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'Why would you swap your nice warm van, where you can eat your butties and listen to the radio?' Mainstreaming a niche of cycle logistics in the United Kingdom

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ABSTRACT

Due to a high level of dependency on fossil fuels, transport is not only a priority for decarbonsation but also a particularly challenging sector to decarbonise. Significant low-carbon energy transitions in mobility will require changes in practices, technologies, infrastructure and policy. Cycle logistics is a growing economic sector. E-cargo bikes have the potential to replace some delivery and service journeys and to be used in combination with other transport modes to form a network of low-carbon deliveries. In comparison with conventional cargo bikes, e-cargo bikes are adapted with electric assist motors, thereby enabling the carriage of heavier loads over longer distances with lower physical strain on the rider.

This study positions e-cargo bikes as an emerging technology within the Multilevel Perspective (MLP), a framework for understanding sustainable transitions that is structured around three levels: niche, regime and landscape. The Covid-19 pandemic has caused a landscape-level shock that has prompted an interest in increasing active travel and local deliveries. E-cargo bikes are a niche technology, and, although they respond to landscape-level trends, such as decarbonisation and air pollution reduction, the development of cycle logistics faces challenges stemming from the dominant automobility regime. There are limitations with e-cargo bikes themselves, although the technology and practice of e-cargo bike use are developing rapidly; there are factors that relate to the ability of the regime to accommodate and support the niche; there are considerations relating to practices and perceptions; and, finally, there are policy choices that reflect a lack of proactivity in encouraging and enabling e-cargo bike use. The paper explores experiences and perceptions of actual and potential e-cargo bike use and configures the MLP and the relationship between niche, regime(s) and landscape in relation to mobility transitions.

1. Introduction: cities and sustainable transitions

The 'stubborn and overwhelming reliance' [1] of transport on fossil fuels means that the sector is a particularly important focus for decarbonisation. Excluding aviation and shipping, transport accounts for 22% of EU-28 greenhouse gas emissions [2] and is therefore a vital consideration in our changing relationship with energy. In fact, as the transition to low-carbon and net zero societies progresses, we are likely to see greater integration between transport systems and domestic energy [3]. The challenge is not purely technological: transport-related practices and behaviours are 'amongst the most difficult to change' [4]. The decarbonisation of the transport sector is therefore a key area of energy research in the social sciences and humanities [5]. Cycle logistics, a rapidly growing sector both in the UK and internationally, offers potential to decarbonise commercial delivery and service journeys, and it is important to develop its contribution and analyse factors that limit its uptake and development.

In common with other forms of energy consumption, mobility is produced through a socio-technical configuration of elements that includes technology, infrastructure and social practices in the context of markets, policies and cultural meanings [6]. As new elements and configurations emerge, some fade over time, and others endure to become part of the social and physical landscape. With its three levels of niche, regime and landscape [7], the Multilevel Perspective (MLP) has become

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a core framework for analysing such changes across energy and mobility [8].

Cargo bikes are specialised cycles designed to carry heavy loads, and the more recent emergence of e-cargo bikes – with an electric assist motor – has enabled the carriage of heavier loads over longer distances with lower physical strain on the rider. Their popularity has led to an increasingly strong cycle logistics sector.[1] Research has highlighted the potential role of cycle logistics in decarbonisation and the opportunity to situate this technology within energy discourses. Particular reference has been made to urban cycling, electrification and logistics in the context of mobility transitions. In this paper we position and understand e-cargo bikes in the context of mobility transitions and identify factors that are currently limiting wider acceptance of the technology. Using the MLP, we consider the nature of e-cargo bikes as a niche technology, a relatively recent addition to the broader logistics sector, and position them in relation to the regime and landscape to understand the ways in which different actors could support this sector.

This paper details an exploratory qualitative study on the experiences and perceptions of e-cargo bikes through current and potential use cases. We draw on empirical data focused on Greater Manchester and the North West of England and also provide insights that pertain to other cities and contribute to the conceptual development of mobility transitions. Accounts from interviews and focus groups enable us to position e-cargo bikes within the MLP. In a broader sense, we conceptualise the MLP in relation to the fields of mobility and active travel, providing insights into the nature of sustainable transitions and decarbonisation and the mechanisms through which they can be enabled.

2. Context

2.1. E-cargo bikes and cycle logistics

There is a broad consensus on the need for action on transport and that this remains 'a particularly stubborn piece of the climate puzzle' [9]. Whilst electrification of the vehicle fleet offers some benefits in relation to climate change [10] and, to some extent, air pollution [11], it has little impact on car dependency, including social inclusion and other aspects of mobility justice [12]. Even at high rates of electrification, a substantial reduction in distances covered by car will still be needed [9]. Active travel (walking and cycling), alongside public transport and land use planning, is part of the response.

There is a well-established body of research on cycling that is expanding geographically, responding to innovations in technology and continuing to highlight complex relationships between cycling and other transport modes [13]. There is also a robust evidence base on barriers and 'systemic sticking points' [14] that can limit uptake of cycling. Concerns around safety in traffic and, relatedly, a lack of consistent, high-quality and separated infrastructure are recognised as the most prominent of these [15–17]. Within this literature, e-velomobility is concerned with the practices, systems and technologies related to electrically assisted cycles, including trikes and rickshaws [18]. The electric assist motor enables the reach of cycling to be extended to a wider range of social groups, spaces and distances [19]. E-bikes and e-cargo bikes tend, however, not to be considered as part of electric mobility per se [10].

In urban areas in particular, e-cargo bikes can provide benefits over conventional delivery vehicles, such as vans. These include the ability to park quickly and cheaply, to store vehicles in constrained places, to manoeuvre through congestion, to utilise dedicated cycle infrastructure and to enter zones for low-pollution vehicles. In comparison with vans and cars, e-cargo bikes require more exertion and physical fitness, but the electric assist motor helps to make cycling with heavy loads feasible for more of the population. The e-cargo bike therefore represents a convenient medium point: enjoying some of the manoeuvrability, easy storage and low-cost operation of the bicycle, whilst approaching the carrying capacity and range of a car or small van. Cycle logistics offers a potential step change for the last mile of delivery journeys [20], perhaps most effectively as part of a system of hubs in which there are relatively high densities of operation [21]. This is valuable, since the last mile is often considered the least efficient, most expensive and most polluting part of the chain due to the intensive use of diesel vans, the frequent stopping and starting, and the navigation of complex and congested urban areas [22].

Research has demonstrated potential for cycle logistics to aid city decarbonisation efforts [23] and provide advantages to businesses, including lower capital expenditure, running costs and training overheads as well as higher speeds in congested areas [24]. Whilst Lenz and Riehle [24] found user fatigue to be a significant barrier to uptake for cargo bikes, the wider availability of e-cargo bikes, as opposed to those powered only by pedalling, has widened inclusivity by lowering the level of exertion required and allowing people to carry heavier loads over longer distances [25].

Verlinghieri et al. [23] consider cycle logistics in London in detail in the context of increasing interest and use in Europe, arguing that e-cargo bikes can reduce carbon emissions in urban logistics whilst maintaining a similar level of service and that a reconfiguration of distribution networks can better enable e-cargo bikes to fulfil their potential. The European Cycle Logistics Federation estimates that 30% of the trips made by delivery and service companies could be transferred to e-cargo bikes [26]. Both Verlinghieri et al. [23] and a study undertaken for Transport for London [25] note some limitations, in relation to cargo weight and journey distance in particular. The latter report suggests, for example, that partnerships between cycle logistics companies and traditional carriers may be required in order to provide a complete solution for customers [25].

