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RESEARCH ARTICLE

The E-bike in Non-Motion: Infrastructural Components of an Emerging Micromobility Practice

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Electrically assisted cycling, e-biking, is a growing global phenomenon. Just as with other vehicles, the e-bike is operated somewhere in place and in connection to other road users, and is far from always in motion. In this article, e-biking and related activities such as parking and storing take centre stage together with infrastructures such as parking spaces and electricity networks, which facilitate and constrain the practice in different ways. The involvement of a specific set of elements makes e-biking a practice in its own right, not only in comparison to other micromobility modes such as conventional cycling and walking, but also compared to motorised driving and in relation to infrastructure, and especially so when the e-bike is in non-motion.

The starting point of the article is an understanding that practices such as e-biking are connected not only to other practices, but also to small- and large-scale infrastructures and to the context within which it is performed. The empirical material was collected in semi-urban and urban settings in Sweden, a country where cycling is presented as a primary solution to reach net zero emissions of greenhouse gases by 2045 but where the car is by far the dominant mode of personal transport. By analysing interviews and diaries written by e-bikers as well as policy documents, the relationship between e-biking and surrounding infrastructures comes under scrutiny. Insufficient cycle parking infrastructures are shown to discourage usage beyond trips between two places with (known) safe parking possibilities. This avoidance of linking practices risks limiting the range of activities for which e-bikes are used.

An increased knowledge of the infrastructural and situational conditions of e-biking as set out in this article can facilitate planning and policy making and is important to better understand the challenges and opportunities involved in the transition towards a sustainable transport system and therefore highly relevant to contemporary debates.

Keywords: e-biking; micromobility; infrastructures; cycle parking; linked practices; practice theory; sustainable transport

Introduction

Increased walking and cycling are promoted in policy worldwide with the intention of decreasing car driving and stimulating a transition to a fossil-free transport system. This is evident not least in Sweden, the country where this study is conducted and a country that aims to become the "first fossil free welfare nation in the world" (Swedish Ministry of the Environment, 2018). E-biking, electrically assisted cycling, can be regarded part of such a desired transition. E-biking is a growing global phenomenon, is part of a larger trend of increased electrified micromobility options (together with, for instance, e-scooters) and includes electrified cargo-cycles and other types of modified cycles (Baid and Hjälmdahl, 2019; Li et al., 2021; Madapur, Madangopal and Chandrashekar, 2020; McQueen et al., 2021). Because it is a travel mode that facilitates individual travel without close physical interaction with others, e-biking became popular during the Covid-19 pandemic.

Reasons to use e-bikes for everyday travel, highlighted by e-bikers themselves, are highly connected to the flexibility and convenience the practice offers (Edberg, submitted for review). Previous research suggests that e-biking implies more and longer trips, and that it replaces travel not only by conventional cycles but also by cars (Cherry and Fishman, 2021; Fishman and Cherry, 2016; Fyhri and Fearnley, 2015; Fyhri et al., 2017; Popovich et al., 2014). Some of the benefits of e-biking are that in comparison to conventional cycles, it facilitates riding with cargo and children, in steep uphill and windy conditions without the cyclist becoming sweaty and despite physical disabilities. At the same time, the practice offers an active travel mode, being outdoors and independent from timetables and traffic jams (Behrendt, 2018; Cherry and Fishman, 2021; Plazier, Weitkamp and van den Berg, 2017; Rérat, 2021). The composition of elements, for instance the combination of electric motor, chain and bodily movements that implies voluntary assistance but requires pedalling and charging, give e-biking a distinctive form compared to other micromobility modes as well as in comparison to car driving.

However, e-biking does not take place in a vacuum. Just as with other vehicles, the e-bike is operated somewhere in space and time and in connection to other road users. Dant (2004, p69) explains, in relation to the driver-car assemblage, how different networks are needed to achieve mobility. In this article, it is argued that the distinctive characteristics connected to e-biking give the practice particular needs of and relationships to surrounding infrastructures, particularly so when the e-bike is standing still. The infrastructural challenges for the e-bike in motion are more similar to the ones facing cycling in general (Edberg, submitted for review). These challenges largely stem from an unequal relationship to the car, where the car dominates the streets, and thus marginalises cycling and other forms of micromobility (Cox, 2021; Urry, 2004). Practices connected to e-biking such as parking, locking and charging take centre stage in the article, together with related infrastructures such as road and electricity networks, which facilitate and constrain the practice, as well as how it is bundled together with other practices in different ways. The aim of the article is thus to increase understanding of the particularities of e-biking in non-motion and its relation to infrastructures, but also to highlight the unequal power relations that exist between different forms of mobility and the continued dominance of motorised traffic.

