The Promise of Low-Carbon Freight

Benefits of cargo bikes in London

August 2021

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The mission of KR Foundation is to address the root causes of climate change and environmental degradation.

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pedal me

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Summary

Freight transport contributes significantly and increasingly to climate change. In urban areas, goods vehicles contribute to deteriorating public space quality, air quality, and other road users' safety. In London alone, between 2015 and 2017, vans and HGVs together were involved in 32% of total fatal collisions. The 213,100 vans owned by Londoners, when parked outside, occupy around 2,557,200 sqm of road space, the equivalent of just under twice the size of Hyde Park. The growing demand for home deliveries is predicted to worsen the situation, which will not be contained by shifting to less polluting vehicles alone.

Cargo bikes, having become popular in several cities, can provide an alternative to the current damaging freight transport model which is increasingly relying on delivery vans. This report provides a study of the logistics potential of cargo bikes for urban deliveries. Using GPS data, we compare routes taken by Pedal Me cargo bikes in London with routes that vans would have to take to deliver the same parcels.

We find that the service performed by the Pedal Me freight cycles is an average of 1.61 times faster than the one performed by van. Moreover, in the 98 days of work sampled, Pedal Me helped save a total of 3,896 Kg of CO_2 and over 5.5 kg of NO_x, showing that cargo bikes can serve their customers better than a van without generating many of the externalities currently associated with urban freight.

Previous systematic studies have estimated that just over half of all motorised freight logistics in urban areas could be done by cargo bike. We've assumed that at least part of this is immediately possible in London. We estimate that expanding cargo bike services to replace 10% of the van-km currently driven in London would mean saving as much as 133,300 tonnes of CO_2 and 190.4 thousand Kg of NO_x per year. At the same time, it would reduce urban congestion and free a total of 384,000 sqm of public space usually occupied by parked vans and 16,980 hours of vehicle traffic per day.

These benefits are not just specific to London, with the 100,000 cargo bikes introduced in Europe between 2018-2020 estimated to be saving, each month, the same amount of CO_2 needed to fly about 24,000 people from London to New York and back, i.e. 80 Boeing 777-300 flying over 890,000 Km.

We conclude with some key recommendations for supporting the expansion of cargo bike freight in London and improving our roads for many that still struggle to use them safely.

1. Introduction

Freight transport contributes significantly and increasingly to climate change, constituting 30% of global carbon emissions from road transport. One big chunk of these emissions is produced by Light Goods Vehicles (LGVs) or vans, which are increasingly used to deliver or move goods in urban areas. Vans also contribute to deteriorating conditions on our roads; in European cities, goods delivery is reported to cause 40% of total particulate emissions and 50% of the total NOx[1].

In the UK, vans have been the fastest-growing source of road traffic since 1985, with van-km increasing by 106% over the last 25 years[2]. In 2018, the Committee on Climate already estimated that 22% of this growth in van-km was due to increased internet retail deliveries. The recent changes in travel behaviours linked to the Covid-19 pandemic, and the increasing reliance on home delivery services, are expected to worsen this situation, with government projections of a nearly 70% further increase in van-km by 2050[3].

In this scenario, the government strategy for carbon emission savings, centred on supporting EV uptake, further regulating CO_2 emissions and introducing wider Clean Air Zones (CAZ) and Ultra Low Emission Zones (ULEZ), might not contain the negative impact of this growth. Even with cleaner technologies, we expect cities to see a growing fleet of LGVs congesting roads, using public spaces for parking, and deteriorating conditions and safety for those walking or cycling or using public transport[4].

A comprehensive solution to this problem requires a radical shift in production and consumption patterns, with greater reliance on local production and more precise options to address and tax the embedded carbon of consumer choices. These are vital strategies, especially if lowering greenhouse emissions has to be coupled with social justice objectives and increasing quality and liveability in urban (and not only urban) environments[5].

Whilst achieving such a radical shift might require a more substantial commitment to solving both the climate change

[1] Wrighton and Reiter (2016). CycleLogistics – Moving Europe Forward!
[2] DfT (2020). Provisional Van Statistics 2019-2020
[3] See for example, Mattinson (2020). Lockdown order surge underpins Just Eat Takeaway.com global sales jump
[4] And still worrying levels of carbon emissions if no further actions are taken, as stated by DfT itself in the report: DfT (2020). Decarbonising Transport: Setting the Challenge
[5] See for example: D'Alessandro et al. (2020). Feasible alternatives to green growth

emergency and air pollution at all governance levels, actions can and must begin at all levels. In this, grassroots innovations have the potential to upscale and accelerate transitions[6].

One such 'innovation' is the adoption of bikes or e-bikes[7] not just for personal mobility but as an efficient tool for transporting goods, other people, children, animals and much more. Cargo bikes, typically used in our cities before the uptake of the private automobile, and daily used in other geographical contexts where other options are not available, are coming back to the UK and becoming increasingly popular in western countries.

Image credit: Radek Kucharski // CC BY 2.0

Freight cargo bikes companies are spreading rapidly, with sales of cargo bikes across Europe doubling just in a few years accompanied by funding to support their uptake. Many cities across Europe and beyond are subsidising cargo bike trials and studies[8]. Evidence is growing around cargo bikes' potential to provide a non-polluting and low-carbon

[6] See for example the different example of 'city makers' proposed in Koning et al. (2017). Ten types of emerging city makers
[7] Brand (2020). Cycling is ten times more important than electric cars for reaching net-zero cities
[8] City Changer Cargo Bike (2020). European Cargo Bike Industry Survey

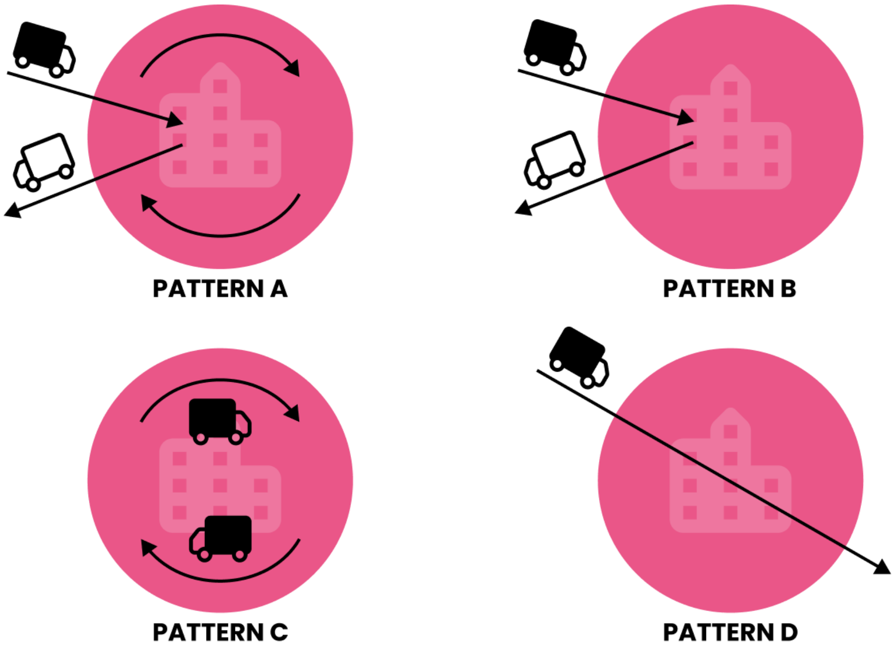
alternative, especially for short-distance delivery. Cargo bikes can improve urban environments whilst ensuring fast and reliable delivery of goods.

This report explores, in-depth, the benefits of cargo bike use starting from the perspective of Pedal Me, a fast-growing cargo bike logistics company in London. By analysing GPS data that depicts the work currently done by Pedal Me, we show how cargo bikes can deliver goods in a faster and cleaner way than vans currently do, as well as contribute to broadening our conception of what can be achieved through sustainable modes of transportation. Pedal Me is proposed as an example of new urban logistics configurations that can shift priorities, practices and values around the movement of people and stuff in our cities.

