Department for Transport

E-cycles Rapid Evidence Assessment

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Contents

Executive summary

Introduction

This rapid evidence assessment (REA) was conducted as part of the scoping phase of the Department for Transport's evaluation of its investment in e-cycle projects, aiming to increase e-cycling, cycling and/or e-cargo use. This review builds on a previous evidence review in 2021.

The REA addressed three research questions, the key findings of which are summarised below. A range of evidence sources were reviewed, including peer-reviewed academic papers and evidence from other sources such as public sector project reports and research commissioned by interest groups or manufacturers ('grey' literature).

There are limitations to the quantity and quality of the evidence, for example, small sample sizes and in the case of the grey literature limited information provided about the underlying sample. There are also gaps in the evidence, for example how e-cycles could support different journey types and how their use varies and could be increased among different demographic groups in the UK.

Who uses e-cycles?

There is European and North American evidence about the characteristics of e-cycle users but limited evidence about the characteristics of users in the UK. This could be due to the fact that e-cycle use and ownership is low in the UK. Generally, the evidence suggests that e-cycle users tend to be older. However, other characteristics, including gender, income and education appears to differ between countries.

There is some evidence to suggest that users are also more likely to be living in households with children.

In addition, a Dutch study found e-cycle owners are more likely to be living in areas of lower population density.

For e-cargo cycles, there is limited information overall about users, with most of the limited literature focusing on intended use in businesses and almost nothing about personal use. Indicative evidence shows that e-cargos are used by women to transport children. Furthermore, evidence indicates that people in the 25-34 age bracket were most likely to consider buying an e-cargo but this is intended behaviour as opposed to actual behaviour.

What are the determinants, motivators and barriers to e-cycle use?

Key recurring motivators are listed throughout the literature relating to enjoyment, physical and mental health, ability to ride longer and faster, reduced physical effort compared to using a conventional cycle (especially when carrying heavy loads), and overcoming hilly terrain.

The key barrier to the use of e-cycles is the high cost of purchasing an e-cycle, particularly among young people. The other main barriers are anxiety about how long the battery will remain charged, heaviness of e-cycles, maintenance, security and access to safe cycling routes.

Lack of knowledge about e-cycles is also a barrier to uptake, including information about where to find e-cycles for sale and how to charge them; most people were not confident in how to purchase an e-cycle.

Some of the barriers were perceptual rather than actual (i.e. barriers from people who have little knowledge or experience of using an e-cycle). There is evidence to suggest that barriers and motivators shift once people have experience of using an e-cycle.

E-cycles share barriers with conventional cycles such as safety concerns and a general unwillingness/lack of interest in cycling.

There is evidence to suggest that motivations and barriers vary according to gender and age, and also change after using or trialling an e-cycle. For example, non-users are more likely to report anxiety about charging and the weight of the cycle as barriers compared to users.

Shared e-cycle schemes

Shared e-cycle schemes can give people the chance to experience an e-cycle without committing to buying one, which may lead to a decision to buy an e-cycle in future. Shared schemes are also a way for people to use an e-cycle on an ongoing basis without the relatively high upfront cost of purchasing an e-cycle. There is evidence to suggest that shared e-cycle schemes can encourage e-cycle use, at least in the short term. One study found that participants were more likely to use a shared e-cycle when they did not have access to their own cycle. The study also found participants were more likely to switch from car to a shared e-cycle for journeys where they could reduce their

journey time by using an e-cycle rather than a car, for example because it enabled them to avoid traffic congestion.

Switching from other modes

There is some evidence that e-cycle schemes can enable people to shift mode from private cars. Participants in a small e-cycle loan scheme reduced their car use and some went on to purchase an e-cycle after the loan ended, hinting at the potential for loan schemes to bring about longer-term behaviour change.

However, evidence shows that not all schemes are successful in encouraging people to switch from cars to e-cycle. Participants in a shared e-cycle scheme reported that they switched predominantly from public transport, with frequent car users least likely to switch to e-cycles. Participants already using predominantly privately owned conventional cycles were also less likely to switch to a shared e-cycle.

Gaps in the evidence

This review found gaps in the current evidence that the national e-cycling programme or future research could help to address. These include:

- More information about how e-cycles could support different journey types for personal use.
- How e-cycle usage and potential usage varies among different demographics groups in the UK.
- Effectiveness of different outreach methods to broaden e-cycle awareness and use.

E-cargo use

There is limited evidence about e-cargo use and potential among both individuals and businesses. The national e-cycling programme does not include e-cargos so it cannot be used to address gaps in the e-cargo evidence, but the notable gaps that could be addressed through other research include:

- How e-cargo usage and potential usage varies among different demographics groups in the UK.
- Demographic and locational factors that make suitable contexts for projects to increase the uptake of e-cargos in the UK.
- The extent to which factors affecting e-cargo uptake, such as the availability of cycling infrastructure, can be overcome through targeted interventions/trial projects that address issues such as knowledge of and access to e-cargos.

1. Introduction

Background

Steer, with the Institute for Transport Studies (ITS) of the University of Leeds, were appointed by the Department for Transport (DfT) as monitoring and evaluation partner for e-cycles interventions. This Rapid Evidence Assessment (REA) forms part of the scoping phase of the e-cycle interventions evaluation. The evaluation focuses on initiatives to increase e-cycle and e-cargo use that have been delivered recently in England supported by DfT funding, chiefly the Access Fund (including the e-cycle extension fund) and Capability Fund and the national e-cycles programme Cycling Made E-asier.

The purpose of this REA is to inform the development of a monitoring and evaluation framework for DfT's investment in e-cycling. It seeks to collate information about the profile of current e-cycle users and the barriers and motivations for e-cycle use. This REA also sought to find any new evidence about the impact of e-cycle projects on increasing the uptake of e-cycles. The research questions the review seeks to answer are set out in the next section. This REA concludes with a summary of the gaps in the evidence that the forthcoming Cycling Made E-asier programme could be used to address.

Scope of this Rapid Evidence Assessment

The aim of this REA is to provide insight into three research questions about e-cycles and e-cargo bikes (e-cargos):

1. Who is an e-cycle and e-cargo user?

2. What are the determinants of e-cycle (including adapted e-cycles) and e-cargo use? What are the barriers and motivations for use?

3. What additional evidence exists on the effectiveness of measures to increase e-cycle/e-cargo use?

This REA is intended to complement a previous literature review commissioned by DfT, which focused on the efficacy and impact of trial schemes in increasing uptake of e-cycles[1].It is also intended to take into account new evidence published since 2021.

As explained in Section 2, this REA has considered evidence from both the academic and 'grey' literature. The academic literature comprises papers that have been peer reviewed and mostly from published journals. The grey literature includes publications from the public sector or lobby groups, which have generally not been subject to peer review, although an academic institution or research agency may have been commissioned to undertake the research.

Structure of this Document

This report is structured as follows:

- Section 2 summarises the methodology used in conducting the REA and the general limitations of the literature and studies that have informed this REA.
- Sections 3 to 5 present the findings as they answer each of the research questions.
- Section 6 sets out the gaps in the evidence identified through this REA.

Appendix A includes a precis of each research paper referenced in this REA and Appendix B includes more details of the methodology including the search protocols used.

[1] Behavioural Impacts of E-cycle Trials: A Rapid Evidence Assessment (2021)

2. Methodology and limitations

Methodology

A review of the academic literature was conducted focusing on papers published within the last two years (i.e., the period since previous DfT literature review). The grey literature and academic literature were approached separately, and due to the different nature and sources which make up these categories, different exclusion criteria and methods were applied. A summary of the papers considered is provided in Appendix A.

The review of grey literature began by considering papers already known to the research team against the research questions. Then a wider search was conducted using key words linked to each research question. Grey literature was searched through freely available search engines and returned a high number of extraneous results (including retail and adverts).

Further details about the search protocol and exclusion criteria can be found in Appendix B.

Limitations of this review

This review sought to gather recent evidence to address the research questions, building upon previous literature reviews including evidence gathered by DfT[2]. It should be noted that not all of the research questions can be answered comprehensively from the literature, with studies of varying quality and quantity to draw upon. The literature around e-cargos is notably sparse. Where possible this REA has also sought to gather further information since academic literature reviews on e-cycling by Bourne et al. (2020, 2022). Older sources, generally pre-2020, have been used sparingly, in line with the search

[2] Behavioural Impacts of E-cycle Trials: A Rapid Evidence Assessment (2021)

criteria and to gather additional evidence not included in the other literature reviews.

The literature includes studies of varying scale and quality, often with small sample sizes and without identified control or comparison groups. In the case of non-academic sources, details about the research methods used and sample sizes achieved can be lacking. Some peer reviewed studies have been undertaken among university communities that may not be representative of wider communities and demographic groups.

A key academic paper is a 2020 meta-study by Bourne et al., which considered the findings of 76 papers investigating the impact of e-cycling on travel behaviour. The study consisted of peer-reviewed primary research with experimental and non-experimental studies, including cross-sectional and longitudinal quantitative and qualitative methods. Only research studies with adults were considered in the paper. Additionally, the participants had to be owners of an e-cycle or had regular access to it (e.g. use of an e-cycle sharing scheme). This means that the evidence reported in Bourne et al. (2020) has been conducted among people with experience of switching to and using e-cycles. In contrast, evidence from other studies (e.g. Shimano Steps, 2020) includes perceptions about barriers and motivators to e-cycle purchase and use amongst people who have had little to no experience of using an e-cycle. Caution needs to be taken when drawing conclusions from some studies, as the evidence is illustrating intended behaviour rather than actual behaviour.

Editorials, opinion pieces and commentaries as well as review articles were excluded from the Bourne et al. (2020) meta-study as the findings are not necessarily based on evidence. When referencing Bourne et al. (2020) in this REA an additional check of the quality of the underlying studies has been made and often multiple sources are referenced where it was considered useful to give additional detail about the underlying source used in the meta-study.

The grey literature includes papers produced by organisations within the e-cycling industry, including manufacturers (e.g. Shimano Steps, the component manufacturer) and interest groups promoting the use of e-cycles (e.g., CoMoUK, the shared mobility charity). These organisations have a commercial interest in the development of the industry and their papers may not have been subject to the same scrutiny as peer reviewed journal articles in the academic literature.

The grey literature does not always outline sample specifications, for instance, in terms of demographics and therefore it can be difficult to assess the representativeness of the research findings. Where information about sample size and data collection methods was provided in the source these have been included in this review where it is helpful to contextualise the evidence quoted.

3. Who are e-cycle and e-cargo users?

Key findings

- There is European and North American evidence about the characteristics of e-cycle users but limited evidence about the characteristics of users in the UK. This could be due to the fact that e-cycle use and ownership is low in the UK.
- Generally, the evidence suggests that e-cycle users tend to be older (e.g., usually over 55s). However, other characteristics, including gender, income and education appears to differ between countries.
- There is some evidence to suggest that users are more likely to be living in households with children.
- In addition, a Dutch study found e-cycle owners are more likely to be living in areas of lower population density.
- Evidence from a shared e-cycle scheme found that users were more likely to replace car trips with e-cycling, compared to users of conventional cycles.
- E-cycle users have been found to make longer trips than convention cycle users.
- For e-cargo cycles, there is limited information overall about users, with most of the limited literature focusing on intended use in businesses and almost nothing about personal use.
- Indicative evidence shows that e-cargos are used by women to transport children. Furthermore, people in the 25-34 age bracket were most likely to consider buying an e-cargo but this is intended behaviour as opposed to actual behaviour.

Introduction

This section is divided into two broad subsections covering first e-cycle users and then e-cargo users. This section begins with an overview of the demographic characteristics of e-cycle users then considers evidence about the trips people make by e-cycle.

- E-cycle ‘trips’ are addressed first presenting findings regarding trip length, frequency, and substituting factor of car trips.
- Findings regarding users are then presented and organised by factors such as age, sex, and prior cycling awareness.
- E-cargo findings are presented in two sections, addressing e-cargos for personal and business use separately.
- The personal use section presents findings as related to characteristics, and trips.
- The e-cargo business use section presents findings on business sizes, and types as well as reported trip lengths and types.

E-cycle users

Demographic profile of users – age, gender, income and household characteristics

Melia and Bartle (2021) undertook research into e-cycle use in the UK, including a literature review of UK and international evidence, which is a useful starting point for addressing Research Question 1. “Most of the published articles from Western countries report on: small-scale trials, small-scale surveys (or large surveys with a small number of e-cycle users), qualitative research or reflections on the role of e-cycles in transport policy” (p.2). Findings from their review of global evidence includes:

- Analysis of three years’ worth of data (2013-2015) from Dutch National Mobility Survey by Kroesen (2017) found that e-cycle owners are more likely to be older, retired and female, from households with higher level of income, living in areas of lower population density.
- MacArthur et al. (2018) conducted a survey of 1,796 e-cycle owners, of which 1,666 were from the USA and 133 from Canada and found that they were more likely to be older, highly educated, white, male, living in households with children.
- A survey by Wolf and Seebauer (2014) of 1,396 people in Austria who bought an e-cycle between 2009 and 2011 found that 62% were over the age of 60 with lower levels of income and education, which the researchers associated with the older age of people in the sample. It should be noted that there is little known about the respondents and sampling approach.

Bourne et al. (2020) found studies that have shown a difference in the gender distribution among e-cycle users between countries that have high rates of cycling for both genders, such as Denmark and (Dutch-speaking) Belgium, (Kroesen, 2017; Van Cauwenberg et al., 2018) and countries with lower rates of cycling, such as the USA (MacArthur et al., 2014; 2018) and Australia (Johnson and Rose, 2013). In countries with higher rates of cycling women often make up

the majority of e-cycle users whereas in countries with lower rates of cycling e-cycle users are mostly men.

