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Delivering The Last Mile: Scoping the Potential for E-cargo Bikes

Luke Blazejewski, Graeme Sherriff, Nicholas Davies

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University of Salford MANCHESTER

SHUSU
SUSTAINABLE HOUSING & URBAN STUDIES UNIT

Healthy Active Cities

Delivering The Last Mile

Scoping the Potential for E-cargo Bikes

Luke Blazejewski
Graeme Sherriff
Nicholas Davies

UKRI Engineering and Physical Sciences Research Council

About the authors

Healthy Active Cities is a research group at University of Salford that was formed in 2018 to bring together researchers and stakeholders to develop research on transport in Greater Manchester and beyond. The group has a particular interested in sustainable and active travel technoloiges and practices.

The **Sustainable Housing & Urban Studies Unit (SHUSU)** is a dedicated multi-disciplinary research and consultancy unit providing a range of services relating to housing and urban management to public and private sector clients. The Unit brings together researchers drawn from a range of disciplines including: social policy, housing management, urban geography, environmental management, psychology, social care and social work.

The reseach team for this report comprises:

- Dr Luke Blazejewski, University of Salford
- Dr Nicholas Davies, Glasgow Caledonian University
- Dr Graeme Sherriff, University of Salford

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EXECUTIVE SUMMARY

Transport is a major contributor to urban greenhouse gas emissions and therefore of priority in mitigating climate change. In responding to multiple pressures that include development, population growth and recent marked increases in online shopping, cities must identify new technologies to reduce emissions and improve freight efficiency, whilst enabling people and goods to reach their destinations.

E-cargo bikes are an emerging technology with a low carbon footprint and lower running costs when compared with vans. They demonstrate increased potential to avoid contributing to, and being delayed by, traffic congestion. In comparison to conventional bikes, the combination of an electric-assist motor and larger frame offers the capacity to carry bulkier and heavier objects over longer distances. There is scope for businesses to use the vehicles for local deliveries and for the bikes to be used in connection with distribution hubs to provide a sustainable last mile.

Greater Manchester Our research was conducted in Greater Manchester, an area with a demonstrable commitment to boosting the use of active travel modes. Whilst not our focus, COVID-19 proved inescapable as a context for the research, since it has not only affected walking and cycling practice in the area, and Europe as a whole, but has also provided a stimulus for the adoption of e-cargo bikes to provide deliveries during lockdown.

Aims Through a set of interviews and focus groups, discussions were held with businesses beginning to use the bikes as part of daily operations, and others who are beginning to see a role for them in their sector. In this scoping study, the aim was to better understand the potential impact of e-cargo bikes on the carbon footprints of freight deliveries and individual businesses as well as on the practices and daily operations of those businesses. Barriers to use were also considered, including the ways in which they could be removed, reduced or overcome, and the extent to which existing infrastructure can accommodate e-cargo bikes.

Current practice Examples of current practice included volunteer-led e-cargo bike delivery networks connecting businesses with local customers, and a laundry business using e-cargo bikes to pick up and deliver laundry. Interviewees and focus group participants saw opportunities to use the bikes within their sectors, including surplus food collections for a homeless shelter, waste management, catering, local supply chains, and collections and deliveries across large sites such as universities and hospitals. Participants recognised advantages of using e-cargo bikes. These included the reduced environmental impact, as well as the predictability of journey times, and additional time savings relating to parking and turning around in comparison to using a van. The ability of staff and volunteers to use the bikes without the requirement of formal driver training and a licence was also attractive.

Challenges Whilst discussions demonstrated potential roles for the vehicles, participants identified factors that would currently act as deterrents or barriers to use. These included the size and cost of the vehicles. The research suggests that e-cargo bikes are perceived to be expensive in comparison with other options. To some extent these perceptions of cost stem from an unfamiliarity with e-cargo bikes, and are compounded by the potential perceived risks to their business of trying a new approach. Businesses also needed to be confident that staff could ride the bikes safely and to ensure that they had provided opportunities for training and risk assessment. Certain types of deliveries brought particular challenges: keeping food warm for example, and managing multiple pickups. In some cases, waste collection for example, the capacity of the bikes may be the limiting factor.

Perceptions were also a factor: it may be challenging for businesses to convince their staff to leave the comfort of a van and use what remains an unfamiliar mode of transport and one with the connotations of risk, comfort and speed that can be associated with cycling. Relatedly, levels of awareness of e-cargo bikes remain low, with the implication that few businesses are likely to consider them to be an option. Infrastructure and road space allocation is also a consideration and e-cargo bike riders described challenges involved in using existing infrastructure that is aimed at conventional bicycles rather than modified and wider vehicles.

Technology In overcoming these barriers, it is clear that technology plays an important role. The electric assist motor makes the bikes accessible to a wider cohort whilst also allowing for larger and heavier loads. GPS tracking and mapping services enable businesses to track their vehicles and plan efficient routes. Communication technologies facilitate smooth operations through contact with staff, customers and delivery riders. Online shopping has provided local businesses with a way to provide access to customers wishing to have home deliveries, an approach that has been particularly valuable during the COVID-19 pandemic.

Ways ahead As part of their decarbonisation efforts, there is an opportunity for cities to facilitate the adoption of e-cargo bikes in the business community and to identify the sectors, business types, and operations in which they have a role. There is a need to raise awareness of e-cargo bikes and to provide advice, support and financial incentives for businesses that want to try out this technology. Consideration should also be given to cycling infrastructure in the context of e-cargo bikes, and road space allocation to ensure that people can ride the vehicles with confidence safely and maximise the benefits for traffic flow.


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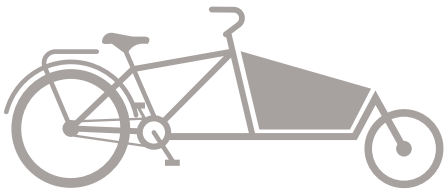
1. INTRODUCTION



Cities around the world are responding to pressures of development and population growth, and the need to balance these with reducing carbon emissions from freight transport continues to pose logistical challenges. With a view to developing solutions to these complex challenges, it is essential to understand emerging mobility technologies and practices, as well as their societal readiness, as we transition towards a decarbonised future.

In this report we consider one such emerging technology, the electric cargo bike, or e-cargo bike, and its potential to decarbonise deliveries, particularly for the last mile of journeys. The last mile refers to the final part of journeys involving the movement of goods, often from a distribution hub on the edge of a city centre to a final destination in the city centre (Halldórsson and Wehner, 2020). The last mile of any journey is a key challenge in transport planning, and it is important to explore how this emerging mobility technology might integrate with current transport practice across different types of industries. We are interested in identifying the opportunities for e-cargo bikes to reconfigure how last mile deliveries are made (Sutton, 2020a).

1.1 Sustainable urban transport

For cities to meet their carbon targets, and for the Paris Agreement (United Nations, 2015) to be successful, rapid and meaningful change is required. Sustainable urban mobility needs to become a foundation of the development of every city on the planet, with buy-in from as many sectors as possible. Within the context of this study, developing a sustainable and efficient freight transport network is an essential part of this puzzle. Currently, over 50% of the world's population live in cities (Fyles and Madramootoo, 2016), with some studies suggesting that number could be as high as 76% (Kemper, 2019). Almost three quarters of Europe's population live in urban or suburban areas (Eurostat, 2016) and alongside these challenges there is a growing need for more liveable city centres for urban residents.

Liveable cities ensure a safe, healthy, friendly, sustainable and clean environment for their citizens while guaranteeing easy access to goods and services. The upward trajectory in urban populations, combined with the increasing popularity of online shopping, has seen a substantial growth in deliveries in urban areas (Li et al., 2020). In some ways, online shopping does contribute to the liveable city agenda by ensuring access to goods for all; however, this rise in e-commerce has also led to a surge in urban freight and more vehicles on the road because of the need to transport an increasing amount of goods every year. If no intervention is made, the number of delivery vehicles in the top 100 cities globally is expected to increase by 36% by 2030 (Deloison et al., 2020). Currently, urban mobility accounts for 40% of all CO_2 emissions from road transport and up to 70% of other pollutants from transport across Europe (European Commission, 2015). In 2019, vans made up 15% of UK road traffic and collectively drove more than 76 billion kilometres (Burns, 2020). If van usage continues to grow as anticipated, then urban congestion is expected to grow by 21% by 2030 (Deloison et al., 2020). London alone is expected to see a 20% increase in congestion by 2030 (Burns, 2020). This will be likely to lead to an increase in air pollution and energy consumption and will increase the length of private and commercial journeys, exacerbating the problem and creating unattractive and unliveable cities (Schliwa et al., 2015).