2. Are vans taking over our roads?

Figure 1 exemplifies the different ways in which the movement of freight impacts city centres. Increasingly strict regulations have helped prevent pattern D, where a van or truck simply crosses an urban area. However, vans are still widely used by the retail sector, e-commerce deliveries and the postal distribution to move goods from the outskirts to the centres (pattern B), or deliver to different locations within the centre (pattern A), or simply contributing to exchanges within the urban areas (pattern C).

Fig. 1: City Logistics' Patterns (adapted from Maess 2017, p. 8)

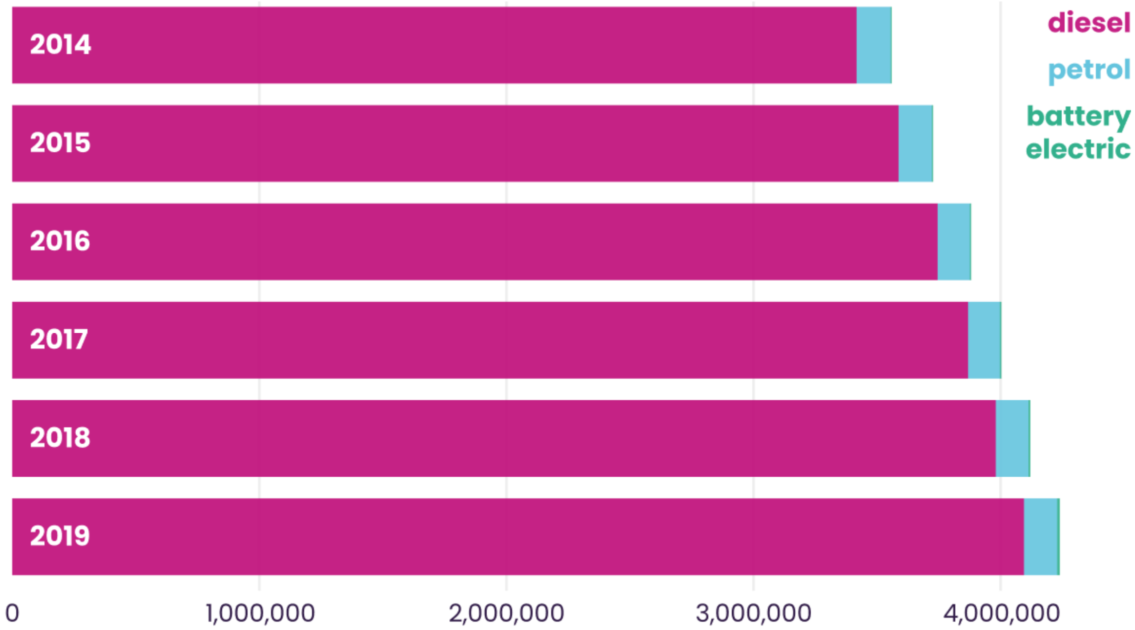


In 2019, in the UK, vans travelled over 84 billion vehicle kms, accounting for 16% of all road vehicle kms travelled annually[9], and 14% of all urban road kms travelled[10] (e.g. 46% of van-km are in urban areas). The number of van kms travelled has increased by over 106% in 25 years[11]. Similarly, the number of registered vans has been steadily increasing nationally since the '90s, reaching more than 4.1 million vehicles in 2019, with 58% of all vans owned by a business[12]. Over 96% of these vehicles are diesel-powered, with the number of electric vans

[9] DfT (2020). Road traffic statistics
[10] Data from: DfT (2019). Table TRA0104, Road traffic (vehicle miles) by vehicle type and road class in Great Britain, annual 2019
[11] DfT (2020). Provisional Van Statistics 2019-20
[12] Ibid.

only slowly increasing but still below 1% (see figure 2 below). Despite the government plans to promote a fast transition to zero-emission vehicles[13], the freight sector remains one of the hardest to decarbonise, especially by solely changing the type of vehicles used whilst demand is growing substantially.

Fig. 2: Licensed light goods vehicles at the end of the year by propulsion/fuel type[14]



In London, van-km, which had been dropping after the 2008/9 economic crisis, have been steadily increasing since 2012, raising concerns for future scenarios[15]. In 2019, vans accounted for 16% of all kms travelled and constituted 6% of all motorised vehicles. In the capital, vans constitute around 80% of all commercial traffic and are responsible for almost all of its recent growth[16]. As reported in the 2019 'Freight and servicing action plan' by TfL[17], this growth is likely to be linked to the rising population and the shift of London's economy increasingly towards the service sector. With the shift of industrial land further from the centre, changes in land use might also explain the substantial growth in van-km, especially in Outer London, compared to the total number of vehicles. The latest decline in the number of registered vans in London might instead reflect the effects of new taxation measures. The introduction of the T-charge meant that many vehicles became effectively unusable in the inner part of

[13] DfT (2018). The Road to Zero
[14] DfT (2020). VEH0403: Licensed light goods vehicles at the end of the year by propulsion and fuel type: Great Britain and United Kingdom
[15] TfL (2019). Freight and servicing action plan
[16] London Assembly (2017). London stalling: Reducing traffic congestion in London
[17] DfT (2020). TRA0106: Motor vehicle traffic (vehicle miles) by vehicle type, region and country in Great Britain

London unless they pay a substantial amount for travelling in the area[18].

A recent DfT survey investigated the use of vans in the UK[19]. Preliminary results show that at least 16% of vans are used to deliver/collect goods, whilst 41% are used to transport material/provide a service. These two purposes account respectively for 23% and 48% of all kms driven, with around 21 billion kms driven only to deliver goods across the UK[20]. On a typical day, 43% of vans used to transport materials and 39% of the ones used to deliver/collect goods wouldn't travel further than 25 kms from their home base, showing that, in both cases, cargo bikes are likely to be able to replace at least some of the trips made by vans.

[18] These changes are predicted also here: DfT (2020). Vehicle Licensing Statistics: Notes and Definitions . For an overview on the T-Charge see: BUYACAR TEAM (2019). What is the London T-Charge?
[19] DfT (2020). Provisional van statistics: 2019 to 2020
[20] Another study reports up to 6 billion van-km associated only with internet retail sales in 2016 (Committee on Climate Change (2018). Chapter 5 Annex: Growth in Van Demand)

3. The costs of urban motorised freight

CO_2

As shown, transporting freight contributes significantly to greenhouse gas emission worldwide. One reason is also the fact that vans (and HGVs) emit more CO_2 per mile travelled compared to cars. The latest figures reported by BEIS[21] suggest average van emissions are 246.2 gCO_2e/Km while an average petrol car emits 147.8 gCO_2e/Km.

In 2019, road transport accounted for 24% of all UK emissions, and 91% of all transport emissions. HGVs and LGVs accounted for 32% of total road transport emissions, with vans alone emitting 16% of the total. The increased mileage and the number of vehicles on the roads also corresponds to increasing van emissions. These have increased by 67% since 1990, from 11.6$MtCO_2e$ in 1990 to 19.2$MtCO_2e$ in 2019[22]. These figures do not account for the emissions embedded in vans' manufacturing, estimated at 8,800 Kg and 7,500 Kg of CO_2 for an electric and conventional van respectively[23].

Concerns regarding the widespread use of vans are not only related to their contribution to climate change but also their direct negative impacts on urban environments.

NOx and PM

Vans specifically contribute substantially to urban air pollution, especially as diesel vehicles are significant emitters of NOx and PM_{10}. In 2018 vans in the UK emitted 92.4k tonnes of NOx, accounting for 23% of all UK NOx emissions from road transport, a 39% increase compared to 2008 levels. It is crucial to note that all other road transport decreased their NOx emissions in the same decade, with cars' levels going down by 45% and HGVs by as much as 86%[24].