A review into the benefits of increasing e-cycle use in the UK by campaign group Bike is Best (2022) in partnership with the University of Westminster included evidence about the profile of e-cycle users. They cited research by Rerat (2021), which reported from a survey of 14,000 people in Switzerland, finding that e-cycle users were more likely to be women and older, and more likely to be parents, in comparison to users of conventional cycles. It should be noted that this sample was drawn from participants in a national cycle to work campaign, which only included commuters and existing users of standard cycles and e-cycles, and therefore is not representative of the wider population.

UK-specific evidence on the demographic profile of e-cycle users is very limited. Wave 5 of the National Travel Attitudes Survey (2021) found 152 people (3%) of its sample of 2,554 (drawn from the National Travel Survey sample on a random probability sample basis) owned or had regular use of an e-cycle. No information is presented about the characteristics of the e-cycle users.

CoMoUK (2016) looked across 11 pilot projects consisting of 188 shared e-cycles found that the majority of shared e-cycle users[3] were aged 35-54 (44%) and that people aged 16-24 and 65+ were underrepresented. The research also found that many of the new people attracted to cycling through a shared e-cycle scheme were women or people aged between 35 and 64 (although the report does not give details about the demographics of the people newly attracted to a shared conventional-cycle scheme for comparison). Further, men were less represented among shared e-cycle users (45% of shared e-cycle users were women), in contrast to only 25% of all cycling trips being made by women. Although it should be recognised the report is not comparing like with like here – a more meaningful comparison would have been to state the proportion of shared e-cycle trips made by women in comparison to cycling trips made by women.

According to Wave 8 of the DfT's Technology Tracker (December 2021) there was a slight decrease in self-reported knowledge of e-cycles to 72%, from 75%[4] (Wave 7, June 2021). The percentage of those who said they know a great deal or fair amount fell by 10 percentage points between Wave 7 and 8, from 35% to 25%. Wave 8 (December 2021) found that only 28% of those aged 75+ said they had heard of e-cycles and knew nothing about them. This was higher than all other age groups, and 12 percentage points higher than those aged 55-64. Knowledge of e-cycles was higher among higher income households at 82% for households with annual earnings between £52-£99,999 compared to 67% in

[3] A shared cycle scheme is one in which a pool of cycles is publicly available and accessed by members/users such as London's Santander Cycles. E-cycle examples are: Voi, Human Forest and Lime Bikes.

[4] In Wave 7 of DfT's Technology Tracker, self-reported awareness among the 3,392 adult respondents was 75%.

households earning up to £25,999. However, knowledge of e-cycles does not always translate to use. Wave 7 of DfT's Technology Tracker (June 2021) found that 91% of people had never used an e-cycle and this was highest amongst those aged over 75 (97%). It should be noted that the tracker does not differentiate between users and non-users of e-cycles in its findings.

This REA found minimal evidence about relationships between race, religion or belief and use of e-cycles or e-cargos. DfT's Technology Tracker (Wave 7, June 2021) found that 16% of respondents from minority ethnic backgrounds had never heard of e-cycles, 10 percentage points higher than among white respondents.

Trip characteristics

A key source here is the meta-study by Bourne et al. (2020) on the frequency and duration of e-cycle use, and the impact e-cycles have on the travel behaviour of users. Seventy-six studies were included in their research, sourced from global published and unpublished academic and grey literature, prioritising recent sources. Where possible commentary is provided on the quality of the sources referenced by Bourne et al. (2020) although in many cases they refer to multiple sources to illustrate findings and a review of all their source literature has not been possible within the scope of this REA.

Trip length

Bourne et al. (2020) reported that the mean daily distances travelled by e-cycle ranged from 2.7km to 24km with the majority of studies reporting mean daily distances of 3km to 11.5km (Haustein and Møller (2016a)). They also report that those travelling for recreation cover longer distances than those travelling for utility. By contrast, the National Travel Survey (2021) shows an average trip length across all modes and journey types of 4.1 miles or 6.6km, although the 2020 figure is higher than the average across preceding years correlating with the uptake in cycling during the coronavirus pandemic.

Bourne et al. (2020) also found evidence that participants cycle longer distances on an e-cycle than a conventional cycle. A randomised controlled trial in which adults had access to either an e-cycle or conventional cycle for three months showed a median distance cycled per week difference of 8.3km (20.2km for e-cycles and 11.9km for conventional cycles) (Bjørnarå et al., 2019).

Research among over 13,000 people across 11 European nations, commissioned by manufacturer Shimano Steps (2020), suggested that the future growth in e-cycle usage could see people making longer trips. The findings showed that increasing the distance travelled was the main reason that people would want to buy an e-cycle (32%), including UK where this reason also scored highly (30%). It should be noted that the sample included e-cycle

users and non-users, although no details were provided on the proportion of users and non-users. This means it is unclear how the main triggers for buying an e-cycle may vary by users and non-users.

SEStrans's Go e-Bike report (2018) analysed data from a pilot of seven e-cycle hubs in southeast Scotland. At an e-cycle hub at the University of St Andrews, e-cycles were used by university staff for commuting and at the weekend, with each e-cycle travelling an average of 660 miles per year. Across all seven e-cycle hubs the highest frequency of trip length was 2 to 5 miles (approximately 30% of trips) with the shortest (under 1 mile) and the longest (over 10 miles) being least common (10% each). One third (33%) of users reported that they had previously made the same trip daily by car. It should be noted this was a relatively small pilot and the University of St Andrews e-cycle hub may not be illustrative of wider potential given St Andrews is a relatively small town and the pilot focused on the university.

Journey purpose

Bourne et al. (2020) found that e-cycles are used more for utility purposes rather than leisure. There are differences in journey purpose by age group, with people under the age of 55 using their e-cycle primarily for commuting (MacArthur et al., 2014 and 2018) and older people using their e-cycles more for shopping or visiting friends, although it is plausible that this pattern applies to other modes of transport since older people are more likely to be retired and therefore not commuting. There was no evidence about variation in e-cycle journey purpose by gender.

Frequency of use

Bourne et al. (2020) reported the frequency of e-cycle usage to range from 1.9 to 5.1 days per week. This information has been gathered by reviewing over sixty studies, the majority of which relied on self-reporting during e-cycle loan schemes (a small number used GPS trackers). Comparable data for conventional cycles is not included in the paper.

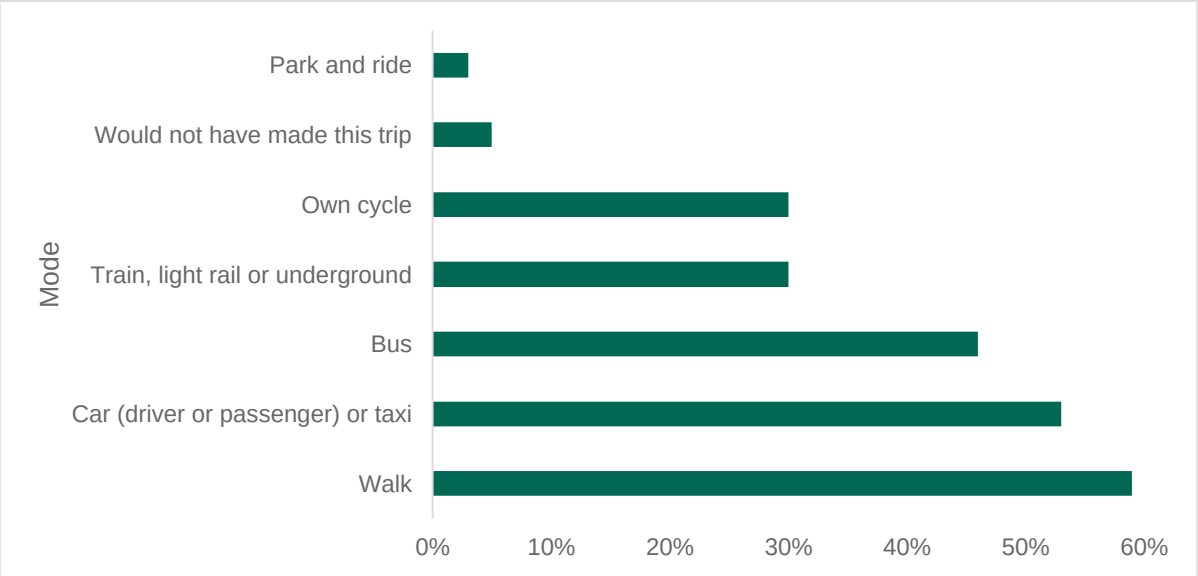
Replacing car trips

Bourne et al. (2020) found that e-cycles appear to substitute 23-72% of conventional cycle journeys and 20-86% of ‘short’ private car journeys although the length of these journeys is not defined in the source literature. It is recognised that this is a very broad range and further investigation would be required to understand the variation. The replacement factor is dependent on the primary mode of transport prior to introduction of e-cycles. Locations with high cycling levels were found to replace more trips from conventional cycles whereas areas with low levels of cycling were found to replace more trips from car to e-cycle.

Analysis by CoMoUK (2021) found that shared e-cycle users were more likely to replace car trips than shared conventional-cycle users, with 34% among e-cycle users compared to 24% among conventional-cycle users reporting that they were replacing more than five miles of car travel per week through use of the shared cycle and e-cycle scheme. A further finding was that shared e-cycle scheme users were replacing 34% more car miles than conventional cycle users (at an average of 4.5 miles per week vs 3.4 miles per week).

The CoMoUK (2021) report also provides data for shared cycles (conventional and e-cycles) on which modes they were replacing with the shared cycle scheme. Cycle share users were asked which modes they would use for their 'most common trip' if cycle share was not available and were able to select multiple answers (see Figure 3.1).

Figure 3.1: UK responses to questions: 'Which modes would you use for your "most common trip" if the bike share wasn't an option? Please select all that apply' (CoMoUK, Annual Bike Share Report 2021 - online survey of 4,264 UK respondents aged 15-64s)



A trial by the National Renewable Energy Laboratory (2021) in Colorado USA, which provided 3-month loans of e-cycles, found that during the trial e-cycles became the dominant mode of those taking part in the study making up 30-35% of their trips (although the study divided car trips between 'car with others' and 'car drove alone' which when combined totalled (49.4%) putting e-cycle use into second place).

E-cargo users

E-cargos for personal use

Age

Shimano Steps (2021) found that across Europe people aged under 35 (25%) were more likely than older age groups to consider buying an e-cargo, although price was not included in the question. Additionally, Shimano Steps (2020) found that buying an e-cycle to carry heavy loads, such as groceries or children, was most popular among 25-34 year olds (16% out of the total sample of 13,412 adults) compared to the other age groups.

Among UK respondents there was less interest in e-cargos compared to the average across Europe. Some caution is needed when considering these findings, which, although based on a large sample size, are drawn from papers with little detail on the sampling approach used. These sources have been included because they hint at where uptake of e-cargos could be greatest, in the context of sparse evidence generally.

Gender and family/parental status

Boterman (2020) undertook qualitative analysis of Dutch newspaper articles into the perceptions of e-cargo users and found e-cargo cycle users are often perceived to be elitist by members of the Dutch public and hypothesises this may be due in part to the higher cost of an e-cargo as well as the e-cargo being a demonstration of lifestyle choices that tend towards notions of an urban elite. They also note that the term “cargobike mum” is used more frequently in a review of newspaper occurrences than “cargobike dad” or “cargobike parents”. They also note that women cargo users report being subject to harassment regarding the safety of their children due to their choice of transport.

Riggs and Schwartz (2018) suggest cargo cycles (not exclusively e-cargo) could be a tool for increasing cycling rates amongst women and find that 78% of women making trips by cargo cycle were doing so with children, compared to 56% for men. They also found a higher substitution rate of car trips amongst women than men after introduction of cargo cycles with 77% of women reporting it as their primary mode compared to 66% of men. These findings were gathered from an online survey of 300 individuals (of 2,500 distribution list) who had recently made a cargo cycle purchase in the USA. Of these, 173 were deemed valid responses and were assessed using descriptive statistics and cross tabulations.

Race, religion or belief

This REA did not return relevant literature regarding the cross-section of race, religion, or belief and e-cargo usage.

Trip length, type, and frequency

The National Travel Survey (2021) shows that 94% of school trips of 2 to 5 miles made by 5- to 10-year-olds are made by car/van and only 8% of primary school children travel further than 5 miles. Trips under 5 miles are typically considered appropriate to cycle and could reasonably be made by e-cargo in some areas. However, further research is needed to understand how e-cycles/e-cargos could impact and potentially ease combined trips (school runs and commute), since such journeys are rarely linear and are often influenced by various factors such demographics, lifestyle, location, age of children, etc.

Business Use

Business type

Transport for Quality of Life (2019) conducted a literature review about the potential for e-cargos to reduce congestion and pollution from vans in cities on behalf of the Bicycle Association, the industry body. Growth areas for e-cargo, drawn from a paper by Maes (2018) are:

- Gig economy (e.g., Deliveroo)
- Courier services (short mile A to B transport for one client)
- UCC partners (last mile deliveries from an urban consolidation centre)
- Postal services
- As a service vehicle for plumbers, electricians, etc.
- As an in-house delivery service by flower shops, bakeries, etc.

The Bicycle Association's Last Mile Call for Evidence Response (2018) presents a case study of DHL in the Netherlands where, as of 2015, 10% of the DHL Express fleet has been replaced by cargo and e-cargos, and 60% of inner-city delivery journeys are made by cycles.