1.2 E-cargo bikes

E-cargo bikes are specialised bicycles designed to transport heavy loads. They offer a practical solution for transporting goods sustainably at a low cost. They are often larger and heavier than conventional push bicycles and are equipped with an electric assist motor similar to those seen in electric bicycles, which are growing in popularity (Alderson, 2019). This helps the rider travel longer distances, transport heavier loads and tackle steeper hills with relative ease. Bike designs include a cargo area consisting of an open or enclosed box for transporting goods, usually mounted at the front or back of the bicycle. They have evolved from the cargo bike, a similar design without electric assistance.

The potential of e-cargo bikes stems from their ability to provide sustainable freight transport that can operate in the confines of city centres, which are often highly congested spaces. Alleviating the stresses on freight flows in these areas can have a positive impact on productivity, congestion, health and wellbeing, as well as carbon reduction. In 2018, 56% of the total volume of goods moved domestically in the UK by British HGVs started and ended in an urban area (Mills, 2019). With this in mind, finding ways to transport goods in urban environments without contributing to traffic congestion is essential (Figure 1). There are potentially many freight-related transport needs that can be switched to e-cargo bikes, including postal deliveries, food and drink deliveries and the maintenance of essential services (Cairns and Sloman, 2019). These areas, and others, could act as a starting point when considering the role of e-cargo bikes in the UK.

1.3 Greater Manchester

This study is focused on Greater Manchester, an area with cycling rates pre-COVID-19 quite typical for the UK, with the overall modal share for cycling remaining low. According to a 2017 study examining active travel behaviour, researchers found a nascent interest in cycling in Greater Manchester, with 26% of residents surveyed stating that they did not currently cycle but would like to (Sustrans, 2017). In this context COVID-19 may be framed as an unintended and unforeseen enabler of active travel. During 2020 Greater Manchester saw a surge in active travel following the outbreak of COVID-19, with levels of walking and running for exercise up by 120% and cycling for exercise up by 45% (Salford City Council, 2020). Reasons for these unprecedented increases in active travel go beyond the recreational behaviour of individuals and include other changes such as local authorities rolling out temporary active travel infrastructure and businesses revisiting how all deliveries can be made.

Greater Manchester has recently seen significant investment in walking and cycling and the appointment of a Cycling and Walking Commissioner, reflected in the launch of an ambitious active travel strategy known as the Bee Network (Boardman, 2018). Manchester was also the first city outside Asia to host a Mobike bike sharing scheme, in 2017 (Sherriff et al., 2018), and since then it has begun to position itself as a leader in the active travel and micromobility environment.

In 2021, there are plans for the city region to host a range of shared active mobility schemes, including e-scooters (Timan, 2020), a large-scale bike sharing scheme (Griffiths, 2020) and an e-cargo bike sharing scheme known as eHUBS (Interreg, 2020). The **eHUBS Project**[1], which is of particular relevance to this research, aims to provide both businesses and the general public with access to a fleet of e-cargo bikes that can be rented for a range of purposes. It is hoped that the eHUBS Project will contribute to an increased presence of e-cargo bikes in Manchester, normalising their use for other road users, building on the growing cycling agenda and raising awareness of their potential to offer a sustainable alternative to fossil fuel freight when it comes to last mile deliveries.

Figure 1 An example of an Urban Arrow e-cargo bike

1 More information available @ https://www.nweurope.eu/projects/project-search/ehubs-smart-shared-green-mobility-hubs/

1.4 This research

This study aims to identify and evaluate the potential of e-cargo bikes across different sectors in the city region of Greater Manchester. The findings will provide new knowledge that will be valuable to the study of sustainable cities, transport and freight and to urban practitioners, planners and decision makers with a remit to reduce carbon-intensive travel and boost healthy active transport. It is the first substantive investigation into e-cargo bike usage in the UK and sets the groundwork for future academic investigation.

The study addresses key research questions relating to e-cargo bikes and their ability to reduce the need for motorised freight-based transport, contributing to reduced CO_2 emissions, cleaner air and less congestion in compact urban environments. We present those questions here, and this compact pilot study is the first step in the process of addressing them.

1. What is the potential for e-cargo bikes to reduce the impact of freight delivery in urban areas by replacing fossil fuel-powered delivery vehicles?
2. What is the potential impact on the carbon footprint of businesses and organisations of using an e-cargo bike? How can this be measured?
3. What are the actual and perceived barriers to e-cargo bike uptake across sectors? How might they be removed, reduced or overcome?
4. How might infrastructure accommodate a significant increase in e-cargo bikes? What features are required of infrastructure – whether on the road or in organisations and businesses – to facilitate a significant increase in e-cargo bike usage?
5. How does the uptake of e-cargo bikes for deliveries and other daily operations relate to business practices and expectations?

1.5 This report

In Chapter One we introduce e-cargo bikes as an emerging e-mobility solution to freight-based transport challenges. Following this, Chapter Two provides further context for e-cargo bikes, discussing the growing e-mobility movement and the role of e-cargo bikes within it. The findings of the study are presented in Chapters Three, Four and Five, and the research questions outlined above are addressed. In Chapter Six we examine e-cargo bikes in the context of societal readiness and building a sustainable transport future, and our key findings from this examination are summarised in Chapter Seven. At the back of the report we provide a list of references and the methodology in an appendix.

2. E-CARGO BIKES IN CONTEXT

2.1 The challenge of transport in cities

Urban transport has profound impacts on public health, climate change, air quality and the economy. Towns and city centres are subject to severe congestion, to which freight is a key contributor. In 2018, HGVs accounted for 11% of miles travelled on motorways and 9% of miles on rural dual carriageways (WSP, 2019), and van mileage has increased by a fifth since 2008. In the UK vans and light commercial vehicles make up around 15% of traffic and cause over 30% of NO_x and particulate emissions (Cairns, 2017). Road traffic in Great Britain has also increased from 255 billion miles travelled in 1990 to 328 billion miles in 2018, an increase of 27% (Clarke and Ainslie, 2019).

In June 2019 the UK Government passed a net zero law to end the country's contribution to climate change by 2050 (Shapps, 2020). However, in 2018 only 0.5% of all vehicles licensed in the UK were classed as ultra-low emission vehicles (Clarke and Ainslie, 2019). With this in mind, there is a long road ahead to net zero, but this should also be seen as an opportunity for emerging mobility technologies to transform the way we move both ourselves and goods around.

The European Cycle Logistics Federation assessed the scale of urban van and car travel that could be suitable for transfer to e-cargo bikes and suggested that 10–30% of trips made by delivery and service companies in cities could potentially be replaced by e-cargo bikes (Cairns and Sloman, 2019). This would have significant implications for the decarbonisation agenda. At Deliveroo, a project leader in their Global Vehicle Solutions department described how e-bikes deliver 20% more orders an hour on average when compared with conventional push bicycles, leading to both an increase in revenue and also fewer deliveries being made by motorised vehicles during busy periods (Mileham, 2019). Clearly, there is great potential to introduce e-cargo bikes in the coming years.

2.2 E-cargo bikes as a response

As we have established, e-cargo bikes are bicycles designed for transporting heavier loads. They come in a range of shapes and sizes but are generally bigger and heavier than a conventional push bicycle. They have an electric assist motor, which works in conjunction with the pedal to allow the rider to travel further and faster with heavier loads. This electrified design follows the popularity of e-bikes (conventional-style bicycles with an electric assist motor), which have been proven to remove

Figure 2 **Congestion from road traffic has a significant impact on air quality in cities**

some of the typical barriers to cycling such as hills, longer distances and concerns about personal fitness (Alderson, 2019).

There are many reasons to suppose that the removal of these barriers also offers benefits for business operations and decarbonisation more generally.

- E-cargo bikes take up less road space than vans or other light commercial vehicles and can travel through city centres relatively unhindered using suitable cycling infrastructure.
- Replacing vans with e-cargo bikes can also reduce CO_2 emissions, reduce congestion, make less noise and contribute to cleaner air for all.
- You can often easily park for free (often outside your final destination), and e-cargo bikes are cheaper to repair than conventional motorised vehicles (Cairns and Sloman, 2019).
- They do not require a driving licence to operate, and, while training can be beneficial to new riders, it is not mandatory.
- Research has also suggested that e-cargo bikes may have advantages on the road, as they may be more visible to other road users due to their size (Riggs, 2016) and therefore are at low risk of collisions when compared with a conventional bicycle or bicycle trailer.

