



From elements to policies: A Shovian social practice perspective on pathways to facilitate daily E-bike commuting

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ABSTRACT

The rise of pedal-assisted bicycles (e-bikes) has the potential to contribute to reducing ubiquitous automobility and its negative externalities on the global climate, mobility justice and the quality of urban life. But what makes this new practice so successful in recruiting new practitioners? What policies can ensure that e-bikes are used in a wide range of situations, thus substituting as much car driving as possible - or even reducing the number of cars? The study focuses on commuting as this use case frequently entails the main obstacles to e-biking in daily routines (e.g., sweat, weather, transporting children or goods). The analysis is primarily based on interviews with practitioners and initially provides a thorough depiction of the practice elements (meanings, materials and competences) involved in e-bike commuting. It furthermore elicits key drivers of and barriers to daily e-bike commuting, points to a number of elements that are important to overcome these barriers and develops two tangible policy approaches to foster the substitution of e-biking for car driving.

1. Introduction

Many industrialized nations are witnessing a sharp increase in the sales of electrically assisted bicycles (e-bikes)¹ (Bourne et al., 2022). Moreover, the development has far exceeded expectations: In 2017, the German cycling industry organization expected the share of e-bikes sales to grow from 15% to 30% “in the long run” (ZIV, 2017). But only three years later, in 2020, the numbers had already more than doubled: 39% of all bicycles sold in Germany were electrified (see Fig. 1). In 2021, e-bikes sales reached 2 million vehicles in Germany, equating to 76% of car sales in the same year (2.6 million; KBA, 2022).² Despite the substantial growth of e-bike sales, its potential for the mobility transition has received little public attention.

How much the sales of e-bikes actually contributes to reducing car driving and car ownership remains disputed (see Cairns et al., 2017; Jones et al., 2016; Kroesen, 2017; de Kruijf et al., 2018; Lienhop et al., 2015; McQueen et al., 2020; Moser et al., 2018; Philips et al., 2022; Söderberg et al., 2021). Sun et al., (2020) state that “It is important to gain further insights into the modal shift directions before moving on to unconditionally embracing e-bikes and promoting their use [...]”. Yet it is clear that e-bikes enable more people in more places to use velomobility for more purposes (Rérat, 2021) and car substitution effects appear to be

most robust for commuting trips (de Haas et al., 2022).

This paper builds on the assumption that the modal shift effects of e-bikes are not predetermined, but rather contingent and alterable. The analysis therefore investigates the characteristics of current e-biking in order to elicit insights for interventions that increase the modal shift effects of this still rather new phenomenon. To this end, the paper employs social practice theory as developed by Shove et al. (2012) and provides three contributions to the subject: First, it presents an encompassing account of the practice elements (meanings, materials and competences) of e-bike commuting. These findings set the ground for future quantitative research, for example on the co-occurrence of elements, on the relationships among elements or on their relative importance to the viability of the practice under different circumstances. Second, the analysis qualitatively describes how the interactions among elements form key drivers and barriers to daily e-biking. This enables starting points for interventions to be identified. Third, this paper proposes practice-element and practice-interaction based policies to overcome the identified barriers and hence foster the use of e-bikes for commuting and other daily trips.

To encourage more people to switch away from driving and towards e-biking, in as many situations as possible, it is important to understand the various factors that drive or hinder daily e-biking. Studying “the

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¹ This paper is focused on e-bikes with a motor cap at 25 km/h.

² The 2021 halt in sales growth can primarily be attributed to supply chain problems (ZIV, 2022).

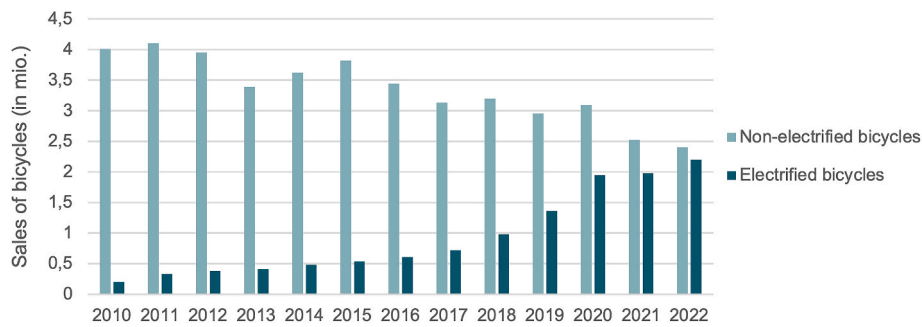


Fig. 1. Sales of different bicycle types in Germany between 2010 and 2022.
Source: The author, based on press releases by ZIV (e.g., ZIV, 2017, 2022, 2023).

commute” appears to be especially suitable for such an endeavor as the commute (i.e. going to and coming back from work) entails most - if not all - challenges posed by daily utility e-biking: First, commuters often need to navigate narrow spatio-temporalities including childcare and domestic tasks (e.g., dropping-off/picking-up children, grocery shopping), where timeliness, reliability and the ability to transport goods or people are prerequisites (Stein et al., 2022). Such spatial, temporal and functional characteristics can imply a dependency on car driving (see Mattioli et al., 2016). Second, the spatio-temporality of commutes is often fixed so that situations adverse to cycling (such as darkness, tiredness, rain and rush hour) cannot be avoided. Third, commuters arrive at work - a place where cleanliness norms and appropriate clothing are often important (Lee, 2016), which can conflict with the sweat and dirt associated with cycling. Last but not least, understanding and altering commuting practices is relevant as commutes account for 21% of all distance traveled and 25% of the mobility related greenhouse gas emissions in Germany (Nitschke et al., 2022).

This study is based on a rather small qualitative sample ($n = 8$) and includes only middle-aged practitioners (40–59 years old). Still, the chosen maximum variation sampling strategy facilitates a comprehensive overview on the current shape of the practice for this age group in Germany. Practitioners were sampled both in the hilly and car-dominated city of Wuppertal as well as in Münster, a flat city with a high modal share of cycling. Empirical data was furthermore gathered using video ride-alongs, interviews and a researcher’s notebook. The interviews were systematically analyzed using template analysis (see King, 2012) with the help of qualitative research software (MAXQDA).

The article is structured as follows: section two briefly introduces the chosen practice theory paradigm and then dives into the literature on the study of (e-)biking from a social practice perspective. Then, the case study and its methodology are specified. Section four presents the elements of e-bike commuting, discusses relevant barriers and highlights the particularities of commuting. Chapter five first summarizes practice-element oriented policy strategies and then outlines two tangible approaches to fostering daily (e-)velomobility. The article finishes with a summary.

2. An elements perspective on social practices and respective research on velomobility

Social practices are interpersonally shared sets of actions such as greeting, getting married or trading shares on stock markets.³ Scholars of practice claim that social practices are the fundamental ontological substance of social life and that both everyday activities and “social phenomena such as organizations, power, science, education, and transportation [can be] understood as constellations of, aspects of, or rooted in

practices.” (Schatzki, 2016). Shove et al. claim that “practices emerge, shift and disappear when connections between materials (technologies, tangible entities, “stuff”), competences (skill, know how, technique) and meanings (symbolic meanings, ideas, aspirations) are made, sustained or broken” Shove et al. (2012). This strain of practice thought is hereafter referred to as a “Shovian” perspective.

Fig. 2 depicts how a social practice, such as cycling, can be displayed in its elements either as a whole (practice-as-entity) or by means of different instances (practice-as-performance). While the elements integrated into different practice-as-performances vary between individuals, contexts and even instances (see Hui, 2017), the performed practice-as-entity remains intersubjectively recognizable. Fig. 2 uses bold circles and lines to highlight elements and connections that are essential to the practice and included in all performances (e.g., keeping one’s balance when cycling). Some elements can be more important to the practice-as-entity than others (larger bubbles). They may still only be included in some, but not all performances (e.g., in Fig. 2 “protective gear” or a “joy” of cycling are only present in performance 2).

