, I didn’t feel safe to ride between the cars on the road . . . I thought it was safer on the bike path . . . ”

Test person 56, female, age 44, 28 km

“ . . . Where it (the speed limit) was 50 km, I actually drove as much as possible on the road, which I found much more relaxed, than riding on the bike paths . . . I quickly decided to ride on the road, it’s more comfortable, less dangerous . . . ”

Test person 80, male, age 55, 32 km

“ . . . Before the testing period, I thought it (the speed pedelec) was something dangerous and not for me. In hindsight, it is . . . ”

Test person 22, male, 46 age, 25 km

Mental Health

Before the test period, the participants suggested that their physical condition would improve but applied less importance to a possible improvement of their mental state as a motivator. After three weeks of experience, that changed. The participants really enjoyed arriving fresh and awake at work. Being in nature and spotting all sorts of animals is something that is often repeated as enjoyable. Commuting with a speed pedelec made most participants less stressed and more mentally ready for the day ahead.

“ . . . Mentally, I am also fresher at work. More relaxed. With other vehicles I’d arrive at work with more stress . . . ”

Test person 124, male, age 40, 33 km

A similar story for the commute home, the participants’ thoughts were either focused on the road or wandered off during the ride, thus once the participants came home, they no longer thought about work. Some even claimed to have renewed energy when they came home.

“ . . . I also had that during the cycling, that I could forget about work, and could consciously come home . . . I was so concentrated on the road that I, as a matter of speaking, did not have time to think . . . ”

Test person 59, male, age 31, 20 km

Competitiveness

The participants also felt motivated to commute with a speed pedelec out of some kind of competitive spirit. Participants not only tried to compete with themselves by trying to shorten the travel time each commute or by trying to reach new maximum speeds, they also competed with other road users or even their own partner. The former was done by wanting to leave faster at red lights or passing by other speed pedelec-users. The latter translated in sending travel times to each other or training together, one with a speed pedelec, the other with a racing bike.

“You’re just pushing for the limit of maximum speed . . . You start to reason, at that speed (45 km/h). I can overtake the next cyclist, and the next . . . “

Test person 123, male, age 34, 24 km

“ . . . I’d like one that can do 45 an hour. That’s when the competitive spirit comes up in me as well. Especially when I drive home, I can improve my travel time and take screenshots to send to my husband . . . ”

Test person 58, female, age 36, 18 km

Properties

Before the test period, there were some concerns mentioned by participants regarding the battery and the reliability of it. This was seen as a barrier for uptake, but the test period proved that the concern for reliability was justified, not only with regard to the battery but to the entire speed pedelec. There was only one test period out of the 10 conducted where there were no "defects" to one speed pedelec in the fleet.

A summary of the defects encountered is: many flat tires, a bike stand broke off, battery connection problems, pedals broke off, charging problems, software malfunctions, chain breaks, broken gears, squeaking brakes, malfunctioning gear systems, broken mirror, broken gear shifter, a broken crank, motor malfunctions, battery casing came loose, oxidation of charging contacts, bolts came loose, ball bearing broke, spokes broke, saddle clamp broke, mudguard came loose, horn kept honking, horn did not work, bell broke, broken assistance controller, deformed tire, etc.

Social Interaction

Another barrier was the negative attention the participants received from other road users that were mostly confused as to where the speed pedelec should be—on the road or on the bicycle path. Situations where participants were forced off the road by car drivers or where impolite hand gestures were directed to the participants were not uncommon. These incidents gave the participants the feeling that they did not truly belong anywhere, as they were not accepted by either cyclists or cars on the bicycle path or the road, respectively. Only a few participants perceived themselves as "cheaters" for using a speed pedelec to commute.

" … I think that people still look at this in a negative way, like 'You are in the way!' … "

Test person 111, female, age 52, 30 km

" … I once passed a group of race cyclists, I passed them doing 40, and they called me a cheat … "

Test person 45, female, age 38, 20 km

Personal Mobility

Finally, regarding time management, where before there was a belief that time gain was a certainty and it was a strong motivator, and for some it appeared to be so, after the test period, the time gain was more relative. Where some had time gain while actually traveling, they still had some time loss with the preparation of their commute and the handlings after the commute, namely packing the accessories, (un-)stalling the speed pedelec, charging the battery, and/or changing rain clothes. Facilities adapted to e-cycling do take away a large amount of those issues.

" … It's an obstacle for me to switch to a speed pedelec because of the hassle of getting ready. I just want to be able to lock my bike and start working … "

Test person 123, male, age 34, 24 km

" … I lost the time I took in the morning to get a coffee, because I needed to change clothing … "

Test person 24, female, age 42, 23 km

Compared to the car, the speed pedelec proved to provide less flexibility and required more planning with regard to work visits, family life, groceries, and hobbies.