Further information regarding business types suitable for e-cargo use is presented in Section 4 of this report.

Trip length and type

Much of the literature on trip length and type focused on the potential for e-cargos and there is less evidence about how they are used at present. Studies looking at the potential for mode shift to e-cargos are based on relatively small

pilot studies across Europe such as the CycleLogistics initiative (which pooled the experience and data from e-cargo operators in seven European cities) and the LEFV-LOGIC project (five trials of Low Emission Freight Vehicles in the Netherlands, three of which involved e-cargos).

The Transport for Quality of Life report on the potential for e-cargos notes that they are most suited to dense urban areas, and those areas which have relatively high density of suitable delivery demand, or areas where trips are relatively short. These findings were synthesised from the published literature of e-cargo and draw heavily from lessons learned the CycleLogistics and LEFV-LOGIC projects. It also finds that 10-30% of trips made by delivery/service companies could be replaced by e-cargos – these figures are drawn from the two projects listed.

Narayanan et al. (2022) summarised the literature on trip types for e-cargo, stating that they can be divided into ‘service’ and ‘delivery’ trips. Service trips refer to businesses using e-cargo to bring their service to a customer’s location (e.g., tradespeople using e-cargo to transport tools). Delivery trips consist of five market segments: postal services, courier services, parcel services, home delivery services (e.g., restaurants and small retailers) and internal/on site transport (such as within a large company grounds). These findings are primarily drawn from Wrighton and Reiter (2015) evaluation of the CycleLogistics project; Gruber and Narayanan (2019) analysis of real-life cargo cycle data; and 45 expert interviews conducted by Rudolph and Gruber (2017).

Naryanan et al. (2022) found the following regarding the nature of e-cargo trips:

- E-cargo is best suited for high density areas (e.g., central business districts and historical centres) and urban morphologies of narrow streets and historic buildings. Steep gradients negatively impact e-cargo usage.
- The implementation of high-quality cycling infrastructure, shortcuts for cycles, restrictions for motor vehicles, and parking controls benefits and encourages e-cargo use.
- Maximum distance travelled per delivery ranges from 4-50km with the majority under 20km and a daily range of 80-120km travelled is observed.
- E-cargo is best suited to organisations with smaller catchments and delivering small volumes of non-heavy goods. It is particularly suited to deliveries with short time windows.

Narayanan et al. (2022) also found that total vehicle kilometres travelled could be reduced with the use of e-cargos as they are able to circumvent restrictions on motor vehicles.

A large-scale commercial pilot launched by New York City’s Department of Transport (NYC DOT, 2021) sought to understand how businesses could embed cargo and e-cargos into their business model, without negatively impacting delivery patterns, and what types of journeys were made by vans that could be replaced by cargo and e-cargos. The pilot started with three delivery companies (UPS, DHL, and Amazon) using 100 cargo and e-cargos- (although

the proportion of each is not known)– expanding to six companies and 350 cycles over time.

Some learnings can be drawn from the evaluation report of this pilot. They found that the service user or the type of trip that can easily swap to e-cargo usage is made to residential addresses – mostly to residential blocks with few or no kerb regulations. They noted that e-cargos are uniquely equipped to make these deliveries and 80% of e-cargo deliveries on the trial were to residential addresses. The trial also found that 72% of e-cargo deliveries occurred during the week, 60% were made during daytime hours (9am-5pm) and that unloading typically took five minutes or less. But the report did not compare this to unloading times and trip types of traditional modes used. Note that these figures should be understood within the context of the business models trialling them, and that the trial does not publish the broader trip types of participants. It is also necessary to consider the impact of the coronavirus pandemic on delivery trip types which potentially distorted the number of residential deliveries being made.

Substituting potential

Narayanan et al. (2022) reviewed the literature assessing the substituting potential for e-cargo and present the following findings (Table 3.1). They note that these do not include potential for service trip replacement. They found that e-cargos are ill-suited in replacing truck deliveries and car and van trips are better suited for replacement by e-cargo. However, they do not provide discussion of the reasonings of these findings.

Table 3.1: Reported replacement effect of motor vehicles by e-cargo as reported in academic literature reviewed by Narayanan et al. (2022)

Reference	Assessed Effect	Study details
Gruber et al. (2013)	66-83%	Of direct courier deliveries. Modelled substituting potential based on trip and delivery (weight/size/type) data.
Lenz and Riehle (2013)	25%	Of all freight transport at city centre. Qualitative research – surveying and in-depth interviews of industry experts.
Koning and Conway (2016)	63%	Actual e-cargo penetration of total cycle freight (103 tonne-km/day in 2001 vs 1107 tonne-km/day in 2014). Paris Study. Modelled using real world data (and therefore subject to other variables such as labour availability).

Wrighton and Reiter (2016)	17%	Based on real-world data of CycleLogistics project measuring shift from car trips (previous mode of deliveries recorded).
Melo and Baptista (2017)	10%	Freight transport in areas with maximum linear distance of 2km. Modelled using ‘microscopic traffic simulation’ for Porto (Portugal) using AIMSUN 8.1.2. model.

The NYC DOT e-cargo pilot scheme found that e-cargos can replace vans at a 2:1 or even 1:1 basis at certain points and for certain deliveries – with 20 e-cargo miles per day evenly replacing 20 van or box truck miles. As noted above these trips fulfil a specific trip type.

4. What are the determinants of e-cycle and e-cargo use? What are the barriers and motivations for use?

Key findings

E-cycles

- Key recurring motivators are listed throughout the literature relating to enjoyment, physical and mental health, ability to ride longer and faster, reduced physical effort compared to using a conventional cycle (especially when carrying heavy loads), and overcoming hilly terrain.
- The key barrier to the use of e-cycles is the high cost of purchasing an e-cycle, particularly among young people. The other main barriers are anxiety about how long the battery will remain charged, heaviness of e-cycles, maintenance, security and access to safe cycling routes.
- E-cycles also share barriers with conventional cycles such as safety concerns and a general unwillingness/lack of interest in cycling.
- Shared e-cycle schemes can give people the chance to experience an e-cycle without committing to buying one, which may lead to a decision to buy an e-cycle in future. Shared schemes also enable people to use an e-cycle on an ongoing basis without the relatively high upfront cost of purchasing an e-cycle.
- There is evidence to suggest that motivations and barriers vary according to gender and age, and also change after using or trialling an e-cycle. For example, non-users are more likely to report anxiety about charging and the weight of the cycle as barriers compared to users.

E-cargos

- The literature on e-cargo use is relatively limited. For business use, e-cargos are better suited to dense urban areas particularly those with a

historic core that may limit access for conventional delivery vehicles. They are less suited to urban areas with steep gradients because repeatedly climbing gradients shortens the range of the e-cargo.

- A barrier to use, particularly on a trial basis, is businesses not knowing how to integrate an e-cargo within their existing operations (including the economic framework) but this can be overcome as knowledge and awareness increases.
- Infrastructure may play a role in enabling greater e-cargo use. As with cycling, users are likely to be less comfortable sharing space with motor vehicles preferring segregated infrastructure, however, cycle tracks need to be wide enough to accommodate e-cargos which are often considerably wider than a conventional cycle.
- Lack of good quality parking including overnight storage and charging is perceived to be a barrier.
- Some sectors are deemed to be more suitable than others for using e-cargos. Suggested sectors include administrative, legal, advertising, medical sector (e.g. delivery of prescription medicines), food and flowers.
- For personal use, people are motivated by greater perceived safety of an e-cargo compared to a conventional cycle, for example when transporting children. The opportunity for physical activity compared to a car also encourages personal use.

Introduction

The findings are presented in two sections, firstly e-cycles and then e-cargos. The e-cycles section presents findings from Bourne et al. (2020 and unpublished 2022 follow up) since the meta-study is of such relevance to the research question. Other sources of evidence are then presented including a section specifically on shared e-cycles where evidence usefully relates to the research question. In comparison to e-cycles there is a smaller body of evidence for e-cargos, with studies tending to be smaller-scale and qualitative.

E-cycles

Motivators (meta-study by Bourne et al., 2020; 2022)

A key starting point for addressing this research question comes from two literature reviews conducted by Bourne et al. The 2020 paper is a meta-study of 76 published and unpublished articles summarising e-cycle usage patterns, purpose of use, impacts on travel behaviour and motivation for and barriers to using e-cycles. Twenty-eight of the studies looked at motivation for riding or purchasing e-cycles and 37 reported on the barriers to e-cycling, combining findings from research among users and non-users of e-cycles. Of the 28 studies featured in Bourne et al. (2020) looking at motivational factors and how these vary across demographic characteristics among existing users and non-users, the following was found:

- Purchasing an e-cycle was commonly reported in relation to overcoming barriers to conventional cycling including hilly terrain, expended effort and providing facility for longer and/or faster trips.
- Younger adults were, compared to their older counterparts, more motivated to use e-cycles due to environmental concerns and travelling costs.
- Older adults were motivated to use e-cycles as e-cycling offset their physical limitations to a certain extent and to continue to be active despite physical limitations.
- Whilst there was little coverage of gender differences, they cite the work of MacArthur et al. (2014, 2018), which finds women were more likely than men to purchase e-cycles due to hilly terrain and to ride with friends/family members.
- The motivation for e-cycling to the workplace allows more sustainable travelling and better mobility around the city.

Bourne et al. (2022) highlight an ability to carry children and shopping as important motivations for e-cycle use by younger people. Use amongst older age groups is more motivated by desire to keep fit despite physical limitations.

Bourne et al. (2020) tabulate meta findings from 43 studies on participants' reported benefits of e-cycling. The most commonly reported benefits were:

- Fun/enjoyment (21 studies)
- Ability to ride longer distances (20)
- Faster journeys (18)
- Ability to carry heavier loads (17)
- Reduced perspiration (15)
- Reduced overall effort (12)
- Ability to ride hilly terrain (12)

Other less-cited benefits related to increased feelings of safety compared to conventional cycling, health, less impact from the wind, and cost savings in comparison to car or public transport.

Barriers (meta-study by Bourne et al., 2020; 2022)

Bourne et al. (2020) identify barriers to e-cycling from 37 studies in terms of individual, social, environmental and e-cycles specific aspects. The most commonly cited barriers included:

- Range anxiety (19)
- Traffic concerns (feeling unsafe riding with motor vehicles) (17)
- Cost of e-cycle (17)
- Weight of e-cycle (17)
- Cycle security (15)
- Cycle Maintenance issues (14)

- Weather (13)
- Lack of cycling infrastructure e.g. cycle tracks (11)

Most of the barriers above relate to concerns about e-cycles specifically and environmental factors rather than individual or social issues. It appears social stigma[5], parking issues, and difficulty riding with a dead battery are relevant but secondary concerns. Interestingly, the fact that less physical effort is required to use an e-cycle compared to a conventional cycle was a deterrent to uptake amongst younger people in some studies.

It is also interesting to note that safety issues emerge across the review studies as both potential barriers and motivations for use. Some studies highlight that higher speeds allow users to keep up with traffic flow more, whereas other users worry about speed leading to increased possibilities of collision with other road users and pedestrians.

Bourne et al. (2022) highlight there is a difference in perceptions between users and non-users with non-users more concerned about weight and range than users (Simsekoglu and Knockler, 2019). Non-users were also more sceptical about the health-related benefits. The authors also highlight a number of studies where these negative perceptions are shown to reduce with use.

New evidence since Bourne et al. (2020) – barriers and motivators

Mayer (2020) investigated barriers and motivations to e-cycle usage in the USA. The study was qualitative, involving semi-structured interviews with 47 e-cycle users including seven open-ended questions relating to e-cycle motivations, benefits, and policies. The study found that:

- Key motivations for e-cycle usage were identified as including saving money, personal interest in technology, increased mobility and reduced effort, and environmental concerns.
- Key barriers to e-cycle usage were identified as general lack of cycling infrastructure, social stigma including how they would be perceived by people using conventional cycles, and fears of policy change (e.g., restrictions on the usage of e-cycles, presumably in the same way that limitations are placed on speed at present).

The two following studies were conducted in China, it is important to note that some of their findings are specific to the Chinese context and may not be entirely transferrable to the UK. It should also be noted that in China e-cycles

[5] Bourne et al. (2020) reference six studies when stating that irrespective of whether a country has high or low levels of cycling, e-cycling retains a social stigma and there is a perception that e-cycles are for lazy or overweight people. They conclude that authorities should promote cycling as a normal mode of transport – including by loaning e-cycles to people for a trial period because there is evidence (from four studies) that negative perceptions of e-cycling are reduced once people have tried it.

are primarily throttle controlled rather than pedal assisted as in the UK and are often closer to a moped than a conventional cycle.

Firstly, Hu et al. (2021) considered the impact of the built environment around residential and work locations on individuals' commute mode choices in small cities using a study based in Guanyu, China. Surveys were conducted with 459 respondents: 325 living in urban areas; 134 living in rural areas to identify factors that affect commute mode choice including by car, e-cycle, bus, conventional cycle and walking. The study found that:

- Individuals with lower incomes, and women (compared with men) were more likely to use e-cycles.
- The built environment of the end destination rather than beginning (i.e., the place of work rather than residence) had a greater impact on individual commute mode choice.
- The impact of the built environment differs in rural and urban locations. There are also differences in commuting behaviour between large and small Chinese cities. For example, residents in smaller cities have shorter commute distances with e-cycles being a popular commuting choice and buses are rarely used for short trips, whereas residents in large cities tend to use public transport and have longer commutes.