It is furthermore possible to distinguish between different “variants” of a practice (see Hui, 2017). The meanings, materials and competences integrated when e-biking to work are, for example, much more common to each other than to the elements integrated into tandem cycling for leisure. This article therefore does not seek to present an encompassing account of e-biking as a whole, but rather focuses on e-bike commuting, which does, as is argued above, feature key characteristics of its “parent”, namely daily utility e-biking. It furthermore focuses on e-biking with a motor assistance limitation of 25 km/h.

Few studies have considered e-biking from practice perspectives. McHardy (2013) studies the interaction between body and machine. He is interested in the process of “fitting” e-bikes to bodies and the establishment of what counts as “normal” e-biking in the process of pre-testing and re-arranging e-bike prototypes. Le Bris’ (2015) encompassing PhD thesis coined the term ‘practice-careers’ to describe the process of getting acquainted with, taking up and adjusting individuals’ e-biking practices. Although she induces categories from empirical data via a grounded theory driven methodology, Le Bris comes up with three practice dimensions that are rather similar to the elements proposed by Shove et al. (2012): knowledge & purpose (meaning), materiality (materials) and doing & social context (competences). The Shovian model thus seems to fit the practice of e-biking well. Empirically, Le Bris finds a strong association between e-biking and weakness/age among trainees in rural Germany (Le Bris, 2016; Le Bris and Rothfuß, 2015). Rérat (2021) finds that the motor support expands cycling practices by reducing barriers such as distance, gradient and physical effort. Based on a large sample from Switzerland, he reports that e-bikers are recruited from more car-affine groups than cyclists and infers that e-bikes are a good complement or alternative to cars. Edberg (2023) focuses on parking infrastructures and finds that the choice of e-biking for trips is strongly related to the availability of parking opportunities suitable for

³ For an introduction to social practice theory see Reckwitz (2002).

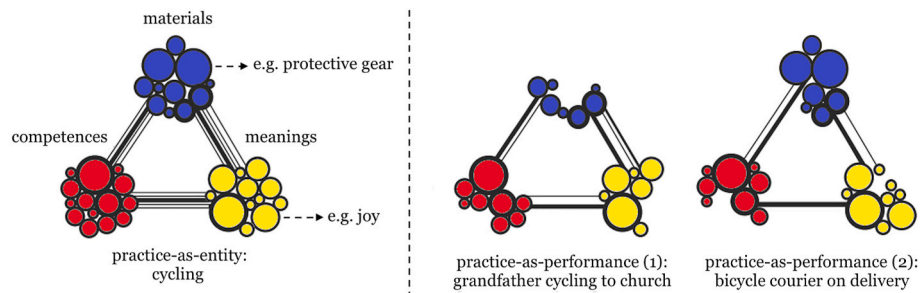


Fig. 2. Cycling depicted as a practice-as-entity and as two different practice-as-performances. Source: Schneider, P. R. (2022), based on Kuijer (2014).

e-bikes, which are heavy and demand more protection against weather and theft. Finally, studying mobility practices using the closely related domestication theory, Naess et al. (2023) highlight sensory and emotional aspects of e-biking and find the practice to be characterized by the same attributes as car driving: freedom, comfort and speed. They report that after trying out this practice for two weeks during their study, which implied reflecting on the practice, two-thirds of the 19 Norwegian participants bought their own e-bike.

Further literature on e-biking from an explicit practice perspective is not available. Hosseini et al. (2023) show that e-biking is more suitable as a local standalone mode of travel than bicycling and also complements long-distance railway travel. It is thus suitable for both short- and long-distance substitution of car driving. A general, up-to-date review of bicycle commuting, including the particularities of e-biking, can be found in Banerjee et al. (2022). For an encompassing review on the global development of cycling in the last 30 years (including e-biking), which includes analysis on user groups as well as factors influencing trip length and speed, see Buehler and Goel (2022). The remainder of this review focuses on literature on cycling and commuting from a Shovian angle.

Hofmeister and Keitsch (2016) studied cycling in Trondheim (Norway) and Freiburg (Germany). They provided an extensive list of elements and relate the differences in elements to the differences between the places being studied as well as to different purposes dominant in the two cities (utility vs. leisure cycling). Their findings engage with the differentiation among variants of cycling and provide initial clues as to the elements that sustain a cycling variant or make it viable in the first place. Scheurenbrand et al. (2018) argue that the presence (or absence) of other practices, such as policing or traffic education, can have a substantial impact on the types of bicycles in use as well as the skills available, and hence on the elements of utility cycling as a practice-as-entity at a specific spatio-temporal location. Spotswood et al. (2015) investigate the meanings, materials and competences involved in commuter cycling and provide a rather limited set of two competences, three materials and six meanings associated with utility cycling. Cass and Faulconbridge (2016) provide an account that comparatively depicts the Shovian elements of commuting by car, bus and bicycle. Yet despite drawing on a comprehensive data set compiled over the course of two years that included interviews, footage and travel diaries, etc. involving 61 commuters, they too only list a small number of elements. Thus, a thorough account of the Shovian practice elements of utility cycling, let alone e-bike-commuting, does not exist to date.

3. Case study and methodology

Nicolini (2009b) argues that practices should be studied using multiple perspectives, by re-positioning in the field and switching theoretical lenses. He suggests first studying the details of a practice and its accomplishment (“zooming in”, for e-biking e.g., McHardy, 2013) and then refocusing on how the practice persists in time-space and interferes with other practices (zooming out, for cycling e.g., Watson, 2012, 2013).

As this study intends to investigate e-biking situated in the commute, it needs to grasp aspects of both: details of conduct, such as the emotions practitioners feel when riding early in the morning, as well as the interdependence of e-biking and other practices such as childcare. As such, this paper takes a mid-zoom perspective.

3.1. Data generation tools

The literature on e-biking from a social practice perspective is scarce and there is no study that focuses on e-bike commuting. Thus, a qualitative account of an explorative nature suits the purpose best (see Stebbins, 2001). As practitioner accounts can provide access to elements that cannot be reliably observed such as smelling, feeling, thinking (Hitchings, 2012; Kuijer, 2014), and as interviews furthermore enable the exploration of structures and linkages between practice elements (Spotswood et al., 2015), interviews were chosen as the primary means of data generation. Focused interviews (see Helfferich, 2019) were conducted as this method enables a balance to be struck between openness, necessary for exploration, and focus, necessary to grasp as many practice elements as possible as well as to elicit practice elements sedimented in the unconscious through routine (see Giddens, 1984). The interviews were conducted at a place chosen by the interviewees (at home or in public), recorded and transcribed verbatim. Several interviews were preceded by video-recorded ride-alongs and included an interview to the double (see Nicolini, 2009a). The data also comprises transcripts of self-observation. It was collected during the research for a master’s thesis; methodological details can be found in Schneider (2022).

3.2. Sampling places and practitioners

The sampling of interviewees and places of study aimed at comprehensive coverage of the phenomenon. Practitioners were thus sampled at two different places. Using modal split and topography as proxies for the dissimilarity of cycling conditions (see Xie and Spinney, 2018), Wuppertal and Münster were determined to be appropriate places for the study. In 2016/17, cycling accounted for 30.9% of all trips in Münster, a city located on a flat plane (29.8% by bicycle, 1.0% by e-bike; self-reported). Wuppertal, on the other hand, is characterized by a hilly topography and cycling accounted for only 2.2% of all trips in 2016/17 (2.0% by bicycle, 0.2% by e-bike).⁴

Potential interviewees were approached while riding their e-bikes either downtown or on bike lanes along roads connecting the inner city to the suburbs. They were offered €10 in compensation for their participation. The purposive sampling focused on recruiting a wide variety of individuals with regard to age, sex, family status, employment and commuting distance (c.f. Hui, 2016). While this was achieved with

⁴ Modal split calculation from Schneider (2022) based on the MID data (BMVI, 2017).

regard to most characteristics, young and non-academic practitioners remained underrepresented (see Table 1). The sample is therefore not representative of the general population but typical for the current composition of the e-biking community in Germany (see Jurczok, 2019). Almost one in every three individuals approached agreed to participate. This high rate points to comparatively little self-selection (Engel and Schmidt, 2019).