" … You have to do some preparation before you come here. That was actually the hardest part for me … "

Test person 19, male, age 54, 8 km

" … The problem is, it's not like getting in and out the car. You already need some preparation … "

Test person 81, male, age 51, 20 km

" ... With the car, you can drop the kids off and go directly to work. That's a different feeling compared to the speed pedelec ... "

Test person 116, female, age 34, 22 km

4.3.4. Other Findings

Besides motivations and barriers towards speed pedelecs for commuting, the exit focus groups also showed other findings. In this section, those particular findings are described.

Speed Differences

The test fleet used during one year of testing consisted of a variety of speed pedelecs with the biggest distinction to be made between the maximum continuous power of the motors, particularly with two categories: 350 W and 500 W. It was noticeable that almost all participants who rode a speed pedelec with a 350 W motor indicated that they could not easily reach 45 km/h. They claimed to have a top speed of 42 km/h, requiring quite some effort to maintain, with an average speed of 38 km/h. Only few participants could actually continuously ride at the maximum motor assisted speed limit.

" ... I couldn't easily reach 45 km/h with the speed pedelec ... "

Test person 69, female, age 35, 23 km

" ... Above 43 km/h, I had the feeling that the support was almost gone. It's like riding with a brake on ... "

Test person 49, male, age 36, 28 km

" ... Reaching 45 km/h, that went pretty smoothly, yes ... "

Test person 112, female, age 37, 35 km

Not reaching the maximum speed of 45 km/h was, for some, a disappointment, because before testing, they assumed that the maximum speed was an achievable speed. According to the test persons, it is possible with the 500 W speed pedelecs but not with the 350 W speed pedelecs. This is, however, yet to be confirmed by GPS data collected within the scope of the 365SNEL project.

" ... I had a bit of a disappointment with the speed. I thought each speed pedelec could go 45 km/h ... "

Test person 51, female, age 34, 20 km

After accepting the feeling of disappointment and letting go the urge to try and reach 45 km/h, the participants experienced a sense of freedom and relaxation, which made the commuting trips less about gaining time but more about mental relaxation, being outside, and exercising.

" ... I do hear that others could use their bikes a lot faster and quite effortlessly. But that is not really necessary for me personally ... "

Test person 74, female, age 48, 24 km

Comments of Speed Pedelec Specifics

The test fleet consisted of speed pedelecs of different brands and different components. The different motors were already mentioned, but tires, lights, acoustic warning devices (bell or horn), position of the rear view mirror, and size of the handlebars were also different. After the test period, the participants had positive and negative views on these components. The obligatory mirror [65], for example, was generally well accepted and highly used by participants. However, some experienced difficulties with it, as it lost its functionality by fogging up or by not holding the ideal position due to vibrations. Others with a mirror positioned on the side of the handlebar found it enlarged the handlebar by about 10 cm, making it difficult to maneuver between objects, leading to small accidents or incidents with other passing road users.

" … I've also had a cyclist really tapping my mirror, You get out of the way as much as possible, but cyclist misjudge that … "

Test person 21, female, age 40, 20 km

" … I found that (mirror) very useful, very good. But I think it makes your bike a lot wider … "

Test person 107, male, age 50, 30 km

" … I understood the usefulness, but it was more wrongly oriented than it was placed correctly … "

Test person 7, male, age 30, 25 km

Another component the participants had reservations about was the acoustic warning devices, particularly with the bicycle bell and the horn. On the one hand, the bicycle bell was perceived as too quiet when participants approached other road users at high speeds, whereas the horn was considered too aggressive and loud. The participants often cited that the horn did not have the desired effect of warning other road users of their presence but instead startled other road users. Participants started to develop different techniques to warn other road users, e.g., by honking 50 m in advance and then another time before passing by. There were even some participants who did not use their acoustic warning device and yelled or used the squeaking of their brakes to notify others of their presence. All of the participants indicated they always aware of the situation around them and adjusted their speed when approaching other bicycle path users.

" … Yes, I never used it (the horn). Sometimes I waited until they noticed me, just because I found it unpleasant for them to use it … "

Test person 68, male, age 30, 31 km

" … The annoying thing is also that when there are people in front of you cycling or walking that you want to pass by, that they or don't react to your horn or think that that sound comes from the road. So you should always slowdown, which I did … "

Test person 88, female, age 27, 26 km

In addition, fatter tires were found to be good because of better road handling, and the advice came from the participants to install indicator lights on the back of the bicycle, thus they did not have to release the handlebars at high speeds to signal to other road users where they were going.

" … What I did miss was an indicator light. To drive 45 km/h on the Belgian roads and then extend one hand … If then you drive in a pothole, you have an accident … "

Test person 120, male, age 35, 11 km

" … The first time I thought: 'Help, there are no indicators here."

Test person 16, female, age 57, 10 km

Participants with a speed pedelec with a 500 W motor who reached speeds close to 45 km/h also complained about wind noise and pain in their ears. This was solved by some by riding with earplugs or ear plugs with music playing. Whether or not this was a safe measure to solve the problem of wind noise was a point of great discussion.