Secondly, Xin et al. (2022) examined the effect of e-cycle users' psychological characteristics and risk attitudes on e-cycle mode choices based on a case study of frequent users in Shanghai. However, any firm conclusions about mode choice preferences are difficult to make given these are existing e-cycle users in a context very different to the UK. Nonetheless, Xin et al.'s (2022) findings included:

- Increasing travel distance reduced the likelihood of using e-cycles in comparison to car or public transport, but lower income and educated groups have a higher distance tolerance.
- When travel distance was shorter than 15km, the likelihood of using e-cycles was higher than that of using car or public transport. When the distance exceeded 15km, the likelihood of using e-cycles dropped to second place behind public transport (subway in this research).
- For older (aged 40-60) e-cycle users, the likelihood of using e-cycles increased slightly as travel distance increased. This likelihood of usage was only second to the subway when the travel distance was greater than 15km. Younger users generally prefer subway. A number of other potentially important factors including purpose, departure time, comfort and safety aspects are not covered in the modelling.
- Owning a car was associated with a lower likelihood of using e-cycles.

Van den Steen et al. (2019) investigated the motivations for and barriers to using speed pedelec for commuting and the users' experience.[6] In this study, speed pedelecs are considered distinct from standard e-cycles as they travel up to 45km/h (or 28mph), far above the UK's current speed limit for e-cycles of 15.5mph. Twelve focus groups were held with 100 participants from 10 companies before the start of a speed pedelec usage trial. During the trial, all participants were asked to replace their current commuting modes with a speed pedelec for up to three weeks. The research focused on car commuters and the sample included a small number of people switching from conventional cycle, car-share or public transport. Commuters travelling 15-35km were also prioritised in the sample because speed pedelecs were perceived by the researchers to better suit longer commutes. Key findings included:

- The low maximum assisted speed of the e-cycle (rather than speed pedelec) (25km/h) was perceived as a barrier to using e-cycles for commuting, especially for those who regularly use a conventional 'racing' cycle.
- Electric components regarding the battery and the availability of nearby repair shops were also identified as barriers to using e-cycles for commuting.
- Before the trial, five motivations to using speed pedelec for commuting were identified, including high speed, increased mobility, derived physical and mental benefits, and positive environmental impacts.
- Before the trial, three barriers to using speed pedelec for commuting were identified, including the high cost of ownership of speed pedelec, safety concerns, and undesirable geographical conditions.

After the trial, some motivations and barriers to speed pedelec use changed:

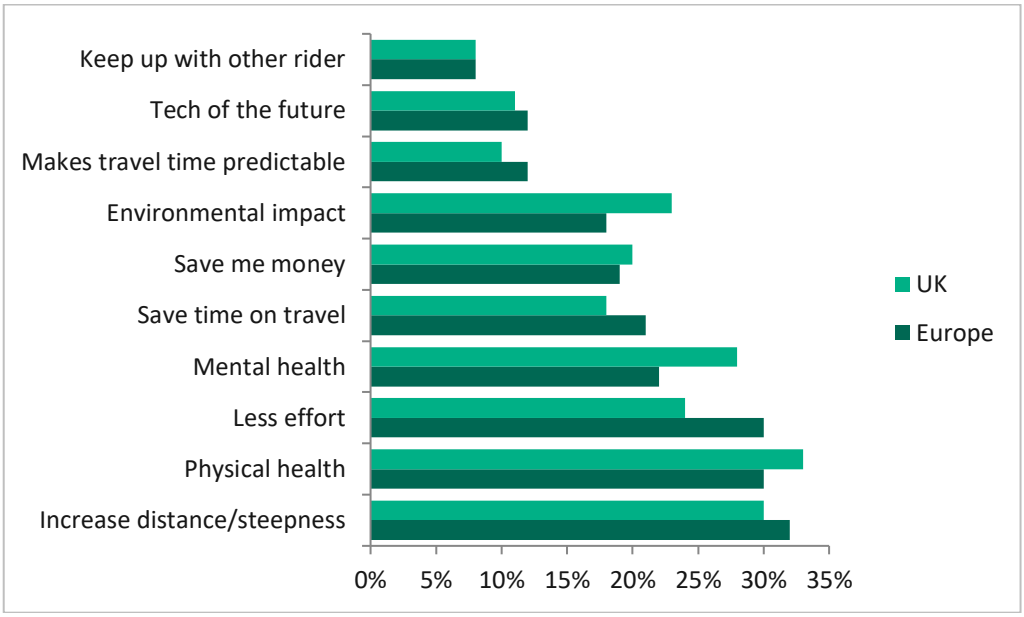
- Fewer participants had traffic safety concerns for using speed pedelec; more participants saw the derived mental health benefits as a motivator to using speed pedelec.
- The feeling of competitiveness emerged as a motivator to speed pedelec usage, with users reporting enjoying travelling faster than other road users, friends/family, as well as beating their own personal records.
- Some participants had the feeling that they were not accepted by either cyclists or cars on the cycle path or the road, respectively, which became a barrier to speed pedelec usage.

Shimano Steps, the components manufacturer, undertook research across 11 European countries and over 13,000 people, in partnership with YouGov (Shimano Steps, 2020). They found that being able to travel longer distances or

[6] Speed Pedelecs or S-Pedelec: pedelec is often the more popular term in the Dutch context for an e-cycle. S or Speed Pedelecs have a higher-powered motor and can travel up to 28mph. The distinction between pedal assisted e-cycles and electric mopeds is not always clear across different contexts. However, speed pedelecs are pedal assist are not throttle controlled. In the UK a speed pedelec is classed as a moped and requires a licence plate.

overcome steep hills is the primary perceived motivation for purchasing an e-cycle by European respondents, followed by reduced physical effort and improving physical health (Figure 4.1); among UK respondents 'physical health' was the greatest single perceived motivation.

Figure 4.1: European average and UK responses to question: 'In general what, if any, of the following reasons would make you want to buy an e-cycle' (Shimano Steps, 2020 – online survey of 13,412 European e-cycle users and non-users, size of UK sample unknown).



Shimano Steps (2020) also found a number of perceived barriers to e-cycle take up in the UK, as illustrated in table 4.1.

Table 4.1: UK average reported perceived barriers (Shimano Steps, 2020 - sample size for UK respondents unknown, total sample size across Europe 13,412)

Barrier	UK percentage
Expensive	35%
Don't like cycling	27%
Wouldn't feel safe riding	19%
Lack of safe storage at home/work	17%
Fitness wouldn't improve	16%
Don't know enough	14%
Can't store at home	13%
Cheating	11%
For older people	2%

As detailed in Table 4.2, Shimano Steps (2020) found some variance in the prevalence of barriers across age and gender, but across all groups ‘expensive’ and ‘don’t like cycling’ rank first and second. Similarly, all groups reported the same barrier as least important which is the perception that e-cycle are ‘for older people’, showing that not everyone considers e-cycles to be just for older age groups. People aged 18-24 stand out as the most different from average, ranking ‘safety’ as of lower importance than average, whereas awareness and cost standout as barriers for this age group.

Younger people are also more concerned that electrical assistance negates the benefits of cycling, ranking ‘fitness wouldn’t improve’ and ‘cheating’ higher than average among other age groups. This corroborates with the findings in the academic literature as presented by Bourne (2020).

There is also a correlation between age and e-cycle awareness: with younger people more likely to feel they ‘don’t know enough’ and older people less likely to find this to be a barrier. Women and people aged over 55 are more concerned with road safety than average. Storage issues and perception of e-cycles as being for older people have low variance amongst groups.

Table 4.2: UK responses to question "Which of the following would be a reason NOT to buy an e-bike?", Showing percentage differences from UK average by age and sex. Higher percentages reflect this group reports the barrier more frequently than the UK average (Shimano Steps, 2020 - sample size for UK respondents unknown, total sample size across Europe 13,412).

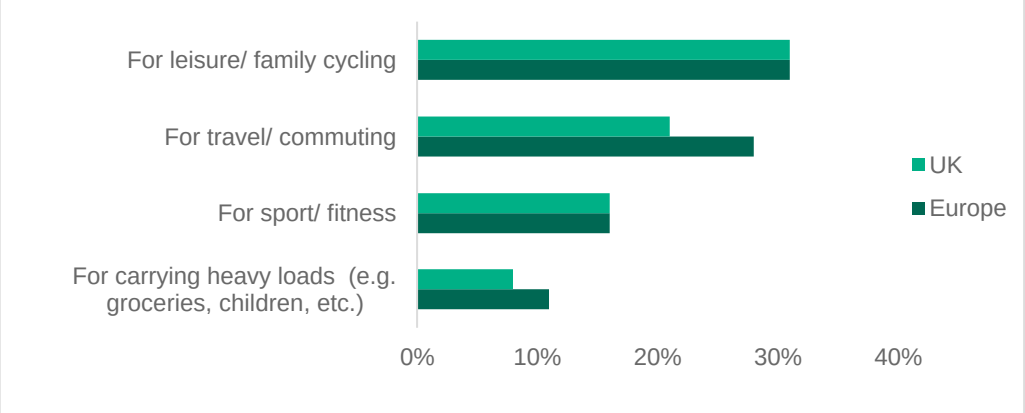
Barriers	UK average	Male	Female	18-24	25-34	35-44	45-54	55+
Expensive	35%	+3%	-3%	+8%	+5%	+2%	0%	-5%
Don’t like cycling	27%	-5%	+4%	-2%	+5%	-1%	-2%	-1%
Wouldn’t feel safe riding	19%	-3%	+3%	-7%	-1%	-5%	-1%	+4%
Lack of safe storage at home/work	17%	0%	-1%	-1%	+2%	0%	-1%	-2%
Fitness wouldn’t improve	16%	+3%	-2%	+7%	+1%	+5%	+3%	-5%
Don’t know enough	14%	-3%	+4%	+6%	+6%	+2%	-5%	-4%
Can’t store at home	13%	-1%	+1%	+1%	+2%	-3%	+1%	0%
Cheating	11%	+2%	-2%	+9%	+3%	+5%	-2%	-5%
For older people	2%	+1%	-1%	+1%	+1%	+1%	-1%	-1%

Note: the source paper (Shimano Steps, 2020) contains minimal details on data collection methodology and it is unclear whether these results are statistically significant.

An update by Shimano Steps to their 2020 paper (Shimano Steps, 2021) found that people could be motivated to use e-cycles because of concerns about

coronavirus and contagion via public transport; this was a key motivation among 39% of those interviewed.

Figure 4.2: European average and UK responses to question: "What was/would be the MAIN purpose of purchasing or using (e.g. loan, hire, rent, etc) an e-cycle?" (Shimano Steps, 2020 – online survey of 13,412 European e-cycle users and non-users, size of UK sample unknown, percentages in the source do not sum to 100).



Research conducted with 2,078 British adults and published by campaign group Bike is Best (2022) found 67% of those showing an interest in purchasing an e-cycle agreeing that the upfront cost deterred them from purchasing. The public opinion survey posed questions to respondents about what would help them to use e-cycles, including subsidised purchase and opportunities to try an e-cycle. Of those who expressed an interest in buying an e-cycle, 67% admitted that upfront costs were off putting. It also finds that the majority of those interested in buying an e-cycle would not be likely to purchase a £1000 cycle with a subsidy of £150. However, with a subsidy of £450, 74.3% of respondents stated that would be likely or very likely to do so. The report also found that 55% of respondents stated that an opportunity to test an e-cycle away from traffic, as well as receive ongoing maintenance support would be 'very' or 'fairly' important in deciding whether to buy an e-cycle. Similarly, just over 40% rated the opportunity to borrow an e-cycle for an extended period and to receive training as important to inform whether they make a purchase.[7]

Bike is Best (2022) also suggests that a lack of knowledge of e-cycles may also be a barrier to e-cycle use. Responses to questions in a survey about where to find e-cycles for sale and how to charge them suggest an information gap and need for clearer communication alongside financial incentives/trials. The survey found most people were not confident in how to purchase an e-cycle with only 8.3% of respondents stating they would know where to start looking for e-cycle.

[7] in response to the question "How important, if at all, would each of the following opportunities be in deciding whether or not you would purchase an e-cycle?".

The New York City Department of Transport's Commercial Cargo Bicycle Pilot trial scheme found there was strong interest in e-cargos in the logistics industry and a perception that they may be of benefit to businesses. However, the study found that further uptake would need to be enabled through innovative street design and kerb management tools as well as ensuring legislation is business friendly regarding e-cargo (for example, larger e-cargos were banned from using dedicated cycle lanes during the trial period).

Plazier et al. (2018) examined the advantages and barriers to uptake of e-cycles among students, commuters and people living in rural areas in the Netherlands. Their paper combined findings from previous mixed method research approaches. The findings are summarised below:

- For students they list independence, health benefits, and potential to form long-lasting habits as advantages to increasing e-cycle use among this group. Affordability was a key barrier to uptake among students/young people. Further, at current purchase prices – e-cycles can reduce travel costs only if they remove the need for other costly modes – shifting from conventional cycles, subsidised school transport, or trip-sharing with commuting caregivers – will make little to no savings.
- For commuters the need to combine activities may present a barrier or limitation to further e-cycle use for commuting - primarily lower average speeds and reducing carrying capacity compared to a car may make it difficult to combine with school drop-off/pick-up.
- For e-cycle use by people in rural areas where journey distances are typically longer and public transport provision poorer than in urban areas, the advantages of e-cycles include that longer distances can be cycled in comparison to those with a conventional cycle, which may in turn enable people to access public transport. However, while rural residents have longer average travel distances than urban residents, they also make fewer trips and may be less likely to experience congestion and delays in comparison to urban journeys. For these types of trips, the authors conclude that an e-cycle's lower speed (and therefore longer travel time) is a potential barrier to e-cycle use by car- and bus-users where there are long distances between destinations (although what constitutes a 'long distance' is not specifically qualified in the paper).