Increased knowledge of the relationship between new mobility modes such as e-biking and infrastructures can facilitate planning procedures and policy making and is thus of general interest. The starting point of this article is an understanding that practices such as e-biking are connected not only to other practices but also to small- and large-scale infrastructures and the context within which they are performed. Infrastructures thus have great influence on how these practices are performed and on how they are understood.

Mobility practices, infrastructures and links between them

Practice theory is, for several reasons, considered a suitable tool to analyse e-biking in relation to infrastructure and other practices. One reason is that it offers the possibility to analyse the mundane and everyday as embedded in processes of social transformation, including climate change measures and the transformation of the transport system.

Practices can be explained as routinised types of collective behaviours consisting of three interrelated constitutive elements: materials, competences and meanings. When links between those elements are created or broken, practices arise, persist or vanish (Shove, Pantzar and Watson, 2012). In relation to this study, it is particularly relevant to stress how practices are linked to each other. Shove, Pantzar and Watson (2012) distinguish between bundles and complexes. The former denotes more loose-knit connections, whereas the latter represents more integrated patterns including practices temporally sequenced with each other. E-biking is intrinsically connected to practices such as pedalling, locking, parking and charging, for instance, but also more loosely to practices such as shopping or picking up children.

Starting with an understanding of materials and practices as interconnected, it is obvious that vehicles and the practices that they are part of exist in relation to other material objects, practices and social structures (Shove, Watson and Spurling, 2015). Vehicles are ridden and parked somewhere, by someone, for different purposes, and they compete for space, uses and status. This implies internal conflicts amongst individual practitioners in the choice of transport mode, in urban planning about which forms of mobility should be prioritised and in national and international energy and environmental policies. Micro- and meso-level mobility issues, such as individual travel choices, the diverse opportunities different social groups have to make those choices and municipal planning, are seen as inextricably linked to macro-level issues of climate change and energy transition (Sheller, 2019).

Most of the social practices we conduct every day are connected to infrastructures in one way or another: cooking, shopping, exercising and communicating depend on power grids, food delivery, internet fibre cables and so on (Shove, Trentmann and Watson, 2019). Transport is no exception. The commute, just as the leisure ride, is connected to roads and their maintenance, just as parking facilities and motorised vehicles are linked to gas/charging stations and networks of fuel provision/electricity. In line with the growing levels of energy consumption on a global scale (Shove, Trentmann and Watson, 2019), the electrified cycle thus has more infrastructural interconnections than the conventional cycle. In addition, they are part of creating an (increased) need for electricity. Coutard and Shove (2018) show how infrastructures planned and built to meet expected needs also foster those needs and create new practices by introducing widespread connections to the electric grid – the same processes that have created and still enforce the domination of automobility (Urry, 2004).

Infrastructures can be divided into soft (skills, knowledge, etc.) and hard (material structures such as roads, cables, etc.) (Cox, 2021, p15). The definition used in this article is limited to "the material arrangements that enable and become integral to the enactment of specific practices" in line with Shove's understanding (Shove, Trentmann and Watson, 2019, p4; see also Shove, 2017). Even if focusing on the material aspects of infrastructures, it is important to underline that these arrangements and how they come about will foster future practices. As Schatzki (2019, p109) notes, "material things, events, and processes are crucial components of the action chains through which social life evolves". Infrastructures have a background role that makes them able to shape and support practices as well as the relations between different practices (Shove, 2017, p167). Demands for resources cannot be understood as stable but change over time and differ depending on context. The development of

infrastructures and of practices thus stimulates each other in different wanted or unwanted directions (Shove, Trentmann and Watson, 2019, p4) and thereby influences the development of social-technical systems at large (Watson, 2012).

Cox (2021, p15) underlines that infrastructures both provide "the potential for social actions and processes and are produced by social actions and processes", which means that they facilitate some actions but obstruct others. Infrastructures and mobilities are thus intertwined and highly political (Cox, 2021; Sheller, 2018). For example, Merriman (2016) describes how parking policies can be used as an attempt to steer mobility behaviour. He further explains how parking spaces, rather than being static infrastructures, should be regarded as "complex environments which gather and resonate with multiple affects and atmospheres, 'infrastructuring' subjects, environments and communities in diverse ways" (Merriman, 2016, p95). In the same line of thought, Dant (2004) and Koglin (2017) argue that materialities are the infrastructural space where mobility takes place, but also that they affect how the movements are being performed (for instance, through urban planning). Materialities, together with different interactions and relations, form urban mobilities.

Regarding mobility as localised and materialised implies that infrastructures, often apparently fixed in space, such as petrol stations, roads and buildings, are seen as embedded elements in the practice. This makes immobility and mobility interlinked (Hannam, Sheller and Urry, 2006; Sheller and Urry, 2006) or, going even further, impossible to separate, because infrastructures range beyond their material borders and are "dynamic, contingent, in process and in movement" (Merriman, 2016, p84).