In terms of particulate matter, vans account for 16% of both PM_{10} and $PM_{2.5}$ total national emissions (e.g. both from direct exhaust emissions and as an effect of wear and tear phenomena). While the tailpipe emissions have started to fall in the last decade (-20%), tyre and brake wear and road

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[21] Department for Business, Energy & Industrial Strategy (2020). Greenhouse gas reporting: conversion factors 2020

[22] Department for Business, Energy & Industrial Strategy (2018). UK greenhouse gas emissions statistics

[23] Ager-Wick Ellingsen et al. (2016). The size and range effect: lifecycle greenhouse gas emissions of electric vehicles

[24] DfT (2020). ENV0301: Air pollutant emissions by transport mode: United Kingdom

abrasion, which generate important volumes of particulate matter (reaching 60% of $PM_{2.5}$ and 73% of PM_{10}[25]), have gone up, also due to increasingly heavy vehicles being introduced, especially electric vehicles[26].

Taking up public space

In London alone, there are 213,100 vans which, when parked outside, occupy around 2,557,200 sqm of road space[27], the equivalent of just under twice the size of Hyde Park. Nationwide, an area slightly wider than the whole of Oxford is covered in vans[28]. Moreover, often vans are parked outside regular parking spaces, either because their size exceeds the standard parking bay[29] or because they cannot find one. Parking tickets are reported to be one of the main costs faced by courier companies like UPS or FedEx in city centres[30].

Vans contribute substantially to increasing congestion problems in London[31]. Various studies show the magnitude of their effects on public roads, including the 2018 Mayor of London strategy, which reports freight distribution constituting a third of London's morning traffic peak[32]. On average, a van driver is reported to spend around 9 min per trip looking for a parking space[33], making up 67h per driver per year. This leads to a vast amount of excess driving time if we consider that, on a typical day, business vans are reported to make an average of 9 stops, and ULEVs', which are most likely to be used for delivery purposes, report an average of 22 stops[34]. We have also shown how van-km are growing rapidly, whilst car kms are dropping (- 9% compared to 2000) despite the number of both cars and vans increasing[35]. This traffic makes roads and pavements more unpleasant for others, especially as it occurs mainly at peak

[25] Emissions Analytics (2020). Press Release: Pollution From Tyre Wear 1,000 Times Worse Than Exhaust Emissions
[26] Electric vans are substantially heavier than their diesel counterparts, so that derogation on normal regulation of LGVs have been proposed to allow extra weight for electric vans of up to 750 Kg to compensate for the weight of the battery DfT (2018). Regulatory changes to support the take-up of alternatively-fuelled light commercial vehicles - government response
[27] This assuming they occupy a standard parking space, which is around 12sqm in the UK. However, there is evidence that most vans are occupying wider areas (Vanarama (nd). The UK's Commercial Parking Crisis)
[28] Total number of vans * 12sqm, which gives about 50 sqKm
[29] Vanarama (nd). The UK's Commercial Parking Crisis
[30] Ganniger (2015). Upset Over a Parking Ticket? Wait Until You See What FedEx and UPS Have to Pay
[31] London Assembly (2017). London stalling: Reducing traffic congestion in London
[32] Mayor of London (2018). Mayor's Transport Strategy
[33] INRIX (2017). The impact of parking pain in the US, UK and Germany
[34] DfT (2020). Provisional Van Statistics 2019-20
[35] The Society Of Motor Manufacturers And Traders (2017). Light Commercial Vehicles Delivering For The Uk Economy

times when many others are walking, cycling or riding public transport[36].

Road safety

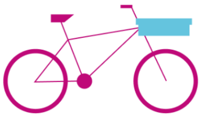
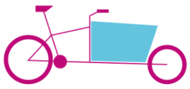
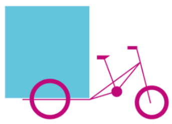
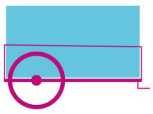
Finally, freight vehicles in general are often responsible for road collisions, making roads less safe, especially for vulnerable transport users. In London alone, between 2015 and 2017, vans and HGVs together were involved in 32% of the total fatal collisions[37]. In 2019, freight vehicles were involved in 17% of the total collisions in London[38]. A study from the USA analysing road collision data between 2005 and 2015 found that "freight-involved injury and fatality rates are rising more rapidly than overall road traffic-related rates, both in all areas and in urban areas. These crashes are also increasingly occurring on local roads and arterials as opposed to interstates"[39].

[36] See: TfL (2019). Freight and servicing action plan
[37] TfL (2019). Freight and servicing action plan
[38] TfL (2020). Casualties in Greater London during 2019 September 2020 1. Executive Summary
[39] McDonald (2017). Urban freight and road safety in the era of e-commerce

4. Introducing cargo bikes

With urban freight delivery increasingly disrupting our roads, it is not difficult to imagine the potential benefits of widespread use of cargo bikes, especially in densely populated areas or Central Business Districts. Food delivery companies have understood this for many years, with Deliveroo cyclists becoming a regular sight in cities across several countries. Companies like UPS, DHL, and FedEx have been using cargo bikes for almost a decade in the USA. But cargo bikes are far more versatile and can be used for a much wider range of activities. Recent estimates report that 51% of all motorised freight trips (for a total of around 1,75 million van-km) in European cities could shift from car to bicycle or cargo bicycle[40]. This shift is possible also thanks to the several types of cargo bikes available, varying loading mechanisms and increasing capacities, and reduced prices compared to motorised alternatives.

Fig. 3: Cargo bike types and capacities, adapted from Element Energy (2016)[41].

Name	Payload	Width
Messenger 	20-40 kg 0.03-0.05 m³	50cm
Front-load cargo bike 	100-125 kg 0.1-0.7 m³	50-90cm
Rear-load cargo bike 	100 kg 0.4-0.8 m³	50cm
Front-load cargo trike 	100-200 kg 0.2-0.6 m³	80-90cm
Rear-load cargo trike 	200-300 kg 0.5-1.5 m³	80-120cm
Trailer 	60-150 kg 0.2-2.1 m³	80-110cm

Cyclelogistics suggests a range of prices and loading capacity starting from lighter bikes priced at €1,000 - €2,000 that can load up to 80 Kg to heavier (and more expensive) bikes capable of moving up to 350 Kg[42]. Cargo bikes can be both electrically or non-electrically assisted. In the UK, bikes can have a maximum power output of 250 W and provide electric assist up to 15.5mph/25km/h. Higher power and

[40] Wrighton and Reiter (2016). CycleLogistics – Moving Europe Forward!
[41] Element Energy (2018). TfL Cycle Freight Study
[42] CycleLogistics (2019). 20 Good Reasons to Ride a Cargo Bike

speeds are classed as a moped and would require a licence, insurance and safety equipment[43]. The debate around e-bikes (and e-cargo bikes) regulation is ongoing in many places, with, for example, New York City legalising their use in 2020[44].

It is difficult to assess the number of cargo bikes currently being used in various countries. A recent survey of 38 EU cargo bikes manufacturers found almost 50,000 bikes sold between 2018-2019 and a similar or higher figure is expected for 2020, for a total of over 100,000 sold in just 3 years[45]. An earlier survey (2016) found cargo bikes operating in 93 urban areas across Europe, with 900 cargo bikes of different forms being used[46]. In the UK, cargo bike freight is active in over 25 cities, with at least 19 companies operating services[47]. These bikes are used to deliver goods or provide assistance with different logistical arrangements, from point-to-point operations, multiple deliveries from one distribution centre, or last-mile operations[48].

The benefits of cargo bikes

The growing use of cargo bikes is expected to bring substantial benefits, both for those using delivery services, those working in the sector and those that currently pay because of the high externalities linked to van use.