2.2. The multilevel perspective (MLP)

The MLP is a framework for the analysis of socio-technical transitions and has been applied across food, energy, housing and mobility [27]. It is an influential framework that continues to be widely applied to energy and mobility [28]. According to the MLP, transitions comprise technological developments and changes in consumer practices, policy, infrastructure and business models [29,30]. Geels [31] defines the three levels of the MLP:

1. **niches** – emerging technologies and practices;
2. **socio-technical regimes** – existing ways of doing things within a socio-technical system characterised by the 'alignment of existing technologies, regulations, user patterns, infrastructures, and cultural discourses' [31]; and
3. **socio-technical landscape** – spaces, ideologies, values, beliefs, concerns, media landscape and macroeconomic trends.

New technologies and practices develop interdependencies with social, technical and institutional factors, such as production, supply chains, users, infrastructure and markets. These interdependencies take time and resources to develop and evolve and have tended to lock society into dominant technological solutions protected by vested interests, such as the private car [32], enduring through engrained practices that are 'consistently and faithfully reproduced' [33]. Whilst the socio-technical landscape is characterised by stability, there are changing trends and priorities, such as decarbonisation, that put pressure on regime-level actors. Landscape changes can also be sudden and unexpected; they include wars, economic crashes and, topically at the time of writing, global pandemics. These events demand responses at the regime level and potentially catalyse niche development.

[1] http://cyclelogistics.eu/sites/default/files/downloads/Recommendations_guide%20version.pdf [accessed March 2023].

2.3. E-cargo bikes within the MLP

2.3.1. Socio-technical landscape

There is some flexibility [34] in defining the regime(s) and landscape, often varying by technological and geographical context. MLP research has therefore tended to configure and populate the MLP in relation to a particular focus. Fig. 1 visualises the regime and landscape elements that we consider to be pertinent to e-cargo bikes and cycle logistics.

The socio-technical landscape is characterised by cultures surrounding travel practices as well as the built and planned environment. Whilst it is predominantly a stable and slowly moving context, there are trends that put pressure on regimes, and these, in turn, shape the conditions in which different niches prosper, stagnate or fall. These include international policy focus on climate change and air quality; advances in technology within and outside mobility; and the increasing prominence of online shopping and home deliveries.

Alongside these relatively gradual trends, the 2020 Covid-19 pandemic heralded a sudden landscape shock, termed an 'avalanche' in that it was low-frequency, high-amplitude, high-speed and expansive in scope [28]. Initially at least, there was a pronounced impact on mobility and transport provision, resulting in a 'sudden and dramatic shift to a slower, more localised and less-carbon intensive existence' [35] with implications for urban air quality and global greenhouse gas emissions [36]. Some cities became proactive in providing dedicated infrastructure and other support for cycling in a bid to support the 'reactivation of commuter cycling through the disruption of the routinised and motorised commuter journeys' [37]. Kanda and Kivimaa [38] noted the impact of Covid-19 in terms of 'potentially kick-starting transformations in established socio-technical systems, [and] also… affecting emergent sustainability niches'.

2.3.2. Dominant and contender regimes

The dominant mobility regime is characterised by reliance on private vehicles powered by petrol or diesel. It is stabilised by engrained personal and commercial practices, road infrastructure, networks of refilling stations and a political-economic context that reinforces car dependence [39]. In demarcating the context within which e-cargo bikes operate, we denote a connected *sub-regime* representing freight and logistics, characterised by Heavy Goods Vehicles and van use and stabilised by dominant technologies, incumbent businesses, formal structures relating to staff qualifications and protocols and reliance on 'just-in-time' deliveries both within and at the culmination of supply chains [40].

Building on Strauch [41], who argues for widening our conceptualisation of the regime level beyond the mainstream, and following Geels [42], who notes the potential value of paying attention to multi-regime interactions in sustainability transitions, we include two other regimes in Fig. 1. Firstly, active travel is a regime characterised by walking and cycling and their infrastructure and is bolstered by cultural and policy changes favouring these modes, such as health and sustainable living. Geels [31] has counted active travel amongst 'subaltern' regimes, on the basis that it is smaller in participant numbers but relatively stable in terms of communities of actors, practices, beliefs and capabilities. It could, however, be argued that active travel has become increasingly prominent in the last ten years. We use 'contender' as an alternative term to imply a more dynamic relationship between active travel and the dominant regime and to reflect the fact that its rapid growth, in many contexts, is a form of instability. We include e-cargo bikes and other electrically assisted vehicles in this regime since the need to pedal qualifies them as active travel [43].

A third regime – a 'contender' in some respects but also lodged firmly in the dominant regime – is electric mobility. Its inclusion within the dominant regime reflects the fact that it is by nature a technological change that, whilst requiring changes in engines and energy sources, requires little change in the other factors that stabilise the regime. Vehicles are still driven on the same roads at the same speeds over the same distances: '[battery electric vehicles] are not establishing a new market as such; they are a niche product seeking to disrupt an existing one' [44]. There is some disagreement on the positioning of electric vehicles within

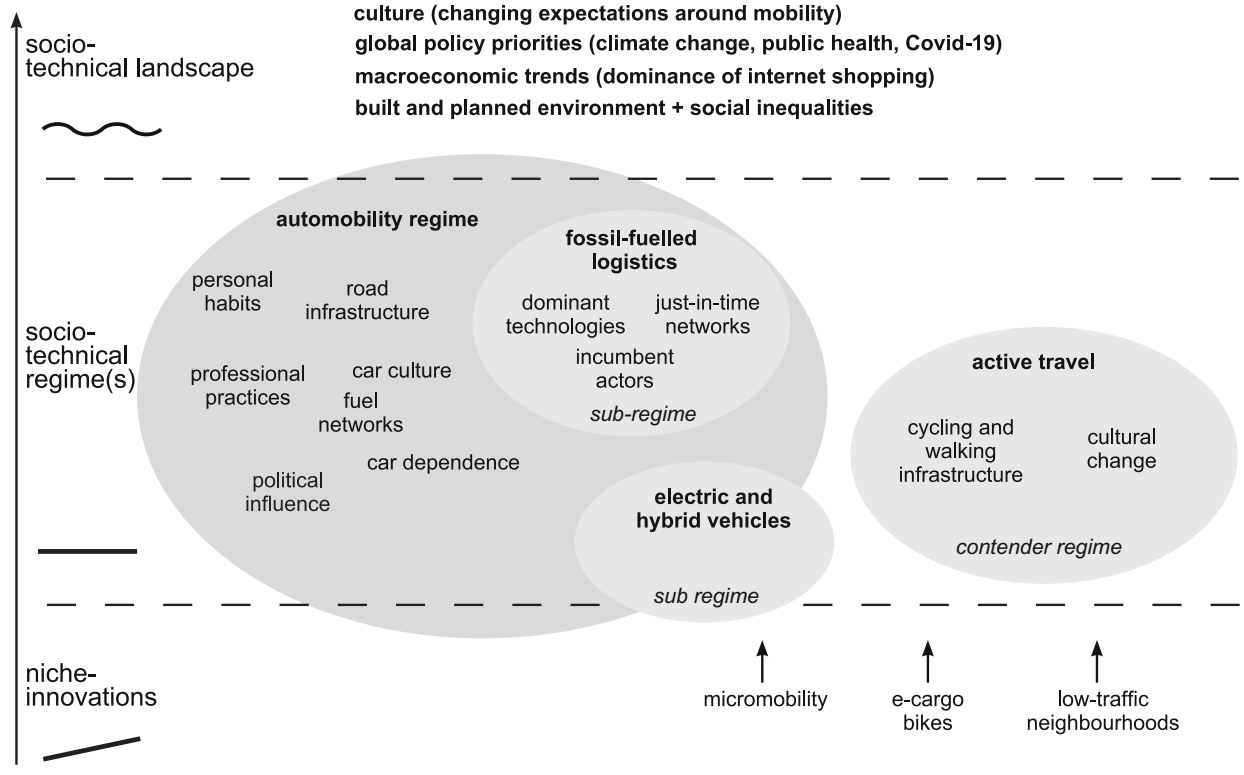

Fig. 1. E-cargo bikes within the Multilevel Perspective (MLP).

the MLP. Strauch [41] convincingly argues that the technology has reached a tipping point and that '[its] ascent towards regime scale will continue'. In contrast, the relatively peripheral status of active travel means that a similar increase in its size, reach and prevalence will require substantial changes in infrastructure, practices and cultures: whilst it might have the endurance of a regime, it is further from achieving parity.