Over the past ten years e-cargo bikes have risen up the political and social agenda in major European cities, in part due to the three-part EU-funded Cyclelogistics project City Changer Cargo Bike (Behrensen and Sumer, 2020b). This project aims to provide training and workshops to raise awareness and educate people about the potential of e-cargo bikes as an emerging e-mobility option, with a long-term view of achieving cost-effective, sustainable and large-scale deployment of e-cargo bikes in the public, private and commercial sectors to improve the quality of cities for all.

Results from a survey carried out by the Cyclelogistics project in 2020 revealed that the overall cargo bike market is growing across Europe. In 2018, 17,785 cargo bikes were sold. In 2019, these sales increased by 60%, and in 2020 they are forecast to increase by a further 53% (Behrensen and Sumer, 2020a). Most notably, the sales of conventional cargo bikes (cargo bikes without an electric assist motor) are falling, while the sales of e-cargo bikes continue to rise (Burgin, 2020). This is reflective of developments in e-mobility currently happening in Europe. For example, in the Netherlands e-bikes outsold conventional push bicycles for the first time in 2018 (Alderson, 2019), and in 2019 e-cargo bikes outsold electric cars in Germany (Behrensen, 2019).

> We've gone from nowhere in 2012 to being at the table that matters, and it is quite an extraordinary story (Interview I).

The employment of e-cargo bikes for urban sustainable transport is a relatively new field of research in the UK. Previous studies have focused their attention on examining the role of e-cargo bikes in European countries where the bikes are better established and cycling levels are already high (Gruber and Kihm, 2016; Hess and Schubert, 2019; Elbert and Friedrich, 2020). The Cyclelogistics project noted that e-cargo bikes could make 51% of all logistic trips and 25% of commercial deliveries in European cities and has made the case for businesses to make significant savings by switching to e-cargo bikes (Fištrek and Rzewnicki, 2016). These findings are changing the way people think about cycling and logistics and are catching the attention of policy makers who are looking for solutions to global urban problems such as poor air quality, congestion and increasing physical inactivity (Sutton, 2020c). Beyond the scope of this report, but of relevance to our future transport practices, self-driving e-cargo bikes are also being considered (Krause et al., 2020).

2.3 E-cargo bike use

In the UK e-cargo bike use is generally quite low (Cairns and Sloman, 2019), but it is growing in popularity as part of the wider e-mobility movement including e-bikes, e-scooters and electric vehicles (Alderson, 2019). While this study aims to better understand the potential for e-cargo bikes in Greater Manchester, the limited data available nationwide in this field represents an opportunity for future research, especially as the landscape is beginning to change.

In 2020, the Department for Transport made £2 million available to support local authorities to bid for the acquisition of e-cargo bikes as part of the eCargo Bike Grant Fund, with the aim of increasing the number of e-cargo bikes being used. Councils were able to bid for up to £200,000, purchasing 282 bikes for local authorities and subsidising a further 409 bikes for local businesses to support green last mile deliveries.

Plymouth City Council were successful in receiving £123,500, which they have used to award 22 new and existing businesses with £4,750 each towards the cost of 26 e-cargo bikes (Plymouth City Council, 2020). This has shown commitment on behalf of Government to trial alternatives to fossil fuel freight. In total, 18 councils across the UK were successful in this scheme, which has put 691 e-cargo bikes on the road to support the transition to a low-carbon sustainable transport future. Looking to the future in the UK, Transport for London have estimated that up to 14% of vans could be replaced by e-cargo bikes by 2025 in parts of London where vans contribute to more than 60% of local traffic (Burns, 2020).

The potential role of e-cargo bikes in a sustainable society is demonstrated by some early case studies in the UK. In London, a butcher who began using an e-cargo bike for deliveries instead of a van whenever possible was able to reduce his CO_2 emissions by 75% (Cairns and Sloman, 2019). The Newcastle upon Tyne Hospitals NHS Foundation Trust trialled an e-cargo bike delivery scheme over a three-month period in 2019 in the city centre, ultimately saving 212 kg of CO_2 and £6,250 (a potential saving of up to £25,000 per annum) (NHS, 2019). Oxford hosted the first international e-bike summit in 2019, which included panels on e-cargo bikes (Mileham, 2019).

In Europe there is a well-established cycling community, including the Cyclelogistics project, which is contributing to learning on the potential role of e-cargo bikes in businesses and communities. However, when compared with other major European cities the UK is still has a long way to go. In the Netherlands the global courier service DHL currently makes 60% of their inner-city deliveries using a fleet of non-electric cargo bikes (Erlandsson, 2017), serving as a proof of concept for other cities that sustainable last mile deliveries are possible. With technology evolving rapidly, e-cargo bikes will undoubtedly begin to contribute to this approach as it is accelerated across other markets over the coming years.

2.4 The COVID-19 context

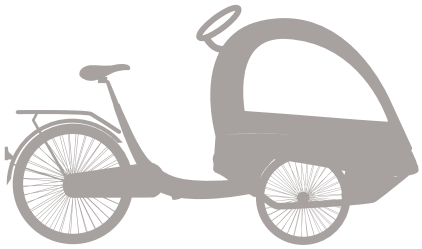
Whilst not the main focus of our study, the COVID-19 pandemic provided an inescapable context and one that has influenced cycling and walking in the UK. Active travel increased markedly during the first national lockdown period between March and May 2020 (Sherwood, 2020), with cycling numbers up by 300% in some parts of the UK (Sutton, 2020b). This is generally understood as a response to people only being allowed outside for essential activities, such as grocery shopping and daily exercise, where they were recommended to 'minimise the time you are out of your home' (Greig, 2020). This significant and rapid increase led many local authorities to invest in temporary pop-up cycle lanes (Figure 3) to capitalise on the interest in active travel (Laker, 2020; Visontay, 2020). In Manchester a pop-up lane along the A56 led to a fourfold increase in cycling when compared with equivalent figures from 2018 (Whelan, 2020).

Due to their ability to move goods around efficiently while adhering to social distancing, e-cargo bikes grew in popularity during the first wave of COVID-19 in the UK. This growth was facilitated by the Department for Transport's eCargo Bike Grant Fund, which has supported new and existing businesses to purchase e-cargo bikes with a view to helping them continue trading during the pandemic, and in many cases improving access to goods and services for vulnerable people (Brighton & Hove Council, 2020; Plymouth City Council, 2020). The popularity of this scheme was undoubtedly helped by the low levels of traffic seen on UK roads between March and May 2020, which allowed cycling levels to grow to unprecedented levels and the small number of e-cargo bikes in the UK to become more noticeable on the roads.

Pedal Me is an e-cargo bike passenger and delivery service in London and serves as a good example of how these developments are impacting businesses. During the first national lockdown Pedal Me's trade dropped by 80% overnight, leading them to furlough most of their workforce (Sexty, 2020). However, with the urgent need for socially distant urban mobility that came with the challenges of a locked-down city, their demand grew exponentially. They were formally recognised as essential workers and contracted to deliver PPE to NHS staff on the front line, as well as delivering over 400 food drops a day to vulnerable people around the London Borough of Lambeth, with each delivery weighing between 15 and 20 kg (Sexty, 2020). Clearly, there have been isolated success stories for e-cargo bikes preceding this study, which demonstrate the need for further research and the value that our findings provide.

Figure 3 **An example of pop-cup cycling infrastructure in Manchester**

3. THE USE OF E-CARGO BIKES



After we conducted five interviews with e-cargo bike pioneers (people who use the bikes on a regular basis) and five focus groups across a range of business sectors, the findings highlight an array of themes that include barriers to uptake, opportunities for further rollout, the role of technology in an e-cargo bike world and the experience of riding e-cargo bikes in the UK. Each theme has been broken down into subsections, and these are examined in further detail below.

3.1 Current e-cargo bike use

We identified ways in which e-cargo bikes are currently being used, as well as potential uses envisaged by the research participants. During the interviews we spoke to five e-cargo bike pioneers who had experience of using e-cargo bikes in Greater Manchester, particularly in small communities.

During the first national lockdown in March 2020 one participant in Yorkshire experienced symptoms of COVID-19 and had to self-isolate for two weeks. During this time she began thinking about how to support her local shops and suppliers and meet the needs of vulnerable people who had to stay at home. She decided to hire an e-cargo bike from a local supplier and recruit a group of volunteers to use the bike. In March 2020 she launched the **Cargodale project**[2], and in the first month the group completed 251 deliveries, covering 411 miles and saving 61 kg of CO_2 (Kubitz, 2020b). In the case of Cargodale, their main suppliers were the local indoor market, whose traders had quickly adapted to accommodate online orders of vegetables, meat and cheese, and the local wholefood shop, which was taking phone orders. They receive a list of deliveries from each supplier and use a combination of journey planning tools to create the optimal delivery route and manage the round (Kubitz, 2020a). On busy days they complete upward of 20 orders:

> Basically, what happened was that there were lots of shops that needed deliveries. I couldn't even go out at the time. Basically, I just coordinated the people coming and picking the bikes up, doing the deliveries and then bringing it back (Interview II).