" … The sound of the wind, I found very unpleasant. The first week I drove around with earplugs … "

Test person 123, male, age 34, 24 km

" … While you're cycling, the wind is bothering you. I've cycled a couple of days with made-to-measure earplugs with music or something, but it didn't help … "

Test person 94, male, age 35, 20 km

Legislation and Regulation

Before the testing period, the participants were informed on rules and legislation concerning speed pedelecs in Belgium. The difference between a pedelec and a speed pedelec was explained, as were the consequences in regulation. Almost all participants made use of the possibility to choose between the road and the bicycle path. The choice for the road was usually motivated by the poor quality of the cycling infrastructure and a mismatch in speed between bicycle path users and the speed pedelec user. However, during the focus groups after the testing period, it became apparent that a large proportion of the test subjects had not always adhered to the traffic regulations. This manifested itself in two ways: riding on bicycling paths when that was not allowed and not abiding to the speed limits, in particular on tow paths (speed limit of 30 km/h) [66]. In the first case, they often found riding on the bicycle path safer than riding on the road or found it unnecessary to change from bicycle path to road when there was no other change in infrastructure except for a road sign. Most of the participants made the assumption that the road signs were, in most cases, not yet adapted to facilitate speed pedelecs, and it was therefore permissible to ride on those paths. For some, the road regulations and road signs were not always clear-cut, even after an extensive explanation before the testing period. In the second case, the participants indicated that they most often violated the speed limits when the situation lent itself to driving at higher speeds than the speed limit, for example, on the good infrastructure of the tow paths. Some were even unaware of the specific speed limit on the tow paths, even after the information sessions at the start of the testing periods.

" … Although the tow path, there I doubt if I can only go 30 km/h there. In itself, those are the places where you can get your speed, aren't they? … "

Test person 113, female, age 54, 30 km

" … In the 30 km/h zone, I find it very difficult to drive 30 km/h. I was always over the limit … "

Test person 89, female, age 40, 26 km

" … What disappointed me was the road signs, that I didn't see much P's [speed pedelec sign in Flanders] Yes, are those road signs not yet adjusted or not? I don't know … "

Test person 127, male, age 48, 18 km

" … I didn't look at the signs to see if I was allowed to drive there or not actually. I always thought it too complicated … By the time you realized what to do, you were already past it … "

Test person 51, female, age 34, 20 km

" … I still find it something strange. For me it is neither a bike nor a moped. It rides on the bike path, but you are not a bike. I don't really know. It is hard to put a finger on it … "

Test person 19, male, aged 29, 3 km

Wearing a helmet was also obligatory, and all participants confirmed that they wore the helmet for all of their commuting trips. Only for short distances, less than 5 km to the bakery or store, a few participants mentioned not wearing the helmet.

" … Yes, I almost always wore my helmet. I didn't wear it on one occasion, to go to the store … "

Test person 14, female, age 28, 3 km

A final noticeable finding regarding the legislation surrounding speed pedelecs was the participants' amazement at the lack of knowledge and the subsequent interest their environment had for the subject of speed pedelecs, with one participant even getting approached by a police officer asking if she needed a driving license to drive that vehicle:

" … He (the police officer) asked me: 'Do you need a driver's license for that, too?' I thought 'Shouldn't you just know that? It's your job.' … "

Test person 71, female, age 43, 15 km

Personal Mobility

Some participants claimed to take the same route every day, mostly the experienced riders who had already optimized their route during (e-)bike commuting trips. Nevertheless, most indicated that they changed their routes in search for better infrastructure and roads with less traffic, avoiding city centers and maneuvers. With the help of the pedal assistance, participants were free to explore for a route to work away from traffic.

> *" … By using the speedelec [sic] I found a nicer and quieter way to cycle to work. With the speedelec [sic] you dare to try another way because a few km detour is not burdensome … "*
>
> Test person 100, male, aged 54, 24 km

Social Interconnections

Finally, what was striking about the different companies was that, during the test period, the participants sought each other out, even without knowing each other at first. Participating in the project or all riding the same kind of vehicle created a kind of connection among participants. Possible routes were being compared, experiences shared, and people cycled together and were comparing speed pedelecs among each other. Whether such social interconnections within the group were a result of partaking in a project together or all commuting with a speed pedelec or a combination of the two was not part of this research and remains unclear. It was experienced as a positive effect of the testing period.

5. Discussion

5.1. General Overview of Motivators and Barriers before and after Testing Period

Table 6 gives an overview of all motivators and barriers given by the participants for each vehicle with a ranking of importance marked by the size of the dot (●) before and after the testing period. This is linked to literature by the indications of a grey background.

Table 6. Overview motivators and barriers after testing period.