3.3. Data analysis

The transcripts were scrutinized using template analysis as developed by King (2004, 2012) to create a fine-grained coding tree in between top level categories deduced from practice theory and bottom level codings induced from the data. Initially, three templates were developed irrespective of each other in MAXQDA using the most different interviews with regard to the practitioners' characteristics. This step was included to decrease path dependency related to the content and structure of the first coded interview. The three templates were then merged into an overarching template that was applied to the whole data set. The coding entailed meta codes for sensitizing the analysis to aspects such as subtones, emotions, suggestive questioning, etc. Along the way, memos were constantly being developed to grasp overarching themes across the data set and hence establish a situated understanding of the interrelations between coded aspects (see Kuckartz, 2018). The pseudonymized data and the coded data set are available from the author.

In order to reveal potential biases, this section finishes with a couple of notes on the researcher. This research was conducted by an able-bodied man who has been living in urban environments all of his life, an academic who can conduct much of his work remotely. The researcher enjoys cycling himself and makes substantial efforts to live sustainably, a lifestyle that is important to his personal identity. As such, the meanings, materials and competences of e-biking fit him quite well. His analysis may therefore underrepresent barriers to and overemphasize drivers of more frequent e-bike commuting.

4. Results: the elements of e-bike commuting and their interrelations

This section begins by introducing a graphic representation of e-bike commuting as a practice-as-entity. The second and third paragraphs flesh this out by qualitatively describing the barriers to utility e-biking in general and by specifying particularities of commutes.

4.1. An elements map of e-bike commuting

Fig. 3 provides an overview of the elements of e-bike commuting as a practice-as-entity. It presents 27 elements of meaning that relate to the individual (emotions, values), to the reactions of others and to functional advantages as well as limitations of the practice. The 33 elicited competences specify relevant bodily and emotional capabilities and explicable knowledge, list organizational competences and point to the outsourcing of skills to third persons or digital devices. Finally, the 55 materials depicted include stuff on/about rider and bike, cargo and other objects which are relevant to the practice.

It should be noted that this depiction of e-bike commuting as a practice-as-entity partially includes contradictory elements. For example, the segment on *materials - stuff on/about the rider - clothes* contains functional and chic, two characteristics that were used as antagonisms in the interviews. This results from the inevitable variation within any single practice-as-performance and between different groups and places (see section 2). Yet the broad set of tangible categories introduced in Fig. 3 enables exactly such differences to be investigated: Future research could use the elements shown to quantitatively study the co-occurrence of elements, the relationships among elements or the relative importance of elements to the functioning of the practice under

different conditions. Such research could furthermore set the ground for insights into differences between practice variants or inform policy approaches tailored to different groups.

The collected data suggests that the elements of e-bike commuting as a practice-as-entity (see Fig. 3) are not randomly distributed across individuals and performances. Certain constellations of elements (practice variants) co-occur more frequently than others and the data suggests that the practice variant an individual engages in impacts the situations and purposes in which the (e-)bike is used. For example, riding to work in any weather appears to be strongly associated with the use of rain gear and baskets/panniers in which the clothing is stored to be available at any time. This is in line with the findings of Hofmeister and Keitsch (2016), who find the elements of cycling to vary with different practice purposes (utility/leisure). Insights into such variants may help to elicit key elements for daily riding and for the individualized targeting of different groups of practitioners.

Eliciting the details of such different practice variants requires both qualitative and quantitative insights. The present article can benefit respective quantitative research by supplying an encompassing set of elements induced from practice. Further research may shed light on practice variants by investigating the types of connections between the elements, e.g., using the twelve types of connections among elements proposed by Macrorie (2016). In order to refrain from naturalistic logics, a comparison of elements and their associations in low, medium and high cycling contexts (e.g., England, the Netherlands, Germany) would be particularly interesting.

It should be noted that those practice elements and related barriers that are specific to recruitment and dropping out of the practice are not presented in this study. Anecdotal evidence suggests that a number of such barriers, e.g., unavailability of secure, ground-level parking with electric plugs deter many potential practitioners from engaging in the practice in the first place. Lapsed e-bike commuters, on the other hand, may have realized that carrying their e-bike to the third floor every day does not work for them. Neither of these individuals is integrated in the present study and the respective elements are thus not present in the data.

The depiction of practice elements in Fig. 3 both facilitates an overview of e-bike-commuting as a social practice and enables quantitative investigations. A situated understanding of the practice, however, can only emerge from an investigation of the elements' characteristics and their interactions. The following paragraphs thus begin by qualitatively exploring utility e-biking in general and then illustrate the particularities of commutes.

4.2. Key barriers to and drivers of utility e-biking

A major feature of electrically supported cycling consists in the joy of speeding up and riding fast. Markus (55, scientist): *"E-biking is great fun because you are quick and, if you want to, you can have a sporting challenge and work off your energy [...]. I am faster now and less frustrated because I can keep up better with the car's traffic light circuits and uhm – the interplay between engine and body is also fun."* This emotion is not restricted to elderly or physically impaired practitioners and is perceived as particularly intense when riding uphill or getting on an e-bike for the first time. The e-bike thus shifts the meaning of velomobility from sports and exertion towards comfort and joy. This aspect is particularly pronounced when the route includes hills, headwinds or long distances as well as in situations where practitioners feel "under the weather" and not at full physical or mental strength, e.g., early in the morning or when they are feeling a bit sick. Experiencing this joy appears to be the major driver for taking up e-biking and is thus suspected to be a key driver of the practice's rapid dispersion. Yet some practitioners, those who usually cycle fast, face a different emotion: they "hit a wall" at 25 km/h, when the motor decouples and they are suddenly faced with a bike that is too heavy to ride at a speed they are used to. This barrier can be moderated either through emotional self-regulation or by using newer, more

Table 1
Key characteristics of sampled practitioners.

Pseudonym	Sex	Age	Distance to office (one way)	E-bike com- muting days per week	Type of job	Duration of e-bike use	Previous means of commute
Clara	f	59	2,7 km	5	carework	1 year	car
Annabell	f	54	5 km	5.5	undisclosed	5 years	car, bicycle
Alina	f	52	7 km	7	teaching	many years	car
Markus	m	55	12 km	2	science	0.5 years	bicycle
Astrid	f	40	10–12 km	1–3	marketing	2 years	foot, bicycle, subway
David	m	51	12–15 km	5	marketing	0.75 years	car, bicycle, scooter
Paul	m	55	10 km	5	architecture	0.2 years	car, train + bicycle
Thorsten	m	41	11 km	4	industry	0.5 years	bicycle

Abbreviations: f = female, m = male, km = kilometers.