Firstly, cargo bikes can help reduce carbon emissions from activities in urban areas. Let's assume that 2 cargo bikes can replace a (diesel) van (although, as we will discuss later, studies show that replacement is in most cases 1:1[49]) which would have been driving for 6 hours a day, 5 days a week, with a speed of 15 km/h[50]. Then, the 100,000 bikes introduced in Europe in just 3 years could be saving the same amount of CO_2 each month needed to fly about 24,000 people from London to New York and back, i.e. 80 Boeing 777-300s flying over 890,000 Km[51].

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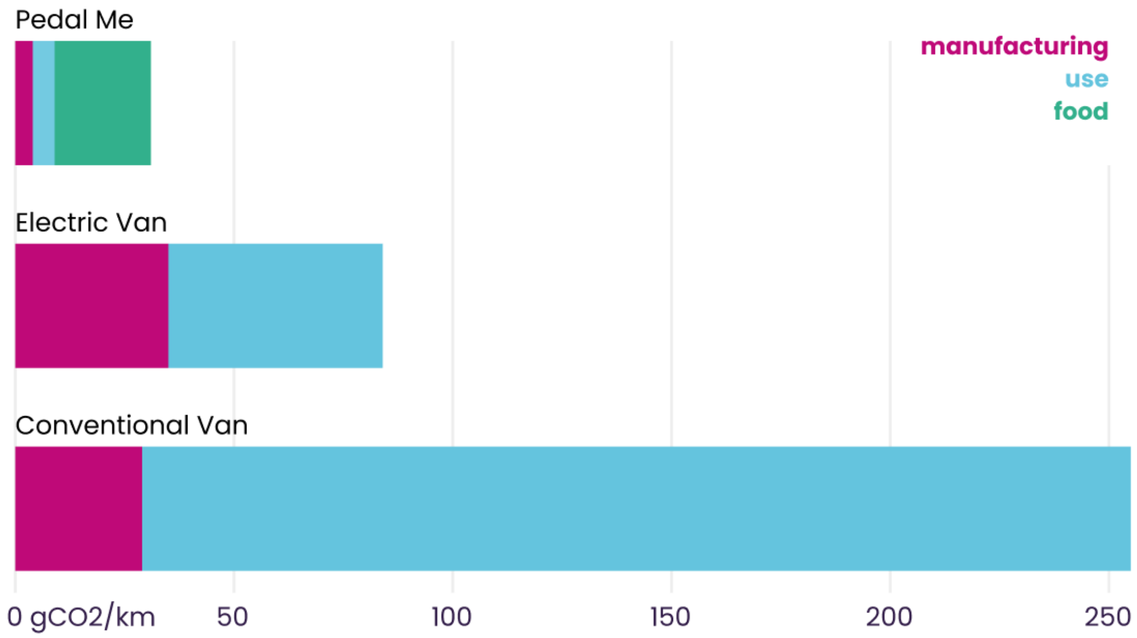
43 Gov.uk (nd). Electric bikes: licensing, tax and insurance
44 Colon (2020). Justice Delivered: E-Bikes Legalized Statewide In Budget Bill
45 City Changer Cargo Bike (2020). European Cargo Bike Industry Survey
46 Cairns and Sloman (2019). Potential for e-cargo bikes to reduce congestion and pollution from vans in cities
47 Element Energy (2018). TfL Cycle Freight Study
48 For a list of case studies showing different modality of cargo-freight see Element Energy (2018). TfL Cycle Freight Study and Cairns and Sloman (2019). Potential for e-cargo bikes to reduce congestion and pollution from vans in cities
49 See for example Melo and Baptista (2017). Evaluating the impacts of using cargo cycles on urban logistics: integrating traffic, environmental and operational boundaries
50 This is the average speed reported in some literature, see for example Allen et al. (2021). Understanding the transport and CO2 impacts of on-demand meal deliveries: A London case study
51 For more examples on potential CO2 savings from cargo bikes see Cairns and Sloman (2019). Potential for e-cargo bikes to reduce congestion and pollution from vans in cities. We are assuming that a van emits 6.1 tCO2e per year, substantially

Following the data provided by Pedal Me[52], we can refine this calculation accounting also for the emissions costs of electric cargo bikes (including both CO_2 emissions linked to electricity provision, 4.5g CO_2/km, and the CO_2 emitted to produce the extra food used to pedal, 22g CO_2/km). Each month the e-bikes would emit as much as 8 Boeings 777-300 flying back and forth from London to New York, while helping us save the emissions of 72 other Boeings. The savings are even higher if we account for the cost of manufacturing vans, which, when diesel, produce as much as 7,500 Kg of CO_2[53] vs as little as 280 Kg CO_2 to make a cargo e-bike. A life span approach can further clarify the hidden effect of manufacturing costs. Pedal Me estimate that, over its lifetime, a diesel van would emit at least 8 times as much CO2 per kilometre as an e-cargo bike (see figure 4):

Fig. 4: Lifecycle emissions from cargo transport options, adapted from Pedal Me[54].



Replacing vans has many hidden complexities that the above exercise is unable to account for. Recent studies have, however, shown promising results. Research with real-time data from food delivery services in London calculated that cars would emit 11 times more than bikes to deliver the same

lower than reported in the literature elsewhere, with, for example, Cairns and Sloman estimating 10.5tCO2e per year. Emissions from a London to New York flight are taken from: Kommenda (2019). How your flight emits as much CO2 as many people do in a year

[52] Pedal Me (nd). How sustainable is the Pedal Me fleet?

[53] Electric vans would cost even more due to their higher weight, with manufacturing cost being estimated around 8,800 Kg of CO2. See: Ager-Wick Ellingsen et al. (2016). The size and range effect: lifecycle greenhouse gas emissions of electric vehicles

[54] Pedal Me (nd). How sustainable is the Pedal Me fleet?

parcels[55]. Another model based on van routes by a leading carrier company showed that porters and cyclists could replace 95% of the van trips in London's Central Activities Zone. Thanks to the setup of several collection and delivery points where a truck would deposit parcels, porters and cyclists could save up to 2 million kg CO_2 per year[56]. Our study in the next section will also refine these calculations by looking at a different logistic model for cargo bikes.

The same cargo bikes are also helping improve air quality in the cities where they operate. In the study reported earlier, replacing traditional vans in London's Central Activities Zone with porters or cyclists is estimated to save 1,633 Kg NOx annually. An earlier study commissioned by TfL said that "each light goods vehicle (LGV) replaced in central London saves over one tonne of CO_2 and almost three kilograms of NOx per year"[57].

Several studies have also shown how, under appropriate conditions, cargo bikes can make urban freight more efficient by reducing delivery distances and times. For example, a trial by DfT found that 97.7% of orders from a local Sainsbury’s could be fulfilled in a single e-cargo bike journey. Additionally, thanks to their ability to use cycle lanes and bus lanes and park closer to the delivery locations, cargo bikes followed shorter and faster routes, improving the service's overall performance[58].

Academic studies report different results but agree on cargo bikes' ability to optimise logistics in densely populated areas with dense delivery points. In 2019, Sheth and colleagues tested four cargo bikes scenarios in Seattle. They demonstrated that cargo bikes are more cost-effective than delivery trucks when used in combinations with localised pick up points, small delivery volumes and close destinations (10 km for a route with 10 parcels per stop)[59].

In other studies, bikes are used in combination with delivery vans and the setup of new distribution centres. For example, Office Depot trialled a new consolidation centre near the Tower of London; the use of electric vans and tricycles to deliver parcels in the area allowed a reduction of 20% in the

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[55] Allen et al. (2021). Understanding the transport and CO2 impacts of on-demand meal deliveries: A London case study

[56] Quantifying environmental and financial benefits of using porters and cycle couriers for last-mile parcel delivery

[57] Element Energy (2018). TfL Cycle Freight Study, p.5

[58] DfT (2019). Future of mobility: urban strategy

[59] Sheth et al. (2019). Measuring delivery route cost trade-offs between electric-assist cargo bicycles and delivery trucks in dense urban areas

total distance travelled[60]. A 2017 study on Porto, based on a microscopic traffic simulation model of electric cargo bikes replacing diesel vans in local trips, showed that cargo bikes can replace up to 10% of the conventional vans on a 1:1 ratio without changing the overall network efficiency, and reducing CO2 emission by 73%[61]. We explore the potentials for cargo bikes to improve urban logistics in Section 6 of this report.