Topics	Before						After	
	Bicycle		Pedelec		Speed Pedelec		Speed Pedelec	
	Mot	Bar	Mot	Bar	Mot	Bar	Mot	Bar
Properties	-	-	●	●	●	•	●	●
Environmental impact	●	-	•	-	●	-	●	-
Geographical conditions	-	●	•	-	•	•	•	•
Personal mobility	•	•	•	-	●	•	●	•
Cost of ownership	-	-	-	-	•	●	•	●
Traffic safety	-	•	-	•	-	●	•	●
Social interactions	-	-	-	-	-	-	•	•
Speed	-	-	-	●	●	●	•	•
Physical effect and mental health	●	•	•	-	•	-	●	•
Competiveness	-	-	-	-	-	-	●	-

In Table 6, it can be noticed that not all motivators and barriers discussed in literature were discussed in the focus groups. More importantly, there were motivators and barriers that were not included in the literature. After the testing period, it even appears that a new category, *Competiveness*, can be added with regard to the motivators speed pedelec users have for commuting.

Compared to bicycles, our findings confirm previous results in the literature, add the fact that, for some, commuting by bike is the fastest way to work (*Personal mobility* motivator).

A similar statement can be made for motivators and barriers towards pedelecs for commuting, with the noticeable exception of the new barrier, which is related to the maximum pedal assisted speed of 25 km/h. The participants found this to be limiting, as especially the trained cyclists could reach higher speeds with less effort on a lighter bicycle.

As for the motivators and the barriers in relation to speed pedelecs, it should be noted that, before the testing period, participants were convinced that the maximum pedal assistance speed of 45 km/h was a speed they would easily achieve and would drive at almost constantly during their commute. This assumption largely influenced their views on *Personal mobility*. Time gain appeared to be, for most, the biggest motivator to take up a speed pedelec as a commuting vehicle. There were concerns regarding *Traffic safety* caused by weather conditions, unknown traffic regulations, and recognizability and acceptance of speed pedelecs by other road users, which proved to be barriers besides the most important barrier, purchase cost. After the test period, the idea of riding 45 km/h constantly was dropped, and the predictability of their commute became more important as a motivator.

With regard to *Traffic safety*, many participants made, according to their own judgement, good use of the possibility of riding on either the road or on the bike path, which increased their feeling of being safe as they felt able to drive safely in traffic. Another change after the testing period was the increased importance participants attached to their mental wellbeing during commuting, where this was not the case before. Others saw the speed pedelec as a means of unleashing their competitive spirit, which created a new category of motivator besides the nine pre-defined categories. Although competitive spirit can also be intuitively placed as a motivator for bicycles and pedelecs, this aspect did not emerge as a motivator for commuting in the initial literature study or during the focus groups before the testing period. Only after the testing period did competitiveness emerge as a motivator to ride a speed pedelec. A subsequent literature review shows that facilitating competition through gamification with smartphone applications such as Strava can have a motivating effect on increasing bicycle use [67,68]. A similar effect might be possible for e-bikes but is, to the best of our knowledge, not reflected in the literature. Changes in barriers were noticeable concerning planning and flexibility, which proved challenging in comparison to the ease of a car. Concerns were also raised about the reliability of the speed pedelec as a vehicle property, as several malfunctions or defects regularly occurred throughout all the testing periods. For those who were planning to completely substitute their former commuting vehicle, that was seen as a barrier. Lastly, the negative reaction of other road users proved for some participants to be a demotivator for the uptake of a speed pedelec.

5.2. Limitations

This study was conducted over a period of one year in Flanders, Belgium, which meant that only Flemish companies were able to participate in the project. It is possible that companies with an existing cycling culture or a tendency to focus on more sustainable commuter traffic were more inclined to apply, which may bias the results. A similar statement could be made about the participants, as those who applied may have been inclined to switch to a speed pedelec or were already in favor of it. The previous statements about the selection bias are also further influenced by the fact that Flanders is a region with a strong cycling culture. Furthermore, for each company, no control group without an intervention organized was used as a baseline to compare the change in motivators and barriers. In order to determine whether the motivators and the barriers with respect to speed pedelecs—and consequently the potential of the speed pedelec as a commuting vehicle—would change in a different context, a longitudinal qualitative study in other regions across the globe is recommended.

6. Conclusions

The speed pedelec has the potential to be a sustainable alternative for cars with internal combustion engines for commuting purposes. For the Belgian case, commuting with a speed pedelec can solve problems regarding congestion and air pollution. Numbers show that there is a rise in uptake of the speed pedelec in Flanders in particular.

In order to answer the research questions related to the motivators and the barriers for people to use a speed pedelec as a means of commuting instead of their car and to what extent this can be compared with bicycles and pedelecs as well as to capture the experiences after three weeks of testing with a speed pedelec as a commuting vehicle, this paper defined nine different categories of motivators and barriers on existing research related to bicycles and pedelecs and benchmarked them with motivators and barriers captured during a long-standing speed pedelec try-out test.