Melia et al. (2021) found – from their survey of 2,092 e-cycle users and potential users in the UK – the following themes as motivations and barriers to e-cycle usage (which largely confirm those given elsewhere in the literature). Motivations for e-cycling included personal benefits to health and wellbeing, especially as related to aging, ill health or disability; fun or exploration; improving fitness; widening transport options; environmental concerns or reducing car usage. Barriers were the relatively high initial cost of purchase; storage issues such as lack of space or security concerns; the relatively large weight of an e-cycle.

Melia et al. (2021) also considered the role of e-cycles in overcoming some of the barriers to cycling generally. The barriers to cycling of bad weather, fear of other traffic on main roads, concern about riding in the dark, vulnerable feelings at junctions and worries about social perception were the same for e-cycle users and conventional-cycle users. The barriers addressed by e-cycles were unwillingness to cycle longer distances and the wish to avoid the extra physical effort of cycling up hills.

Jones et al. (2016) present findings from a small study involving in-depth interviews with 22 e-cycle owners from the UK and the Netherlands. Participants were recruited through opportunity sampling and the small pool of participants cannot be assumed to be representative; the authors state that the sample is potentially biased towards those more pre-disposed to cycling. However, the strength of this source is in the depth of the responses gathered regarding motivations and determinants of e-cycle users. The motivations for using an e-cycle were:

- E-cycles can overcome the physical limitations of cycling brought on by older age or a health condition.
- E-cycles can enable longer journeys to be made and provide opportunities for e-cycle journeys that would not have been possible by conventional cycle.

Jones et al. (2016) found three main barriers to e-cycling among users who took part in the study:

- Technological (the e-cycle itself and equipment): relatively high initial purchase price was emphasised, as well as difficulties manoeuvring the cycle, finding models which could carry children, concern about battery performance and charging issues.
- Social (stigma and safety): a perception of stigma attached to e-cycling including that it is ‘cheating’ because less effort is required that a conventional cycle, with some users attempting to find models which did not appear to be different in appearance from conventional cycles. Users also reported finding interactions with other road users stressful e.g. other road users do not anticipate the higher speed of the e-cycle compared to a conventional cycle.
- Infrastructure: the UK participants expressed dissatisfaction with the condition of traffic infrastructure and lack of dedicated space for cycling.

Shared E-cycle Schemes

Li et al. (2021) investigated factors that affect individuals' intention to use shared e-cycles using the extended theory of planned behaviour, which assumes that individuals have deliberate control over their behaviours. Online questionnaire surveys were conducted with 751 respondents in China and their findings included:

- People tend to have a positive attitude and would use a shared e-cycle's service if it's good quality in terms of comfort, repair, and usage procedures.
- Environmental concerns had an indirect positive effect on the intention to use e-cycles through the mediation of attitudes and subjective norms. Marketing through social media appealing to people's environmental sensitivities is recommended.
- Policy support in favour of sustainable travel to restrictions on motor vehicle use had an indirect positive effect on the intention to use e-cycles through the mediation of attitudes and subjective norms.

Bieliński and Ważna (2020) investigated differences between e-cycle and e-scooter sharing systems in Tricity, Poland in terms of users' characteristics, reasons to use the system, and travel behaviour. Surveys were conducted on a random sample of 633 respondents. Respondents were asked about the reasons that discouraged them from using shared e-cycles. Results were based on descriptive analysis:

- Among users of the system, the most common reason that discouraged the use of e-cycles was the limited number of shared e-cycles provided (30%), which was followed by frequent breakdowns of the shared e-cycles (16%), owning a cycle (16%), and the long distance to shared e-cycle stations (12%).
- Among non-users, the most common reason that discouraged the use of shared e-cycles was owning a cycle (24%), which was followed by the limited number of shared e-cycle provided (18%) and frequent breakdowns of shared e-cycles (9%).

The findings of research by CoMoUK (2016, 2020, 2021), the shared mobility advocacy group in the UK, reveal some interesting links to the wider uptake of e-cycles. The 2016 report from their Shared Electric Bike Programme, involving 39 cycle share projects in the UK, concluded that shared e-cycles helped to overcome certain barriers that are present in conventional cycling and private e-cycle ownership:

- Cost of buying an e-cycle: overcome by the pay-to-use model of shared e-cycle schemes.
- Physical effort of cycling (perceived and real): overcome by electric pedal-assistance.
- Cycle maintenance and repair: overcome as user not responsible for care of shared e-cycle.

E-cargos

There was less evidence on the determinants, barriers and motivators to e-cargo use especially in relation to the personal use of e-cargos. Most of the evidence is drawn from smaller and/or qualitative studies among businesses. There is limited evidence about the UK context, a key UK paper being a report

by Nestrans, the transport partnership of Aberdeen city and county, into a small-scale e-cargo pilot in Aberdeen (described later in this section).

Business use

Narayanan and Antoniou (2021) undertook a meta-study on e-cargos and identified 26 influencing factors of e-cargo use by businesses which they group into six categories described below. The meta-study consisted of studies using the following methods: surveys, workshops and interviews; trials and pilots; stimulations; review papers and optimisation programming. The literature on e-cargos is relatively limited and these findings should be read in that context.

Operational

- E-cargos are suited for areas with dense population and commercial activity (Choubassi et al. 2016; Navarro et al. 2016; Niels et al. 2018; Oliveira et al. 2017; Schliwa et al. 2015).
- E-cargos are less preferred by organisations with a larger catchment area of commercial trips (Narayanan et al. 2022).
- E-cargos are suited to small volumes of non-heavy goods (Lenz and Riehle, 2013).

Vehicular

- Technical shortcoming can affect user acceptance, such as weak motors or technical malfunctions of engines and batteries (Heinrich et al. 2016).
- Purchase price and electric range are important conflicting factors – with longer electric range preferred, but with this coming at a higher purchase price (Gruber et al. 2014 and Gruber and Kihm, 2016).
- Availability of weather protection supports use, but it is unclear whether this refers to protection of the goods or rider (Faxér et al. 2018).

Infrastructural

- Better cycling infrastructure required to support uptake, with sources reporting users being uncomfortable sharing roads with cars (Faxér et al. 2018; Rudolph and Gruber, 2017). E-cargo cycles also require wider cycle lanes than conventional cycles.
- Implementation of shortcuts for cycles also supports e-cargo uptake (Narayanan et al. 2022).
- E-cargos are more suited to urban areas with narrow streets and historical buildings because of their smaller size compared to conventional delivery vans or lorries but are less suited to areas with steep gradients because repeatedly climbing gradients shortens the range of the e-cargo (Schliwa et al. 2015; Oliveira et al. 2017; Rudolph and Gruber, 2017).

- Lack of good quality parking including overnight storage and charging is perceived to be a barrier (Faxér et al. 2018; Nocerino et al. 2016).

Workforce

- Increasing age and income, and lower educational level found to negatively influence e-cargo willingness by messengers (freelancers contracted on commission using private vehicles) (Gruber et al. 2014; Gruber and Kihm, 2016).

Organisational

- E-cargos can be suitable for: administrative sphere (letters/parcels, under time pressure); legal industry; advertisement sector; medical sector (e.g., delivery of prescription medicines); food; and flowers shops (Maes and Vanelslander, 2012). This is largely based on research with seven stakeholders within Flanders and Brussels 'messenger' industry.
- Organisations perceiving higher operational benefits such as accessibility, flexible parking, and travel time reliability are more likely to purchase e-cargo. Organisations can also be motivated by the perception of 'soft benefits' (e.g., better image, higher enjoyment, improved employee health and achieving corporate environment goals) Maes and Vanelslander, 2012; Choubassi et al. 2016; Nocerino et al. 2016; Narayanan et al. 2022).
- Users of e-cargos reported to face fewer conflicts/issues with people around while carrying out unloading activities compared to lorry drivers (Moolenburgh et al. 2019).[8]

Policy

- A major factor influencing shift from conventional vehicles to e-cargo is implementation of conventional vehicle access restrictions (Choubassi et al. 2016; Lenz and Riehle, 2013; Narayanan et al. 2022; Navarro et al. 2016).
- Parking policy for conventional vehicles similarly influences uptake – such as higher parking fines for conventional modes or parking restrictions (Choubassi et al. 2016; Lenz and Riehle, 2013).
- Lack of perception of e-cargo cycles as suitable, lack of information, and positive relationship between e-cargo cycle use and the perception of existing information as sufficient suggests a knowledge gap hindering uptake (Lenz and Riehle, 2013; Schliwa et al. 2015; Gruber et al. 2014).
- Owners of small business perceive switching away from conventional motor vehicles as a perceived sign of commercial failure, whereas larger

[8] Research is based on seven Dutch case studies of businesses using Light Electric Freight Vehicles ranging from e-cargos to small electric distribution vehicles (small electric vans with loading capacities of 200-750kg and vehicle weights up to 1000kg).

businesses and start-ups are less concerned (Wrighton and Reiter, 2016 – German Cyclelogistics trial focus group).

Additional evidence about barriers and motivators for business use of e-cargos

The Bicycle Association's Response to the Department for Transport's call for evidence on 'Last Mile' deliveries (2018) drew on qualitative information gathered from among its members, and identified the following as key industry barriers to further take-up of e-cargo:

- Lack of awareness and research to prove their potential and justify investment.
- Initial cost of e-cargos (especially for small businesses).
- Economic framework whereby externalities of higher-impact modes are not borne by operators e.g. the costs of higher emissions and air quality impacts are not passed in full back to the operator.
- Market distortions from other vehicles (e.g. subsidies for other logistics vehicles such as electric vans or cars but not for e-cargo cycles).
- Other issues including lack of cycle lanes and road design, pavement parking, and lack of current 'ecosystem' of support, training, and expertise.

Nestrans's E-Cargo Bike Trial Status Report (2020) into a small-scale trial using six e-cargos by businesses in Aberdeenshire. It was based on a two-front-wheeled cargo trike as well as a 'bakfiets' style cycle which is similar to a conventional e-cycle though elongated. They had anticipated that unfamiliarity with e-cargos would be a barrier to uptake. However, Nestrans found that users quickly adapted to use of the trike, and instead found that the additional storage requirements of the longer cycle were a more significant barrier than unfamiliarity with how to use the cycle.

Dybdalen and Ryeng (2021) investigated the challenges and obstacles faced by e-cargos on winter roads in Norway based on tracking and seven interviews of cargo cyclists. Unsurprisingly snow and ice were found to hinder e-cargo operations (though it is unclear whether this was because it is harder to ride in wintry conditions per se or because lower temperatures reduced battery life). E-cargos with highly durable parts, larger wheels, suitable clothing for riders and good route planning were found to help mitigate the impacts of wintry conditions and the researchers concluded urban delivery is feasible on winter roads. In general, the UK experiences winters that are less harsh than Norwegian winters so it is reasonable to expect the challenges of winter e-cargo use could be overcome at least as easily as in Norway.

Lui et al. (2020) explored factors that affected cargo cycle users' route choices in two case study areas of Amsterdam and Stockholm. The volume of heavy vehicles in traffic was the most important route choice consideration with users preferring routes with fewer heavy vehicles. Other important considerations

included type of road, smoothness of surface and car traffic volume. Other findings included route barriers posed by segregated cycle paths with heavy cycle traffic in Stockholm (along which it may be challenging to ride a large e-cargo cycle) and the frequency of traffic lights in Amsterdam (though it is unclear if this barrier is specific to e-cargos compared to other modes).

Faxer et al. (2018) explored the potential of four-wheeled cargo pedelecs through qualitative analysis of a scheme providing such vehicles to four logistics firms for employees' use. Limited parking space, safety concerns, and handling emerged as barriers to use. Employees could also use the e-cargos for personal trips and the study found they were used for carrying children. Integration into an existing delivery schedule was found to be challenging, largely it appears because of lack of familiarity with the capabilities of an e-cargo and it is unclear from the research whether this challenge could be overcome over time as operatives' familiarity with e-cargos increases.

Hess and Schubert (2019) investigated the perceived barriers of using e-cargos in Switzerland by researching a shared e-cargo scheme, comparing survey responses by scheme members and non-members. Good access to alternative modes providing an equal or similar service and poor sharing-support services were the most important inhibitors of use. For uninterested non-members of the shared e-cargo scheme, safety concerns, sharing support and the relatively large size of e-cargos were barriers.

Personal use of e-cargos

Thomas (2021) looked at family use of e-cycles and e-cargos in the San Francisco Bay area, involving interviews with 20 parents/caretakers, of which 13 used e-cargos. E-cargos were seen as helping overcome safety fears particularly among women on account of the size of the e-cargo, which gave them greater confidence. Finding somewhere large and secure enough to park an e-cargo emerged as a key barrier. There were further general findings regarding motivational factors including getting exercise (compared to using a car), and in comparison to a conventional cycle, the greater ease of cycling with the weight of children on board.