By reducing the number of vans driving in densely populated areas, cargo bikes are also of great help in freeing up public roads and pavements. This is especially considering that, as discussed, delivery vans are reported to spend 9 minutes on average per trip to find a parking space and are often forced to block pavements or cycle lanes in the absence of suitable space. With the adoption of further parking restrictions in residential areas, the situation might worsen, with parked vans disrupting and endangering pedestrians, cyclists and residents. With their substantially smaller sizes and manoeuvring space, cargo bikes are expected to provide a suitable solution in many studies[62].

Finally, cargo bikes mean more bikes on our roads, interacting with other road users and making them aware of bikes' existence and benefits. As reported by one of the Pedal Me organisers[63]:

> *"Not a lot of people appreciate that cycling is a much more social experience than using any other type of vehicle. You are very much outdoors, in the moment, and able to see better and hear better than anyone in a motor vehicle. And so it goes that being a Pedal Me rider you get a lot of questions from other people on the street."*

Cargo bikes make cycling more visible and present in our cities. This increased presence of bikes and connected higher demand for cycling provision can help support transition to active travel for other users, for example, by requiring drivers to increasingly adapt to their presence. At the same time, cargo bikes allow delivery workers to adopt healthier options for their daily jobs, with earlier surveys reporting high satisfaction amongst drivers that shifted to bikes[64].

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[60] Leonardi et al. (2012). Before-After Assessment of a Logistics Trial with Clean Urban Freight Vehicles: A Case Study in London. The change also allowed a 55% drop in CO2 emissions.
[61] Melo and Baptista (2017). Evaluating the impacts of using cargo cycles on urban logistics: integrating traffic, environmental and operational boundaries
[62] Cairns and Sloman (2019). Potential for e-cargo bikes to reduce congestion and pollution from vans in cities.
[63] Pedal Me (nd). "Is that difficult?" Cycling, Training and Riding Cargo Bikes for a Living
[64] TfL (2019). Evaluation of freight consolidation demonstration projects

This doesn't mean that cargo bikes are a magic solution to urban freight issues. Many of the above benefits come with potential unintended consequences that have to be taken into account to maximise cargo bikes' potential and reduce conflicts and injustice in our cities and roads.

The limits of cargo bikes

Limitations of cargo freight highlighted in the literature, and often voiced on social media, belong to three very different domains.

Firstly, concerns are linked to the efficiency and cost-effectiveness of an urban freight model centred on bikes. The central question is 'how many vans can be replaced by bikes without affecting delivery times or costs'? As summarised by Leonardi and colleagues[65], concerns are linked to the bikes' limited payload weight and volume compared to vans, limiting the type of loads they can carry and customers they can serve. Simultaneously, the theoretical lower speed of bikes in 'free flow' conditions makes them unpalatable, especially in modelling scenarios that compare them to vans, without accounting for the actual speeds of vans in urban scenarios or the ability of bikes to use bike lanes. Lower speeds also mean that bikes seem unsuitable to cover a long distance and access depots usually located on cities' outskirts.

As we will explore in the next section, a solution to this shortcoming is reconfiguring distribution services that use cargo bikes to their full potential. But we also invite readers to reconsider the importance of time efficiency vs the ability to save lives by reducing pollution or car traffic. Overall, we believe the cost-effective function of bike delivery should account for their ability to save millions of pounds in healthcare and broader societal costs vs the waiting time of, for example, a same-day delivery[66].

Secondly, concerns are linked to the issues that workers in the cargo bike sector face daily. As reported by Allen and colleagues[67], moped, tricycle, and bike drivers in the meal delivery sector face threatening conditions in urban traffic and are at high risk of being involved in collisions. As we will explore in the next section, significant improvements can be achieved thanks to increased training and safety

[65] Leonardi et al. (2012). Before-After Assessment of a Logistics Trial with Clean Urban Freight Vehicles: A Case Study in London
[66] Several studies are available which calculate the economic and health costs linked to transport externalities. Amongst many, see for example: Khomenko et al. (2021). Premature mortality due to air pollution in European cities: a health impact assessment
[67] Allen et al. (2021). Understanding the transport and CO2 impacts of on-demand meal deliveries: A London case study

investments and better cycling networks. However, it is essential to consider how these issues result from broader systemic problems of a car-centric urban environment. The evidence is overwhelming of the high share of responsibility that motorised vehicles have in creating unsafe roads and causing traffic fatalities, with pedestrians and cyclists suffering the most casualties.

Significant concerns also arise regarding the working conditions in the sector, with increasing evidence and debates on the precarity and exploitative working conditions of delivery workers in the gig economy[68]. Regulation and different work culture in the sector are required, something that is, however, not connected with the type of travel mode used as much as to the economic model adopted increasingly by companies in the sector. It is important to note that similar concerns exist for motorised taxi services and the van delivery sector itself. Here van drivers are reported to suffer detrimental and highly unsafe working conditions often to fulfil the company requirements, including leases on their vans and meeting unreasonably high minimum quotas of deliveries[69].

Thirdly, many might be concerned with potential conflicts between cargo bikes and other bikes in the use of cycling infrastructures or with cargo bikes disrupting pedestrians and other vulnerable road users' sense of safety. In the current scarcity of adequate space for walking and cycling, these debates are likely to emerge. But, as in the previous point, we invite readers to reflect on the grounding cause of this conflict, i.e. the unfair share of urban space dedicated to motorised traffic vs the scarce space which other users have left to move. In the contemporary climate and health emergency, the answer cannot be a further reduction in the number of cyclists or pedestrians, but an increase in available space and infrastructure for them to reach their destinations or simply meet, relax or play. As we will see in the next section, actors committed to promoting cycling practices, such as cargo bike companies, can support a rapid policy shift in this direction.

[68] See for example: Temperton (2018). The gig economy is being fuelled by exploitation, not innovation or Tassinari e Maccarrone (2020). Riders on the Storm: Workplace Solidarity among Gig Economy Couriers in Italy and the UK - Arianna Tassinari, Vincenzo Maccarrone, 2020

[69] See for example: Gurley (2020). Amazon Delivery Drivers Are Overwhelmed and Overworked by Covid-19 Surge or Shakespeare (2021). I struggled as a self-employed Amazon driver – while the company boomed | Rupert Shakespeare

5. Cargo bikes in London: the case of Pedal Me

In London, urban and peri-urban freight delivery has been a critical target of traffic reduction measures, resulting in a slow decline of vehicles entering the inner part of the city[70]. However, the rising demand for home deliveries remains a crucial challenge for future scenarios, with the total number of vehicles driven in the city growing annually[71]. As we showed before, a few studies have explored the potential for bike-freight in London, with estimates that up to 14% of vans in London could be replaced by cycle freight by 2025[72].

One issue with the evidence reported above is that, when forecasting widespread uptake of cargo bikes, models start from the point of view of what vans are already doing most of the time as this is the only data available. This means that most modelling exercises expect bikes to adapt to a distribution model designed with a motorised vehicle in mind, which cannot make the most of cargo bikes' potential. There is a lack of studies which analyse the potential of cargo bikes starting from an assessment of what cargo bikes are already doing (for example by using cargo bike data, rather than van data). This is fundamental to be able to realistically consider the concrete possibilities and benefits of broad-scale adoption. It is here that the example of Pedal Me comes into play, providing one of the first examples of an integrated approach to freight from the perspective of a cargo bike service. In this section, we analyse, in detail, this approach thanks to the availability of detailed GPS data on Pedal Me pick up and drop off locations.