This work shows that the benefit speed pedelecs bring with regard to time management caused by their higher maximum pedal assisted speed was a main motivator before testing. Motivators identified by the novice users that became clear after the testing period were mental and physical benefits of being outside, exercising, and mentally relaxing during the commuting trips, especially if the former mode of transport was a car. Barriers identified before and after the testing period were purchase cost, perceived traffic safety, and reliability.

The defects encountered by the participants over the three weeks testing period suggest that quality and reliability of speed pedelecs remain issues that may become or remain barriers to higher uptake in the future, especially as these issues occurred over a short time frame starting from brand new vehicles. While many of these issues appear to be related to infant mortality within the bathtub reliability curve, the high purchase cost appears to increase expectations by users about quality and reliability, more so than (cheaper) pedelecs and bicycles.

In terms of policy implications, participants indicated that incentives such as the improvement of the knowledge of the traffic regulations by the general public, the set-up of leasing programs, cycle reimbursement for speed pedelec commute, and increased investments in appropriate infrastructure would help to overcome the perceived barriers. If the goal is to stimulate the use of speed pedelecs for commuting purposes, these aspects are recommended for further investigation. The appropriate way to inform all road users about the road regulation related to speed pedelecs in order to increase the sense of safety of all parties needs further investigation. Additionally, it is important to understand how safety is perceived by speed pedelec users and to study how to increase this feeling of safety if the aim is to stimulate the use of speed pedelecs. A recurring aspect where improvement is achievable is the amelioration of the cycle infrastructure, which remains unclear, even to the participants, as to what appropriate speed pedelec infrastructure should be. To obtain a more complete insight into the total cost of ownership, research into the exact operational and non-operational costs is needed to uncover the extent to which bicycle reimbursement and leasing programs can play a role in convincing non-users to use a speed pedelec as a commuting vehicle and how this compares to the total cost of ownership of a car, a motorbike, or public transport. Finally, as a new category of competitiveness emerges after the test periods, the question is raised as to what extent stimulating this competitiveness through gamification can stimulate the uptake of speed pedelecs but also what impact this has on user behavior and consequently on the overall safety of road users.

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References

1. Weiss, M.; Dekker, P.; Moro, A.; Scholz, H.; Patel, M.K. On the Electrification of Road Transportation—A Review of the Environmental, Economic, and Social Performance of Electric. *Transp. Res. Part D* **2015**, *41*, 348–366. [CrossRef]
2. Messagie, M.; Boureima, F.; Coosemans, T.; Macharis, C.; Van Mierlo, J. A Range-Based Vehicle Life Cycle Assessment Incorporating Variability in the Environmental Assessment of Different Vehicle Technologies and Fuels. *Energies* **2014**, *7*, 1467–1482. [CrossRef]