2.3.3. Niches

We position cycle logistics as a niche that sits 'underneath' these regimes. In Section 4.1.1., we discuss the ways in which our data confirms this positioning. E-cargo bikes perhaps fit optimally under the active travel contender regime, whilst also connecting to the electric and hybrid vehicles sub-regime. E-cargo bikes need not be viewed in isolation: other developments – arguably also niches – such as low-traffic neighbourhoods [45] and micro- and shared mobility [46,47] intersect with, support and facilitate their use and market penetration. We do not argue that e-cargo bike activities are niches in the sense of being 'protected' spaces [48] or the subject of strategic niche management [49], but rather in the sense of being 'radically new and precarious innovations' [31]. At the niche level, actors are much less constrained by dominant institutions and can experiment with radical alternatives to solve societal problems [4].

3. Methodology

The overall aim of this six-month study was to evaluate the potential uptake of e-cargo bikes for businesses and small-scale freight transport in the UK, with Greater Manchester as a pilot study area. The research design reflected the non-mainstream nature of e-cargo bikes by employing an exploratory qualitative approach and analysis [50].

Fieldwork, in 2020, consisted of five semi-structured interviews with individuals involved in the cycle logistics sector and five focus groups – local authorities, private sector, higher education, services and miscellaneous – who had experience of, or an interest in, incorporating cycle logistics into their operations. Purposive sampling [51] was used, reflecting the specific nature of the respondents that the research intended to reach. Our sample comprised organisations that were using e-cargo bikes in their operations or were interested in exploring how they might use them. This recruitment strategy reflected the nascent nature of e-cargo bike use, deliberately not limiting the investigation to current use cases.

Due largely to social distancing restrictions at the time, focus groups were conducted online using Microsoft Teams or over the phone and lasted between 60 and 90 minutes. Participants were asked to introduce themselves and describe their connection with and experience of e-cargo bikes. In order to respond to and build upon issues raised by the participants, the discussion was semi-structured around a topic guide. The facilitator asked the participants about their current business operations and how cycle logistics fits into, or might fit into, them; what advantages and disadvantages e-cargo bikes might bring to their sector; what challenges and barriers they saw and the ways in which they might overcome them; what changes to facilities and infrastructure would help them to use e-cargo bikes; and what technologies and other tools would be useful in this regard. The participants were selected through the researchers' networks.

There are potential limitations that stem from the small-scale nature of the funded project. Whilst we drew from a relatively small set of interviewees and focus group participants, we did find it very challenging to recruit, and this reflects the fact that few organisations are actively considering cycle logistics. This meant that we were reliant on our own networks and their contacts, including a database of participation of policymakers, businesses, community activists and others in our 'Healthy Active Cities' seminar series. We conducted data collection over the relatively short period of two months. This meant that we did not account for seasonal differences, and, whilst seasonality is important in active travel research, the purpose of the research was to explore views on cycle logistics at a point in time rather than to understand patterns of use throughout the year.

Item	Description
Interviewee 1	Transport consultant working in bicycle business, including a service to hire out e-cargo bikes
Interviewee 2	Founding member of a local delivery service using e-cargo bikes
Interviewee 3	Founding member of a (different to Interview 2) local delivery service using e-cargo bikes
Interviewee 4	Founding member of a local delivery service using e-cargo bikes
Interviewee 5	Individual who has used e-cargo bikes extensively in the UK and elsewhere as part of his professional life
Focus Group 1	People working in local authorities who are considering using e-cargo bikes (4 participants and facilitator)
Focus Group 2	People working in private businesses who are either using e-cargo bikes or considering using e-cargo bikes (4 participants and facilitator)
Focus Group 3	People working in the education sector who are considering using e-cargo bikes (6 participants and facilitator)
Focus Group 4	People working in different part of the service sector, each with some experience of using e-cargo bikes (6 participants and facilitator)
Focus Group 5	Miscellaneous group of people from different sectors, with an interest in e-cargo bikes but not currently using them (3 participants and facilitator)

The Covid-19 pandemic had a complex impact on our delivery and findings. At the time of data collection, sudden landscape changes were causing dramatic changes in mobility and shopping patterns. These changes directly impacted cycling and e-cargo bike use, and lockdowns and social distancing rules were radically changing the ways in which researchers were collaborating and fieldwork was being conducted. We recognise a need to reflect upon the ways in which these factors shape research and influence findings [52]: we felt that we were researching (sustainable mobility) transitions from within a quite different global transition. Being limited to online methods meant that richer interactions, such as spending a day with an e-cargo bike courier, were not possible. On the other hand, it meant that we were able to involve participants who might not otherwise have taken the time to travel to an in-person meeting.

4. Findings

4.1. E-cargo bikes as a niche

4.1.1. Niche characteristics

Our discussions on e-cargo bikes add weight to the notion that they are a niche technology. The unfamiliarity of the technology to many people, the relative cost, the immaturity of the market and its relationship to established business practices all suggest that the vehicles are being used outside mainstream operations and are therefore external to the more established regime(s).

Participants reflected, for example, on the unfamiliarity of the vehicles and challenges in engaging with businesses: *'At the moment, you can't talk to somebody about using a cargo bike. Most people have never seen one'* (Interview 1). This unfamiliarity was reflected in, and accentuated by, the scant availability of information relating to how to integrate e-cargo bikes into business practices.

Another factor is relative cost: a less established second-hand market, in the UK at least, means that interviewees were comparing new e-cargo bikes with used vans: *'…you're normally looking in the region of £2000 to £5000, and then, when you look at a second-hand van, that can almost be purchased for that price'* (Focus Group 1). This is a reflection of the novelty of the technology and is something that will be likely to change over time as the market develops. Cost is not, however, a simple consideration. One focus group participant, who ran a business making deliveries by e-cargo bike, found the capital outlay acceptable and that it was balanced by operational costs: *'So in fact it's much cheaper than vans.*

We can buy a bike for £7000, pay a rider minimum wage. They don't need a driving licence, all of that good stuff…'. They also valued the increased punctuality resulting from being able to avoid congestion.

We recognise that these observations are UK-centric and that e-cargo bike markets and operations are more established elsewhere. We also note that the situation is changing rapidly in the UK, and we can expect that it will continue to do so. One of our participants opined that *'If Amazon were using these bikes, for example, local communities, and it was working and it was on the news and everything… it's quite difficult to be an early adopter'* (Focus Group 4). In November 2022, Amazon announced that they are starting to use covered e-cargo bikes in Manchester and London,[2] and we can expect that large operations like this will have some influence on the practices of other businesses.

4.1.2. Using e-cargo bikes: current use

Motivations of people and businesses for adopting e-cargo bikes in their practices can be explored by discussing use cases. Our participants discussed speed; avoiding and negotiating traffic; reducing time spent finding parking spaces; increasing reach to places not accessible by motor vehicle; not needing to recruit people with driving licences; lower wage costs; reduced emissions affecting local air quality; and visibility in relation to being seen to be sustainable.