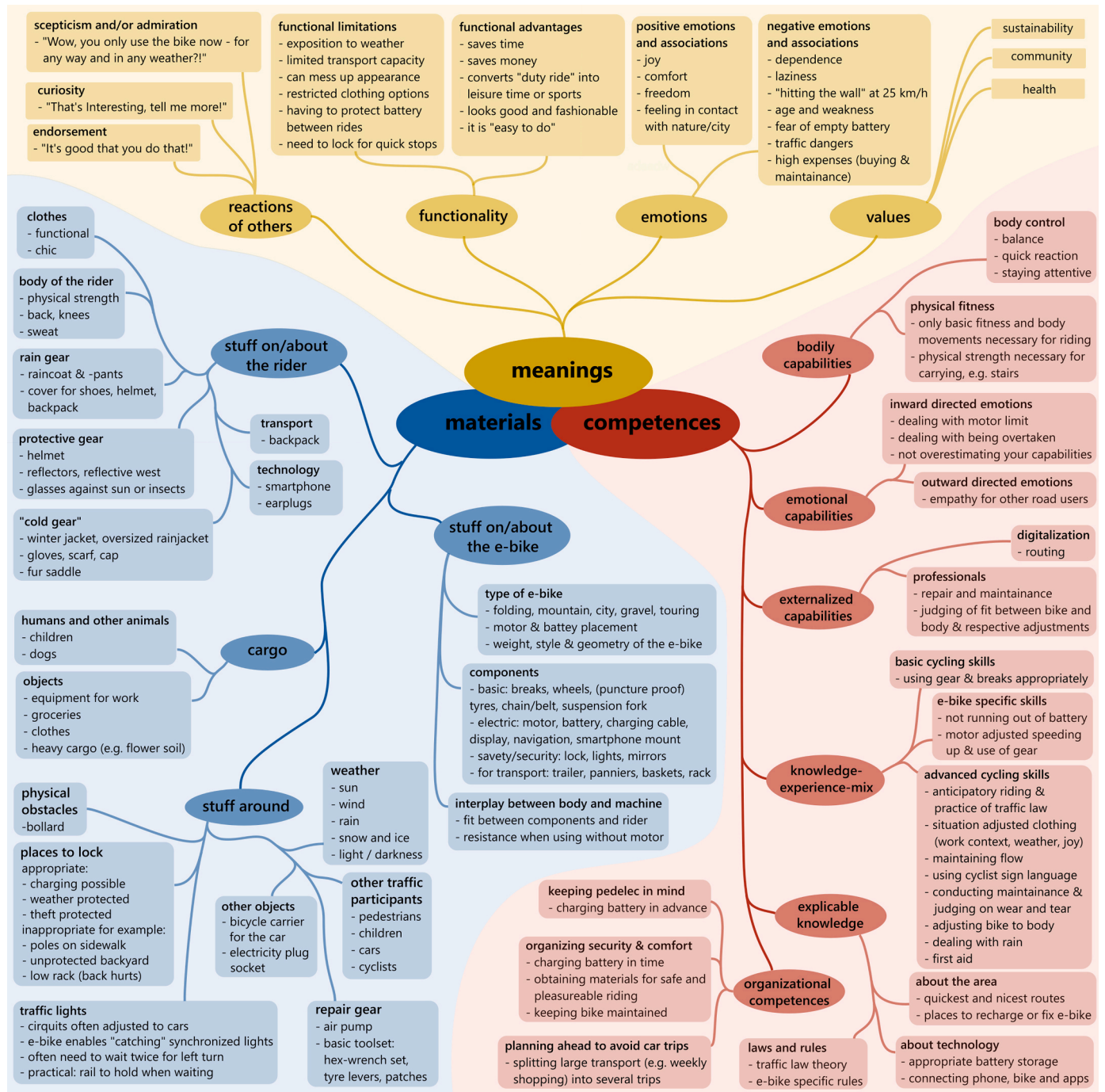


Fig. 3. Meanings, materials and competences of e-bike commuting. Source: The author, based on Schneider (2022).

lightweight e-bikes that start from around 14 kg, have little friction and thus make cycling above the motor limit feel like riding a “regular” bicycle.

In hilly environments (such as Wuppertal) and for individuals with limited physical abilities, the motor support means practitioners do not have to judge in advance whether they can cycle a particular route – the e-bike *can* become the default mode of mobility for most everyday utility trips rather than being an on/off option restricted to certain circumstances. For practitioners like Alina (52, early adopter, physically impaired), the e-bike is thus associated with freedom: *“Freedom, uhm, really being capable to just start riding without having to consider the disease or headwind or anything, that is a great feeling of freedom [...]”*. But cyclability is also extended in flat areas and for able-bodied persons: surfaces such as gravel and forest paths are not associated with struggle anymore, a change that adds flexibility to route planning and makes enjoyable routes off the main roads more accessible. But the freedom, joy and flexibility associated with e-biking depend on the battery life. Thus, judging and managing power requirements according to the situation are important e-biking competences. In addition to this, knowledge about and space for weather-adjusted storage (protection against heat, cold and exposure to water) are decisive when it comes to the durability of the materials and thus comfortable riding in the long term.

As opposed to being in a public transport vehicle or in a car, riding an (e-)bicycle means moving without shelter under the open sky. This aspect can constitute both a driver and a barrier. On the one hand, direct contact with the sun, air and surroundings is a major source of positive emotions towards cycling. Clara (59, caregiver) highlights: *“Simply this connection with the world around, which cycling entails [...] and the sun shines and you see plants becoming successively greener [...] that’s always very, very lovely.”* Yet these emotions depend on the surroundings and Clara also negatively highlights exposure to noise and smells on some routes, e.g., when riding along a main road: *“[...] between all these machines, even when cycling lanes exist, it stinks so much, well, I find that very unpleasant.”*

Most interviewees have a very positive image of and receive positive comments about their e-bike and themselves e-biking. They like the look of their e-bike and explain that the association between e-biking and old age/fragility has faded in recent years. Astrid (40, frequently transporting children) notes: *“Around four years ago, when grannies started using e-bikes, e-bikes were associated with age and weakness. But today they are very normal, kids use them to go to school.”* This impression from Münster (high cycling context) differs slightly from Wuppertal, where peers react with more curiosity about, and interest in, this still-novel practice. It seems like the strong association between e-biking and age/weakness found by previous studies (e.g., Le Bris, 2016) has diminished over time.

The analysis finds rain and cold to be major situational barriers to daily e-biking.⁵ Some respondents reported avoiding rain by switching to their car as soon as clouds were in the sky. These respondents also indicated that they did not own rain gear. Others ride in any weather. They use some or all material elements available to protect their bodies and belongings from discomfort and damage. Covers range from rain jackets to shoe covers, from gloves to fur saddle overlays. As backpacks increase the rain permeability of jackets, block air exchange and thus cause more sweat, the use of panniers or trailers is of great avail, especially for sweat averse and comfort-seeking commuters. Some practitioners perceive getting changed and wearing protective gear as a burden while others perceive getting changed as a quick and simple process. Most all-weather riders use lightweight, small volume rain equipment that they keep in their panniers or backpacks between trips, so they are always readily available. Rain and cold covers therefore appear to be a key facilitator of daily velomobility. The importance of

protection against rain is strongly related to the length of the commute and the interpretation of “bad” weather varies substantially. Many respondents associate rain with discomfort while others consider it to be a refreshing experience that makes them feel in touch with nature.

Like “bad” weather, the risk of theft is a barrier that impedes many rides. Practitioners mitigate this by using stronger locks or GPS trackers, buying insurance and choosing suitable locations to lock up their e-bikes. Safe parking is strongly connected to adequate material arrangements (e.g., well-lit racks, video surveillance, bicycle storage). An additional risk occurs when batteries, which often cost between €500 and €1,000, are not integrated into the frame. Many models can be kicked off and stolen, a phenomenon that was much more of an issue for practitioners in Münster than in Wuppertal, where e-biking - and thus opportunities for theft - was not as common.

Two further aspects present major barriers to everyday (e-)velomobility. These are the limited range (as compared to cars or public transport) and limited transport capacities. However, by utilizing the pulling power of the e-bike’s motor and either choosing a transport-adapted e-bike (e.g., cargo bike or longtail) or by adding panniers, baskets or trailers to “regular” e-bikes, the latter key barrier can be diminished with regard to many everyday applications. Several practitioners claim to now do all their shopping, etc. by e-bike and some state that they altered their shopping practices and now buy more frequently and at locations that involve fewer detours than when shopping by car. Others, however, still “need” a car to do the weekly groceries (e.g., to carry drinks) and only run small errands on their e-bikes. This could be tackled through interrelated practices, e.g., by promoting drinks delivery services.