Pedal Me is a cargo and passenger bikes service founded in London in 2017 and supported by public fundraising. It currently operates within a 9-mile radius of Central London (with the option for longer journeys), utilising a fleet of 55 Urban Arrow bikes and 45 employees, covering 25,000km each month.

Pedal Me represents a unique case for its fleet's exceptional capacity and versatility and its innovative approach to logistics. Pedal Me claims to be the only cargo freight service whose bikes can carry the following, in one ride, back to back

[70] TfL (2019). Freight and servicing action plan
[71] TfL (2020). Travel in London Report 13
[72] Element Energy and WSP (2017). Strategies to increase uptake of cycling freight in London

in the same day while moving at an average speed of 15 km/h in Central London"[73].

- two adults and a small dog
- 480L of essential products and food
- 150kg of liquors and beers
- 50 hot meals
- a cement mixer
- a fridge

Image credit: Pedal Me

Central to Pedal Me is an "*ethical motivation driving training, employment, risk management and environment*", which also makes it a strong driver of change, synergistically bringing together business and campaigning objectives (a quick look at Pedal Me's twitter profile can give an idea of the spirit of their work)[74]. For example, Pedal Me offers their customers the opportunity to share delivery runs, reducing costs whilst using a sustainable alternative[75]. By providing a reliable and affordable delivery service, it supports local business, produce, and services, becoming an ally of those companies that make sustainability a core value or work in the voluntary sector[76]. For example, during the Covid-19 pandemic, Pedal Me has helped the health sector by partnering with Lime to offer free rides to vaccinations[77].

[73] Pedal Me (nd). Disrupting urban logistics - the Pedal Me approach
[74] See also: Pedal Me (2019). Interview with Jon (Shareholder)
[75] Pedal Me (2020). Sharing is Caring
[76] Pedal Me. (2020). Home Delivery is here!
[77] Minchin (2021). Lime and Pedal Me team up to join vaccination race

Pedal Me is also committed to promoting ethical employment and training practices, responding to the shortcomings in the sector highlighted above. It aims to provide secure employment for its workers and promote new safety standards and training in an industry currently lacking any regulation[78]. All Pedal Me riders are employed full-time, with pre-scheduled shifts and hourly pay (as opposed to the per-delivery pay in the gig economy model). Pedal Me also has in-house cycling instructors and a cargo bike-specific curriculum (manoeuvring of the bike, loading, road training, etc.) and have set up a thorough training programme that riders must progress through and be tested on thoroughly[79].

These inspiring concepts also help reinvent urban freight in a moment of crisis, maintaining a reduction in costs. This is achieved by following some innovative strategies in the sector. Pedal Me has broadened and diversified the services it provides over the years by mixing passenger and freight delivery. Approaching multiple markets simultaneously means the company was able to be adaptive and resilient in the face of unexpected changes. For example, during the first Covid-19 lockdown, Pedal Me adapted to the sudden loss of all office food deliveries by quickly switching over to offering safer travel options for vulnerable patients and delivering care packages to assist residents in Lambeth[80].

By engaging with several local business and services, Pedal Me aims to promote a new concept of urban logistics that they call the Agile Urban Mobility network[81]. This approach combines both point-to-point and multi-drop jobs as well as passengers and freight transport in the same time window. This means that cargo bikes move between a highly dense network of pick-up and drop off points. Each cycle, once finished with a job, rather than returning to the depot, can go directly to the nearest pick-up point thus reducing the distance travelled and 'dead' miles. Such an adaptive approach to logistics, which benefits from bikes' reliability in fluctuating traffic conditions, coupled with a direct link to customers, allows for greater resilience to disruption and further service reliability. Simultaneously, as we will see in the next section, it challenges the unsustainability of the gig economy and the costs of consolidation centres.

[78] Pedal Me (2019). Our Safety Procedures
[79] Pedal Me (nd). Cargo Bike Rider Training

[80] Pedal Me (2019). Our Vision
[81] Pedal Me (nd). Disrupting urban logistics - the Pedal Me approach

6. What if Pedal Me used vans? Modelling the benefits of freight cargo bikes

The nature of jobs undertaken by business-to-business microservice freight companies such as Pedal Me is unique and still understudied. Pedal Me's clients range between small and medium-size businesses, predominantly from the service sector, such as online retail sales, which includes grocery deliveries, takeaways and other home-delivered meals. One freight payload consists of one pick-up and multiple deliveries, distributing small and medium-sized goods such as takeaways, flowers, groceries, or baked goods to consumers' homes.

To better understand the way this setup can maximise the potential of cargo bikes, we set up a new study aimed at answering the following research questions:

1. Is the delivery of goods faster if Pedal Me used vans instead of freight cycles?
2. How much CO_2 and NOx are saved from the micro-service deliveries performed by a fleet of freight cycles compared to delivering the goods by diesel (or electric) vans?

To answer our research questions, we randomly sampled 928 jobs undertaken by Pedal Me cargo bikes in 98 days between 03-06-2020 and 19-02-2021 to account for weather variations and convenience (including demand) of the freight cycle service across different seasons.

The final GPS dataset contained 13,735 geographically referenced pick-up and delivery locations of goods. Each job consisted of a journey made by one cargo bike, from one (in a few cases more than one) pick up location to different drop off points, with the number of drop off points varying between 1 and 122. The significant variation in the number of stops is due to the parcels' differing size and weight. Each job's pick-up and delivery locations varied across London, with most of them concentrated in the inner part, as visible on the heat maps below. The orders were first picked up by the cargo bike from the local business' location, of which 87.26% were located in Inner London boroughs and only 12.74% in Outer London boroughs. Once picked up, the goods were promptly dispatched across various destinations, of which

86.67% were in Inner London boroughs and 13.33% in Outer London boroughs.

We used the dataset to create a routing problem and measure the difference in speed of delivered goods and the total kilometres travelled using two different delivery modes: cargo bike and van.

We generated route lengths and time travelled using GraphHopper's Routing API. Passing on the GPS travel locations to the API using RStudio's integrated development environment, we recreated the journeys travelled by the fleet of cargo bikes and vans. When routing for the cargo bikes, we have set up the routing problem based on the bicycle's limited payload. Each job is performed by one cycle, using the optimisation functionality of GraphHopper's algorithm. In the case of bigger loads, the bicycle returns to the same client's pick up location multiple times. Afterwards, the distance and time travelled per job are accumulated into a grand total for each day.

To recreate the van's journeys, we assumed that the van performed the same jobs differently. Since it is well evidenced by other studies[82] that the van's payload capacity is significantly (up to five times) larger than that of the freight cycle, we have recreated the routing problem by instructing the van to collect and deliver the packages based on the locations' spatial proximity. Thus multiple jobs are performed in one load capacity. In this case, the van collects and delivers orders along the way without making return trips to collect (or drop off) items from locations it has already visited.