5. What additional evidence exists on the effectiveness of measures to increase e-cycle/e-cargo use?

Key findings

- New evidence (identified as part of this review) is generally consistent with the existing literature. In particular, there was consistency in the identified barriers of cost of purchasing, cycling infrastructure and concerns around security of e-cycles in terms of risk of theft while unattended. However, as with other studies, there was mixed evidence of mode-shift, with some studies finding a reduction in car use and others finding people were more likely to shift from bus to e-cycle.
- Three new studies were identified. One examined a university e-cycle sharing scheme trial in the USA, another considered a Polish e-cycle sharing scheme, and the third study looked at a small e-cycle loan scheme in the Netherlands.
- The USA e-cycle sharing study showed an increase in awareness of e-cycles between the pre- and post-trial surveys.
- Evidence from the Polish scheme suggests that participants switched predominantly from public transport to e-cycles, with heavy car users least likely to switch to e-cycles. Those with privately owned conventional cycles were less likely to switch to a shared e-cycle. Continued use was higher among those without access to a cycle, and for those who would reduce their journey times by using an e-cycle to avoid traffic congestion.
- Findings from the Dutch small-scale e-cycle loan pilot at a university aimed at staff and students, found evidence for mode shift from car to e-cycles (and conventional cycles).
- No new UK studies were found, so comparability with the UK context may be limited.

Introduction

The purpose of this section of the report is to present new evidence about the effectiveness of trial schemes aimed at increasing the use of e-cycles. Due to a recent rapid evidence assessment focusing specifically on the effectiveness of trial schemes, this research question returned the smallest quantity of new research. The following section presents an overview of the Behavioural Impacts of E-cycle Trials: A Rapid Evidence Assessment (2021), which represents recent academic literature seeking to understand the effectiveness of measures to increase the use of e-cycles. These section after that summarises three studies published since the 2021 REA was undertaken.

Overview of the 2021 study

The 2021 study reviewed evidence from trials or pilots of e-cycles numbering around 40 studies of which 20 were focused on in-depth and were published between 2015 and 2021. Findings from a selection of the pertinent research questions addressed in this study are presented. This document of more recent literature has sought to establish whether there are additional contributions to these findings, but does not repeat the findings from the original REA.

Findings from new evidence

The three peer reviewed studies can be considered individually as they cover different aspects. In the first, Handy et al. (2022) examine a university e-cycle sharing scheme at Davis, USA. The 513 study participants were a sample of university employees and students who were asked about their awareness of the e-cycle scheme. The study involved three waves of surveys, one survey conducted six months before the introduction of the scheme and two surveys respectively conducted six and eighteen months after the introduction of the scheme. The findings showed an increase in awareness of e-cycles from 43% pre-trial up to 75% 18 months later and an increase in participants considering an e-cycle as a viable commute mode increased from 20% pre-trial to 30% post-trial. Detail on the statistical significance of these findings was unavailable. Highest levels of awareness were observed for USA-born graduates. Lower levels of awareness were found for women pre-trial although not post-trial. Higher levels of awareness changes were observed for less confident cyclists, but increases were independent of travel attitudes.

Bielinski et al., (2021) also examine e-cycle sharing schemes, focusing on self-reported usage during a scheme based in the Tricity region of Poland (Gdańsk, Gdynia, and Sopot). Usage was monitored through pre- and post-scheme surveys. Participants reported that they switched predominantly from public transport, with heavy car users least likely to switch to e-cycles. The study also found that those currently using predominantly privately owned conventional cycles were less likely to switch to a shared e-cycle. The likelihood of continuing to use a shared e-cycle was higher among those without access to a

cycle, and for those who would reduce their journey times by using an e-cycle to avoid traffic congestion. As an aside, it is notable that the presence of hills was a key factor in discouraging cycling in general.

Ton et al. (2021) report findings from a small-scale e-cycle loan pilot at a Dutch university, aimed at staff and students. In contrast to Bielinski et al. (2021), this study found mode shift from car to e-cycles (and conventional cycles) as a commuting mode to university. Among the 82 participants, car use fell from 88% to 63% and 24% of participants purchased an e-cycle within three months of the pilot. While it is a small study within a university setting that is unlikely to be typical of the UK population, the findings hint at the potential of e-cycle trial schemes to change travel behaviour, notably:

- The most important variables behind a decrease in car use after the trial were firstly the purchase of an e-cycle, secondly improved perception of the safety of e-cycles and thirdly participants' own willingness to change behaviour.
- E-cycle loan participants were encouraged by their experience and while they didn't continue to use an e-cycle they did use a conventional cycle more (use of conventional cycles increased from 5% to 12% after the intervention.
- Participants said that the relatively high cost of purchase was the main reason for not buying an e-cycle and that future pilot programmes could investigate the impact of helping people to purchase an e-cycle incrementally.

6. Evidence gaps

Table 6.1: Evidence gaps from this Rapid Evidence Assessment

Research area	Details of gap	Outcomes of research
The impact of financial incentives on different demographics across the UK.	The REA present findings that young people find cost to be a particular barrier to e-cycle uptake while also showing high levels of interest and opportunity for growth. Young people are also interested in e-cargos, which are often the most expensive models of e-cycles. This REA returned only broad information on this topic, and further research could provide more details on how best to overcome the barrier posed by cost. Further research into non-UK contexts may also reveal lessons learned from different models of financial incentives as there are more examples of financial incentivisation of e-cycle use outside of the UK.	Research into the success of different financial incentives may allow for the future removal of barriers to high potential growth demographics. It may also be valuable to research alternative models of e-cycle provision that mitigate cost as a barrier (e.g. shared-ownership, or leasing/subscription).
More granular information regarding trip types for e-cycles and e-cargos for personal use.	Further information is required regarding trip types. This REA returned information classifying trips into broad categories such as 'leisure.' This subject could benefit from more qualitative research into trips to provide more detailed information about e-cycle and e-cargo trips. For example, the potential for e-cargo to replace 'school run' trips for primary school aged children could be explored in more depth – understanding in detail the barriers to uptake such as complex or combined trips (i.e. with morning commute) – this has been highlighted as a potential barrier in the research reviewed.	More precise information regarding trip types and purposes will allow for a more accurate understanding of the substitution potential of e-cycles and e-cargo and targeting of interventions to increase uptake.

	Research could also look at potential e-cycle trips, such as by using the Propensity to Cycle Tool, and not just those already made by e-cycle.	
Research into the different substituting potential of e-cycles by geography.	This REA finds that both e-cycles and e-cargo could have varying substituting potentials in different locations. E-cycles have been shown to replace more car trips in locations that have low current cycling levels. More research is needed to understand how this should focus policy and interventions to increase uptake, for example understanding which locations with low levels of cycling have sufficient e-cycling potential to warrant an intervention.	Research undertaken to understand areas with a high substitution potential will reveal target areas for future pilots.
Research to fill gaps regarding e-cycle and e-cargo usage amongst specific demographics across the UK.	This REA found minimal information regarding actual e-cycle and e-cargo usage as well as barriers/ motivations/ determinants across the following demographic areas: Disability and physical fitness level Race, religion, and belief Socio-demographic and financial status Rural geographies This REA did find evidence regarding demographics of sex and age, but some of this was people's stated intentions and some was from studies with sample sizes that did not enable statistically significant conclusions to be made. Information regarding e-cargo for personal use against all these demographics is especially limited.	More detailed information regarding these demographics may allow for broader engagement with potential e-cycle users and help to overcome barriers to e-cycling, as well as the use of e-cycles to overcome barriers present in conventional cycling. Research into e-cargo use as well as barriers/determinants for different demographics is required to facilitate broader uptake. For example, research into the affordability of e-cargo usage compared to other modes amongst low-income households may be fruitful in encouraging uptake and removing of barriers.
Further research into different methods for outreach to broaden e-cycle awareness and maximise engagement with pilots.	This REA finds that pool cycles and cycle share schemes attract a broader demographic than conventional cycles. However, further research could help to understand whether any demographic groups are being left behind by the use of technology involved, and determine which approaches are best for encouraging and enabling increased use among different demographic groups.	This research would help to focus engagement with participants in future interventions to enable and encourage use e-cycles and e-cargos.
Research into suitable locations for e-cargo trials.	E-cargo has been shown to have higher take-up among businesses in locations with dense urban areas and infrastructure that deprioritises the movement of motor vehicles. An evidence gap exists to tailor this information to the UK setting and	This research may help to direct plans to implement e-cargo usage at scale and allow for focused application of resources.

	assess which UK locations may best support a higher substitution of motor vehicle trips.	
The e-cargo impacts of within-trial measures vs external factors/measures.	The REA revealed that e-cargo uptake for business may be heavily dependent upon factors external to trials such as cycling infrastructure, how externalities of high impact modes are returned to businesses, legislative changes, and whether any current or planned measures can make businesses question their ongoing usage of motor vehicles. Further research is required to assess whether trials which provide financial support, advice/knowledge, or e-cargo loans can be effective without changes to these other factors.	This research may inform the rollout of commercial e-cargos at scale and determine best application of resources.
The potential within “closed communities” such as universities. As well as into different residential environments more broadly.	This REA returned evidence that there may be potential for growth amongst closed communities such as universities (CoMoUK, 2016). But further research is needed to facilitate usage as presence alone may not be enough (Go-Ebike, 2018). In the example of university accommodation residents may share similar demographics, similar destinations, and are connected through shared institutions. This may create streamlined channels for engagement.	Research into closed communities may provide a productive area for directing future trials.

Appendices

Appendix A: References

Reference	Methods	Study aims	Context
Selvabaskar, S.S., Anushan, C.S.A. and Alamelu, R.A., 2015. 'Preference of e-Bike by Women in India–a Niche Market for Auto Manufacturers'.	• Questionnaire surveys were conducted with 1100 residents in Madurai. • Chi-square analysis on respondents' ranks for the factors (8 factors in total) that induced them to buy e-cycles.	The study aimed to investigate the awareness level of e-cycles, factors influencing the preference for e-cycles, and satisfaction with e-cycle use amongst residents in Madurai.	Madurai, India
Bicycle Association, 2018. 'Response to The Last Mile A call for evidence'.	Study commissioned to look into the potential for e-cycle cargo use for freight/business. Uses data provided by the UK Cycle Logistics Federation - however notes that the quantitative data provided by the federation is limited due to low levels of e-cargo use in the UK. Therefore, also relies on data provided by Transport for Quality of Life.	Aims to demonstrate the potential of e-cargos for last mile goods delivery.	UK wide
Bieliński, T. and Ważna, A., 2020. 'Electric scooter sharing and bike sharing user behaviour and characteristics'. Sustainability, 12(22), p.9640.	• Questionnaire surveys were conducted on a random sample of 633 respondents. • Respondents were asked about the reasons that discouraged them from using shared e-cycles. • Descriptive analyses on the percentage of people choosing the reasons that discouraged them from using shared e-cycles.	The study aimed to investigate the differences between e-cycle and e-scooter sharing systems in terms of users' characteristics, reasons to use the system, and travel behaviour.	Tricity, Poland
Bieliński, T., Kwapisz, A. and Ważna, A., 2021. 'Electric bike-sharing services mode substitution for driving, public transit, and cycling'. Transportation	• E-cycle share scheme. • 488 participants • Before and after surveys were conducted. • Data were analysed using descriptive analyses and double-hurdle models.	• The study looked to understand the factors correlated with the use of e-cycle share systems. • Note. Participants	Tricity, Poland

research part D: transport and environment, 96.		in the survey before the trial were recruited from a random sample, but only 23% of these participants took part in the survey after the trial.	
Bike is Best, 2022. 'Achieving our E-bike potential'.	Report published by lobby group Bike is Best, developed in partnership with the University of Westminster. Consists of a review of academic and policy literature, use of the Propensity to Cycle tool, and a new public opinion survey on attitudes to e-cycles. Within this source it is the literature review and primary research survey that are of greatest interest to this REA. The primary aim of this report is as a piece of cycling advocacy and to advise policy makers. Polling was conducted by YouGov, conducted Jan 2022, included 2078 adults and is weight to be representative of all GB adults.	Aims to present findings on e-cycle potential to encourage further uptake and inform policy change. Bike is Best advocate for better provisions for cycling as well as cycling behaviour change.	UK wide
Boterman, W.R., 2020. 'Carrying class and gender: Cargo bikes as symbolic markers of egalitarian gender roles of urban middle classes in Dutch inner cities'. Social & Cultural Geography, 21(2), pp.245-264.	A qualitative content analysis of Dutch national newspapers reporting on or discussing cargo-cycle usage by parents. Findings which are relevant to this REA regard the perception of the use of cargo cycles by parents in a context where their use is already prevalent.	Aims to show that e-cargo cycles are a symbol of the way middle-class parents challenge and negotiate dominant norms regarding parenthood	Netherlands
Bourne, J.E., Cooper, A.R., Kelly, P., Kinnear, F.J., England, C., Leary, S. and Page, A., 2020. 'The impact of e-cycling on travel behaviour: A scoping review'. Journal of transport & health, 19, p.100910.	• A scoping review was conducted. Using five-stage methodological framework to screen sources from an initial 2841 records. • 28 studies on the motivation for riding or purchasing e-cycles. • 37 studies on the barriers to e-cycling Of the studies review 48 were peer-reviewed research papers and 28 were drawn from grey literature. The studies are to be considered of good quality.	The study is a scoping review aimed at summarising the knowledge of e-cycle usage patterns, the purpose of using e-cycles, the impact of using e-cycles on travel behaviour, and the motivation for and barrier to using e-cycles	Not limited by geographic scope, but largest source of literature was from Germany and 80% originated in Europe.
Cherry, C. and Cervero, R., 2007. 'Use characteristics and mode choice behavior of electric bike users in China.' Transport policy, 14(3), pp.247-257.	• Travel diary surveys were conducted with conventional cycle, e-cycle, and liquefied petroleum gas (LPG) scooter users. • The number of respondents was 1198 (696 in Shanghai and 502 in Kunming). • The surveys contained two parts: (1) a travel diary for the previous day's travel; and (2) information about respondents' socioeconomic characteristics and attitudes. Descriptive analyses on the percentage of people choosing the	The study aimed to investigate e-cycle users' characteristics, their reason to adopt e-cycles, and the factors influencing e-cycle travelling in China.	Kunming and Shanghai, China