Even if often highly visible, infrastructures are often taken for granted by their users (Shove, Trentmann and Watson, 2019, p3), and the changes in everyday practices that need to follow technological changes and mobility transformations are often overlooked (Freudendal-Pedersen et al., 2020). But, as Freuendahl-Pedersen and colleagues (2020, p2) stress, "The organization of urban space and access to it go hand in hand with changing the relationships between people and mobility artefacts." Also Shove, Watson and Spurling (2015) emphasise how infrastructures shape and reflect social practices, but also how they connect them in time and space. By discussing energy consumption in general and car dependence in particular, they note, for instance, that sociological analyses of car driving surprisingly often omit underlying reasons to travel by car and other practices that it enables, but they also leave out related aspects such as routes. Similarly, Spurling and colleagues (2013) and Cass and Faulconbridge (2016) underline the need to take related practices into consideration when analysing the development of mobility practices. In an era in many ways permeated by mobility, it is important to see travel as something more than just a movement from A to B by paying attention to the power relations, cultural markers and broader societal impacts that driving, for example, has had and continues to have (Cook and Butz, 2019; Sheller, 2019), but also more practically as connecting mobility practices to other practices. Cass and Shove (2018) refer to the sequencing of practices, that is, those practices that precede and follow other practices.

Taking the argument one step further, Cass and Faulconbridge (2016) critique analysing modes in isolation from activity, for instance, analysing cycling without considering why the cycling takes place. It is therefore more meaningful to put emphasis on the cycle commute, they argue. In this study, the focus is slighlty broader than just the commute. The reason is that other parts of everyday mobility are conducted in relation to the commute, and a pure commuting trip was thus hard to single out. Examples include cycling children to and from school, shopping and visiting relatives. In other words, practices are bundled in time and space and thus develop jointly (Watson, 2012). The more practices that are bundled together within the same time frame, the more complex mobility practices get (Southerton, 2003).

The combination of activites is thus an integrative part of everyday mobility and something that is important to take into consideration when trying to understand why different forms of mobility become popular or not, not least because studies show that the more complex a journey is, the more likely that it will be conducted by car due to time and space pressures (Cass and Faulconbridge, 2016). E-biking has proven to have the potential to offer the same solutions, especially cargo-bikes and long tails (a type of two-wheeled cargo-bike with extra space behind the saddle), as long as the trips are not too long (Edberg, submitted for review). However, as discussed later, insufficient infrastructure implies obstacles and affects the linkage of practices.

E-bikes, parking and risk of theft

In this article, I use the term *e-bike* to describe the artefact used when cycling assisted by an electric motor. There are alternative terminologies used, such as E2W (short for electric two-wheeler) and pedelec (short form of pedal electric bicycle) (Behrendt, 2018; Cherry and Fishman, 2021; Rérat, 2021). The e-bike as defined here requires that the pedals are physically turned, but the rider can switch on a small electric motor to obtain assistance. The motor can be a maximum of 250 watts and can only give assistance up to 25 kilometres per hour in order to be classified as an e-bike in Sweden and the EU (European Parliament, 2002; Swedish Ministry of the Environment, 2017, §2). The motor is powered by a battery located in different places on the cycle depending on the design. On some models, the battery is placed under the package holder or on the frame, whereas on other models, the battery is more neatly merged into the frame. The battery is usually locked onto the cycle, but depending on its location and type of lock, it is more or less difficult to break the lock and remove the battery.

Behrendt (2018) proposes the concept "e-velomobility" to underline the difference between e-biking and other types of e-mobility that do not require pedalling, but also from cycling without assistance. For the sake of this study, it is important to underline that the practice of e-biking is seen as including electric assistance, or the active cessation of the assistance. In other words, cycling an e-bike without an attached battery is not regarded as e-biking.

Previous studies tend to focus on the infrastructure necessary for the movement of cycles, such as roads or separation of lanes for cycles and motorised vehicles (Heinen and Buehler, 2019), but this study focuses on the e-bike in non-motion. Cycles, just as with other vehicles for private transport, are parked for most of the time. In comparison to cars, cycles are often parked in other places rather than in formal, designated cycle parking spaces (cycle racks and the like)—so-called fly-parking (Aldred and Jungnickel, 2013; Larsen, 2017). This might be a result of cycles taking up less space and being easier to move around, or that cycle parking is less regulated and penalised. But it can also be due to lack of formal parking spaces (Nakamura and Abe, 2014, in Buehler, Heinen and Nakamura, 2021, p104) or lack of parking spaces located in the right places (e.g., close to commuting hubs).