[82] Leonardi et al. (2012). Before-After Assessment of a Logistics Trial with Clean Urban Freight Vehicles: A Case Study in London

Fig. 5: Cargo bikes and van routes on 03-06-2020

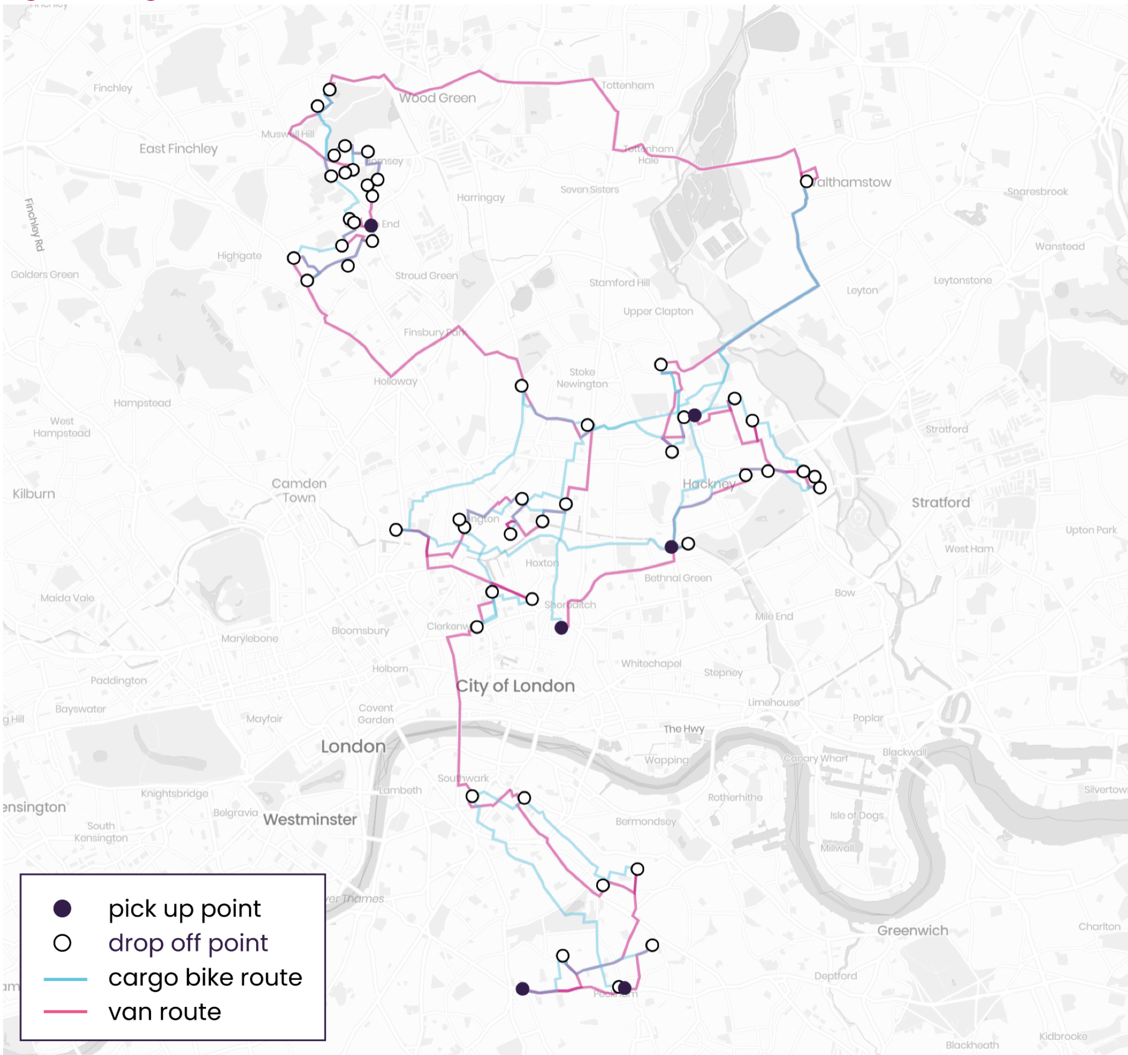


Figure 5 illustrates jobs performed for six clients on 03-06-2020, the blue line showing six bike routes, and the pink line the route travelled by one van. Due to load capacity constraints, the cyclist first picks up all the orders from the client's depot (i.e. one job) and delivers them based on spatial proximity to complete one job before moving to the next one, following Pedal Me's Agile Urban Mobility network idea.

After routing for all 928 jobs, we generated the average time travelled per job for the cargo bikes and obtained the total average time travelled by one cargo bike per day. We corrected the time travelled by including a 3 min slack at every drop-off point to account for the average time spent by the consignee to park and unload the order at every delivery location. Our data show that Pedal Me bikes spend on average 2min50s (SD=24min08s, with N=40,000 deliveries) between "arrived at location" (50 or 100m from the location) and "task completed" [83]. This takes into account parking and delivery since "arrived" here means "50 or 100 meters from location". After the time correction, we calculated the average number of packages delivered each hour and the speed of service.

The van's travel time obtained from the routing model did not account for delays due to congestion (free-flow model). Therefore, relying on literature findings [84], we have used 0.87 as a correction coefficient to adjust the daily average speed of 15.6 km/h to the average van speed observed by other studies in London (13 Km/h). The average dwell time between stops is longer for the van compared to the bike, as widely reported in the literature[85], due to parking-related delays (cruising time) and the carrier's walking time from the kerbside parking to the delivery spot and back. Using the findings from a London based GPS-tracked study of delivery vans[86], we have added a constant delay time of 8.1 min at each drop-off point[87] and adjusted the route length to include the cruising distance, which we estimated to be 180m per each km travelled, thanks to the model developed by another GPS study[88].

The figures below present an overview of the measurements for the bikes and the van's deliveries and can be used to compare their performance. The bikes' performance changes depending on the number of jobs: for longer routes, bikes are significantly faster whereas, on days with smaller jobs and shorter routes, bicycles and vans perform similarly (see Figure 6), albeit with bicycles still being the faster delivery mode.

[83] This is the time reported also by other studies on bike deliveries in London. See: Allen et al. (2021). Understanding the transport and CO2 impacts of on-demand meal deliveries: A London case study

[84] See for example: McLeod et al. (2020). Quantifying environmental and financial benefits of using porters and cycle couriers for last-mile parcel delivery

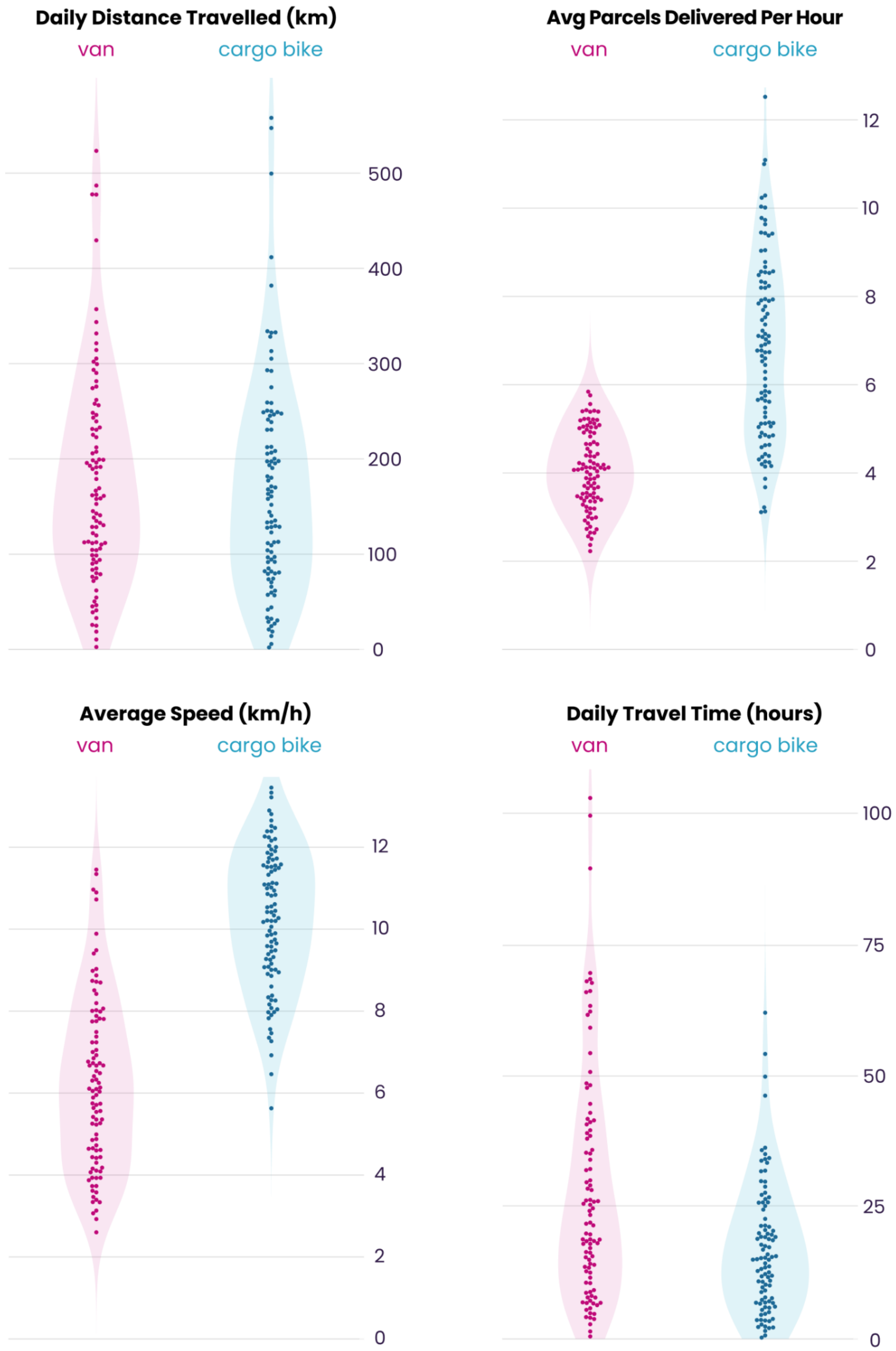
[85] As discussed before, time spent searching for parking is estimated to cause delays up to 62% of the actual delivery time