Whilst many participants discussed practical and contextual benefits, user experience was also highlighted, particularly when recruiting others to e-cargo bike use. This interviewee manages a local e-cargo bike library:

> We do talk about the cargo bike smile quite a lot, but, really, it's universal, you know. It's quite remarkable how people get off a cargo bike after their first ride and they've got a silly grin on their face. It happens every time.
>
> (Interview 1)

Two local initiatives, based respectively in Manchester and Todmorden and staffed by volunteers, grew in size during the first Covid-19 lockdown in the UK (Spring 2020), a reflection of increased demand for local deliveries. During 2020 and 2021, both initiatives continued to expand their services, purchasing more e-cargo bikes, growing their partnerships and volunteer base, securing funding and expanding their business models to introduce salaries, with a view to capitalising on increased interest in their services.

The Manchester organisation, Chorlton Bike Deliveries, developed their idea from conversations during lockdown: *'It would be great now that there's hardly any traffic, and we could ride around in Chorlton, and we'd get our exercise. We can fill in some of these gaps of being able to help with deliveries'* (Interview 4). They approached different local shops with different levels of resulting enthusiasm, in some cases due to having other arrangements in place – 'we got vans' – and in others relating to capacity – 'oh we're overwhelmed, and people want to have deliveries?' They also became involved in a response to food waste, shifting food from grocery shops to 'both a food bank and a pantry' and diverting produce from the waste stream.

The other case, Cargodale, also grew in response to lockdown restrictions: *'Those people couldn't shop. They couldn't get deliveries. The fact that the town was able to stack up and deliver to them was really important'* (Interview 2). This case is noteworthy as it is located in a peri-urban area, and therefore delivery distances can be longer and the topography is more challenging.

In some ways, then, these reflect specific requirements during a very particular period of time. A contrasting example was a more established laundry collection service business operating in a busy UK city (this time outside the North West), whose entire fleet of vehicles was made up of e-cargo bikes: *'our model is that we collect relatively low quantities of laundry from both business and consumer customers'* (Focus Group 3). This case demonstrated a direct attempt to influence the regime: *'we're trying to reengineer the laundry industry from the ground up, and we started up by solving the logistics problem, and we find that using large-capacity e-cargo bikes, it's remarkably efficient around the city centres'* (Focus Group 2). The business had originated with *'just a delivery backpack and a push bike'*, and e-cargo bikes enabled them to expand the operation *'as soon as he realised it was actually a decent idea'* (Focus Group 2).

4.1.3. Using e-cargo bikes: envisioned uses

Alongside these examples of actual e-cargo bike use, potential users discussed potential ways of operationalising e-cargo bikes. A private catering business operating on a university campus noted that e-cargo bikes would enable them to navigate the campus much more easily, without the challenges of finding parking or carrying food on foot: *'for us, it's getting around campus quickly, and I think with the e-cargo bikes it'd be a lot easier and simpler to get to people because, obviously, there's parts of the campus you can't get to in vans and things like that'* (Focus Group 3). Local authorities identified an operational role for e-cargo bikes, especially where operations were spread across a number of offices. Large industrial sites could facilitate internal freight distribution with e-cargo bikes:

> …so, even though you're a big distribution centre, you might not have an outdoor forklift because you might not need one, in which case a cargo bike just to move things around outside. These places are enormous, so actually getting people around the buildings [is challenging]. We did often use bikes just to get people around the buildings quickly, so it's definitely a use case for cargo bikes.
>
> (Focus Group 5)

A hospital services team suggested an innovative way of repurposing older service infrastructure, noting that *'a number of our hospital sites have basically got an internal distribution tunnel, which – it isn't accessible to a Ford Transit, but it would quite neatly fit an e-cargo bike'* (Focus Group 4).

For a small charity, e-cargo bikes offered potential to make food pick-ups easier, cheaper and more inclusive (in the sense of not requiring volunteers to be able to drive or have access to a car). Currently, the operation of picking up food to be distributed at the end of the day was challenging:

> what has given us a challenge is accessing the end-of-day food in Manchester. We rely heavily on volunteers, and it's quite challenging to get from where we are [] into Manchester… quite a busy time around five, six in the evening most of the time. Park, stop at shop, get the food, and maybe do that two or three times… that means that our volunteers, rather than having to pedal a [conventional] bike, to have the electric option, going into town, picking up food from both corporates and shops.
>
> (Focus Group 5)

Note that the electric assist element of e-cargo bikes is mentioned here in relation to making them more inclusive.

In this scenario the size of e-cargo bikes relative to vans provides an advantage. In a mixed service fleet, the inclusion of cargo bikes reduces the size and impact of the fleet as a whole: *'cargo bikes reduce down the size [of the delivery fleet]. We can actually get them closer into the hospital site and then not have these [other] vehicles trundling around our hospital sites and impacting on the air quality all day'* (Focus Group 4).

Other participants suggested that e-cargo bikes were unlikely to replace their current vehicles. An example related to capacity when conducting waste collections: *'but it's that bulking of a ton of waste – it obviously can't reflect what we do at the moment if it's on an e-cargo bike'* (Focus Group 4). They were interested in combining e-cargo bikes with other vehicles to make the process more efficient: *'I could see that that could be sped up by the fact that you've got someone on a bike doing that sort of job: collecting lots of sacks, putting them in one place to then to be*

[2] https://www.aboutamazon.co.uk/news/sustainability/amazon-expands-electric-cargo-bike-deliveries-in-manchester-and-london [accessed March 2023].

transported out to the disposal site' (Focus Group 4).

4.2. Developing the niche

4.2.1. Understanding limits

Before analysing barriers to cycle logistics at regime and landscape levels, we consider ways in which the technology may be self-limiting. We conceptualise these as niche-level barriers. It is appropriate to be realistic about the limitations of e-cargo bikes, both to inform the future development of the vehicles and to be clear about their potential role within logistics networks.

We have already noted capacity in relation to waste collections. Whilst e-cargo bikes do vary in scale and design, they cannot match the largest motor vehicles: *'You haven't got the massive capacity that you have in the van. You can't just take everything all at once'* (Interview 2). In the same focus group, a participant considered the possibility for deliveries to be made by their organisation. In addition to *'greening the fleet'* with electric cars, they were keen to assess the potential of e-cargo bikes. Their representative estimated that e-cargo bikes would have limited value: *'It's a large, sprawling site we've got… but we currently use an [electric truck] that goes round. We've made an investment there already, but potentially an e-bike would supplement there as well'* (Focus Group 4).

Another limitation, or at least a practical challenge, is organising journeys around the need to keep the battery charged*: 'You've got to charge the battery because driving with no battery is really no fun'* (Focus Group 2). Range is an important issue: *'…more and more we're coming up against the issue of distance and volume. We have a lot of customers that would use us but are outside the city centre, but it's impractical to serve them using bikes, so we're going to be looking at an electric van'* (Focus Group 2).

Type of load is a further consideration. Delivering hot food was seen to be challenging, especially as part of multiple mixed loads such as supermarket deliveries: *'There's only one barrier; well, two really. One, hot food, that's the biggest one; and two, just doing multiple pick-ups'* (Focus Group 2).

These challenges relate to the physical nature of an e-cargo bike, and weight and volume are likely to remain limitations that could result in vans continuing to be needed for some tasks. They also relate to e-cargo bike design: as the technology matures, the range of use cases can widen, for example by addressing the storage challenges stemming from food carriage: *'…parts of our vehicle design is to enable the movement of hot and cold food. So the vehicle would have hot storage as well as cold storage'* (Focus Group 2).

4.2.2. Landscape factors: trends and shock

In the MLP, as applied to mobility, the socio-technical landscape is relatively stable, albeit with relatively slow-moving collective shifts in awareness of climate change and the need to decarbonise transport systems. In contrast, Covid-19 was a rapid shock on a global level with implications for regimes and opportunities for niche development.