4.3. The commute – drivers of and barriers to e-biking to/from work

A traditional (albeit currently changing) characteristic of the commute is its spatio-temporal fixity, which implies unavoidable coincidences of commutes with uncomfortable cycling conditions such as rain, darkness and rush hour. Therefore, good equipment including lights, brakes, mudguards, etc., as well as alertness and good traffic sense are important materials and competences for daily e-bike commuting. Depending on the equipment and conditions, practitioners may arrive wet and muddy, sweaty and/or with messed up hair. Such impacts on the bodies of practitioners can, depending on the context and individual, be acceptable or bother practitioners significantly as the appearance of employees at offices is of importance for their relationships with colleagues, supervisors and customers (Pajunen, 2021). In this regard, the data shows substantial differences between (self-identified) male and female practitioners. All of the women interviewed mentioned sweating less on an e-bike than on an unsupported bicycle and most added that this characteristic enables them to cycle to work in office clothes. Clara (59, caregiver) notes: *“[that] is something I find really comfortable for everyday cycling because I [...] can simply ride in office clothes because I do not arrive bathed in sweat and have to shower and get changed first. I just get off my velo and go into the office.”* Astrid (40, frequently transporting two children) enjoys dressing nicely for work. She confides that, while the e-bike enables her to ride in office clothes, they still need to be quite functional and she therefore has to compromise on her look. Several female interviewees reported that they felt uncomfortable after sweating, that they could not wear certain types of clothing when cycling – especially skirts, wide trousers or dresses – and that their hair gets messy. Male practitioners also report sweating less and liking it. However, their aversion to arriving sweaty and untidy is much less pronounced. They reported enjoying riding fast, above 25 km/h, and did not speak about having to compromise on their appearance. The reliability of these findings is restricted by the small number of male interviewees (n = 4) but is supported by the fact that one of the interviewees was wearing a suit – the most formal office wear for men – when he was approached on his commute. This involvement of gender identity is more pronounced for cycling than for other commuting

⁵ See de Kruijf et al. (2021) for a quantitative, longitudinal study on weather and e-biking.

modes (see Steinbach et al., 2011). The e-bike’s support is hence found to decrease the gender related barriers to bicycle commuting for self-identifying women. Yet societal gender norms still create uneven barriers for people with different gender identities.

Another driver of e-bike commuting is that there is a good chance of arriving relaxed and on time as neither traffic jams, late trains nor occasional health problems delay the commute. Alina (52, teacher), whose health status can change drastically in a few hours, explains: “Because of my illness I always had to check – ok, am I fit for cycling today, can I make it? Now, with the e-bike, that’s great, I can set the assistance level and do not have to think twice, so now I can cycle to work.”. Paul (55, architect) elaborates on the flexibility of the pedelec: “[...] especially in rush hour traffic, I can get very angry when the traffic is not running smoothly. This situation is much more relaxed on the pedelec because I can go my own way and take over when someone is too slow for me. This way I can ease stressful situations, which is not possible when driving my car.” The ride furthermore provides a timeslot to warm up before and cool down after work, which was noted as a driver of e-bike commuting by several respondents and reported to be more pronounced for commuting by bicycle than by car.

While the commute to work is often spatio-temporally fixed, the way back home comes with more flexibility. Thus, a number of everyday practices such as shopping (e.g., food, errands, DIY materials), leisure activities (e.g., visiting friends, leisure rides, sports) and family care (e.g., picking-up children) are frequently integrated into the ride back home. The motor support substantially increases the range of practices that can be combined with bicycle commutes and facilitates their performance, yet most of these combinations are not viable without material elements that afford adequate transport capacities. Rain and sweat are perceived as much less problematic on trips back home than on the way to work. Several practitioners utilize their commute back home to

turn their obligatory ride into a pleasure/leisure ride. They choose differing routes and spend time enjoying the surroundings, weather, themselves and their machines. Others utilize their commute home to exercise, freeing up other time slots they would otherwise need for physical fitness.

5. Policy approaches to enhance e-bike commuting

Sustainability-oriented interventions in practices can be designed to substitute practices, to re-craft practices or to change how practices interlock (Spurling et al., 2013, c.f. Shove et al., 2012). These approaches translate almost exactly into the mobility transition framework to “reduce, replace and improve” unsustainable modes (vermeiden, verlagern, verbessern, see Hennicke et al., 2021). Practice oriented policy interventions can target both drivers and barriers. Yet the paper at hand focuses on barriers, as these appear less fuzzy and individual in the analyzed data. This section therefore begins by presenting an overview of key barriers and lists the relevant elements. It then outlines two feasible policies.

5.1. Addressing the barriers

The empirical data suggests that three key aspects, namely weather conditions, transport capacity and time/distance inhibit most potential rides. Table 2 shows a range of policy approaches to these and other barriers, either by engaging with practice elements (re-crafting) or through interrelated practices (changing how practices interlock). In Table 2, blue elements/policy approaches address materials, red ones address competences, golden ones address meanings and orange ones point to interrelated practices. Thus, policy approaches such as mobility

Table 2
Elements and respective policy approaches to address key barriers to e-bike commuting.

Barrier	Issue	Relevant elements or practices	Policy approaches
Weather conditions	Rain/getting wet & dirty	Rain pants, ponchos, overshoes, mudguards, panniers, comfort, social norm, experience	Procuring rain gear, public campaigns, traffic education, remote work skills
	Cold/freezing	Jackets, gloves, overshoes, comfort, norm, office hours	Procuring cold gear, public campaigns, mobility management
	Danger	Slippery surfaces, light	Infrastructure standards, road clearance & maintenance
Transport capability	Groceries	Panniers/basket, trailer, shopping frequency, drinks delivery	Public campaigns, mobility management, delivery services
	Children	Children’s seat, trailer	Discounted VAT, subsidies
Time / distance	Speed	E-bike braking, traffic light circuits, street signs	Change traffic rules and prioritize road users
	Distance	-	-
	Timing	Flexible drop-off/pick-up times at kindergartens, spatio-temporal flexibility at work	Change childcare facility laws, mobility management, handling of remote work
Reliability, representability and occasional demands	Repair	Public repair stations with guides, public air pumps, puncture-proof tires, repair experience, independence	Mandatory air pumps at bike shops and gas stations, public repair stations, traffic education
	Sweat, office norms, restricted clothing options	Panniers, panniers, reflection on office norms	Traffic education, public campaigns
	Illness, transport, etc.	Taxi, on-demand ride-pooling, car sharing, car rental	Political support for public transport, inclusion of remote places, taxi service areas

management can be printed in different colors depending on the element on which the intervention is focusing. For example, in order to address the social norm of (not) cycling in the rain, a major city could show their use of rain-adapted equipment on local TV or social media during a municipal pro-cycling campaign. They could ask their citizens to try (experience) the gear for themselves and explain that they may find it surprisingly comfortable.

5.2. Two tangible intervention policies

Strengers and Maller (2014) point out that any performance of a practice demands the integration of elements from all three dimensions. Interventions should thus be multidimensional and address several meanings, materials and competences at the same time. Furthermore, taking the fluid nature of practices into account, policies should be closely monitored and feedback and learning should be integrated (see Graham, 2018). Therefore, as the suggested policies are based on an explorative account (see Stebbins, 2001), the proposed interventions should be accompanied by an evaluation, either by means of a living lab (see Hasselkuß et al., 2017) or a randomized controlled trial.

5.2.1. “An e-bike deserves company”

This policy approach aims at the moment when individuals acquire a new e-bike - and thus at a point in time when the future e-biking practice is comparatively contingent and influenceable (Le Bris, 2015). In this situation, the combination of an individualized consultation with a price reduction on equipment may influence the elements that are integrated into future practice performances - and hence the potential of the practice to overcome barriers to daily practice-performance. Individuals who buy e-bikes could thus be offered:

- A consultation: In order to raise awareness of current barriers to cycling, participants should first be asked about the types of trips and situations in which they currently *do* and *do not* cycle. Then, the individualized consultation should engage with reported (and other) barriers by providing applicants with knowledge of related materials and competences - e.g., to reduce sweat, enable transport, prevent theft, improve comfort or align with the social norms of their respective workplace (see Table 2). The advice should preferably be conveyed in person and materials should be available so that practitioners can become familiar with the objects. Furthermore, the advice should point to specific products that suit the needs of the respective individual because the process of finding and choosing the right commercial product itself can pose a barrier to implementing the advice. The consultation should furthermore include aspects of price psychology and hence increase awareness of the costs of a car. It should furthermore communicate the health benefits of active mobility, thus altering the meanings associated with car driving and e-biking.
- A special offer: In order to incentivize the translation of knowledge into material, the consultation should be accompanied by a component that allows for a price reduction on the purchase of utility-oriented cycling gear (see Table 2, Fig. 3) when purchased with the newly ordered (e-)bike.