When parked, cycles risk being damaged or stolen (Aldred and Jungnickel, 2013; Buehler, Heinen and Nakamura, 2021), a risk that is enhanced for e-bikes due to their relative higher value both in terms of cycle and batteries (Popovich et al., 2014). Cycle theft is one of the most common property crimes in Sweden. In total 10.5% of all households report that they had been subject to such a theft in 2020 (Swedish National Council for Crime Prevention, 2022). At the same time, it is often regarded as a low police priority (Johnson, Sidebottom and Thorpe, 2008; Van Lierop, Grimsrud and El-Geneidy, 2015), In Sweden, only slightly more than 0% of reported cycle thefts, and 1% of e-bike thefts, were solved in 2020 (Swedish National Council for Crime Prevention, 2022). Because the chances of solving such crimes are so low, it becomes the responsibility of owners to find strategies to overcome the issue, as discussed in this article.

Buehler, Heinen and Nakamura (2021, p104) underline that "A supply of bicycle parking that meets quantity and quality demands can encourage cycling", and they even claim that parking supply can be a determinant of cycling (see also Heinen and Buehler, 2019; Larsen, 2017). As discussed later, such issues are not least evident with e-biking because the material elements of e-bikes increase the need for good parking spaces.

Methods and context

The empirical material was collected in semi-urban and urban settings in Sweden, a country where cycling is presented as one solution to reach net-zero emissions of greenhouse gasses by 2045 (Swedish Ministry of the Environment 2018, p230), but where the car is by far the dominant mode of personal transport (Koglin, 2021). One dilemma in countries such as Sweden is the weather conditions that, during parts of the year, make micromobility demanding. The Swedish government provided an electric vehicle grant (2017–2019) with the aim to increase "climate friendly transport" (Swedish Ministry of the Environment, 2017, 1§). The majority of the participants in this study were found among recipients of this grant, whereas others were recruited through related Facebook groups, via events for cyclists and by advertisements in public places. The study was thus directed to those owning their own e-bike, not for people using rental schemes or similar.

The informants were between 30 and 72 years old and lived in the southern part of Sweden, with a slight preponderance of women. The main scope of use for the e-bike was as a means of travel primarily for everyday activities such as commuting. Thus, most participants owned some sort of classic city e-bike of different price classes. Out of 25 participants, 13 owned a city bike, 4 owned a mountain bike, 5 owned a hybrid type and 3 owned e-cargobikes.

A minority used their e-bike for all travel, but most of the participants also occasionally used other vehicles besides the e-bike, such as cars, conventional cycles or public transport, to different extents. Other micromobility solutions such as mono-wheels and speed bikes were also observed in the material. Several of the participants owned more than one e-bike, primarily then adding a cargo-bike (box-bike or long-tail) to the ordinary e-bike, but also combining a utility e-bike with a mountain e-bike type for leisure cycling.

The analysis of the relationship between e-biking and surrounding infrastructures of non-motion is mainly based on interviews with and diaries provided by e-bikers. This was supplemented by observations which materialised as photographs and written reflections by the author in connection to the interviews. In the diaries (*n*, 25), e-bikers were asked to describe (using both written word and photographs) and reflect upon all their journeys, not only the ones conducted by e-bike, over the period of at least one week. The procedure was repeated three to four times at different points in the year. Diaries give linearity over time (Kaun, 2010) and can thus show developments and temporal shifts. In addition, the diarist is free to independently formulate answers without time pressure. Interviews, in contrast, are more constructed situations, but because in this case they were framed as conversations between the interviewer and the informant, they served as tools for enhanced reflection. By giving different ways to express oneself, diaries and interviews complement each other (Elliott, 1997; Kenten, 2010). This "diary-interview" method is considered useful when phenomena are either hard to observe or so mundane that they are difficult to describe at a later occasion (Kenten, 2010; Zimmerman and Weider, 1977).

To create an enhanced understanding of e-biking practice and to engage in the performance of e-biking, the interviews (*n,* 10) were partly conducted in a mobile and active format (Cox, 2019). That implied the interview either started or ended with a joint cycle tour, usually

between the informants' home and work. The mobile part proved difficult to record, not least when driving through heavy traffic or wind. Instead, notes were taken as soon as possible after the interview. The cycle tour, often extended by the author to other paths in the vicinity after the interview, also functioned as an opportunity for further observation.

Transcriptions of interviews and field notes as well as the diary notes and photographs provided by the participants and taken by the author were coded using the software NVivo. An inductive approach permeated the coding process. The themes that emerged where further analysed using the theoretical framework described earlier.

In the following sections, the results from the empirical study will be described, analysed and discussed.

E-biking and infrastructures of non-motion

E-biking is considered a travel mode that combines freedom and independence with reliability and comfort. That is the primary reason to use e-bikes as a main everyday travel mode according to those recruited to the practice. It can "make this grey everyday life easier" (Michael) and makes it possible to "control your day" (Sandra). Informants claim that the main benefits of e-bikes in comparison to cars are that they are easy to park, can be driven in a multitude of different places, are not affected by traffic jams and allow users to be outdoors. In comparison to public transport, e-bikers do not need to adjust their lives to fit specific timetables or be bound by set routes, and in comparison to conventional cycles, it is possible to overcome uphill stretches, wind and long distances; arrive at an expected time without being sweaty; and get every day exercise when desired.