To some extent, this change was favourable for van use: *'ironically, Covid took all the vans off the street, didn't it, and made it really easy for the delivery vans that were there'* (Interview 3). It also, however, created both motive and opportunity to make more use of e-cargo bikes. One interviewee had been inspired to start using e-cargo bikes: *'It would be great now that there's hardly any traffic, and we could ride around in Chorlton, and we'd get our exercise. We can fill in some of these gaps of being able to help with deliveries'* (Interview 4). Another interviewee reflected on the opportunity for e-cargo bikes to be used to provide shopping services to those people having to isolate: *"I was on that two-week 'You mustn't go out if you've got symptoms of a cold'. I suddenly realised all of the things that you needed and all of the shops that I would like to buy things from"* (Interview 2). This prompted them to set up a cargo bike deliveries service:

> Basically, I could send someone and say, 'Look, I'd like to pick this up the day after, but we could do this for any other customers as well', and we've got people that want to do it. Just give us a ring. (Interview 2)

These developments were aided by an existing UK government scheme making funding available for local businesses to invest in the bikes for their services [53], reflecting an overall trend towards supporting low-carbon modes. Councils responded by introducing 'pop-up' cycle infrastructure in Greater Manchester. Individuals also reported benefiting from established social networks to be able to source cargo bikes from shops in order to set up informal delivery schemes.

4.2.3. Accommodating the niche: infrastructure and facilities

It is not only the dominant regime that presents barriers to the growth of e-cargo bike use; barriers also stem from within the active travel contender regime, even if that regime *should* be supportive. In other words, efforts to increase levels of walking and cycling are not necessarily inclusive of the requirements of e-cargo bike riders. Cycle lanes can bolster the active travel contender regime, but the specifications of the infrastructure can mean that e-cargo bikes and other non-conventional cycles, such as those used by disabled people [54], are excluded, as e-cargo bikes are wider than conventional cycles and have a larger turning circle.

Interviewee 4, for example, described a junction that is particularly challenging on a cargo bike: *'There's no easy way around it. It's not like there is a clean line where you can just take it wide'*. Interviewee 2 recounted similar challenges: *'You'll find a barrier on a path or a step that someone's left in and thought nothing of'*. At the time of the research, they also found online maps, in this case Google, to be *'absolutely unsuitable'* in identifying suitable routes for cargo bikes. Interviewee 5 described challenges in finding places suited to their fitness to cycle and where they feel safe, reflecting on the route planning dimension – *'a whole level of local access that is not mapped, and it's really hard to [navigate]… you're going to have to spend some time working them out using Google Maps and Street View and cycling them and seeing what they're like'*. It is worth noting that these concerns reflect the interviewees' perceptions and experiences at the time of the research and that UK cycle infrastructure design guidelines do specify that cargo bikes should be accommodated,[3] although this varies across the UK. The difficulties stem from where these guidelines are not yet met and the ability of riders to anticipate where difficulties are likely to arise.

The ability of cargo bikes to enable riders to 'beat congestion', our respondents argued, depends on the availability of separated infrastructure: without this, one of the major advantages would not apply. *'If you can filter past traffic, you're essentially traffic-agnostic'* (Focus Group 5), one participant argued. On the other hand, they continued, *'If you've got a big bike or someone that's not comfortable to filter past traffic, then it's going to be, essentially, either the same speed or slower than a car, and then you can get caught in traffic jams at the same time'* (Focus Group 5).

Confidence to cycle in traffic is a clear determinant that enables e-cargo bike use, as in reality e-cargo bikes are more likely to be part of, rather than separated from, general traffic. This reduces the chance of recruiting new users and of including a diverse population: *'if you're new to cycling, taking up cycling, then the barriers on so much of the cycle infrastructure is a real problem. You've got to basically assume that you're going to be a road cyclist at the moment'* (5). In fact, experienced e-cargo bike riders told us that they sometimes chose cycling in the carriageway: *'It's better to stay in the middle of the road and hold your nerve. It's shameful.*

[3] 'We also want to see increasing numbers of cargo bikes to replace some van journeys. Cycle routes must be accessible to recumbents, trikes, handcycles, and other cycles used by disabled cyclists. Many current tracks and lanes are too narrow or constrained to meet these objectives. To allow faster cyclists to overtake, and make room for non-standard bikes, cycle tracks should ideally be 2 m wide in each direction, or 3 to 4 m (depending on cycle flows) for bidirectional tracks though there may have to be exceptions.' https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/951074/cycle-infrastructure-design-ltn-1-20.pdf.

I think if you're not an old hand at cycling, you'd probably not want to do it' (Interview 4). The barrier of perceived danger from road traffic when cycling is not specific to e-cargo bikes [17], but our discussions indicate that this barrier is heightened by the size and unfamiliarity of e-cargo bikes.

The novelty and unfamiliarity of these niche vehicles, combined with a road environment that does not easily accommodate their size, can lead to riders feeling unwelcome on the road and result in tension between road users. Improvements in cycling infrastructure and driving practices would enable e-cargo bikes to better reach their potential. Adaptive strategies may include selecting smaller e-cargo bikes and therefore limiting the carrying capacity:

> We've found that adding a trailer on to the Urban Arrows is brilliant as long as the trailer's weighted. If it's empty, we've had issues with them flipping over, which can be pretty problematic, but that's normally due to other road users careering in the way of our bikes.
>
> (Focus Group 2)

> Our riders always shy away from taking out the biggest bike even if it might be more efficient… they have to deal with the aggravation of the traffic because the bike's so big.
>
> (Focus Group 2)

The awareness, or lack of, of other road users is another element of an unsupportive road environment. Incorporating material on e-cargo bikes into training and professional development programmes for other road users would help them to better understand the needs of e-cargo bikes on the road, it was suggested: *'I think also maybe you need to look at offering training and maybe even online information, etc., about them to bus drivers, lorry drivers, all those sorts of people, who might not appreciate how fast it can move'* (Focus Group 1).

4.2.4. Accepting the niche: attitudes and practices

Dominant attitudes and practices are elements of the landscape and regimes, and the extent to which motor vehicle ownership and use is tied up with notions of independence, freedom and professionalism acts as a barrier to other, newer forms of transport becoming more prevalent.

Policy actors have a role in creating a culture of acceptance around e-cargo bikes: *'…so shifting from it being an option, so if you want to do this, we have this, to almost an expected, we know that everybody's doing this, this is our new normal'* (Focus Group 3). Another participant placed cycling in the context of the transport system; it is not simply about this new mode, but how it is perceived in relation to the other available modes: *'Unless your bike is at least as convenient as your car to get out and go, then you won't use it enough'* (Interview 5).

When discussing the role of e-cargo bikes in the transition away from light commercial vehicles, a process that could involve encouraging drivers to shift from vans to e-cargo bikes, one participant observed that *'a lot of staff have the perception that that is a demeaning of their job role and that they're being pushed down to a cyclist rather than being a driver'* (Focus Group 4). This highlights problems of achieving parity between using e-cargo bikes and driving a van in a professional environment. Alongside more conventional considerations such as range and journey time, participants considered less tangible factors related to comfort and experience: *'why would you swap your nice warm van, where you can eat your butties and listen to the radio, for a bike?'* (Interview 3).

The implication is that current e-cargo bike users tend to be those who already have cycling experience: *'we did find people had to be quite comfortable and have a like towards cycling'* (Focus Group 1); *'If they're not already in a cycling frame of mind, then how do you tempt them to try it?'* (Focus Group 1).

There are also opportunities for a proactive approach towards the normalisation of e-cargo bikes. This has two levels: for many, cycling is an unfamiliar practice, and even those who cycle regularly will be likely to be unfamiliar with e-cargo bikes. A proactive approach means not relying on people to be intrinsically motivated: *'if people are unsure about something, they have to have a strong passion or a motivation internally in order to find out. For most people, they won't bother'* (Focus Group 3). Providing and promoting opportunities to trial the bikes could therefore be an effective policy: *'If we could do a trial, because I think, for me, I'd be scared to death of using a cargo bike because of the size of it, but that's because I've not been on one'* (Focus Group 3). The importance of image and how people feel, as well as having a supportive environment, should not be discounted: *'people having a go on one in a safe environment where nobody is laughing at them'* (Interview 1).