In Germany, this opportunity could initially be offered to applicants for the “Dienstradleasing” model. In this scheme, employers lease (e-) bikes for their employees, who in return give up a part of their salary. Employees then pay less income tax and employers save on social security contributions. The scheme is implemented by local bicycle sales agents in cooperation with specialized service providers. To avoid conflicts of interest, the consultations should not be conducted by the bicycle agents but rather by the leasing service providers or a third party (e.g., a cycling advocacy group) and should be publicly funded. Newson and Sloman (2019) summarize e-bike incentive programs in six European countries and report that the interventions had a significant impact

on the purchase of e-bikes. If empirical investigations were to prove the success of the proposed scheme, the consultation and subsidy could be offered not only to new Dienstradleasing contractors but to everyone buying a new bike or even to the general public.

5.2.2. “Flexibility4Cycling”

An increased ability to avoid cycling-adverse situations (such as rain, darkness, rush hour, frost or the early morning) may support more frequent e-bike commuting and decrease the need for cars. The materials and competences associated with remote work that many employers and employees recently acquired during the COVID-19 pandemic provide an opportunity to transition to much more flexible working hours/places for spatio-temporally flexible workers. Mobility management strategies by employers could strengthen their company’s cycling culture by integrating two aspects:

- Flexible working hours can enable employees to avoid rainfall, frost or darkness and therefore help to keep up environmentally friendly commuting modes in winter and on rainy days. Mobility management schemes by employers could establish a company culture that embraces bicycle commuting by promoting working remotely or shifting work hours as not only being legitimate but also appreciated when it enables environmentally friendly mobility to be kept up.
- Cycling employees, on the other hand, should be informed of the use of rain radars and rain notification apps that can help to find a good time to commute (see Barr et al., 2022).

Such a campaign could be mainstreamed via government programs to support mobility management. It should be discussed and adapted in cooperation with labor unions and employers’ associations to achieve widespread application. It should be noted that these approaches are much less applicable when physical presence at the workplace is necessary. Yet, as most current e-bikers have white collar jobs, the policy approach is most likely applicable for the majority of current e-bike commuters.

Another aspect of commuter flexibility concerns childcare. Family members who provide care have to fit more destinations into narrower time windows, which often pushes them into using the fastest means of transport (Spitzner and Beik, 1995). Policies should thus, for example, encourage nurseries to offer flexible drop-off and pick-up times and provide facilities to store bicycle trailers.

It should be highlighted that the proposed practice-oriented policies do not aim at convincing individuals to cycle (see Shove, 2010). Rather, “An e-bike deserves company” intends to alter the composition of elements that are frequently integrated into e-biking while “Flexibility4Cycling” aims at easing the spatio-temporal restrictions which push many e-bike-practitioners into motoring.

6. Conclusions

This paper provides the first comprehensive account of the meanings, materials and competences currently at play behind e-bike commuting in Germany. The emergence and rapid rise of this practice are found to be primarily evoked by a few major drivers. First and foremost, e-biking evokes a joy of riding unattained by unsupported cycling. Motor and battery furthermore make cycling more suitable for longer distances, a wider range of body types and capabilities, and destinations that demand riders to look and smell ‘good’ after the ride. In a number of situations and for many practitioners, e-biking thus offers a flexibility and effortlessness that is much closer to motoring than to public transport and cycling. However, daily e-bike commuting can be impeded by several barriers that can be summarized in the themes weather, transport capacities, time/distance, reliability, representability and occasional demands. The analysis highlights a number of elements and interrelated practices that potentially allow these barriers to be overcome. It utilizes this vantage point to develop two tangible policies to

foster daily e-bike commuting: “An e-bike deserves company” aims to disseminate relevant meanings, materials and competences right at the moment of purchase, when the future shape of the practice is particularly influenceable. “Flexibility4Cycling”, on the other hand, aims at harnessing the wide diffusion of competences and meanings related to remote work which spread rapidly during the COVID-19 pandemic. Utilizing the fact that many e-bike commuters have white collar jobs that lend themselves to working remotely, it proposes the use of flexible working hours and technology to enable more (e-)bike commutes. It should be emphasized that these approaches do not aim primarily at “convincing individuals”, but rather at changing the element composition of the practice-as-entity and the interaction of commuting with intertwined practices.

The presented findings are limited in two ways. First, the sample is based on middle-aged practitioners and biased toward academics. The range of elements may thus increase when other groups, such as people of lower socio-economic status or who work in non-office environments, take up the practice. Second, the sample consists of active practitioners and thus does not reliably allow for insights regarding barriers that inhibit taking up the practice or drive former practitioners to stop commuting by e-bike.

Future research in this vein could take the elements presented as a starting point to investigate whether different variants of e-bike commuting, i.e., typical constellations of elements and related effects on the practice’s viability for overcoming specific barriers, can be empirically established. The analyzed data suggests that a change in competences, materials and meanings (e.g., related to rain and temperature) as well as in interlinked practices (e.g., panniers, practical storage of rain gear, “freshness”, remote work) could enable many e-bikers to become less reliant on their cars. In order to gain insights into such associations, the elements presented in this paper could serve as a basis for quantitative studies on co-occurrences of elements and related mode-choice effects. Furthermore, qualitative investigations could scrutinize the types of relationships between elements (e.g., supporting, dependent, see [Macrorie, 2016](#)) to obtain a clearer picture of the elements’ interdependencies. As the present analysis is focused on barriers, future research could also focus more on drivers behind the practice and hence investigate pathways to additional recruitment of current car commuters into the practice of e-biking.

E-biking can already facilitate a wide range of daily routine trips for many individuals. Still, some situations (e.g., heavy transport, long-distance or group trips) demand other transport modes. The practice of e-biking could thus benefit from improvements in public transport (e.g., mobility stations, on-demand ride-pooling, micro-mobility), an increase in carsharing options, and changes in urban planning (e.g., bicycle infrastructure, superblocks). The use of (e-)bikes to commute in a wider range of circumstances could in turn reduce peak demand for public transport (e.g., during morning rush hour, in adverse weather). Unlike other sustainability-oriented practices such as rubbish separation and reducing heating, e-biking is associated with joy and is currently attracting more and more practitioners without subsidies or compulsion. This potential should be utilized to speed up the mobility transition.

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Declaration of generative AI in scientific writing

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Data availability

Data will be made available on request.