> Easy to shop easily and get around. Easy to go to meetings, you never have to worry about parking. (Michael, diary)

Despite the many benefits, limitations do exist. Some are complex and hard to overcome without fundamental changes, such as being exposed to the weather, as this would require a fundamental change of norms of comfort for many people (Shove, 2003) at least during the winter months in cold countries like Sweden. Other barriers, such as perceived limitations of transportation capacity and range, are strongly connected to the design of the cycle but also to a car-centric urban planning and social structure (Koglin and Rye 2014; Urry, 2004). In the rest of this article, it is argued that the availability of sufficient infrastructures that enables the linkage of e-biking with other practices is important to overcome such limitations. The diaries and interviews with e-bikers in Sweden show that infrastructural challenges, in comparison to the ones facing conventional cycling, differs more for the e-bike in non-motion than for the e-bike in motion. This explains the focus of this paper.

Parking practices

As stressed in the introduction, cycles spend most of their time standing still for shorter or longer periods. Infrastructures connected to the e-bike in non-motion thus constitute an important part of the practice, not least because infrastructures facilitate or obstruct the sequencing of e-biking with other practices (Cox, 2021). As exemplified in the quotes used throughout this article, the advantages are often linked to practices facilitated through e-biking, such as parking or having a drink.

> Cycled to work despite a little rain. It will go far before I take the car to work. It's so nice not to have to deal with the parking meter etc. (Klara, diary)

> Easy to park and no problem to have a glass of wine with dinner or a pub crawl and then cycle home. Concerns about cycle theft were resolved by bringing it into the courtyard. (Michael, diary)

Even if parking is seen as easy compared to car use, partly because it is less regulated and also due to the ability to use informal spaces such as closed backyards, e-bike parking is often viewed as troublesome. So even if it might seem like a contradiction, parking is often also regarded as a constraining part of e-biking, especially in comparison to conventional cycling. Just as with the benefits, constraints are often connected to (a lack of) surrounding infrastructures, which aggravates the sequencing of e-biking to other practices.

Conventional cycling and e-biking share many of the same issues when it comes to parking, such as insufficient space or non-existent designated areas in residential buildings and workplaces. Peter, one of the participants, needs to carry his e-bike one floor down to a room packed with other, seldomly used cycles. The door closes itself. To be able to enter with the e-bike, Peter previously used a stop block he had created himself. At the end of the interview, Peter showed how he now, since the stop block had disappeared, uses another cycle to keep the door open. It is a rather complicated and tricky exercise but is deemed necessary. To park the e-bike outdoors is not an alternative, nor is carrying it several floors up to the apartment. This example shows the intricate combination of materials and competences included in the practice. For several reasons, parking an e-bike or cargo-bike is more complex and demanding than parking a conventional cycle. For instance, e-bikes are often heavier than conventional cycles (due to the motor and battery), making them hard to carry, and there is a higher risk of the wheel being damaged in cycle stands that only provide support to the front wheel (e.g., grid racks; see Larsen, 2017). Also, cargo-bikes require more space and broader doors. As Martin writes in his diary:

> The cargo bike is stored outside because it is too wide to fit in most spaces I have access to. So far, this usually means frozen brakes. (Martin, diary)

A month later, Martin returns to the problem of being forced to park outdoors in his diary. The following quote shows how insufficient parking infrastructure also affects cycling practice in motion, and thus also how intertwined practices of motion and non-motion are:

> Discovered at the start [of the ride] that the electrical system had broken down due to the rough weather. The combination of moisture and cold force me to ride manually. There is a huge difference between electric and non-electric with a 3-wheeled cargo bike. (Martin, diary)

In the previous example, the e-biking practice was involuntarily turned into a non-assisted cycling practice. All cycles can be affected by outside parking. Brakes can, for instance, freeze. But because more complex material elements (e.g., motor, battery, computer) are included in the practice of e-biking, the parked e-bike is more sensitive to weather events than a conventional cycle. The driving range of batteries is shortened by extreme temperatures, and electric components can be damaged or covered by snow.

> When it was wet snow in the morning, you come out and it's been below zero all day and you had to chop [ice] off to be able to attach the battery. (Peter, diary)

To overcome such events, e-bikers develop different competences. Peter has tried covering the electric components with a bag or bringing a a dish brush to clear away the snow. But problems could be addressed through material components such as weather-protected parking places.