Policies can provide a cost incentive to use e-cargo bikes and other 'clean' vehicles. In Greater Manchester and other cities proposals are being considered that would create a central clean air zone that financially penalises polluting vehicles. Such interventions can even out the price differential between vans and cargo bikes, especially in terms of the last mile within urban centres: *'So you would, for instance, produce a zero-emissions zone in the middle of Manchester, for instance, is one of the things you would do'* (Interview 1).

5. Discussion

Our discussions with stakeholders have evidenced the potential for cycle logistics, in the form of e-cargo bikes, to contribute to sustainable transitions by offering a mobility option with greater carrying capacity than a conventional bicycle and lower emissions than the vans that currently dominate local logistics networks. The MLP offers a useful way of conceptualising the current position of e-cargo bikes as a niche practice and technology. Covid-19 created a landscape-level 'shock' in which cycle logistics has to an extent thrived. Homeworking led to lower traffic levels, and lockdowns and quarantine requirements increased home deliveries.

We recognise that this particular piece of research is centred around Greater Manchester and that there are cities and countries in which cycling and cycling infrastructure are more developed. It could be argued that cycle logistics is less 'niche' in those areas and more accepted by dominant actors and that there is scope for a more rapid transition.

Some of the same characteristics that define e-cargo bikes as a niche explain their low uptake: unfamiliarity amongst the public and businesses, relative cost, especially in relation to the second-hand market, and some incompatibility with existing business practices. Our conceptualisation of barriers, or 'systemic sticking points' [14], that limit uptake of e-cargo bikes aligns with the components of the MLP.

Firstly, there are barriers that are intrinsic to the niche technology and reflect the limitations of the technology itself (as it currently stands), including the capacity of the vehicles, their range and the ability of the design to enable myriad use cases, such as carrying hot food. With the technology developing rapidly, we expect the range of demonstrated use cases to grow over time. The niche needs therefore to be understood in relation to its potential: those imagined use cases that transcend current practice and provide insights into the potential evolution of the niche.

Secondly, certain factors relate to the ability of wider society to accommodate the innovation. These are explained by the relative dominance afforded to the automobility regime. They tend to reflect limitations in infrastructure, space on roads and space for storage, as well as (low) levels of confidence in cycling across the population. Whilst this set of barriers has much in common with the well-established barriers to cycling, there are additional factors relating to the extra space an e-cargo bike requires, especially when turning, and to the unfamiliarity of the vehicles. Policymakers will need to affect the established regime(s) in order to create room for the growth of the niche, making the case for space reallocation in a political climate in which any curtailments of general traffic can be seen to be controversial.

The increasing acceptance of the active travel sphere and the near-mainstreaming of electric vehicles mean that e-cargo bikes have some 'friends on the inside', even if those regimes are currently positioned as

'outsider' contender regimes. There is increasing political and economic will for these outsider regimes to become mainstream. This fluidity is especially important when it is considered that a successful development of e-cargo bikes could be as part of a network of electric delivery vehicles.

Thirdly, there are considerations that relate to practices and perceptions around mobility and touch on the image of cycling and public perceptions relating to it. This group extends to less tangible factors such as the relative comfort of cars and vans and the image of cycling, especially when thinking about recruiting people who do not currently cycle. These are manifest at the societal level, since these practices and perceptions are factors that stabilise the automobility regime.

Finally, there is a set of factors that, rather than being barriers per se, relate to policy priorities and indicate the ways in which transport policy could be more proactive in facilitating niche development. These include projects to enable people to try the bikes, initiatives to promote and 'normalise' the practice of using them, and fiscal measures, such as clean air zones, that make conventional automobile use more expensive. They relate to the relationship between landscape and regime(s) in the sense that they depend on policymakers to challenge the dominance of the automobility regime in order to reflect changing priorities at the landscape level, such as decarbonisation. In doing so, they may have to navigate tensions between regimes: the road infrastructure required to support e-cargo bikes is not necessarily the same as what would accommodate electric cars. This is not to say that the signals at the level of the landscape are consistent and uncontroversial: there are, for example, clear tensions in calling for decarbonisation whilst pushing for just-in-time global logistics networks.

In the case of mobility, the configurations of the regime(s) and their level of dominance are likely to differ across and between conurbations. In comparison with, say, electricity networks and other foci for the MLP, the local conditions, cultures and environment will be (more) important in providing conditions in which a niche could flourish. This is especially the case when there is a direct link between infrastructure provision and changes in practice. Such conditions may be hyperlocal: Greater Manchester's conurbation-wide network of walking and cycling infrastructure, the 'Bee Network', is being expanded but currently represents a relatively small proportion of the road network. Other niches, such as low-traffic neighbourhoods, will provide space for e-cargo bikes to be ridden, implying a need to understand the ways in which these niches interact.

In this study we have emphasised the behavioural aspects of transitions. Shove and Walker [33] comment on the relationship between practices and the MLP, arguing that it is important to look not only at the vertical interactions of niche, regime and landscape but also at the circulation of elements, such as meanings and skills, in society. Although e-cargo bikes are a technology, their use requires a shift in practice much more significant than would be the case in, say, changing from petrol to electric vans. The extent of unfamiliarity, in relation not only to e-cargo bikes but also to cycling in general, is a barrier to many. It is worth noting that our conversations were primarily with people who approached e-cargo bikes from cycling, recruiting people who were already able to cycle confidently on the roads and had the associated level of fitness. Others hinted at potential sticking points for people more accustomed to vans, relating to confidence on the road and the perceived trade-off in comfort and image. This illustrates the importance of how the question is framed: is the development of this niche dependent on converting 'drivers' into 'cyclists' – recognising the conceptual baggage accompanying those terms [55] – or on developing a model in which people who are already adept at and practising cycling are recruited into delivery roles? Reflecting on the discussions with our interviewees and focus group participants, these feel like two quite different challenges.

It is therefore important to understand the nature and level of barriers to change and the points at which policy can intercept: to create a supportive environment for change, provide appropriate infrastructure, facilitate niche-level operators to develop the technology, or foster a level playing field. This implies a normative approach: orchestrating the transition, rather than simply observing it.

6. Conclusion

Cycle logistics, in the form of e-cargo bikes, has the potential to be a low-carbon component of logistics networks and bring elements of electric mobility and active travel into the dominant regime. They connect with a broader transition relating to electrification and the conversion of the grid to low-carbon sources. Not only do they require policy support, but that support needs to recognise and reflect the need for change across technology, infrastructure and practice, as well as the interdependence of these three elements.

In terms of future research, there is clear value in gaining a more in-depth understanding of experiences of using the vehicles, as well as the factors that might limit their uptake. Given the unfamiliarity of the vehicles and the ability of sharing and hire schemes to provide an opportunity to try them out, it is important to gain insights into the way people make use of such systems and the impact this has on their mobility practices: do they continue to use bike libraries and hubs or switch to private ownership, and do behaviour and decision-making differ between businesses and consumers and within those groups? As the world comes out of the Covid-19 pandemic, we are keen to understand the impact of the changing landscape on the favourability of e-cargo bikes and active travel regimes.

Our insights from speaking to potential users provide indications of technological developments that could help to make e-cargo bikes of relevance to more people, and it will be instructive to observe changes in use as the technology develops and responds to demand. Technological change will need to be accompanied by changes in practice, and it will be important to understand the mechanisms of cultural change, including awareness-raising, training and incentivisation. It will be important to understand the relationship between the dominant regime (s) and policy to support e-cargo bikes. What configurations of policy, business and civil society actors will create an enabling environment, and how do these differ by place?