Similarly, in 2020 a group of residents in South Manchester came together to set up a community response to COVID-19 in their local area. They invited people to set up WhatsApp groups in their streets to encourage communication in the neighbourhood, and one of the concerns from this network was how vulnerable people who were self-isolating could access goods. **Chorlton Bike Deliveries**[3] was set up as a response to this challenge: a volunteer-led e-cargo bike delivery service to support local businesses and ensure vulnerable people could access goods during lockdown. Similar to Cargodale, they approached local businesses at a very challenging time and offered their services to ensure vulnerable people had access to food: *'we went and said, "Can we do some deliveries for you?", and they went, "Oh, can't see why not"' (Interview IV)*. This participant commented on finding themselves in a *'network of all that food recycling and food redistribution' (Interview IV),* an example being picking up bananas past their sell-by date from a supermarket, taking them to a community bakery and then taking the resultant cakes on to a local homeless charity. The participant described a catalyst role: *'We've been quite instrumental in linking up some of those agencies and being able to demonstrate that you don't always need a car for these local journeys' (Interview IV)*.

We also spoke to a laundry business that have used e-cargo bikes since their inception to pick up laundry and deliver it after washing: *'we're trying to re-engineer the laundry industry from the ground up, and we started up by solving the logistics problem, and we find that using large-capacity e-cargo bikes, it's remarkably efficient around [the] city centres' (FG2).*

3.2 Emerging e-cargo bike use

There have undoubtedly been isolated success stories with e-cargo bikes preceding this study. However, one of the key challenges continues to be encouraging widespread uptake of the bikes so we can move past these isolated examples towards a more cohesive network. It is important to note that two of the examples mentioned above are volunteer-led schemes, and if we want to maximise the use of e-cargo bikes we need to make this form of urban mobility a viable option for businesses. In order to better understand how the uptake of e-cargo bikes may continue to grow in Greater Manchester, it is useful to discuss the emerging opportunities identified by the participants.

2 More information available at https://www.cargodale.co.uk/

3 More information available at https://chorlton.coop/chorltonbikedeliveries

The **catering sector** was identified as an opportunity for e-cargo bikes to transport small goods across short distances in congested urban environments. Adoption of e-cargo bikes in this sector would, however, not be without challenges. For example, a participant from a catering company noted that the catering needs of an event determines the usability of e-cargo bikes: *'To get that large amount of food over to a function, it would be a lot of bikes to get the food over' (FG3)*. Large events catering for 200+ people tend to be served by vans or light commercial vehicles, as deliveries would otherwise need to be divided into multiple trips by bike or use multiple bikes to deliver everything in one multi-bike joint trip (Figure 4). Currently, chefs are able to prepare everything at once and deliver it in one trip using one van, whereas food preparation would potentially need to be staggered throughout the day to coincide with multiple trips if e-cargo bikes were used. This may have cost implications in terms of added wages.

E-cargo bikes have been considered by a large **waste management** company as a way of reducing waste collection-related congestion in urban areas. The proposition would include switching some motorised trips to e-cargo bikes, whereby multiple pick-ups of waste in the city centre would then be transported by bike to a site two or three miles outside the city for processing. However, a participant expressed concerns similar to those of the catering participant relating to the scale of waste collection and limitations of the bikes: *'One three-and-a-half-ton cage vehicle probably carries about one ton of waste, but that's probably about 20 bin bags. There's probably 300 bins in town that need to be serviced, maybe twice a day, depending on the day' (FG4).* There are also advantages to having a larger vehicle when transporting waste, as the job often requires flexibility: *'If you can have a vehicle that offers you more than one use, then that does offer benefits. That's probably something that an e-cargo bike may not be able to offer us as an organisation' (FG4).*

Supply chains and the way in which goods are collected and distributed were also identified as an area where congestion may be reduced through consolidation:

> If we take, for example, a stationery supplier, we'll all be ordering pens, pencils, paper off, probably, the same framework; off, probably, the same supplier. Is there an opportunity, as organisations, to influence our supply chains to do last mile deliveries differently? (FG1).

Many organisations based in the same city will often order from the same supplier, and it was suggested that these deliveries could potentially be organised in a way so that these joint orders could be delivered in bulk to reduce CO_2 emissions and congestion. This could be achieved by consolidating parcels at distribution centres on the edge of city centres and using e-cargo bikes to collect these parcels and deliver them to destinations in the city centre. This would remove some freight traffic from the roads while contributing to cleaner air and a more sustainable city.

Participants shared other ideas and aspirations in relation to adopting e-cargo bikes in their business practices. Businesses with relatively large sites, for example, could use the bikes for **internal distribution**, such as collecting items from van deliveries and avoiding the need for vans to come onto site:

Figure 4 The capacity of e-cargo bikes was identified as a potential barrier by some businesses (Bike: Riese & Müller Packster 80 / Photo: Beate Kubitz)

> If you need to move stuff from a van that's parked up outside the bollards, and you can't get close, you always get the mailroom stuff and take it out. They're just trolleys that are constantly in demand, so why not have a couple of cargo bikes that are constantly in demand? (FG5)

Similarly, a participant from a large hospital saw a role for e-cargo bikes in deliveries around the site, even, potentially, in the network of tunnels under the hospital, which vans could not enter. A charity collecting **surplus food from cafes** at the end of the day ready for meals at a shelter envisaged a role for e-cargo bikes in enabling them to rapidly pick up produce:

> We rely heavily on volunteers, and it's quite challenging to get from where we are... into Manchester at what is quite a busy time, at around five, six in the evening most of the time. Park, stop at a shop, get the food, and maybe do that two or three times (FG5).

Alongside speed, this represented an opportunity to cut costs for volunteers and therefore be more financially inclusive.

3.3 What's it like to use an e-cargo bike?

Participants who had first-hand experience of using e-cargo bikes reflected on the experience of riding them, as well as the considerations involved in integrating them into business operations. The experience of riding an e-cargo bike is different to riding a conventional push bicycle due to its size, weight and electric assist motor and the heavier loads it often carries. Controlling such a heavy bike can be intimidating for less experienced riders, and this can be a barrier for people who do not already cycle when trying to encourage uptake in the workplace: *'If they're not already in a cycling frame of mind, then how do you tempt them to try it?' (FG1).* However, the simple fun of riding an e-cargo bike was mentioned as something not to be overlooked: *'it's quite remarkable how people get off a cargo bike after their first ride and they've got a silly grin on their face. It happens every time' (Interview I)*. Perhaps one of the appeals of this transport mode is the physical engagement that comes with it. Rather than being a passive user reliant on the mechanics of a fossil fuel-powered engine, with an e-cargo bike your body becomes the engine, and for many this level of physical activity is hugely rewarding.

However, the experiences of riding a conventional push bicycle and riding an e-cargo bike might not be as comparable as originally thought. The infrastructure needs of both are different due to the size and speed of e-cargo bikes, which are not always suited to inner-city cycle lanes. Access to various elements of infrastructure when riding was raised as an important consideration:

> Things that you'll accept on a normal bike or a road bike or a mountain bike, you realise, actually, this barrier is too close. This is discriminatory. These gates, these things that you have to lift a bike onto its rear wheel, that's just not acceptable as part of the cycle infrastructure (Interview II).