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References

- Banerjee, A., Łukawska, M., Jensen, A.F., Hausteijn, S., 2022. Facilitating bicycle commuting beyond short distances: insights from existing literature. *Transport Rev.* 42 (4), 526–550. <https://doi.org/10.1080/01441647.2021.2004261>.
- Barr, S., Lampkin, S., Dawkins, L., Williamson, D., 2022. ‘I feel the weather and you just know’. Narrating the dynamics of commuter mobility choices. *J. Transport Geogr.* 103, 103407. <https://doi.org/10.1016/j.jtrangeo.2022.103407>.
- BMVI, 2017. *Mobilität in Deutschland 2017, Datensatz B2. Bundesministerium für Verkehr und Inneres (BMVI). Berlin - access via the German Aerospace Center (DLR), Cologne [data set]*.
- Bourne, J.E., Kelly, P., Mutrie, N., 2022. The rise of the electrically assisted bicycle and the individual, social and environmental impacts of use. In: Heinen, E., Götschi, T. (Eds.), *Cycling. Advances in Transport Policy and Planning* (10). Academic Press, London, pp. 27–64. <https://doi.org/10.1016/bs.atpp.2022.04.003>.
- Buehler, R., Goel, R., 2022. A global overview of cycling trends. In: Heinen, E., Götschi, T. (Eds.), *Cycling. Advances in Transport Policy and Planning* (10). Academic Press, London, pp. 137–158. <https://doi.org/10.1016/bs.atpp.2022.04.007>.
- Cairns, S., Behrendt, F., Raffo, D., Beaumont, C., Kiefer, C., 2017. Electrically-assisted bikes: potential impacts on travel behaviour. *Transport. Res. Pol. Pract.* 103, 327–342. <https://doi.org/10.1016/j.tra.2017.03.007>.
- Cass, N., Faulconbridge, J., 2016. Commuting practices: new insights into modal shift from theories of social practice. *Transport Pol.* 45, 1–14. <https://doi.org/10.1016/j.tranpol.2015.08.002>.
- de Haas, M., Kroesen, M., Chorus, C., Hoogendoorn-Lansers, S., Hoogendoorn, S., 2022. E-bike user groups and substitution effects: evidence from longitudinal travel data in The Netherlands. *Transportation* 49, 815–840. <https://doi.org/10.1007/s11116-021-10195-3>.
- de Kruijff, J., Ettema, D., Kamphuis, C.B.M., Dijst, M., 2018. Evaluation of an incentive program to stimulate the shift from car commuting to e-cycling in The Netherlands. *J. Transport Health* 10, 74–83. <https://doi.org/10.1016/j.jth.2018.06.003>.
- de Kruijff, J., van der Waerden, P., Feng, T., Böcker, L., van Lierop, D., Ettema, D., Dijst, M., 2021. Integrated weather effects on E-cycling in daily commuting: a longitudinal evaluation of weather effects on e-cycling in The Netherlands. *Transport. Res. Pol. Pract.* 148, 305–315. <https://doi.org/10.1016/j.tra.2021.04.003>.
- Edberg, K., 2023. The (Im-)Mobile e-bike: infrastructural components of an emerging micromobility practice. *Active Travel Studies* 3 (1), 9. <https://doi.org/10.16997/ats.1192>.
- Engel, U., Schmidt, B.O., 2019. Unit- und Item-Nonresponse. In: Baur, N., Blasius, J. (Eds.), *Handbuch Methoden der empirischen Sozialforschung. Springer Fachmedien, Wiesbaden*, pp. 258–404.
- Giddens, A., 1984. *The Constitution of Society: Outline of the Theory of Structuration*. Polity Press, Cambridge.
- Graham, J., 2018. *Governance of Systems of Social Practice for Sustainability: Developing a Reflexive Systems of Practice Approach for Governance of Sustainability* (PhD Thesis). University of East Anglia.
- Hasselkuß, M., Baedeker, C., Liedtke, C., 2017. Social practices as a main focus in living lab research. In: Keyson, D.V., Guerra-Santin, O., Lockton, D. (Eds.), *Living Labs: Design and Assessment of Sustainable Living*. Springer International Publishing, Cham, pp. 23–34. https://doi.org/10.1007/978-3-319-33527-8_3.
- Helffferich, C., 2019. Leitfaden- und Experteninterviews. In: Baur, N., Blasius, J. (Eds.), *Handbuch Methoden der empirischen Sozialforschung. Springer Fachmedien, Wiesbaden*, pp. 669–686.
- Hennicke, P., Koska, T., Rasch, J., Reutter, O., Seifried, D., 2021. Nachhaltige Mobilität für alle. Ein Plädoyer für mehr Verkehrsgerechtigkeit. oekom verlag. <https://doi.org/10.14512/9783962388072>.
- Hitchings, R., 2012. People can talk about their practices. *Area* 44, 61–67. <https://doi.org/10.1111/j.1475-4762.2011.01060.x>.
- Hofmeister, T.B., Keitsch, M., 2016. Framing complexity in design through theories of social practice and structuration: a comparative case study of urban cycling (conference paper). In: *Future Focused Thinking - DRS International Conference 2016 (27.-30.06.2016)*, Brighton.
- Hosseini, K., Stefaniec, A., O’Mahony, M., Caulfield, B., 2023. Optimising shared electric mobility hubs: insights from performance analysis and factors influencing riding