> Cycle parking infrastructure is really bad. There is not enough. Then it is often not weather protected. It may not need to be a house, but maybe a roof anyway, and then there needs to be something to lock things to [...] Cycle paths are a bit mixed, but parking is almost never good I think. (Anna, interview)

The design and material elements involved in the e-bike and in the practice of parking are thus interlinked and affect each other. The solutions pointed out by Anna—weather protected cycle parking with the possibility to secure the vehicle to something—are also highlighted as a concern by policy makers in the national cycling strategy for Sweden:

> It is also increasingly important to consider that new types of cycle vehicles, such as e-bikes and cargo-bikes, place higher demands on accessibility and the design of bicycle parking facilities with theft- and weather protection. (Swedish Ministry of Enterprise and Innovation, 2017, p17)

Most often, parking difficulties in public spaces are not due to lack of space; rather, sufficient infrastructure addressing perceived needs is lacking. These needs are not necessarily connected to transport per se but rather to other policy areas, such as crime, or the consequences of weather events on technological components. The needs stem from practices tangential to the actual physical use of the e-bike. It is thus relevant to involve areas and practices beyond transport in the analysis (Cass and Faulconbridge, 2016). In the following sections, such areas will be discussed in more detail.

Risk of theft

Risk of theft of the whole cycle, of parts such as the battery or of cargo left on the cycle is one of the concerns that most constrains safe parking. As Michael responded when asked what would make him use his e-bike more, "If one could be sure that one could keep it ... It's a nagging worry." Because e-bikes in general are more expensive than conventional cycles, there is a need to use advanced locks and to fasten them to something (a cycle stand, fence, lamp post, etc.). The battery is theft-prone in itself and consequently requires its own locks, or the battery needs to be removed from the cycle. When removed, the battery must be carried around. The parking of an e-bike thus involves many stages and is complex and tiresome, as exemplified by Fredrika:

> A bit stressed at home. Wish it was quicker to lock and unlock the bike. Need to lock carefully as the e-bike is worth some money. (Fredrika, diary)

Safe parking places is an issue in relation to homes and workplaces as well as in public spaces and requires both sufficient materials and competences.

> I have started to roll in the usual e-bike at work as security guards have said that people have been messing with cycles behind my workplace where I used to park. (Klara, diary)

To be able to continue her e-biking practice, Klara changed her parking practice because of the risk of theft. Even if designated areas are available in residential blocks, many prefer to park their e-bikes within the home for security reasons.

> My cycle is expensive, and I lock it as best I can […] I can't keep it in the cycle room; I don't dare […] It's on the balcony. (Michael, interview)

The informants in this study are devoted e-bikers and thus already, to a large extent, had the ability to park their cycle safely at home and at work, or where able to develop the necessary competences or find alternative infrastructure. Examples of alternative parking strategies that appear in the material include on balconies, in garages, outside stripped of all removable parts, under a tarpaulin, in shared cycle rooms or in basements (sometimes requiring the cycle to be carried there). But the storing capacity can also affect whether e-bikes are purchased and what type. Cycles that require more space, especially cargo-bikes, are difficult to manage when in non-motion. The lack of safe indoor options to park his e-cargo-bike restrain Thomas from purchasing a better, more adequate cycle.

> The neighbour here has a Bullitt that costs 50,000–60,000 SEK [or 5,000–6,000 Euros]; it's always locked up. Which I understand. I'd rather have a cycle like that too, really, from a cycling point of view. It's much smoother and faster and all that, but then again, there's this: Do you dare to leave them on the street? It's a bit difficult actually, I think. (Thomas, interview)

In this case, it is not the rather high cost of the e-bike in itself that is deemed problematic but rather where to store it. The risk of theft was therefore regarded as more decisive than the possibility of having a nice cycle ride (Aldred and Jungnickel, 2013; Heinen and Buehler, 2019). In cases where the economic prerequisites are low to start with, the lack of infrastructure to store the e-bike in a way perceived as safe can become yet another reason stopping people from engaging in e-biking in the first place. Unequal distribution and provisioning of infrastructures thus enhance inequalities when fewer mobility alternatives are available for often already disadvantaged groups (Cox, 2021; Sheller, 2019). Segregation and inequalities between different groups and areas can also be amplified by perceived risks of parking expensive e-bikes in particular parts of the city. Michael describes how he avoids going to places in the city that he deems unsafe, such as the suburbs of Stockholm which have a low socioeconomic status—that is, destinations that, from a distance perspective, are feasible to access with an e-bike but are avoided for security reasons.

Parking strategies to link e-biking to other practices

The analysis of interviews and diary notes show that that e-biking is particularly favourable when driving between places with known safe parking possibilities, such as commuting. However, even for those with access to good parking facilities at home and at work, there is often an urge to sequence the commuting to other practices in order to make everyday life as efficient, comfortable and convenient as possible (see, e.g., Cass and Faulconbridge, 2016; Southerton, 2003). As other studies have shown (Cherry and Fishman, 2021), e-biking is, compared to conventional cycling, easier to link to shopping or picking up children because the electric motors help carry heavier loads. However, the bundling together of practices in this way is hampered by difficulties finding appropriate parking places.