	reasons for adopting e-cycles. • Binomial logit models were conducted to explore factors influencing mode choices between e-cycles and conventional cycles.		
CoMoUK, 2020. 'Annual Bike Share Report' and CoMoUK, 2021. 'Annual Bike Share Report'	Reports findings from 39 shared cycle schemes across the UK with a total of 22,000+ cycles. 9 of these schemes offer both conventional and e-cycles, and 12 schemes offer e-cycles only. The report provides information regarding demographics, trips, and user preferences. For this report only information specific to e-cycles is used.	The annual cycle share report is "a key tool for understanding the performance and impacts of the UK's cycle share schemes" and aims to inform relevant stakeholders and policy makers to continue to build on progress of existing cycle share schemes.	UK wide
CoMoUK, 2016. 'Shared Electric Bike Programme Report'.	Results are drawn from 12-month sampling period of 188 e-cycles provided, 2,600 users, and 11,000 journeys made. Data was collected in the following ways: regular management reports, monthly hire data, GPS trackers, rider surveys. Presents findings that: e-cycles attract new users, attracts a wider demographic, enables those with health difficulties, improves health and well-being, enables new trips, reduces journey times, enables hillier trips, amongst other findings.	Aimed to understand how dual factors of electric assistance and easy access to pay-by-the-hour shared provision influences uptake of cycling. Also to understand who uses e-cycles and for what journeys.	UK wide
Department for Transport. 2021. 'Transport and Transport Technology Public Attitudes Tracker' (Wave 7 and Wave 8).	Dft report on attitudes and awareness of various transport technologies. Data gathered by surveying a representative sample of 3,219 adults aged 16+ across England.	To inform decision makers and stakeholders on public awareness of various transport technologies.	UK wide
Dybdalen, Å. and Ryeng, E.O., 2021. 'Understanding how to ensure efficient operation of cargo bikes on winter roads'. Research in Transportation Business & Management, p.100652.	Quantitative analysis: • The study used observations of GPS-tracking of a cargo cyclist, who worked for a logistics company, during their working hours. • The cargo cycle used was a four-wheel cargo cycle equipped with studded tires. • The observations were conducted on 6 different days in winter and spring. Qualitative analysis: • Seven qualitative interviews were conducted with cargo cyclists from 5 different Norwegian cities and the 3 different logistic companies.	The study aimed to investigate what challenges and obstacles are cargo cycle facing on winter roads.	Norway
Faxér, A.Y., Olausson, E., Olsson, L., Smith, G. and Pettersson, S., 2018. 'Electric cargo bike with a twist.'	• Four-wheeled cargo pedelecs (FWCP) were provided to 4 organisations for their employees to use. • Semi-structured interviews were	This study aims to explore e-cargos' potential to replace car use.	Gothenburg, Sweden

	conducted with 10 FWCP users from the focused organisations.		
Gruber, J., Kihm, A. and Lenz, B., 2014. 'A new vehicle for urban freight? An ex-ante evaluation of electric cargo bikes in courier services.' Research in Transportation Business & Management, 11, pp.53-62.	• Surveys with 590 bike/car messengers of courier companies on their willingness to use e-cargo bikes for their daily courier job.	This study aimed to look into the potential market for e-cargos, messengers' perceptions of e-cargo bikes, and factors that affect messengers' willingness to use e-cargos.	Berlin, Germany
Handy, S.L. and Fitch, D.T., 2022. 'Can an e-bike share system increase awareness and consideration of e-bikes as a commute mode? Results from a natural experiment.' International Journal of Sustainable Transportation, 16(1), pp.34-44.	• E-cycle share scheme. • This is a longitudinal study that involves three waves of surveys. Sample size of 513 participants • The three waves of surveys contained one survey conducted 6 months before the introduction of the cycle share system and two surveys respectively conducted 6 and 18 months after the introduction of cycle share system. • The surveys focused on the awareness of e-cycles and the consideration of e-cycles as a commute mode amongst the university employees who lived in Davis and drove to the campus. • The awareness of e-cycles was measured by a question 'Do you know what an electric-assist bicycle is? They are also known as "e-cycles'. • Only those who were aware of e-cycles were asked about their consideration of e-cycles as a commute mode. • Not all participants took part in each of the surveys. • The study used repeated cross-sectional analyses. • Responses were analysed using descriptive analyses and a Bayesian analysis framework.	• The study aimed to examine the impact of an e-cycle share system on the awareness and consideration of e-cycles as a commute mode. • Participants were university employees (faculty, staff, and graduate students) who lived in Davis, drove to campus, and were able to cycle. • The e-cycle share was dockless or free-floating.	City of Davis, USA.
He, M., He, M., Dong, R., & Hou, Y. 2009. 'Competitive Mode Choice Behavior between E-Bike and Bike Based on Discrete Choice Model.' In International Conference on Transportation Engineering. p. 1760-1765.	• Questionnaire surveys were conducted with 502 respondents (303 e-cycle users and 199 conventional cycle users). • The survey included respondents' socioeconomic characteristics and the characteristics of several e-cycle/cycle trips made by each respondent. • 1210 trip records were collected	The study aimed to investigate factors that affect mode choices between e-cycles and conventional cycles.	Kunming, China

He, M., He, M., Yang, X., & Zhao, Q. 2011. 'Measuring the Impact of Latent Variables on Mode Choice Behavior between Bike and Electric Bike'. In Advanced Materials Research (Vol. 255, pp. 4075-4079). Trans Tech Publications Ltd.	• Questionnaire surveys were conducted with 266 respondents who used e-cycles or conventional cycles. • The survey included respondents' socioeconomic characteristics, the characteristics of an e-cycle/cycle trip made by each respondent, and the respondents' preference taste regarding travelling. • Discrete choice models.	The study aimed to investigate factors that affect mode choices between e-cycles and conventional cycles.	Kunming, China
Hess, A. K., & Schubert, I. 2019. 'Functional perceptions, barriers, and demographics concerning e-cargo bike sharing in Switzerland'. Transportation research part D: transport and environment, 71, 153-168.	• Online surveys were conducted with 192 registered members of a shared e-cargo scheme and 109 non-members. • The survey collected information on participants' socioeconomic characteristics and the usage of shared e-cargos. • The surveys used open-ended questions to assess barriers to using shared e-cargos.	The study aimed to investigate perceived barriers of using shared e-cargos.	Basel, Switzerland
Hu, Y., Ettema, D., & Sobhani, A. 2021. 'To e-bike or not to e-bike? A study of the impact of the built environment on commute mode choice in a small Chinese city.' Journal of Transport and Land Use, 14(1), 479-497.	• Questionnaire surveys were conducted with 459 respondents (325 living in urban areas; 134 living in rural areas). • The surveys contained information on individuals' socioeconomic characteristics as well as the location of individuals' residences and workplaces. • Built environment data were acquired from the map of Guyuan city and satellite map images. • The trip time between locations was acquired from Gaode Map. • A nested logit model was used to identify factors that affect commute mode choice. • The nested logit model considered 5 modes, namely, car, e-cycle, bus, conventional cycle, walk.	The study aimed to investigate the impact of the built environment around residential and work locations on individuals' commute mode choices in small cities.	Guanyu, China
Lee, A., Molin, E., Maat, K., & Sierzchula, W. 2015. 'Electric bicycle use and mode choice in the Netherlands'. Transportation Research Record, 2520(1), 1-7.	• Surveys were conducted with 217 e-cycle users. • The survey included questions on the reason for e-cycle use. • Descriptive analyses on the percentage of people choosing the reasons for adopting e-cycles.	The study aimed to investigate e-cycle users' characteristics, their reason to adopt e-cycles, and the mode they substituted by e-cycles.	Netherlands
Li, J., Shen, J., & Jia, B. 2021. 'Exploring Intention to Use Shared Electric Bicycles by the Extended Theory of Planned Behavior'. Sustainability, 13(8), 4137.	• Online questionnaire surveys were conducted with 751 respondents. • The surveys contained two parts: (1) individuals' socioeconomic characteristics; and (2) the extended theory of planned behaviour scale that included 6 types of elements. • Structural equation modelling.	The study aimed to investigate factors that affect individuals' intention to use shared e-cycles using the extended theory of planned behaviour.	Meizhou, China

Li, L., Zhu, B., Jiang, M., Cai, X., Lau, A. K., & Shin, G. C. 2020. 'The role of service quality and perceived behavioral control in shared electric bicycle in China: Does residual effects of past behavior matters?'. Environmental Science and Pollution Research, 27(19), 24518-24530.	• Online questionnaire surveys were conducted with 503 respondents who had experience with e-cycles. • The surveys contained two parts: (1) individuals' socioeconomic characteristics; and (2) the extended theory of planned behaviour scale that included 7 types of elements. • Partial least sequenced structural equation modelling.	The study aimed to investigate factors that affect individuals' intention to use shared e-cycles and the behaviour of using shared e-cycles based on the extended theory of planned behaviour.	31 provinces in China
Lin, X., Wells, P., & Sovacool, B. K. 2017. 'Benign mobility? Electric bicycles, sustainable transport consumption behaviour and socio-technical transitions in Nanjing, China'. Transportation research part A: policy and practice, 103, 223-234.	• Intercept surveys were conducted with 403 e-cycler users. Descriptive analyses on the percentage of people choosing the reasons for adopting e-cycles. • Logit regressions were used to analyse the relationship between mode choices and e-cycle adoption reasons	The study aimed to investigate the patterns of modal transitions to e-cycles and the reason that drove such transitions.	Nanjing, China
Liu, G., Nello-Deakin, S., te Brömmelstroet, M., & Yamamoto, Y. 2020. 'What makes a good cargo bike route? Perspectives from users and planners'. American Journal of Economics and Sociology, 79(3), 941-965.	Quantitative analysis: • Online surveys on the stated preferences of 327 cargo cycle users' general route preferences. Qualitative analysis: • Semi-structured interviews with 11 cargo cycle users on the information about cargo cycle usage, route choice preference, and preference between cargo cycles and conventional cycles.	The study aimed to explore factors that affected cargo cycle users' route choices.	Amsterdam, Netherlands ; Stockholm, Sweden
Liu, Y., Ji, Y., Liu, Q., He, M., & Ma, X. 2017. 'Investigating electric bicycles as a travel mode choice for escorting children to school: a case study in Kunming, China'. Transportation research record, 2634(1), 8-16.	• One-day travel diary surveys with 497 households. • Multinomial logit models.	The study aimed to explore how space–time constraints between parents and their children affect travel mode decisions between cars and e-cycles for escorting trips.	Kunming, China
Maes, J., Vanelslander, T. 2012. 'The use of bicycle messengers in the logistics chain, concepts further revised.', Procedia - Social and Behavioural Sciences 39 (2012), 409-423.	• Literature review • A market study of the Belgian bike couriers including surveys (sample size unknown) and round tables discussions with seven bike couriers	The paper explores the use of bicycle messengers as a sustainable transport alternative in the modern logistic chain.	Belgium
Mayer, A. 2020. 'Motivations and barriers to electric bike use in the USA: Views from online forum participants'. International Journal of Urban Sustainable Development, 12(2), 160-168.	• Qualitative approaches • Semi-structured interviews were conducted with 47 e-cycle users. • The interviews included 7 open-ended questions relating to e-cycle motivations, benefits, and policies.	The study aimed to investigate barriers and motivations to e-cycle usage.	USA

Melia, S. and Bartle, C. 2021. 'Who uses e-bikes in the UK and why?', International Journal of Sustainable Transportation.	• Quantitative survey with 2,092 e-cycle users and potential users obtained via online channels • A non-probabilistic sampling approach • Ten respondents (from the online sample) took part in in-depth telephone interviews	• The study aimed to explore motivations and barriers to the wider use of e-cycles amongst different demographics	UK
Narayanan, S. and Antoniou, C., 2021. Electric cargo cycles-A comprehensive review. Transport policy, 116, 278-303	Qualitative scoping review of academic literature relating to e-cargo. Drew literature against key words related to cargo-cycles. Presents findings from 70+ articles. The top geographies for these articles are: Germany (12), USA (5), Belgium, Netherlands, and UK (4 each).	Aims to comprehensively consolidate academic literature on e-cargo cycles for various facets of their application, including typology, penetration, impacts, and policies required.	N/A
NEStrans, 2020. 'E-cargo Bike Status Report'.	Results from a £25,000 e-cargo pilot in Aberdeenshire. This scheme covered six e-cargos, and a five year maintenance plan.	Purpose of the report is to provide information on progress on the use of funding to procure and manage a series of e-cargos as part of a pilot scheme to provide an alternative to vans for local deliveries.	Scotland
New York City Department of Transport, 2021. 'Commercial Cargo Bicycle Pilot Evaluation Report'.	Pilot launched 2019 with three major participants UPS, DHL, and Amazon with 100 e-cargos. As of January expanded to 6 participants and 350 e-cargos. Presents findings on trip types, barriers, and motivations, as well as recommendations for supporting take-up of e-cargo for freight. Note that this source is an evaluation report conducted by NYC DOT to review their pilot, rather than an academic study.	Aimed to facilitate uptake of e-cargo for business as well as present findings on trip types, limitations, barriers, and motivations	New York City, USA
Plazier, P.A., Weitkamp, G. and Berg, A.E.V.D., 2018. 'Exploring the adoption of e-bikes by different user groups'. Frontiers in Built Environment, 4, p.47.	This paper is an academic literature review intended to advise and suggest further research. It lists group specific advantages and disadvantages of e-cycle mobility based on findings from the academic literature.	To encourage the use of integrative, mixed methods research approaches which consider potential e-cycle mobility as the result of individual decision making and shaped by social and spatial contexts to lead to the promoting/adoption of e-cycles among more diverse user groups.	Groningen, the Netherlands