3. Messagie, M. *Life Cycle Analysis of the Climate Impact of Electric Vehicles*; Transport & Environment: Brussel, Belgium, 2017.
4. Stevens, G.; Rotthier, B.; Roetynck, A.; Coosemans, T.; Cappelle, J. *Het Potentieel van Lichte Elektrische Voertuigen in Vlaanderen*; Vlaamse Overheid: Brussel, Belgium, 2017.
5. Vlaamse Milieumaatschappij. *Jaarrapport Lucht, Emissies 2000–2016 En Luchtkwaliteit 2017*; Vlaamse Milieumaatschappij: Brussel, Belgium, 2018.
6. European Commission. *The Environmental Implementation Review 2019*; European Commission: Brussels, Belgium, 2019. [CrossRef]
7. Statbel. Voertuigenpark. Available online: https://statbel.fgov.be/nl/themas/mobiliteit/verkeer/voertuigenpark (accessed on 7 October 2019).
8. Touring. Filebarometer 2017: Verzadiging van Het Wegennet Veroorzaakt een Uitbreiding van de Verkeersdrukte in Tijd en Ruimte. Available online: https://www.touring.be/nl/pers/filebarometer-2017-verzadiging-van-het-wegennet-veroorzaakt-een-uitbreiding-van-de (accessed on 10 October 2019).
9. Departement Omgeving. Milieuvriendelijke Voertuigen. Available online: http://milieuvriendelijkevoertuigen.be/beleid (accessed on 19 October 2019).
10. European Parliament. *Regulations No 3/2014*; European Commission: Brussel, Belgium, 2014.
11. VRT NWS. Meer Dan 16.000 Speedpedelecs Ingeschreven, Vanaf Morgen is Nummerplaat Verplicht. Available online: https://www.vrt.be/vrtnws/nl/2018/12/10/meer-dan-16-000-speed-pedelecs-ingeschreven-vanaf-morgen-is-num/ (accessed on 30 September 2019).
12. Departement Omgeving. *Speed Pedelec Sales*; Vlaamse Overheid: Brussel, Belgium, 2019.
13. Statistiekvlaanderen.be. Population Size and Growth—Statistics Flanders. Available online: https://www.statistiekvlaanderen.be/nl/bevolking-omvang-en-groei#sources (accessed on 26 November 2019).
14. Departement Mobiliteit & Openbare Werken. *Onderzoek Verplaatsingsgedrag*; Vlaamse Overheid: Brussel, Belgium, 2018.
15. Heinen, E.; van Wee, B.; Maat, K. Commuting by Bicycle: An Overview of the Literature. *Transp. Rev.* **2010**, *30*, 59–96. [CrossRef]
16. Fishman, E.; Washington, S.; Haworth, N. Barriers and Facilitators to Public Bicycle Scheme Use: A Qualitative Approach. *Transp. Res. Part F* **2012**, *15*, 686–698. [CrossRef]
17. de Geus, B.; Degraeuwe, B.; Vandenbulcke, G.; Panis, L.I.; Thomas, I.; Aertsens, J.; De Weerdt, Y.; Torfs, R.; Meeusen, R. Utilitarian Cycling in Belgium: A Cross-Sectional Study in a Sample of Regular Cyclists. *J. Phys. Act. Health* **2014**, *11*, 884–894. [CrossRef] [PubMed]
18. De Geus, B.; Hendriksen, I. Cycling for Transport, Physical Activity and Health: What about Pedelecs? *Cycl. Futures Res. Pract.* **2015**, *28*, 17–31.
19. Winters, M.; Davidson, G.; Kao, D.; Teschke, K. Motivators and Deterrents of Bicycling: Comparing Influences on Decisions to Ride. *Transportation* **2011**, *38*, 153–168. [CrossRef]
20. Lopez, A.J.; Astegiano, P.; Gautama, S.; Ochoa, D.; Tampère, C.; Beckx, C. Unveiling E-Bike Potential for Commuting Trips from GPS Traces. *ISPRS Int. J. Geo-Inf.* **2017**, *6*, 190. [CrossRef]
21. Fishman, E.; Cherry, C. E-Bikes in the Mainstream: Reviewing a Decade of Research. *Transp. Rev.* **2016**, *36*, 72–91. [CrossRef]