The perception of e-cargo bikes by other road users may also differ from that of conventional bicycles, as the e-cargo bike rider is often at work and so may receive

Figure 5 New e-cargo bike designs are coming out every year, offering a range of sizes, including smaller models such as this tern GSD

more respect on the road as a result: *'I was commanding more space, but I think people were giving me more space, and we quite quickly got hi-vis jackets, and it very clearly, on the back of the jacket, says Chorlton Bike Deliveries' (Interview IV).*

It was also interesting to discuss the efficiency of e-cargo bikes in congested urban spaces: spaces where the conventional push bicycle is often seen to be the most efficient transport mode. With this in mind, e-cargo bikes would perhaps be expected to build on this efficiency. However, speaking to a laundry delivery company that uses e-cargo bikes on a daily basis, it was noted that the bikes are not always as flexible as conventional bicycles on congested city roads, as their size and weight can sometimes prevent them from filtering through traffic safely (depending on the road): *'If you've got a big bike or someone that's not comfortable to filter past traffic, then it's [the journey time] going to be, essentially, either the same speed or slower than a car, and then you can get caught in traffic jams at the same time' (FG2)*. In this case, when given the choice, riders tended to choose smaller e-cargo bikes to avoid getting caught in traffic or causing unwanted obstructions on the road, in many cases opting to carry smaller loads in favour of a smoother cycling experience. That being said, e-cargo bikes can still offer flexibility in congested spaces when compared with some of the competition, as observed by one participant: *'Whilst I was there, a guy came and delivered an Amazon parcel in a van, and because her road was so narrow he took ten minutes to turn his van around' (Interview IV).*

Both the Cargodale project and Chorlton Bike Deliveries are e-cargo bike deliery services that were set up during the first national lockdown in 2020 by a team of volunteers to meet a growing need to support their local community. They noted that delivering this kind of service professionally becomes complex when wider costs including insurance, maintenance, long-term bike rental or even ownership are taken into account. For businesses, there is sometimes not enough work to employ people as full-time riders, and so the riders often take on other responsibilities:

> All of our riders are full-time and professionally paid... there are challenges associated with that in terms of efficiencies, of costings. The way, so far, that we've managed to make the most of that is the expectation is that our riders will all have other roles and responsibilities within the business (FG2).

Multiple pick-ups across large distances are a challenge for businesses considering e-cargo bikes due to the limited capacity of the bikes and their journey times generally being longer than those of motorised vehicles over large distances. It was agreed by most participants that their most obvious role is in city centres, where they can overcome the last mile problem by being more

Figure 6 Segregated cycling infrastructure in Manchester City Centre set up during COVID-19 on Deansgate, one of Manchester's busiest roads

efficient, reliable and sustainable than vans or other larger motorised modes. This is perhaps the most appealing characteristic of e-cargo bikes for delivery services working in congested urban areas:

> Our issue with bikes is that: could they get from shop to shop to shop in the correct timeframe and then get it delivered to a house, but using it in the inner cities, like Manchester, for example, would be a lot easier because there's a lot less ground to cover. So as we're going into inner cities, it's something that we're definitely going to use, and we think it would be more efficient than using car (FG2).

3.4 Decarbonising freight in a pandemic

During the first national lockdown many businesses had to quickly adapt to ensure they could continue trading, and this often required providing an online shop and a local delivery service. This not only allowed businesses to continue trading but also ensured vulnerable people could still access goods and services during an incredibly uncertain time:

> There are a lot of customers who can't get into the town centre because they are under very strict lockdown. It's really interesting. You don't realise how many people have got health problems, because they manage them in everyday life (Interview II).

When setting up the Cargodale project mentioned above, a local resident saw this growing need for deliveries and leased an e-cargo bike not only to serve her local community but also to reduce congestion on the roads with the rise of online shopping: *'I realise, people being like me, they'd end up staying at home a lot more and ordering things on the internet and getting deliveries and whatever. That would mean loads of vans' (Interview II).* Some businesses already working with e-cargo bikes reported an unprecedented growth in sales before other businesses adapted and caught up with demand: *'COVID sent my business into overdrive really, we were on§ the other end of it, so we went from 100 deliveries a day to 400 deliveries a day during COVID' (FG2).*

The unprecedented rise in homeworking during lockdown had one of the biggest impacts on road traffic for decades (Hencher and Beck, 2020), and many participants in the study were keen to ensure this momentum continues to rise as society transitions towards a new future. Thinking beyond the bikes as tools for business, questions were raised about the role of e-cargo bikes in maintaining connectivity amongst communities and how they can support people who are vulnerable: *'What role can they play in keeping communities connected? What role can they play in intergenerational work, where older people are struggling to get out to the shops?' (FG4).* A Methodist minister in Manchester had recently started meeting his congregation in person post-lockdown and noted the value of his cargo bike: *'we had our first in-person worship since lockdown, we had that outdoors in the car park of the church I look after in Heald Green. So, basically, I carried everything that we needed for that' (Interview V).*

The pop-up cycle lanes installed by local authorities during lockdown may actually provide some of the best infrastructure for e-cargo bikes in Manchester (Figure 6), researchers noted, as the lanes separate riders from both traffic and pedestrians, as well as providing space to keep a safe distance from other cyclists. They also run on popular commuter roads that connect the city centre with its neighbouring suburbs and could, for example, providing direct segregated access for last mile deliveries working out of distribution centres on the edge of the city or any deliveries being made around the conurbation. However, with this set of opportunities comes a series of challenges for any organisations looking to adopt e-cargo bikes as part of their daily operations. In the next chapter we will discuss these challenges in more detail.

4. BARRIERS & CHALLENGES

Participants raised multiple challenges concerning the adoption of e-cargo bikes by new users or people who do not already cycle in some capacity. These perceived barriers included the size and cost of the bikes, difficulties in delivering multiple drop-offs, the loading capacity of the bikes, access to suitable road infrastructure, providing secure storage, and the wider societal awareness of e-cargo bikes. Some of these challenges are similar to the long-established barriers associated with cycling generally, while others are specific to the use of e-cargo bikes. They are discussed in detail here.

4.1 Size and cost

Size and cost were the commonest barriers cited by potential users: *'the idea that you might spend £6000 on the top-end cargo bike is just gobsmacking really' (Interview IV).* These costs are not only a serious investment for businesses but are also seen as a potential risk when comparing the bikes with tried and tested transport modes that people understand: *'I think you're normally looking in the region of £2000 to £5000, and then, when you look at a second-hand van, that can almost be purchased for that price' (FG1).* The costs and associated risks of emerging technologies can still outweigh the potential environmental benefits when making business decisions. This is not exclusive to e-cargo bikes and is an ongoing challenge across many different sectors.

Another issue is that e-cargo bikes are neither small nor light, often weighing between 30 and 50 kg before they are loaded up, and, while more designs are entering the market every year, the bikes that are designed to carry heavy loads are usually much bigger and heavier than conventional bicycles. Therefore, issues around storage and security become additional barriers to potential adopters: *'it is so big compared to a normal bike. We can hang our normal bikes up, and we can't do that with this' (Interview II).* However, for some people a smaller size could be a benefit when routes require them to fit into tight spaces: *'If cargo bikes reduce down the size, we can actually get them closer into the hospital site and then not have these vehicles trundling around our hospital sites and impacting on the air quality all day' (FG4).*

Figure 7 There is a need for increased awareness of e-cargo bikes before they can become part of everyday life

4.2 Transporting hot food

For catering companies tasked with transporting hot food, concerns about heat retention when using e-cargo bikes were expressed: *'There's only one barrier, well, two really: one, hot food, that's the biggest one; and two, just doing multiple pick-ups' (FG2)*. Heat loss while travelling is perceived to be less of a problem with vans; however, vans can be subject to parking and access issues on busy urban roads, something an e-cargo bike is not. One catering service said that sometimes the only option they could see was to park illegally when doing deliveries around their site, as there was often no nearby parking: *'there's double yellow lines out there, so we quite often get parking tickets, because there isn't anywhere where you can unload that is legal' (FG3)*. This led one participant to reflect on the question of choice for businesses and the influential factors involved when moving away from conventional fossil fuel vehicles towards a new sustainable alternative: *'Apart from the environmental push and the internal factors, like a personal business owner's factor, what is there that's making them choose cargo bikes rather than a regular diesel delivery company?' (FG2).*

4.3 Licensing, insurance and security

Licensing and insurance were cited as challenges for businesses thinking about switching to e-cargo bikes. Currently, there is no standardisation across the industry about how to manage the bikes, and, while many operators will have indemnity insurance for their riders, *'they're also keen to make sure that the riders have got the relevant experience. So you can imagine, because they're doing that job as a day job, they'll have risk assessments and rules about who can ride a bike' (FG5)*. This is currently managed at a business-to-business level, which can provide more flexibility for new businesses or start-ups, while offering bigger businesses the opportunity to complement their fleets with a supplementary vehicle that is not tied down to broader licensing limitations. However, it might also act as a barrier for new adopters who do not have the time or qualifications to design their own internal policy. This may seem even more challenging for anyone who is not experienced in cycling more generally.

Insurance came up as a complex issue and again varied from case to case, as larger organisations generally have broader legal considerations to make around risk management. In the case of the volunteer-led delivery schemes in this study, insurance served as a basic protective measure:

> That does give me the peace of mind that if anything happens then my volunteers are protected and we don't get sued (Interview II).

> A big upside of these vehicles is that they aren't licensed. In a way, we don't really want them to be, because that allows a large proportion of the community to actually use them (FG5).