We have explored the potential role and contribution of e-cargo bikes in a sustainable mobility transition. The MLP has enabled us to identify the relationships and interactions between the cycle logistics niche, the regimes and the landscape and to identify priorities for research into sustainable transitions in general and e-cargo bikes in particular. In doing so, we have shaped a research agenda for niche development in sustainable mobility transitions.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Dr Luke Blazejewski reports financial support was provided by Engineering and Physical Sciences Research Council (EPSRC).

Data availability

The data that has been used is confidential.

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References

[1] C. Brand, T. Götschi, E. Dons, R. Gerike, E. Anaya-Boig, I. Avila-Palencia, A. de Nazelle, M. Gascon, M. Gaupp-Berghausen, F. Iacorossi, S. Kahlmeier, L. Int Panis, F. Racioppi, D. Rojas-Rueda, A. Standaert, E. Stigell, S. Sulikova, S. Wegener, M. J. Nieuwenhuijsen, The climate change mitigation impacts of active travel:

evidence from a longitudinal panel study in seven European cities, Glob. Environ. Change. 67 (2021), 102224, https://doi.org/10.1016/j.gloenvcha.2021.102224.
[2] R. Danielis, M. Scorrano, M. Giansoldati, Decarbonising transport in Europe: trends, goals, policies and passenger car scenarios, Res. Transp. Econ. 91 (2022), 101068, https://doi.org/10.1016/j.retrec.2021.101068.
[3] N. Simcock, K.E.H. Jenkins, M. Lacey-Barnacle, M. Martiskainen, G. Mattioli, D. Hopkins, Identifying double energy vulnerability: a systematic and narrative review of groups at-risk of energy and transport poverty in the global north, Energy Res. Soc. Sci. 82 (2021), 102351, https://doi.org/10.1016/j.erss.2021.102351.
[4] L. Whitmarsh, How useful is the multi-level perspective for transport and sustainability research? J. Transp. Geogr. 24 (2012) 483–487, https://doi.org/10.1016/j.jtrangeo.2012.01.022.
[5] L. Ingeborgrud, S. Heidenreich, M. Ryghaug, T.M. Skjølsvold, C. Foulds, R. Robison, K. Buchmann, R. Mourik, Expanding the scope and implications of energy research: a guide to key themes and concepts from the social sciences and humanities, Energy Res. Soc. Sci. 63 (2020), 101398, https://doi.org/10.1016/j.erss.2019.101398.
[6] E.M.C. Svennevik, M. Dijk, P. Arnfalk, How do new mobility practices emerge? A comparative analysis of car-sharing in cities in Norway, Sweden and the Netherlands, Energy Res. Soc. Sci. 82 (2021), 102305, https://doi.org/10.1016/j.erss.2021.102305.
[7] F.W. Geels, Technological transitions as evolutionary reconfiguration processes: a multi-level perspective and a case-study, Res. Policy 31 (2002) 1257–1274, https://doi.org/10.1016/S0048-7333(02)00062-8.
[8] B.K. Sovacool, D.J. Hess, S. Amir, F.W. Geels, R. Hirsh, L. Rodriguez Medina, C. Miller, C. Alvial Palavicino, R. Phadke, M. Ryghaug, J. Schot, A. Silvast, J. Stephens, A. Stirling, B. Turnheim, E. van der Vleuten, H. van Lente, S. Yearley, Sociotechnical agendas: reviewing future directions for energy and climate research, Energy Res. Soc. Sci. 70 (2020), 101617, https://doi.org/10.1016/j.erss.2020.101617.
[9] C. Roberts, Into a Headwind: Canadian cycle commuting and the growth of sustainable practices in hostile political contexts, Energy Res. Soc. Sci. 70 (2020), 101679, https://doi.org/10.1016/j.erss.2020.101679.
[10] C. Corradi, E. Sica, P. Morone, What drives electric vehicle adoption? Insights from a systematic review on European transport actors and behaviours, Energy Res. Soc. Sci. 95 (2023), 102908, https://doi.org/10.1016/j.erss.2022.102908.
[11] E. Holden, D. Banister, S. Gössling, G. Gilpin, K. Linnerud, Grand narratives for sustainable mobility: a conceptual review, Energy Res. Soc. Sci. 65 (2020), 101454, https://doi.org/10.1016/j.erss.2020.101454.
[12] C. Mullen, G. Marsden, Mobility justice in low carbon energy transitions, Energy Res Soc. Sci. 18 (2016) 109–117, https://doi.org/10.1016/j.erss.2016.03.026.
[13] D. Zuev, K. Psarikidou, C. Popan, Introduction, in: D. Zuev, K. Psarikidou, C. Popan (Eds.), Cycling societies: innovations, inequalities and governance, Routledge, 2021, pp. 1–15.
[14] M. Watson, Building future systems of velomobility, in: E. Shove, N. Spurling (Eds.), Sustainable Practices: Social Theory and Climate Change, Routledge, 2013, pp. 117–131.
[15] P. Cox, T. Koglin, The Politics of Cycling Infrastructure, 2020. https://policy.bristoluniversitypress.co.uk/the-politics-of-cycling-infrastructure-in-europe. (Accessed 1 May 2022).
[16] S. Handy, Chapter 9 - making US cities pedestrian- and bicycle-friendly, in: E. Deakin (Ed.), Transportation, Land Use, and Environmental Planning, Elsevier, 2020, pp. 169–187, https://doi.org/10.1016/B978-0-12-815167-9.00009-8.
[17] C.G. Pooley, D. Horton, G. Scheldeman, C. Mullen, T. Jones, M. Tight, A. Jopson, A. Chisholm, Policies for promoting walking and cycling in England: a view from the street, Transp. Policy 27 (2013) 66–72, https://doi.org/10.1016/j.tranpol.2013.01.003.
[18] F. Behrendt, Why cycling matters for electric mobility: towards diverse, active and sustainable e-mobilities, Mobilities. 13 (2018) 64–80, https://doi.org/10.1080/17450101.2017.1335463.
[19] P. Rérat, The rise of the e-bike: towards an extension of the practice of cycling? Mobilities. 16 (2021) 423–439, https://doi.org/10.1080/17450101.2021.1897236.
[20] A. Temporelli, P.C. Brambilla, E. Brivio, P. Girardi, Last mile logistics life cycle assessment: a comparative analysis from diesel Van to E-cargo bike, Energies. 15 (2022) 7817, https://doi.org/10.3390/en15207817.
[21] A. Robichet, P. Nierat, F. Combes, First and last miles by cargo bikes: ecological commitment or economically Feasible? The case of a parcel service company in Paris, Transp. Res. Rec. 2676 (2022) 269–278, https://doi.org/10.1177/03611981221086632.
[22] F. Fontes, V. Andrade, Bicycle logistics as a sustainability strategy: lessons from Brazil and Germany, Sustainability. 14 (2022) 12613, https://doi.org/10.3390/su141912613.
[23] E. Verlinghieri, I. Itova, N. Collignon, R. Aldred, The Promise of Low-Carbon Freight, Possible, London, 2021. https://static1.squarespace.com/static/5d30896202a18c0001b49180/t/61091edc3acfda2f4af7d97f/1627987694676/The+Promise+of+Low-Carbon+Freight.pdf.
[24] B. Lenz, E. Riehle, Bikes for urban freight?: experience in Europe, Transp. Res. Rec. 2379 (2013) 39–45, https://doi.org/10.3141/2379-05.
[25] Element Energy, Cycle Freight Study: An Independent Study Commissioned by Transport for London, 2018. https://content.tfl.gov.uk/cycle-freight-study.pdf.