- demand. *Case Studies on Transport Policy* 13, 101052. <https://doi.org/10.1016/j.cstp.2023.101052>.
- Hui, A., 2016. 'Configuring what comes next': sampling (blog). *Practice Theory Methodologies*. URL: <https://practicetheorymethodologies.wordpress.com/2016/02/18/allison-hui-configuring-what-comes-next-sampling/>. (Accessed 18 August 2023).
- Hui, A., 2017. Variation and the intersection of practices. In: Hui, A., Schatzki, T.R., Shove, E. (Eds.), *The Nexus of Practices: Connections, Constellations and Practitioners*. Routledge, London, New York, pp. 52–67.
- Jones, T., Harms, L., Heinen, E., 2016. Motives, perceptions and experiences of electric bicycle owners and implications for health, wellbeing and mobility. *J. Transport Geogr.* 53, 41–49. <https://doi.org/10.1016/j.jtrangeo.2016.04.006>.
- Jurczok, F., 2019. *Fahrrad-Monitor Deutschland 2019. Ergebnisse einer repräsentativen Online-Befragung*, vol. 216. SINUS Institut im Auftrag des BMVI.
- KBA, 2022. *Jahresbilanz 2021 - Zahlen, Daten, Fakten* [online]. https://www.kba.de/DE/Statistik/Fahrzeuge/Neuzulassungen/Jahresbilanz/Neuzulassungen/jahresbilanz_node.html. (Accessed 18 August 2023).
- King, N., 2004. Using templates in the thematic analysis of text. In: Cassell, C., Symon, G. (Eds.), *Essential Guide to Qualitative Methods in Organizational Research*. SAGE Publications Inc, London, pp. 256–270.
- King, N., 2012. Doing template analysis. In: Symon, G., Cassell, C. (Eds.), *Qualitative Organizational Research: Core Methods and Current Challenges*. SAGE Publications Ltd., London, pp. 426–450.
- Kroesen, M., 2017. To what extent do e-bikes substitute travel by other modes? Evidence from The Netherlands. *Transport. Res. Transport Environ.* 53, 377–387. <https://doi.org/10.1016/j.trd.2017.04.036>.
- Kuckartz, U., 2018. *Qualitative Inhaltsanalyse. Methoden, Praxis, Computerunterstützung*, fourth ed. Beltz Juventa, Weinheim.
- Kuijjer, L., 2014. *Implications of Social Practice Theory for Sustainable Design* (PhD Thesis). Technical University Delft.
- Le Bris, J., 2015. *Die individuelle Mobilitätspraxis und Mobilitätskarrieren von Pedelec-Besitzern. Adoption und Appropriation von Elektrofahrrädern* (PhD Thesis). Eberhard Karls Universität Tübingen.
- Le Bris, J., 2016. Pedelecs as new tools for active mobility: 'cheating' or sustainable transportation? In: Wulfhorst, G., Klug, S. (Eds.), *Sustainable Mobility in Metropolitan Regions: Insights from Interdisciplinary Research for Practice Application*. Springer Fachmedien, Wiesbaden, pp. 173–188.
- Le Bris, J., Rothfuß, R., 2015. *Mit dem Azubi-E-Bike auf dem Weg zur Arbeit* (Global Studies Working Papers). Eberhard Karls Universität Tübingen, Tübingen.
- Lee, D.J., 2016. Embodied bicycle commuters in a car world. *Soc. Cult. Geogr.* 17 (3), 401–422. <https://doi.org/10.1080/14649365.2015.1077265>.
- Lienhop, M., Thomas, D., Brandies, A., Kämper, C., Jöhrens, J., Helms, H., 2015. *Pedelec- und Klimaeffekte durch Pedelec-Nutzung im Individualverkehr. Endbericht* (Report). Institut für Transportation Design (Hochschule für Bildende Künste Braunschweig)/Institut für Energie- und Umweltforschung Heidelberg GmbH, Braunschweig; Heidelberg.
- Macrorie, R., 2016. *Reconstructing Low-Energy Housing Using 'systems of Practice'* (PhD Thesis). University of East Anglia.
- Mattioli, G., Anable, J., Vrotsou, K., 2016. Car dependent practices: findings from a sequence pattern mining study of UK time use data. *Transport. Res. Pol. Pract.* 89, 56–72. <https://doi.org/10.1016/j.tra.2016.04.010>.
- McHardy, J., 2013. The making of electric cycling. In: Shove, E., Spurling, N. (Eds.), *Sustainable Practices: Social Theory and Climate Change*. Routledge, New York, pp. 132–145. <https://doi.org/10.4324/9780203071052>.
- McQueen, M., MacArthur, J., Cherry, C., 2020. The E-Bike Potential: estimating regional e-bike impacts on greenhouse gas emissions. *Transport. Res. Transport Environ.* 87, 102482. <https://doi.org/10.1016/j.trd.2020.102482>.
- Moser, C., Blumer, Y., Hille, S.L., 2018. E-bike trials' potential to promote sustained changes in car owners mobility habits. *Environ. Res. Lett.* 13, 1–6. <https://doi.org/10.1088/1748-9326/aaad73>.
- Næss, R., Heidenreich, S., Solbu, G., 2023. Sensory and emotional dimensions of domesticating new technology: an experiment with new e-bike users in Norway. *Mobilities*. <https://doi.org/10.1080/17450101.2023.2230372>.
- Newson, C., Sloman, L., 2019. *The Case for a UK Incentive for E-Bikes*. Report by Transport for Quality of Life Ltd. URL: <https://www.bicycleassociation.org.uk/wp-content/uploads/2019/07/The-Case-for-a-UK-Incentive-for-E-bikes-FINAL.pdf>. (Accessed 18 August 2023).
- Nicolini, D., 2009a. Articulating practice through the interview to the double. *Manag. Learn.* 40 (2), 195–212. <https://doi.org/10.1177/1350507608101230>.
- Nicolini, D., 2009b. Zooming in and out: studying practices by switching theoretical lenses and trailing connections. *Organ. Stud.* 30, 1391–1418. <https://doi.org/10.1177/0170840609349875>.
- Nitschke, L., Quentin, P., Kanisius, F., Schluckebier, K., Burlon, N.F., Buscher, J., Deffner, J., Bruns, A., Stein, M., Mühhans, H., Othengrafen, F., Joost, J., 2022. *Pendeln verstehen: status quo, Forschungsstand und Perspektiven*. In: *ISOE-materialien Soziale Ökologie* Nr. vol. 67. Institut für sozial-ökologische Forschung (ISOE) GmbH, Frankfurt am Main.
- Pajunen, T., 2021. Too smart-looking for a waiter? – Scripting appearance norms at the theatre of working life. In: Outi, S., Lida, K., Tero, P., Erica, Á. (Eds.), *Appearance as Capital*. Emerald Publishing Ltd., Bingley, pp. 87–101.
- Philips, I., Anable, J., Chatterton, T., 2022. E-bikes and their capability to reduce car CO2 emissions. *Transport Pol.* 116, 11–23. <https://doi.org/10.1016/j.tranpol.2021.11.019>.
- Reckwitz, A., 2002. Toward a theory of social practices: a development in culturalist theorizing. *Eur. J. Soc. Theor.* 5, 243–263. <https://doi.org/10.1177/1368431022225432>.
- Rérat, P., 2021. The rise of the e-bike: towards an extension of the practice of cycling? *Mobilities* 16 (3), 423–439. <https://doi.org/10.1080/17450101.2021.1897236>.
- Schatzki, T., 2016. Practice theory as flat ontology. In: Spaargaren, G., Weenink, D., Lamers, M. (Eds.), *Practice Theory and Research: Exploring the Dynamics of Social Life*. Routledge, London, pp. 28–42.
- Scheurenbrand, K., Parsons, E., Cappellini, B., Patterson, A., 2018. Cycling into headwinds: analyzing practices that inhibit sustainability. *J. Publ. Pol. Market.* 37, 227–244. <https://doi.org/10.1177/0743915618810440>.
- Schneider, P.R., 2022. *Is it Still "Cycling"? Pedelec-Commuting From a Social Practice Perspective* (Master Thesis). Wuppertaler Studienarbeiten zur nachhaltigen Entwicklung no. 28. Wuppertal Institute for Climate, Environment, Energy, Wuppertal.
- Shove, E., 2010. Beyond the ABC: climate change policy and theories of social change. *Environ. Plann.: Econ. Space* 42 (6), 1273–1285. <https://doi.org/10.1068/a42282>.
- Shove, E., Pantzar, M., Watson, M., 2012. *The Dynamics of Social Practice: Everyday Life and How it Changes*. SAGE Publications Ltd., London.
- Söderberg, A., Adell, E., Hiselius, W.L., 2021. What is the substitution effect of E-bikes? A randomised controlled trial. *Transport. Res. Transport Environ.* 90, 102648. <https://doi.org/10.1016/j.trd.2020.102648>.
- Spitzner, M., Beik, U., 1995. *Reproduktionsarbeitsmobilität: theoretische und empirische Erfassung, Dynamik ihrer Entwicklung und Analyse ökologischer Dimensionen und Rahmenbedingungen für Handlungsstrategien: Endbericht*. Wuppertal Institut für Klima, Umwelt, Energie, Wuppertal.
- Spotswood, F., Chatterton, T., Tapp, A., Williams, D., 2015. Analysing cycling as a social practice: an empirical grounding for behaviour change. *Transport. Res. F Traffic Psychol. Behav.* 29, 22–33. <https://doi.org/10.1016/j.trf.2014.12.001>.
- Spurling, N., McMeekin, A., Shove, E., Southerton, D., Welch, D., 2013. *Interventions in Practice: Re-framing Policy Approaches to Consumer Behaviour* (Report). Sustainable Practices Research Group.
- Stebbins, R.A., 2001. *Exploratory Research in the Social Sciences*. SAGE Publications Inc., Thousand Oaks.
- Stein, M., Nitschke, L., Trost, L., Dirschauer, A., Deffner, J., 2022. Impacts of commuting practices on social sustainability and sustainable mobility. *Sustainability* 14 (8), 4469. <https://doi.org/10.3390/su14084469>.
- Steinbach, R., Green, J., Datta, J., Edwards, P., 2011. Cycling and the city: a case study of how gendered, ethnic and class identities can shape healthy transport choices. *Soc. Sci. Med.* 72, 1123–1130.
- Strengers, Y., Maller, C., 2014. *Social Practices, Intervention and Sustainability: beyond Behaviour Change*. Routledge, London.
- Sun, Q., Feng, T., Kemperman, A., Spahn, A., 2020. Modal shift implications of e-bike use in The Netherlands: moving towards sustainability? *Transport. Res. Transport Environ.* 78, 102202. <https://doi.org/10.1016/j.trd.2019.102202>.
- Watson, M., 2012. How theories of practice can inform transition to a decarbonised transport system. *Journal of Transport Geography, Special Section on Theoretical Perspectives on Climate Change Mitigation in Transport* 24, 488–496. <https://doi.org/10.1016/j.jtrangeo.2012.04.002>.
- Watson, M., 2013. Building future systems of velomobility. In: Spurling, N., Shove, E. (Eds.), *Sustainable Practices: Social Theory and Climate Change*. Routledge, London, pp. 117–131.
- Xie, L., Spinney, J., 2018. "I won't cycle on a route like this; I don't think I fully understood what isolation meant": a critical evaluation of the safety principles in Cycling Level of Service (CLOs) tools from a gender perspective. *Travel Behaviour and Society* 13, 197–213. <https://doi.org/10.1016/j.tbs.2018.07.002>.
- ZIV, 2017. *Zahlen – Daten – Fakten Zum Deutschen E-Bike-Markt 2016* (Press Release, 07.03.2017). Zweirad-Industrie-Verband e. V. (ZIV), Berlin. URL: https://www.ziv-zweirad.de/fileadmin/redakteure/Downloads/Marktdaten/PM_2017_07_03_E-Bike-Markt_2016.pdf. (Accessed 18 August 2023).
- ZIV, 2022. *Freiheitsmobilität – Bleibt Stark Nachgefragt* (Press Release, 16.03.2022). Zweirad-Industrie-Verband e. V. (ZIV), Bad Soden. URL: <https://www.ziv-zweirad.de/presse-medien/pressemitteilungen-news/detail/article/freiheitsmobilitaet-bleibt-stark-nachgefragt/>. (Accessed 18 August 2023).
- ZIV, 2023. *Stabiles Hoch und E-Bikes auf der Überholspur* (Press Release, 15.03.2023). Zweirad-Industrie-Verband e. V. (ZIV), Bad Soden. URL: https://www.ziv-zweirad.de/fileadmin/redakteure/Downloads/PDFs/Pressemitteilung_ZIV_Marktdaten_230315.pdf.