Bike theft was raised as a concern for new adopters, as it is felt that e-cargo bikes attract more attention than regular bicycles due to their size and perceived value. The benefit of the bikes being able to deliver to someone's door without the need for street parking comes with the drawback of having to lock the bike to itself (using a frame lock) when there is no post or Sheffield stand available. It is important to note that experiences and perceptions of theft and vandalism vary across individuals, and these potential risks can act as additional barriers for new adopters.

4.4 Perceptions and incentives

The way incentives for travel are managed in organisations makes a difference for people who might be risk-averse or tentative about trying out an e-cargo bike. For example, one focus group participant felt that their employer tended to favour the car. In this case, there were expenses available for staff driving for work but not for equivalent cycle journeys, and the participant felt that the organisation had fairly low cycling levels as a result: *'Nationally, that's the issue – the payment of travel expenses – it is done nationally, and it favours the car by its nature' (FG4).* These incentives not only increase the appeal of car use but also make it less likely that people will explore alternative transport modes for work or seek out information on emerging mobility options such as e-cargo bikes.

One of the more complex challenges is encouraging van users to consider e-cargo bikes as a viable option. Participants noted that businesses are concerned that their staff do not want to be *downgraded* to e-cargo bikes if they were driving a car or a van previously: *'the big problem for the carriers is they've already got a workforce that's unionised, who are used to sitting in a comfy van and out of the rain. They aren't going to want to ride cargo bikes' (FG5)*.

4.5 The need for increased awareness

The perception of risk comes from both a well-honed understanding of how vans operate in a business and a lack of knowledge about, and experience of, e-cargo bikes. Many people in the UK still do not know what they are, and this can be an additional setback before you even begin: *'It's rather like going to somebody who has ridden a horse all their life in 1920 and saying, "What you need is a car", and they go, "A car! What's a car?" That's the stage we're at' (Interview I)*. Increasing awareness of, and education about, e-cargo bikes were generally agreed by most participants to be essential components of the e-cargo bike story moving forward. For many people, if they are unsure about something they need to have a strong motivation to find out more; otherwise, they will just avoid it, as that is much easier than taking a risk: *'I'd be scared to death of using a cargo bike because of the size of it, but that's because I've not been on one' (FG3)*. One participant neatly

summed up the scale of the problem: '*At the moment, you can't talk to somebody about using a cargo bike. Most people have never seen one' (Interview I).*

Multiple participants suggested that one solution to this could be increasing the number of leasing schemes available to people to trial the bikes and better understand what their role might be. Another way of doing this is by introducing *e-cargo bike libraries*. These libraries are essentially a fleet of cargo bikes that are available for businesses or individuals to rent over a flexible borrowing period and are managed by a central organisation (Sustrans, 2019). The libraries offer information about the different models of e-cargo bikes and free training resources for businesses looking to better understand how the bikes can work for them. They can offer free advice on evolving business models and free trials to experience the different types of e-cargo bikes available and explain the varying roles of technology, which came up during discussions as an essential component of the e-cargo bike ecosystem.

4.6 Build it and they will come

One potential solution for convincing businesses and employees to consider e-cargo bikes as an option for them could be the development of segregated cycling infrastructure that is not only safe to use but also provides a real alternative to fossil fuel vehicles in terms of efficiency. One participant noted:

> The obstacle to progress is the right conditions on the road in the city in question, and one is that you've got the right premises, and the second one is that you've got the right rules for ensuring that sustainable transport logistics is the only way to do it. So... produce a zero-emissions zone in the middle of Manchester, for instance, is one of the things you would do (Interview I).

Of course, infrastructure to encourage cycling goes beyond segregated cycle lanes. Infrastructure can also encompass the wider socio-political environment, which relies on the power of decision makers and local authorities when decarbonising a city. These broader strategic decisions are often slow-moving, and it can be challenging to get buy-in from the general public when they present (what is perceived as) an inconvenience to large portions of a population. However, there are some quick wins to be made. Large organisations who manage large sites may be able to adapt their existing infrastructure to accommodate e-cargo bikes if there is a will to do so: *'A number of our hospital sites have basically got an internal distribution tunnel, which isn't accessible to a Ford Transit, but it would quite neatly fit an e-cargo bike' (FG4)*. There is also the opportunity for e-cargo bikes to service large industrial sites, which often have a need to transport small to medium-sized loads over short distances frequently.

The discussions around infrastructure share common ground with cycling more widely but, interestingly, when it came to off-road infrastructure, comparisons were made between the needs of wheelchair users and e-cargo bike users: *'We've got a lot of infrastructure that's supposed to be a cycle route that's actually inaccessible to wheelchairs and really difficult to navigate buggies. Basically, the cargo bike has all of the same problems as those demographics' (Interview II).* This includes canal towpaths, footbridges or riverside cycleways where chicanes often block entry for larger vehicles, including e-cargo bikes. For these reasons, the majority of e-cargo bike users in the study expressed a preference for riding on roads rather than off-road: *'It's better to stay in the middle of the road and hold your nerve. It's shameful. I think if you're not an old hand at cycling, you'd probably not want to do it' (Interview IV)*. This suggests that the size of e-cargo bikes can potentially dictate the experience of the journey, with larger bikes leading riders to use roads, where they are subjected to road traffic and fall victim to congestion.

5. THE ROLE OF TECHNOLOGY

Technology was alluded to in a variety of ways during discussions with participants currently using e-cargo bikes. It seemed that technology was an essential component of running an e-cargo bike operation, and therefore we felt it is an important aspect to discuss here.

5.1 Electric assist

The electric assist motor in an e-cargo bike plays a vital role in the removal of traditional barriers to cycling, which include steep terrain, long distances and concerns about personal fitness: *'I think if you didn't have an electric bike... I think I'd end up feeling quite intimidated really, but I think having an electric bike, you can just pick that pace up a bit' (Interview IV)*. It allows the bike to transport heavy loads that would be substantially more difficult to transport without the assistance of an electric motor. This is the key element that defines the e-cargo bike as a viable form of transport for urban freight delivery. It is not only able to transport heavier goods than a conventional bicycle, but it can do it faster while tackling longer distances and steeper terrain without demanding huge levels of fitness from its rider.

5.2 GPS tracking

Aside from the technology of the e-cargo bikes themselves, one form of technology frequently mentioned in our discussions was GPS tracking technology, which allows operators to keep track of their riders. This has the dual purpose of ensuring rider safety and also service efficiency: *'it's about managing your riders so that they can just do the riding and don't have to be really worried about, "Will I actually reach my destination and be able to deliver stuff?"' (Interview II)*. One participant involved with Chorlton Bike Deliveries noted that many destinations could sometimes be difficult for the rider to locate, as they could be set back from the road or signposted incorrectly. In these instances, the operator was able to consult more detailed maps remotely and redirect the rider to their destination quickly and effectively.

Operators are also able to keep an eye on the overall time being spent on deliveries, allowing them to anticipate more accurately when the rider will return to base to restock the bike. Google Maps was initially a popular choice of technology for organising deliveries, but over time the requirements by operators began to evolve due to increased demand and more complex orders: *'Google*

Figure 8 Technology plays a vital role in the management of e-cargo bike delivery schemes

Maps allows you to put each address in, but it doesn't order it for you in terms of making a nice loop. So we've been in conversation with DriverNet' (Interview IV). Technology that can support delivery planning to maximise the rider's efficiency is a valuable asset, especially when operating in the context of a global pandemic. Journey planning technology can also prioritise the kinds of goods being transported, for example, ensuring that hot food is delivered first. DriverNet is a service used by two of the volunteer-led e-cargo bike delivery schemes mentioned in this study. One participant described it as:

> It's basically a social care, on-demand, bus route planner. They really kindly allowed us to use it to manage our trips and deliveries. Normally, a social care bus would pick people up and deposit them. You can just use it in the same way but for parcels rather than people (Interview II).

5.3 Online shopping

Another form of technology that has surged during COVID-19 is the online shop. During the first national lockdown many businesses had to set up online shops almost overnight to ensure they could continue trading, whereby they would become solely reliant on deliveries. One participant summarised the experience: *'Setting up shops for online stores – it's just a nightmare!' (FG2).*

The availability of this technology has led to a change in practice for many businesses operating in a COVID-19 world. One catering company in the study adapted to the challenges of lockdown by setting up an app targeted at students who were confined to their halls of residence during the final months of their academic year: *'we already have an app at the moment, the Yoyo app, and so during lockdown students would order hot food via the app and we would deliver' (FG3)*. This was a response to the cancellation of hundreds of catering orders for events that were no longer possible under lockdown rules and helped the business continue to trade during a difficult time. The company are now considering using e-cargo bikes for future deliveries: *'for us, it's getting around campus quickly, and I think with the e-cargo bikes it'd be a lot easier' (FG3)*. The bikes could remove barriers such as the parking and access issues mentioned previously, allowing orders to be delivered more efficiently and sustainably than is done with vans, which are limited to nearby roads and struggle to access the central campus.