Rérat, P., 2021. 'The rise of the e-bike: Towards an extension of the practice of cycling?'. Mobilities, 16(3), pp.423-439.	Applies a theoretical framework to address e-cycling based notions of mobility to a large-scale survey of 14,000 cycle commuters in Switzerland. Respondents were sourced through the national cycle to work programme. The study presents fingdings regarding e-cycles ability to overcome certain cycling barriers, as well as information about users.	Aims to contribute toward the field of mobility studies in its aims to explore social formations, practices, structures, meaning and politics of the mobile world.	Switzerland
Riggs, W. and Schwartz, J., 2018. 'The impact of cargo bikes on the travel patterns of women.' Urban, Planning and Transport Research, 6(1), pp.95-110.	Quantitative and qualitative data from surveys of 173 individuals and focused impromptu interviews of women using cargo cycles. The study states that cargo cycles could be a valuable tool in increasing cycling amongst women.	This study aimed to explore gender differences in cargo cycle usage.	California
Sestrans, 2018. 'Go e-bike Impact Report'	Go e-cycle is a regional e-cycle share offer at sites across South East Scotland delivered by transport partnership Sestrans and CoMoUK since 2018. A total of 1,039 trips have been recorded with around 10% of these being made at the St Andrews location. The schemes have a total of 414 signed up members.	Aims to encourage e-cycle take up through community e-cycle share scheme hubs. The report presents findings on e-cycle users and trips as well as the overall impact of the schemes.	Scotland
Shimano Steps, 2020. 'State of the Nation Report'. And Shimano Steps, 2021. 'State of the Nation Report.'	Large survey in partnership with YouGov. The document is a report based on a consumer survey of 13,000 European residents across 11 countries conducted March-April 2020. The report aims to examine the motivations for E-cycle usage and compare similarities and differences across these countries. The report is also supported by comments from stakeholders and industry experts. The 2021 update expands to 14,000 respondents across 12 countries and was conducted July 2021.	Aims to present findings on the general public's perception of e-cycles including purchase interest. Worth considering that the report is produced by a private party and therefore could be prone to some bias.	Europe-wide, with specific data for each participant country
Thomas, A., 2021. 'Electric bicycles and cargo bikes—Tools for parents to keep on biking in auto-centric communities? Findings from a USA metropolitan area.' International Journal of Sustainable Transportation, 1-18.	• Semi-structured interviews with 20 parents and caretakers who used their e-cycles to transport their children. • 13 participants used an e-cargo to transport their children. • 7 participants used a conventional-style e-cycle to transport their children.	The study aimed to understand how and why families used e-cycles and e-cargos to transport their children.	San Francisco, USA.

Ton, D., & Duives, D., 2021. 'Understanding long-term changes in commuter mode use of a pilot featuring free e-bike trials'. Transport Policy, 105, 134-144	• E-cycle loan pilot aimed at Dutch university students and employees. • 82 participants • The data collection involved three stages of surveys. • Stage 1 was organised before the start of the trial, which was designed to collect information about participants' sociodemographic traits and commuting behaviour. • Stage 2 lasted eight weeks. In this stage, participants were offered an e-cycle for travelling. Participants were offered free e-cycles, and were asked to use e-cycles at least twice a week for commuting during the trial period. • At the end of Stage 2, a survey was distributed to collect information about participants' experience of using e-cycles and the intention to continue to use e-cycles. • Stage 3 was organised three months after Stage 2. The survey in this stage was to collect participants' information about their current commuting behaviour, attitudes to modes, and their purchase behaviour of e-cycles.	• The study aimed to investigate how (e-cycle loan) trails changed travel behaviour in the long term. • Participants were university students and employees who commuted to the campus by car at least three times a week. • The trial was an opt-in trial; only people who were interested in testing e-cycles were included. • Participants were offered an option to buy an e-cycle at reduced cost after the trial.	Delft, the Netherlands
Transport for Quality of Life, 2019. 'Potential for E-cargo Bikes to Reduce Congestion and Pollution from Vans in Cities'	Scoping study of e-cargos conducted by TfQL exploring the literature available on e-cargo usage. Review of over 60 sources and 16 case studies.	Aims to scope the potential for e-cargo to replace trips made by vans and provides suggestions for policy makers in order to achieve a greater uptake of e-cargo use by businesses	UK

Van den Steen, N., Herteleer, B., Cappelle, J., & Vanhaverbeke, L. 2019. 'Motivations and barriers for using speed pedelecs for daily commuting.' World electric vehicle journal, 10(4), 87.	• Qualitative approaches. • 12 entry focus groups were held with 100 participants from 10 companies before the start of a speed pedelec usage trail. • During the trial, all participants were asked to replace their current commuting modes with a speed pedelec for up to three weeks. • The entry focus groups focused on motivations to using the current modes and barriers to the non-use of other modes. The entry focus groups were then steered to biking, which covered the use of a conventional cycle to e-cycles, and speed pedelec. • After the trial, 10 exit focus groups were held, which focused on speed pedelec users' experiences and changes in attitude.	The study aimed to investigate the motivations for and barriers to using speed pedelec for commuting and the users' experience.	Flanders, Belgium
Xin, F., Chen, Y., & Ye, Y. 2022. 'Understanding Electric Bicycle Users' Mode Choice Preference under Uncertainty: A Case Study of Shanghai.' Sustainability, 14(2), 925.	• Online questionnaire surveys were conducted with 1,013 respondents who used e-cycles frequently. • The surveys included four parts, namely, respondents' (1) socioeconomic characteristics; (2) emphasis on travel time and cost; (3) risk attitudes; and (4) expected commuting travel cost and travel time. • Note. The study only focused on e-cycle users. • Mode choice models that were built based on comprehensive cumulative prospect values (CPVs). • Risk preferences were used to calculate the parameters in the CPV-based choice models. • Descriptive analyses.	The study aimed to examine the effect of e-cycle users' psychological characteristics and risk attitudes on e-cycle mode choices.	Shanghai, China

Appendix B: Methodology

Search protocol

The grey literature and academic literature were approached separately, and due to the different nature and sources which make up these categories, different exclusion criteria and methods were applied.

The review of grey literature began by considering papers already known to the research team against the research questions. Then a wider search was conducted using key words: “e-cycle”, “e-cycle”, “electric cycle”, “electric bike”, “cargo bicycle”, “delivery bike”, “delivery bicycle”, AND “demographics”, “user”, “user type”, “usage”, “market segmentation”, “market trends”, “trends”, “UK”, “Europe”, “trial”, “scheme”, “project”. Grey literature was searched through public facing search engines and returned a high number of extraneous results (e.g., retail or adverts which provided only product specifications).

A review of the academic literature focusing on papers published within the last two years i.e., the period since previous DfT literature review[9]. Articles about e-cargo and e-cycles were searched for separately using the search terms "e-cargo bicycle", "e-cargo bike", "cargo bike", "cargo bicycle", "delivery bike", "delivery bicycle" together with the various words that could enablers in the title and words that could indicate a trial in the title.

Exclusion criteria

As noted above, the literature was approached with exclusion criteria. The grey literature returned a large number of extraneous results, which have not been included. Grey literature came from private, Non-Governmental Organisations, and governmental sources and often involved some level of collaboration between institutions (e.g. academic institutions and charities). Some large-scale research has been conducted by the private sector e.g. Shimano Steps the components manufacturer, which commissioned market research agency YouGov to survey over 13,000 people across Europe. Other sources in the grey literature include advocacy groups such as Bike is Best and CoMoUK. The implications of this are twofold: survey methodologies are not always published alongside results so in reviewing the findings it is not always possible to understand the strengths or limitations of the research, and secondly because the work is not published in an academic journal it may not have been subject to the level of peer review and scrutiny as research from the academic literature.

The process for refining grey literature was as follows. For each search, results were sifted by their title and preview and selected for further reviewing – this was continued until returned results were of little merit (typically up to 50 results). Examples of sources excluded at this stage were:

- Dictionary definitions.
- Retailer websites with product specifications only.
- Unrelated results or false hits (e.g., based on “demographics” more broadly and unrelated to cycling).

[9] Behavioural Impacts of E-cycle Trials: A Rapid Evidence Assessment (2021)

Sources were sense checked for validity and compiled in a Source Log and downloaded for reviewing. A description of the type of source was presented as well as notes such as sizes of trials. Thirty-four sources were then reviewed in detail. Examples of sources excluded at this stage:

- User facing websites/adverts of trials such as: https://rideonleicester.com/
- Loosely related or insubstantial sources such as: https://www.rutlandcycling.com/pages/ebikes-vs-regular-bikes.html
- Sources directly quoting or repeating the findings of academic studies
- Opinion pieces or sources which would not hold up to scrutiny (e.g. blogs) such as: https://www.cyclesheffield.org.uk/2022/02/01/electric-bike-e-cycles-explained/

The content of sources was included where it adequately answered any of the research questions. Most grey literature reviewed was written for broad readership and in a wide range of formats.

In reviewing the academic literature only peer reviewed articles in English were searched. Searches for papers about e-cycles generated irrelevant hits based on the ‘electric’ keyword. Some papers examined topics related to e-cycles which did not inform the research questions such as conflicts between e-cycle users and pedestrians. Once these were discounted, there were only sixteen papers. Papers were also removed which were covered in DfT’s previous literature review[10] unless it addressed the research questions in this REA. After these exclusions there were fifteen remaining studies.

Searches for e-cargo literature produced many extraneous studies. Some studies were related to riding/risk behaviour of cargo bike users, route choice or optimisation techniques and vehicle design, energy and pollution aspects. Once these were removed seven papers remained. Most of these studies were very heterogeneous in nature: one on four-wheeled cycles, one regarding barriers, one for application in courier services, one focusing on operation in winter roads, one for application in carrying children and another on suitable routes for e-cargo bikes. Only two papers explicitly addressed barriers and perceptions, one of which was regarding shared e-cargo bikes. A further review presents findings on ‘Influencing Factors’ drawn from across the academic literature.

For Research Question 3, again, many extraneous hits were found. Some studies looked at medical trials involving e-cycles, papers that had already been covered in a previous review commissioned by DfT, cycle design and efficiency aspects, and trial assessment methodology. Again, there were also some irrelevant hits based on the ‘electric’ keyword. Other studies were not actually intervention based. Once these were expunged only three papers remained from 144 initial hits, all of which were 2021-2022, i.e., after the previous study in 2021.

Search strategies for the academic literature are detailed below.

[10] Behavioural Impacts of E-cycle Trials: A Rapid Evidence Assessment (2021)

Search Strategies	Limit	Number of hits	Focus
Search strategy Research Question 2 (e-cargo): look up literature in Scopus with the search terms e-cargo bike, cargo bike, cargo bicycle, e-cargo bicycle and delivery bicycle TITLE ("e-cargo bicycle" OR "e-cargo bike" OR "cargo bike" OR " cargo bicycle" OR "delivery bike" OR "delivery bicycle")	Only articles in English	64	Manuscripts published in 2021 and 2022, and those published in peer-review journals
Search strategy Research Question 2 (e-cycles): Search in Scopus on various (e-)(bi)cycles, together with the various words that could enablers in the title. (TITLE ("electric" AND "bicycle") OR TITLE ("e-bike") OR TITLE ("electric" AND "bike") OR TITLE ("e-cycle") OR TITLE ("pedelec") OR TITLE ("trike") OR TITLE ("recumbent") OR TITLE ("handcycle") OR TITLE ("electric" AND "assisted") OR TITLE ("electrically" AND "assisted") OR TITLE ("e-cycling") OR TITLE ("pedal-assist") OR TITLE ("electric" AND "bicycle")) AND (TITLE ("barrier") OR TITLE ("enabler") OR TITLE ("motivation") OR TITLE ("motivator") OR TITLE ("nudge") OR TITLE ("take-up") OR TITLE ("behaviour") OR TITLE ("incentive") OR TITLE ("preference") OR TITLE ("mode" AND "choice")) OR Title ("barrier")	Only articles in English	106	Manuscripts published in 2021 and 2022, and those published in peer-review journals
Search strategy Research Question 3: Search in Scopus on various (e-)(bi)cycles, together with the various words that could indicate a trial in the title. (TITLE ("electric" AND "bicycle") OR TITLE ("e-bike") OR TITLE ("electric" AND "bike") OR TITLE ("e-cycle") OR TITLE ("pedelec") OR TITLE ("trike") OR TITLE ("recumbent") OR TITLE ("handcycle") OR TITLE ("electric" AND "assisted") OR TITLE ("electrically" AND "assisted") OR TITLE ("e-cycling") OR TITLE ("pedal-assist") OR TITLE ("electric" AND "bicycle")) AND (TITLE ("pilot") OR TITLE ("trial") OR TITLE ("scheme") OR TITLE ("project") OR TITLE ("experiment") OR TITLE ("intervention") OR TITLE ("evaluation") OR TITLE ("assessment") OR TITLE ("substitution"))	Only articles in English (LIMIT-TO (LANGUAGE, "English"))	144	Manuscripts published in 2021 and 2022, and those published in peer-review journals