[26] S. Cairns, L. Sloman, Potential for e-cargo bikes to reduce congestion and pollution from vans in cities. https://www.bicycleassociation.org.uk/wp-content/uploads/2019/07/Potential-for-e-cargo-bikes-to-reduce-congestion-and-pollution-from-vans-FINAL.pdf, 2019. (Accessed 9 March 2020).
[27] F.W. Geels, Micro-foundations of the multi-level perspective on socio-technical transitions: developing a multi-dimensional model of agency through crossovers between social constructivism, evolutionary economics and neo-institutional theory, Technol. Forecast. Soc. Change. 152 (2020), 119894, https://doi.org/10.1016/j.techfore.2019.119894.
[28] L. Kanger, Rethinking the multi-level perspective for energy transitions: from regime life-cycle to explanatory typology of transition pathways, Energy Res. Soc. Sci. 71 (2021), 101829, https://doi.org/10.1016/j.erss.2020.101829.
[29] A. Smith, J.-P. Voß, J. Grin, Innovation studies and sustainability transitions: the allure of the multi-level perspective and its challenges, Res. Policy 39 (2010) 435–448, https://doi.org/10.1016/j.respol.2010.01.023.
[30] J. Markard, R. Raven, B. Truffer, Sustainability transitions: an emerging field of research and its prospects, Res. Policy 41 (2012) 955–967, https://doi.org/10.1016/j.respol.2012.02.013.
[31] F.W. Geels, A socio-technical analysis of low-carbon transitions: introducing the multi-level perspective into transport studies, J. Transp. Geogr. 24 (2012) 471–482, https://doi.org/10.1016/j.jtrangeo.2012.01.021.
[32] N. Vähäkari, V. Lauttamäki, P. Tapio, M. Ahvenainen, T. Assmuth, J. Lyytimäki, J. Vehmas, The future in sustainability transitions - interlinkages between the multi-level perspective and futures studies, Futures 123 (2020), 102597, https://doi.org/10.1016/j.futures.2020.102597.
[33] E. Shove, G. Walker, Governing transitions in the sustainability of everyday life, Res. Policy 39 (2010) 471–476, https://doi.org/10.1016/j.respol.2010.01.019.
[34] B. Nykvist, M. Nilsson, The EV paradox – a multilevel study of why Stockholm is not a leader in electric vehicles, environ. Innov, Soc. Transit. 14 (2015) 26–44, https://doi.org/10.1016/j.eist.2014.06.003.
[35] L. Budd, S. Ison, Responsible transport: a post-COVID agenda for transport policy and practice, Transp. Res. Interdiscip. Perspect. 6 (2020), 100151, https://doi.org/10.1016/j.trip.2020.100151.
[36] A. Abu-Rayash, I. Dincer, Analysis of mobility trends during the COVID-19 coronavirus pandemic: exploring the impacts on global aviation and travel in selected cities, Energy Res. Soc. Sci. 68 (2020), 101693, https://doi.org/10.1016/j.erss.2020.101693.
[37] G. Waitt, E. Stanes, Reactivating commuter cycling: COVID-19 pandemic disruption to everyday transport choices in SydneyAustralia, J. Transp. Geogr. 98 (2022), 103270, https://doi.org/10.1016/j.jtrangeo.2021.103270.
[38] W. Kanda, P. Kivimaa, What opportunities could the COVID-19 outbreak offer for sustainability transitions research on electricity and mobility? Energy Res. Soc. Sci. 68 (2020), 101666 https://doi.org/10.1016/j.erss.2020.101666.
[39] G. Mattioli, C. Roberts, J.K. Steinberger, A. Brown, The political economy of car dependence: a systems of provision approach, Energy Res. Soc. Sci. 66 (2020), 101486, https://doi.org/10.1016/j.erss.2020.101486.
[40] S. Srivatsa Srinivas, R.R. Marathe, Moving towards "mobile warehouse": last-mile logistics during COVID-19 and beyond, Transp. Res. Interdiscip. Perspect. 10 (2021), 100339, https://doi.org/10.1016/j.trip.2021.100339.
[41] Y. Strauch, Beyond the low-carbon niche: global tipping points in the rise of wind, solar, and electric vehicles to regime scale systems, Energy Res. Soc. Sci. 62 (2020), 101364, https://doi.org/10.1016/j.erss.2019.101364.
[42] F.W. Geels, The multi-level perspective on sustainability transitions: responses to seven criticisms, Environ. InnovSoc. Transit. 1 (2011) 24–40, https://doi.org/10.1016/j.eist.2011.02.002.
[43] S. Cook, L. Stevenson, R. Aldred, M. Kendall, T. Cohen, More than walking and cycling: what is 'active travel'? Transp. Policy 126 (2022) 151–161, https://doi.org/10.1016/j.tranpol.2022.07.015.
[44] N. Berkeley, D. Bailey, A. Jones, D. Jarvis, Assessing the transition towards battery electric vehicles: a multi-level perspective on drivers of, and barriers to, take up, Transp. Res. A Policy Pract. 106 (2017) 320–332, https://doi.org/10.1016/j.tra.2017.10.004.
[45] H. Larrington-Spencer, A. Sherriff, A. Price, Active neighbourhoods in Greater Manchester : qualitative insights into resident experiences across four case study interventions (Full report), Manchester, 2021 http://usir.salford.ac.uk/id/eprint/62322/1/Active Neighbourhoods in Greater Manchester USIR_theone.pdf.
[46] C. Médard de Chardon, The contradictions of bike-share benefits, purposes and outcomes, Transp. Res. A Policy Pract. 121 (2019) 401–419, https://doi.org/10.1016/j.tra.2019.01.031.
[47] G. Sherriff, M. Adams, L. Blazejewski, N. Davies, D. Kamerāde, From mobike to no bike in greater Manchester: using the capabilities approach to explore Europe's first wave of dockless bike share, J. Transp. Geogr. 86 (2020), 102744, https://doi.org/10.1016/j.jtrangeo.2020.102744.
[48] M. Hodson, S. Marvin, Can cities shape socio-technical transitions and how would we know if they were? Res. Policy 39 (2010) 477–485, https://doi.org/10.1016/j.respol.2010.01.020.
[49] R. Hoogma, R. Kemp, J. Schot, B. Truffer, Experimenting for Sustainable Transport: The Approach of Strategic Niche Management, Routledge, 2017.
[50] M.Q. Patton, How to Use Qualitative Methods in Evaluation, SAGE, 1987.
[51] I. Etikan, S.A. Musa, R.S. Alkassim, Comparison of convenience sampling and purposive sampling, Am. J. Theor. Appl. Stat. 5 (2016) 1–4, https://doi.org/10.11648/j.ajtas.20160501.11.
[52] M.J. Fell, L. Pagel, C. Chen, M.H. Goldberg, M. Herberz, G. Huebner, S. Sareen, U.J. J. Hahnel, Validity of energy social research during and after COVID-19: challenges, considerations, and responses, SocArXiv. (2020), https://doi.org/10.31235/osf.io/pe6cd.

[53] Department for Transport, Funding boost for green last mile delivery bikes, GOV. UK. https://www.gov.uk/government/news/funding-boost-for-green-last-mile-delivery-bikes, 2018. (Accessed 14 December 2021).
[54] N. Andrews, I. Clement, Invisible cyclists? Acknowledging the needs and rights of disabled cyclists, in: D. Zuev, K. Psarikidou, C. Popan (Eds.), Cycling Societies: Innovations, Inequalities and Governance, Routledge, 2021, pp. 156–162.
[55] G. Sherriff, Voting on sustainable transport: communication and governance challenges in greater Manchester's 'congestion charge' referendum, Local Environ. 20 (2015) 1507–1530, https://doi.org/10.1080/13549839.2014.911267.