For the established e-bikers with stable parking possibilities at home and work, parking the e-bike in an unmonitored public space is considered risk-laden and thus constraining.

It affects the whole practice, as well as connected practices such as shopping or going to restaurants.

> Smooth with the cycle, arrived quickly. However, still hard to find somewhere to park the cycle; there are no bike racks there and most of the trees that grow there are too thick for my chain to lock. No good posts either. Found a tree, though, that the chain just reached around. (Peter, diary)

Peter also said in the interview that he had doubts over whether or not to cycle to a particular meeting. However, as he does most often, he ended up using his e-bike despite concerns about theft. Others would never park their cycle outside overnight and feel that their mobility is constrained by the risk of theft, and some, such as Sandra, sometimes refrain from undertaking particular activities when parking feels unsafe, and perceived necessary equipment is unavailable:

> It's not that I keep myself from [leaving the e-bike to run errands]. Or, do you know when I do? I hold back if I don't have my chain with me [so that the e-bike can be secured], then I don't leave the cycle! There was one time my husband had asked, "Can't you just stop at the shop?" But no, I couldn't do that because I don't leave it like that! So, I guess that's the sad thing, that you have to keep thinking about it. (Sandra, interview)

Except when she is unable to lock the e-bike to something, Sandra leaves her cycle to do errands. However, leaving the e-bike unattended creates stress, even if the battery and computer have been removed and the cycle has been secured to something with a heavy lock. Even if the constraints to a large extent are transmittable to conventional cycling, especially if the cycle is expensive, the material features of the e-bike add another level of complexity to parking because more equipment is involved.

Different strategies are deployed to feel as safe as possible when sequencing e-biking with other practices, the most common being to secure the cycle to something and to take the battery and other detachable elements (such as the computer) away. As Sandra phrases it: "If it's outside, I lock it up tight and strip it totally. Even if I go just a few metres away, I do that." The safety measures, however, thus require that equipment such as heavy locks are brought along during the journey, and that batteries etc are carried while the e-bike is stationery.

> That's what you do [bring the battery], but it's also cumbersome. It's built to be carried, but it's still quite tedious to carry around that battery. And [...] I quite often forget it [the battery] [...] It can be a lot. Bag, which is also often a bit too heavy, helmet, battery. And also, if you're going to be somewhere or coming to someone's house, and you just have to, all my big heavy things, I have to put in a corner somewhere. It can feel like you're kind of in the way or something. It can be a bit like this, a bit much stuff. It's nothing that I suffer from, but I still think about it quite a lot. (Peter, interview)

Thus the carrying around of equipment is not only viewed as a hassle, but also sometimes a bit embarrassing and not deemed totally socially acceptable.

Not everyone removes their batteries. For the participants owning e-bike models with more integrated batteries that are harder to remove by force, it is less common to detach the battery. In contrast, it is deemed even more important to lock the e-bike very securely, or not to leave it in places perceived as unsafe.

When it feels unsafe to park the e-bike somewhere, or the hassle of locking and carrying the battery becomes overwhelming, substituting the e-bike for other modes of transport is an alternative:

> If you're going downtown one evening, it's maybe better not to take the e-bike […] Then I'd probably rather take [the regular bike]. I'd probably prefer a regular bike that you don't need to be as careful with and that is not as expensive. (Klara, interview)

Another alternative is to leave the battery at home when parking the e-bike in public spaces at night. This is possible, because the e-bike still functions even without the battery. As the practice is reshaped, the advantages of having assistance are excluded. Most extreme among the informants in their strategies to overcome safe parking is Thomas, who chooses to replace his e-bike with an electric mono-wheeler. Even with disadvantages, such as being illegal to use, and not functioning without a charged battery, the mono-wheeler has the advantage of being able to be brought anywhere – into the grocery store, on the bus or subway, into restaurants, in a car, to work and home.

These examples show how important recent infrastructural investments such as indoor cycle parking in connection to train stations are, but also how previous urban planning affects what mobility modes become dominant (Koglin and Rye, 2014).

New micromobility solutions give new challenges

New needs emerge and are emphasised as e-bikes with cycle carts or cargo-bikes are becoming more common. Such micromobility modes increase the range of practices possible by cycle but lack the ability to protect goods in the same way as a car does. The parking situation (when linking e-biking with other practices such as shopping, for instance) involves concerns not only for the e-bike itself but also for goods purchased. Klara and Martin both find it very convenient to do the weekly grocery shopping by cargo-bike. However, the parking situation makes it more complicated because they are worried about leaving their groceries while carrying out other errands.

> One advantage of the car is that you can lock up previously purchased goods for a short while. With my cycle [without lockable storage compartments] I have to also plan the order of purchases from a theft perspective. (Martin, diary)

The particularities of carrying out errands with a cycle instead of a car creates new competences and practices, such as planning errands in a certain order (for instance, buying the goods most susceptible to theft last), as shown in the quote from Martin. In the situations described earlier, cycle parking is not monitored and is located far from shopping trolleys. With better parking infrastructures and higher prioritizations of cycle thefts, e-biking would be less troublesome and would potentially be able to be bundled together with other practices and thus be able to attract new recruits.