5.4 Communication technologies

In the early days of the first national lockdown social media technology was used to communicate with, and between, businesses that were adapting to the rapid changes taking place by moving their services online. For one participant involved with the Cargodale project, WhatsApp was an essential line of communication with businesses: *'Local shops have just sent me WhatsApps. I've got various WhatsApp groups going on that just show you. They say, "I've got these deliveries, can you do them?"' (Interview II)*. This sentiment was echoed by a participant from Chorlton Bike Deliveries: *'If it hadn't have been for WhatsApp in these past three months, I think all of this would have been extremely difficult' (Interview IV)*. Choosing a social media platform early on and encouraging its sole use for communications may also be a useful approach, as the number of social media platforms available is vast, and this can potentially cause issues for the operator, who would be managing multiple platforms simultaneously:

> Some of my riders use WhatsApp, some use text, some use phone and some use Facebook Messenger; hurray! If I had a business idea, it would be scrapping everyone's disparate communications and putting them in one place. That is an issue (Interview II).

Technology is contributing to our daily lives in new ways every day, and e-cargo bikes (and e-mobility more widely) are no exception to this. At this point we need to ask ourselves: the technology may be working well as a proof of concept, but is the world ready to embrace it? How do we build a world where e-cargo bikes and sustainable freight become legitimate options? In the next section we begin to look at these questions in the context of a rapidly evolving world.

6. THE FUTURE OF E-CARGO BIKES

6.1 Summary of findings

Our findings enable us to respond to the research questions (RQ) that we outlined at the beginning of this report. Our discussions with those currently using e-cargo bikes and those who see a role for them in their businesses evidence a range of ways in which these vehicles can become part of delivery practice and a substitute for other transport modes (RQ1). Although it is outside the scope of this study to measure it, this shows a potential for reductions in carbon emissions and therefore a contribution to the decarbonisation of urban areas and the wider clean air agenda (RQ2).

Notwithstanding these potential benefits and the evidence that some businesses are already making e-cargo bike freight deliveries work for them, there remain significant challenges in relation to mainstreaming this relatively new technology. These include the size and cost of the bikes when compared with other tried and tested (and competitively priced) transport modes such as light commercial vehicles. Other challenges include limited loading capacities, storage, multiple drop-offs (particularly with hot food) and a general lack of awareness of e-cargo bikes (RQ3). Overcoming these challenges relates not only to the design of the bikes but also to the urban environment and available road infrastructure (RQ4), as well as the practices and expectations of businesses (RQ5).

We have seen, for example, that users can experience challenges when using e-cargo bikes on existing cycling infrastructure, which can be narrow and require tight manoeuvres. Similarly, business practices may need to be adapted to ensure that the bikes are kept charged throughout the day and that fresh produce remains fresh and/or warm.

6.2 Estimating societal readiness

The opportunities for e-cargo bikes are clear, but are we ready? In order to answer this question, it is important to understand the societal readiness of e-cargo bikes (Figure 9). Societal readiness refers to the stage of development of a socio-technical innovation and how close it is to being acceptable to society. It determines how effective the innovation is and whether it has potential to work at scale and speed, as well as how it contributes to the public good (Büscher and Spurling, 2020).

Traditionally, societal readiness has often been framed around the question: *How can we make society ready for our technical innovations?* An alternative approach is provided by the EPSRC-funded sustainable mobility network DecarboN8 (Büscher and Spurling, 2020), who ask: *How ready are our socio-technical innovations for society?* In other words, rather than designing a new innovation and convincing swathes of a population to

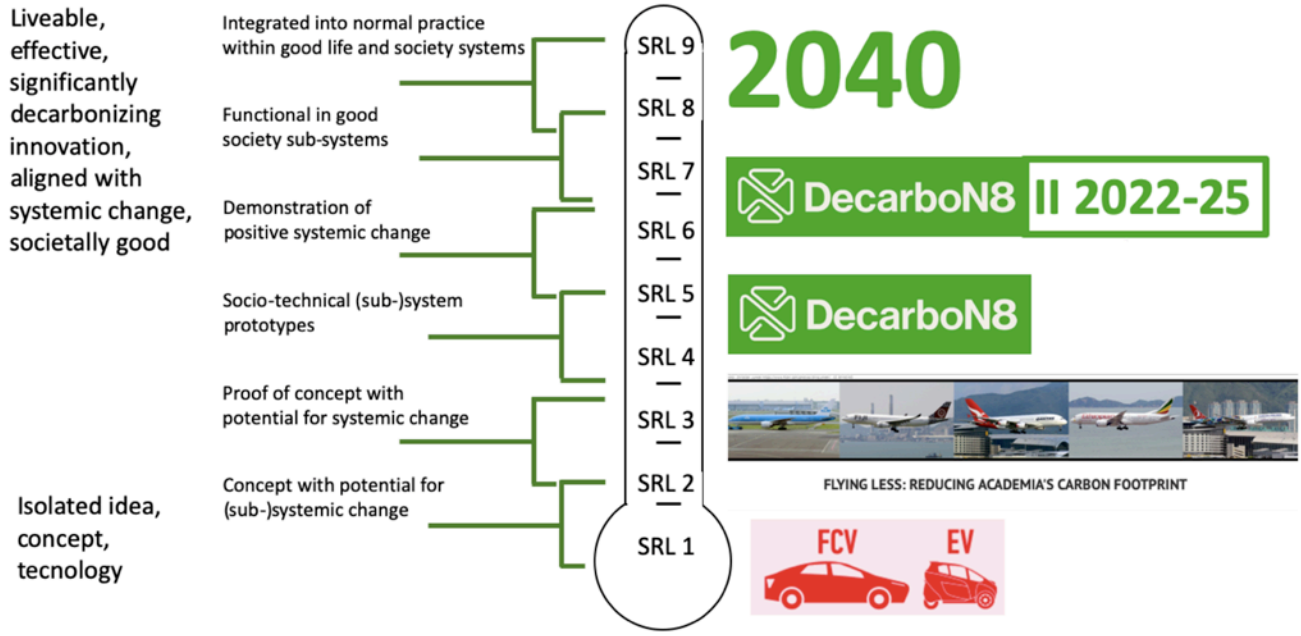


Figure 9 **Socio-technical definition of societal readiness levels (Büscher and Spurling, 2020)**

change their behaviour quickly to accommodate it, how can we design innovations that naturally fit into the existing order of things, requiring minimal behaviour change to accommodate? To illustrate this, they have broken down the concept of societal readiness into nine Societal Readiness Levels (SRLs) that reflect the different stages of an innovation's journey from its initial inception to when it develops, grows and makes its way to becoming acceptable to society.

In terms of placing e-cargo bikes on the SRL scale, this study suggests they are currently operating at SRL 5 in Greater Manchester and have the potential to move to SRL 6 as uptake continues to grow and there is evidence of systematic change, i.e. more businesses use the vehicles and customers come to expect e-cargo bikes to be part of delivery practices. This grading is based on the experiences of our interview and focus group participants, who were largely based in Greater Manchester with two relevant non-Greater Manchester case studies included. It reflects the fact that e-cargo bikes are in operation across Greater Manchester and the UK, even if at a relatively low level, and that there are the beginnings of a socio-technical subsystem evidenced by uptake by businesses and local communities and investment by Transport for Greater Manchester in creating an e-cargo bike hub in 2021.

There is still work to do, however. This study suggests that e-cargo bikes are potentially already operating at SRL 8 and SRL 9 in countries with long-established cycling economies, to the extent that they are considered to be part of everyday business practices. In this sense, the technology has already been designed, tested and manufactured at scale and is now proving to inspire new ways of doing business. Culture also plays a role in this story, with large portions of the population already familiar with bicycles and the physical act of cycling, potentially making it easier for van drivers to transition to e-cargo bikes.

In the UK COVID-19 and the first national lockdown have been instrumental in encouraging broader thinking about sustainable urban transport and the role of active travel in a post-COVID world for businesses and individuals alike. Usage of these sustainable modes remains low, however.