22. Salmeron-Manzano, E.; Manzano-Agugliaro, F. The Electric Bicycle: Worldwide Research Trends. *Energies* **2018**, *11*, 1894. [CrossRef]
23. Bjørnarå, H.B.; Berntsen, S.; te Velde, S.J.; Fyhri, A.; Deforche, B.; Andersen, L.B.; Bere, E. From Cars to Bikes—The Effect of an Intervention Providing Access to Different Bike Types: A Randomized Controlled Trial. *PLoS ONE* **2019**, *14*, e0219304. [CrossRef] [PubMed]
24. Leger, S.J.; Dean, J.L.; Edge, S.; Casello, J.M. "If I Had a Regular Bicycle, I Wouldn't Be out Riding Anymore": Perspectives on the Potential of e-Bikes to Support Active Living and Independent Mobility among Older Adults in Waterloo, Canada. *Transp. Res. Part A Policy Pract.* **2019**, *123*, 240–254. [CrossRef]
25. Dill, J.; Rose, G. E-Bikes and Transportation Policy: Insights from Early Adopters. *Transp. Res. Rec.* **2012**, *37*, 1–11. [CrossRef]
26. Johnson, M.; Rose, G. Electric Bikes—Cycling in the New World City: An Investigation of Australian Electric Bicycle Owners and the Decision Making Process for Purchase. In Proceedings of the Australasian Transport Research Forum 2013, Brisbane, Australia, 2–4 October 2013; pp. 1–10.
27. MacArthur, J.; Dill, J.; Person, M. Electric Bikes in North America: Results of an Online Survey. *Transp. Res. Rec.* **2014**, *2468*, 123–130. [CrossRef]
28. Bourne, J.E.; Sauchelli, S.; Perry, R.; Page, A.; Leary, S.; England, C.; Cooper, A.R. Health Benefits of Electrically-Assisted Cycling: A Systematic Review. *Int. J. Behav. Nutr. Phys. Act.* **2018**, *15*, 116. [CrossRef] [PubMed]
29. Fyhri, A.; Heinen, E.; Fearnley, N.; Sundfør, H.B. A Push to Cycling—Exploring the e-Bike's Role in Overcoming Barriers to Bicycle Use with a Survey and an Intervention Study. *Int. J. Sustain. Transp.* **2017**, *11*, 681–695. [CrossRef]
30. Plazier, P.A.; Weitkamp, G.; van den Berg, A.E. "Cycling Was Never so Easy!" An Analysis of e-Bike Commuters' Motives, Travel Behaviour and Experiences Using GPS-Tracking and Interviews. *J. Transp. Geogr.* **2017**, *65*, 25–34. [CrossRef]
31. Popovich, N.; Gordon, E.; Shao, Z.; Xing, Y.; Wang, Y.; Handy, S. Experiences of Electric Bicycle Users in the Sacramento, California Area. *Travel Behav. Soc.* **2014**, *1*, 37–44. [CrossRef]
32. Jones, T.; Harms, L.; Heinen, E. Motives, Perceptions and Experiences of Electric Bicycle Owners and Implications for Health, Wellbeing and Mobility. *J. Transp. Geogr.* **2016**, *53*, 41–49. [CrossRef]
33. Behrendt, F. Why Cycling Matters for Electric Mobility: Towards Diverse, Active and Sustainable e-Mobilities. *Mobilities* **2018**, *13*, 6480. [CrossRef]
34. Simsekoglu, Ö.; Klöckner, C. Factors Related to the Intention to Buy an E-Bike: A Survey Study from Norway. *Transp. Res. Part F Traffic Psychol. Behav.* **2019**, *60*, 573–581. [CrossRef]
35. Bjørnarå, H.B.; Berntsen, S.; Te Velde, S.J.; Fegran, L.; Fyhri, A.; Deforche, B.; Andersen, L.B.; Bere, E. From Cars to Bikes—The Feasibility and Effect of Using e-Bikes, Longtail Bikes and Traditional Bikes for Transportation among Parents of Children Attending Kindergarten: Design of a Randomized Cross-over Trial. *BMC Public Health* **2017**, *17*, 981. [CrossRef] [PubMed]
36. Munkácsy, A.; Monzón, A. Impacts of Smart Configuration in Pedelec-Sharing: Evidence from a Panel Survey in Madrid. *J. Adv. Transp.* **2017**, *2017*, 4720627. [CrossRef]
37. Schleinitz, K.; Petzoldt, T.; Franke-bartholdt, L.; Krems, J.; Gehlert, T. The German Naturalistic Cycling Study—Comparing Cycling Speed of Riders of Different e-Bikes and Conventional Bicycles. *Saf. Sci.* **2017**, *92*, 290–297. [CrossRef]
38. Jellinek, R.; Hildebrandt, B.; Pfaffenbichler, P.; Lemmerer, H. *Verkehrssicherheit von E-Fahrrädern. Auswirkungen Der Entwicklung Des Marktes Für E-Fahrräder Auf Risiken, Konflikte Und Unfälle Auf Radinfrastrukturen (MERKUR)*; Forschungsarbeiten des oesterreichischen Verkehrssicherheitsfonds: Vienna, Austria, 2013.
39. Hertach, P.; Uhr, A.; Niemann, S.; Cavegn, M. Characteristics of Single-Vehicle Crashes with e-Bikes in Switzerland. *Accid. Anal. Prev.* **2018**, *117*, 232–238. [CrossRef]
40. Edge, S.; Dean, J.; Cuomo, M.; Keshav, S. Exploring E-Bikes as a Mode of Sustainable Transport: A Temporal Qualitative Study of the Perspectives of a Sample of Novice Riders in a Canadian City. *Can. Geogr.* **2018**, *62*, 384–397. [CrossRef]
41. Cyclable. Le Vélo Électrique Rapide S'appelera Speedelec. Available online: https://www.cyclable.com/speedelec-vs-velo-electrique/ (accessed on 2 October 2019).