The battery and its charging

Closely connected to both the e-bike in motion and non-motion are practices related to battery charging. E-biking is thereby connected to, and dependent upon, the electricity network and other related infrastructure. Even if an e-bike can be cycled without assistance, it is no longer "e-biking" if the battery is not charged. A discharged battery can imply that the driver is inappropriately dressed, that the e-bike becomes immobile and that integrated lights do not work, which all hamper travel.

> What is something that I can't do with the cycle? Cycle a really long way. Then you have to know that you can stop and charge [the battery]. (Yvonne, interview)

An e-bike battery can be charged using an ordinary wall socket. Necessary connections are thus often widely available in countries with a high level of electrification (such as Sweden). Due to the risk of fire, e-bikers are sometimes discouraged from charging their batteries unattended, and some companies prohibit workers from charging them at work. It is, however, most often not the availability of charging that is the problem but rather that not even a fully charged battery is enough for the intended route or that cyclists forget to charge the battery. To have a sufficiently charged battery requires competences of planning. Other strategies to ensure a charged battery include having several chargers at different locations (e.g., at work and at home) or to have several batteries.

> Wish it could charge while cycling and braking, like some cars do. Is a little stressful to have to remember to charge the cycle batteries. It's still good that we have two batteries, since we have two cycles. It is less vulnerable. (Yvonne, diary)

Sufficient infrastructure in the form of roads is thus only one piece of the puzzle. Infrastructure for non-motion is also needed.

Conclusions

The main reasons to use an e-bike are that it can be used for many different purposes and on a multitude of different roads, and that it is easy to find parking places compared to cars. However, as this study has shown, the range of the e-biking practice, and thus also the spread to a larger user group, would increase with more developed infrastructures.

Safe parking places is deemed the single most pressing issue for the informants from urban areas in Sweden present in this study. The results show that because e-bikes are heavier, are more susceptible to falling over and to harsh weather conditions, and are generally more expensive and more liable to theft than conventional cycles, more complex and demanding parking conditions are required than for conventional cycles. E-biking in its current form also involves the carrying of batteries and other equipment. It thus needs to be regarded as a practice in its own right in these respects.

Many of the constraining features occur when e-biking is linked to other practices. Insufficient cycle parking infrastructures discourage usage beyond trips between two places with (known) safe parking possibilities. In other words, possibly linked practices, such as shopping or social events that demand the user to leave the cycle in a place perceived as unsafe and unsecure, will be avoided, which risks limiting the range of activities for which e-bikes are used.

It is, however, important to note that new developments in cycle parking are currently underway. For instance, locked cycle garages are being introduced at many railway stations in Sweden. One concrete example is an underground parking garage in central Stockholm offering the possibility to park and charge two- and three-wheeled e-bikes in designated boxes. However, the garage is restricted to monthly tenants and is relatively expensive (Stockholm parkering, 2022). The development shows the dynamic and interdependent relationship between practices and infrastructures, where infrastructures also are shaped by mobility practices. But it also shows how new solutions risk reproducing existing structures and power relations, further favouring already privileged groups. An unequal geographical distribution of access to safe parking spaces thus adds layers of inequality to mobility. It is easier for people living in "safe" areas or with access to their own enclosed garage, people most often

already in privileged positions, to take advantage of the whole potential of e-biking. On the other hand, more privileged groups are also constrained in their e-biking practice if they do not dare to leave their expensive cycles on the streets, or refrain from purchasing them at all.

Another dimension is that the type of parking hitherto reserved for cars – i.e., with high levels of regulation and clearly defined designated areas on streets, in public and private spaces – is being reproduced for other mobility modes the more common micromobility options become. In other words, mimicking the characteristics of car-centric planning has become the ideal without questioning underpinning dominant paradigms of constant movement and growth (see Spinney, 2021).

Increased knowledge of infrastructural and situational conditions of e-biking explored in this article is important to better understand the challenges and opportunities included in the transition towards a sustainable transport system, and therefore highly important. Conscious and inclusive infrastructural planning makes it possible to influence future mobility practice, as the background role of infrastructures makes them able to shape and facilitate practices as well as the relations between practices (Shove, 2017, p167). If low-carbon, health promoting, space-efficient micromobility solutions such as e-biking are to replace automobility in the future, in line with political agendas, a holistic policy approach that takes infrastructures in motion and non-motion into consideration is needed. At the same time, for those excluded from the practice from the start, designated infrastructures such as cycle stands, are pointless. Further studies on how vulnerable groups can be included in mobility transitions are therefore needed.

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Competing Interests

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