6.3 Boosting societal readiness

Perhaps the greatest challenge to moving e-cargo bikes up the SRL scale is that the technology is new but the underlying principle is not. Cycling is not a new activity, and until cycling levels increase across the UK e-cargo bike use will potentially remain a small and slowly growing portion of freight transport. There are many reasons for this that have been discussed previously, but perhaps an important one is that e-cargo bikes currently tend to appeal to people who have a lot of cycling experience. Put simply, e-cargo bikes are more likely to be prevalent if there is a strong local culture of cycling, since this would mean that cycling is a familiar activity and one in which staff and businesses would have confidence, and other road users would be more accepting of people cycling on the roads.

One participant who set up an e-cargo bike delivery service during the first national lockdown noted that: *'I've been riding for a long time, and I also was trained as a national cycling instructor. I'm very confident about road positioning and so on' (Interview IV).* or people with less cycling experience e-cargo bikes can be an intimidating prospect and present particular challenges over and above *conventional* cycling, largely due to the size and form factor of e-cargo bikes.

Although the question 'How ready are our socio-technical innovations for society?' is important and places an emphasis on the appropriateness and particular *fit* of an innovation, these points emphasise that some innovations – particularly those that require changes in behaviour and business practice rather than a more straightforward substitution of one technology for another – will need to be compatible with wider societal shifts. This could mean an acceptance of cycling and the development of a policy environment that favours investment in infrastructure that facilitates it. In this sense, the case of e-cargo bikes reinforces the notion of co-evolution (Brand, 2005; Rydin et al., 2013) by highlighting the importance of factors in our cultures and built environments in the acceptance and development of a new technology. Whilst some innovations can be fitted into existing patterns or practices – in this case, travel patterns and business practices – some innovations demand new ways of acting: in this case, a switch from driving to pedalling, as well as the consideration of reconfiguring delivery patterns.

Technology is evolving rapidly to support the growth of sustainable urban transport, and experiences during 2020 suggest that e-cargo bikes can play a valuable role in a post-COVID world. Acceptance of, and support for, cycling infrastructure are also increasing amongst both policy makers and users and have to some extent been boosted during the pandemic. E-cargo bikes are diversifying quickly, with a range of designs now available on the market to suit a range of purposes from casual domestic use to larger everyday commercial freight. Manufacturers are really pushing to make e-cargo bikes suitable for everyone. The case for e-cargo bikes to reduce CO_2 emissions, improve efficiency within the last mile and become an integral part of transport systems is getting stronger every year.

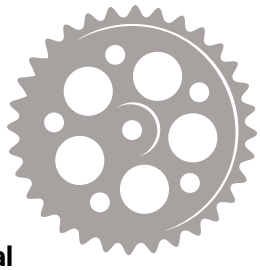
6.4 Implications for future research

This is a scoping study on the potential of e-cargo bikes in Greater Manchester, and it is therefore important to identify the implications for future research in this field. In this study we have been able to provide examples of opportunities where e-cargo bikes can replace light commercial vehicles for deliveries, but it is outside the scope of the report to provide any data on carbon savings attributable to e-cargo bike use. There is an opportunity to better understand the potential impact on carbon emissions through a more detailed understanding of the ways in which e-cargo bikes are used and what *conventional* journeys they replace. The quantification of the impact of e-cargo bikes on business practice – through metrics such as comparative journey times, running costs and the impact upon staff – would provide an evidence base for the value of these vehicles to the economy and therefore have a significant impact on infrastructure and incentives as policy makers discuss the future of sustainable transport.

We have highlighted the relationship between e-cargo bike use and cycling in relation to both the confidence and skills of individuals and, relatedly, the extent and nature of cycling infrastructure. There is a need to better understand the ways in which e-cargo bike use fits with cycling as a practice in a more general sense and to identify the extent to which embedding the former in business practices depends on normalising the latter within the context of everyday mobility. If e-cargo bikes are to be accommodated within the growth of cycling infrastructure currently evident in UK cities, then we need to understand what is required.

Future research can develop further understanding of what challenges particular sectors of the economy would experience if they engaged more substantially with e-cargo bikes, as well as mapping the types of skills required by staff in order to effectively use e-cargo bikes and determine how different levels of training can be delivered. Concerns about insurance were expressed by potential new adopters due to there currently being no standardisation across industries about how to manage the bikes, which are currently managed on a case-by-case level. Finally, identifying what business support measures would enable organisations to more effectively include e-cargo bikes in their delivery fleets would be essential as we continue to identify new uses for e-cargo bikes beyond those discussed here. Ultimately, it is hoped that this study will inspire more research and discussion around the role of e-cargo bikes in society as we scale up the use of e-cargo bikes across industries and move towards a sustainable freight future.

7. KEY FINDINGS



E-cargo bikes have potential

Businesses see value in the vehicles not only because, when compared with vans, they contribute to a smaller carbon footprint and a greener company image, but also in relation to practical benefits. In comparison with conventional bicycles, the larger frame and electrical assistance offer a way to carry relatively large loads without high levels of fitness. In comparison with electric vans, our participants recognised that the bikes offer lower running costs and can reduce congestion. There are opportunities to integrate e-cargo bikes into delivery practices in order to capitalise on their potential for last mile deliveries in the context of freight.

Barriers to using e-cargo bikes are shared with conventional cycling

However, e-cargo bikes also have their own barriers. Electrically assisted bikes help to overcome barriers relating to fitness levels and carrying heavy loads, but e-cargo bikes introduce their own challenges. The potential barriers identified by our participants include the initial capital cost, storage, charging and manoeuvring in traffic, as well as understanding the long-term maintenance of the bikes.

E-cargo bikes are more than just technology

They do not reflect a straightforward substitution in technology. In order to scale up, there is a need for business practices to adapt, new technologies to be adopted and delivery patterns to be changed to inspire long-term decarbonisation. Delivery operatives must also have skills in cycling.

Support for businesses is vital

Not only will businesses compare the initial capital outlay associated with a bike with the cost of a van – for which there is a more developed second-hand market – they will also consider the risks of training staff and rethinking delivery practices. Opportunities to try the bikes, and support for businesses to understand their running costs and how they can adapt their practices to accommodate the bikes should therefore be policy priorities.

Technology is key

Rider tracking and online shops improve efficiency and help to make the bikes a realistic consideration for businesses.

Education and awareness raising are needed

Awareness of e-cargo bikes and their potential remains low. More trial schemes and e-cargo bike libraries are needed for people to understand their potential and how they might use them.

Research can aid the transition

A clearer understanding of the potential emissions reduction from e-cargo bike adoption, the approaches that businesses can take to adapt their practices to benefit from the technology, and the ways in which cities can configure infrastructure and road space to better accommodate the vehicles, will provide a provide a valuable evidence base for a transition to sustainable freight systems.

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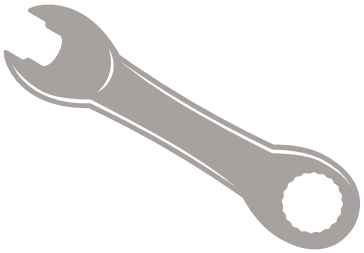
APPENDIX: Methodology



8.1 Aim

This study aimed to understand the potential uptake of e-cargo bikes for businesses and small-scale freight transport in the UK, using Greater Manchester as a pilot study area. We sought to understand the potential contribution of e-cargo bike schemes to an overall reduction in traditional fossil fuel-powered transport, as well as their pragmatic offer as a legitimate alternative to conventional vehicles.

8.2 Process

Data was collected using a three-stage process:

- Literature review
- Five semi-structured interviews
- Five focus groups

Existing literature on e-cargo bikes in cities across the UK and around the world was collated and informed the basis for interview discussions with e-cargo bike pioneers (defined as people already using e-cargo bikes in Greater Manchester). Themes coming out of these interviews were then used to frame the direction of the focus group discussions.

Due to COVID-19 and the need for social distancing, interviews and focus groups were carried out online using Microsoft Teams. The discussions were recorded and sent for transcription, and the transcripts were analysed using NVivo 12. Researchers used a thematic analysis approach to identify themes arising from the discussions.

8.3 Interviews

Five interviews were carried out with e-cargo bike pioneers to understand how e-cargo bikes are currently being used in Greater Manchester. Interviews were semi-structured, allowing discussions to flow naturally but also be supported by a set of predetermined questions identified by the researchers. Consent forms were signed by all participants.

8.4 Focus groups

Five focus groups were then carried out online using Microsoft Teams between August and September 2020 and included 21 participants, with between 4 and 7 people in each group. Each focus group was focused on a particular sector, with the participants reflecting a range of roles within it. The focus groups were semi-structured and guided by a set of predetermined questions based on the findings of the interviews.

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The Crescent
Salford
M6 9PU