42. Wegcode. Artikel 2. *Bepalingen*. Available online: https://wegcode.be/wetteksten/secties/kb/wegcode/100-art2 (accessed on 30 September 2019).
43. Steintjes, S.B. Comparing and Analysing the Behaviour of Users of Conventional Bicycles and Speed Pedelecs: Naturalistic Cycling. Master's Thesis, Utrecht University, Utrecht, The Netherlands, 2016.
44. Stichting Wetenschappelijk Onderzoek Verkeersveiligheid. *Speed-Pedelecs Op de Rijbaan: Observatieonderzoek*; SWOV: Den Haag, The Netherlands, 2017.
45. Blass, P. Speed Differences of Conventional and Pedal Assisted Bicycles in Austria. In *Young Researchers Seminar 2019*; European Conference of Transport Research Institutes (ECTRI): Thessaloniki, Greece, 2019.
46. Gehlert, T.; Schleinitz, M.K.K.; Petzoldt, T.; Schwanitz, S.; Gerike, R. The German Pedelec Naturalistic Cycling Study—Study Design and First Experiences. In Proceedings of the International Cycling Safety Conference 2012, Helmond, The Netherlands, 7–8 November 2012; p. 15.
47. Rotthier, B.; Stevens, G.; Huyck, B.; Motoasca, E.; Cappelle, J. The Rise of the Speed Pedelec, Restrained by Legislation? In Proceedings of the 30th International Electric Vehicle Symposium and Exhibition, Stuttgart, Germany, 9–11 October 2017; pp. 1–11.
48. Rotthier, B.; Stevens, G.; Huyck, B.; Motoasca, E.; Cappelle, J. Is the Speed Pedelec the Light Electric Vehicle That Will Achieve a Modal Shift? In Proceedings of the 2nd World Light Electric Vehicle Summit, Rotterdam, The Netherlands, 22–23 November 2017; pp. 1–6.
49. Macarthur, J. *A North American Survey of Electric Bicycle Owners*; National Institute for Transportation and Communities (NITC): Portland, Oregon, 2018.
50. Schepers, P.; van der Voet, M. *Effecten van Mogelijke Gedragsregels Voor Speed-Pedelecs*; Rijkswaterstraat: Den Haag, The Netherlands, 2014.
51. Rijskoverheid Nederland. Welke Regels Gelden Voor Speed-Pedelecs. Available online: https://www.rijksoverheid.nl/onderwerpen/bijzondere-voertuigen/vraag-en-antwoord/welke-regels-gelden-voor-speed-pedelec (accessed on 10 October 2019).
52. De Clerck, Q.; Van Lier, T.; Lebeau, P.; Messagie, M.; Vanhaverbeke, L.; Macharis, C.; Van Mierlo, J. How Total Is a Total Cost of Ownership? In Proceedings of the EVS29 Symposium, Montreal, QC, Canada, 19–22 June 2016; Volume 8, pp. 742–753.
53. Wild, K.; Woodward, A. Why Are Cyclists the Happiest Commuters? Health, Pleasure and the e-Bike. *J. Transp. Health* **2019**, *14*, 100569. [CrossRef]
54. Van den Steen, N.; Cappelle, J.; Vanhaverbeke, L. Can Speed Pedelecs Really Fulfil the Mobility Needs of Daily Commuters? In Proceedings of the EVS32 Symposium, Lyon, France, 19–22 May 2019; pp. 1–13.
55. Rogers, E.M. *Diffusion of Innovations*, 5th ed.; Simon & Schuster, Inc.: New York, NY, USA, 2003.
56. Runkeeper. Runkeeper. Available online: https://runkeeper.com/ (accessed on 30 October 2018).
57. QSRInternational. NVivo 12. Available online: https://www.qsrinternational.com/nvivo/what-is-nvivo (accessed on 30 September 2019).
58. Braun, V.; Clarke, V. Using Thematic Analysis in Psychology. *Qual. Res. Psychol.* **2006**, *3*, 77–101. [CrossRef]
59. Breen, R.L. A Practical Guide to Focus-Group Research. *J. Geogr. High. Educ.* **2006**, *30*, 463–475. [CrossRef]
60. Reumers, S.; Declercq, K.; Janssens, D.; Wets, G. *VERPLAATSINGSGEDRAG*; Instituut voor Mobiliteit (imob): Hasselt, Belgium, 2017; Volume 32.
61. Rudolph, F. Promotion of Pedelecs as a Means to Foster Low-Carbon Mobility: Scenarios for the German City of Wuppertal. *Transp. Res. Procedia* **2014**, *4*, 461–471. [CrossRef]
62. Rotthier, B.; Stevens, G.; Dikomitis, L.; Huyck, B.; Motoasca, E.; Cappelle, J. Typical Cruising Speed of Speed Pedelecs and the Link with Motor Power as a Result of a Belgian Naturalistic Cycling Study. In Proceedings of the 6th Annual International Cycling Safety Conference, Davis, CA, USA, 21–22 September 2017; pp. 21–23.
63. Federale Overheidsdienst Financiën. Fietsvergoeding. Available online: https://financien.belgium.be/nl/particulieren/vervoer/aftrek_vervoersonkosten/woon-werkverkeer/fiets#q15 (accessed on 10 October 2019).
64. Licht Elektrische Voertuigen—Speed Pedelec. Available online: https://iiw.kuleuven.be/apps/lev/Speedpedelec.html (accessed on 29 September 2019).
65. Commission, E. EU Lex 2016/1824. Available online: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2016.279.01.0001.01.ENG (accessed on 1 October 2019).

66. Mobiliteit en Openbare Werken. Jaagpaden. Available online: https://www.vlaanderen.be/mobiliteit-en-openbare-werken/wegen/jaagpaden (accessed on 1 October 2019).
67. Weber, J.; Azad, M.; Riggs, W.; Cherry, C.R. The Convergence of Smartphone Apps, Gamification and Competition to Increase Cycling. *Transp. Res. Part F Psychol. Behav.* **2018**, *56*, 333–343. [CrossRef]
68. Millonig, A.; Wunsch, M.; Stibe, A.; Seer, S.; Dai, C.; Schechtner, K.; Chin, R.C.C. Gamification and Social Dynamics behind Corporate Cycling Campaigns. *Transp. Res. Procedia* **2016**, *19*, 33–39. [CrossRef]