[86] This is the time reported by another study on van deliveries in London. See: Allen et al. (2018). The Scope for Pavement Porters: Addressing the Challenges of Last-Mile Parcel Delivery in London

[87] Based on times reported in the literature. See: Allen et al. (2021). Understanding the transport and CO2 impacts of on-demand meal deliveries: A London case study

[88] Based on cruising time reported in this study. See: Dalla Chiara (2020). Do commercial vehicles cruise for parking? Empirical evidence from Seattle

Fig 6. Comparison of vans and cargo bikes for deliveries



Our results show that the cargo bikes travelled a total time of 1,680 hrs and distance of 16,450 km to perform the 982 jobs, while the van travelled 2,777 hrs and 14,694 km excl. cruising distance or 17,400 km incl. cruising distance to perform the same deliveries. The van's daily average modelled speed is 15.6 km/h. After correcting to incorporate traffic congestion, it is reduced to 13.57 km/h[89], or 6.21 km/h after adding the consignee and parking-related delays. The daily average speed of cargo bikes is 10 km/h corrected for consignee time or 15.49 km/h excluding the consignee time. The adjustment for consignee time to the daily average speeds includes the time used to unload the packages and walk from the van's/bikes' parking location to the drop off point, including the handover time. Every hour the van delivers 4 packages whilst the cargo bikes delivers nearly 7 packages per load every hour[90]. Since more bikes simultaneously deliver the parcels, the hourly average per fleet is significantly higher. The average daily travel time also shows that at least 3 vans would be needed to replace the fleet of cargo bikes if an 8 hours shift is considered.

Table 1. Results from cargo bike vs van modelling.

Metric	Cargo bikes	Van
Total time	1.680 hrs	2.777 hrs
Total distance covered	16.450 km	17.400 km
Average speed	10 km/h	6.21 km/h
Drop-offs per hour	7	4
Average daily travel time	17 hrs	28 hrs
Average daily distance travelled	168 km	177 km
Total CO2 emissions	372 kg	4268 kg

We can now use these findings to respond to our second research question.

Assuming that a cargo bike emits a total of 22.6gCO_2/km (including the emissions embedded in the extra food needed to power the bike)[91] and a diesel van emits on average 245.3 g CO_2/km[92], then the jobs performed saved a total of 3,896 kg

[89] See for example: McLeod et al. (2020). Quantifying environmental and financial benefits of using porters and cycle couriers for last-mile parcel delivery
[90] For more detailed breakdown see appendices.
[91] Pedal Me (nd). How sustainable is the Pedal Me fleet?
[92] Department for Business, Energy & Industrial Strategy (2020). Government greenhouse gas conversion factors for company reporting: Methodology paper

of CO_2 and 3,927 kg of CO_2e[93], i.e. 90.5% saving. Based on these estimates, we find that the current Pedal Me cargo bike fleet and duty cycle save as much as 14,510 kg of CO_2 over a year compared to using diesel vans.

Adopting the NOx per Km averages used in another study[94], we can also estimate Pedal Me contribution to improving air quality which amounts to over 5,5 kg of NOx in just 98 days of work. This means Pedal Me contributes to saving around 20 kg of NOx per year.

Overall, cargo bikes appear to serve their customers better than a van would do without generating any of the negative externalities associated with van delivery. Pedal Me's logistics model shows the notable benefit of this novel organisation of microservice for small and medium-sized freight distribution without the need for urban micro consolidation centres. In the case study presented, the local businesses' locations are the pick-up locations for the freight service. This choice improves the flexibility of the retail and logistics services increasingly needed to respond to the ever-growing demand for delivering consumer goods to customer’s homes. Furthermore, the approach helps eliminate the additional urban space required for extra consolidation storage capacities, the high operating costs related to maintaining such consolidation centres in the delivery catchment areas (predominantly in densely populated areas), as well as the distance travelled to carry goods to and from these locations ('dead miles').

[93] I.e. including N2O and CH4. For more information see: Department for Business, Energy & Industrial Strategy (2020). Government greenhouse gas conversion factors for company reporting: Methodology paper
[94] 0.32 g/Km NOx for a Euro 6 van. See: McLeod et al. (2020). Quantifying environmental and financial benefits of using porters and cycle couriers for last-mile parcel delivery

7. The promise of Low-Carbon freight: a simple scenario for the future of cargo bikes in London

Based on the above findings, we can draw some broader conclusions about the impacts that wider adoption of cargo bikes can have in London. As mentioned, earlier studies have estimated that at least 14% of vans in London could be replaced by cargo bikes. The CycleLogistics study estimated that 51% of motorised trips linked to the delivery of goods in urban areas could be replaced by bikes or cargo bikes. With 23% and 48% of all km driven in London to deliver/collect goods or transport material/provide a service, and mainly on trips not further than 25 km, we can expect cargo bikes to have significant uptake in the city.

But for simplicity, let's assume that 10% of London van-km (i.e. 595 million van-Km) will be replaced in the near future by cargo bikes working with Pedal Me's standards. What would be the impact of such a 10% substitution?

10% fewer van-kms means a drop of over 1.6 million van-km per day. Given that less than 1% of London's vans are electric, we assume that the van-km saved would have been travelled by Euro 6 diesel vans. Assuming that these vans are delivering parcels following our model, then a fleet of cargo e-bikes will be able to deliver the same amount of parcels in 0.94 times the distance, helping to save 133.3 million kg of CO_2 and 190.4 thousand kg of NOx per year.

Moreover, following our results, we can assume that a London delivery van working an eight-hour shift covers about 50 km per day. Therefore, replacing 10% of van-km could mean removing 32,000 vans[95] which each day would be temporarily parked in public space, covering a total of 384,000 sqm of public space. 10% less van-km would also mean losing 16,980 hours of vehicle traffic per day, if we assume that the van would only travel during the daytime.

[95] Almost 15% of the total vans registered in London in 2019.

8. Conclusion

Services like the one provided by Pedal Me have a great potential to improve our cities, contributing to reducing transport emissions, reducing air pollution, freeing space on pavements and public roads and improving street safety. Eventually, even giving back road space for other public uses such as pop-up parks, gardens or urban farms, ameliorating the urban heat island effect and cooling down our warm cities. Our simulation shows that cargo bikes offer a greater advantage over vans in delivering goods in the city, not only considering the time saved in navigating busy and congested roads filled with motorised and polluting traffic, but also the clear advantage of freight deliveries by bicycles in comparison to vans with respect to the speed of service. Without suffering from traffic congestion, cargo bikes are also likely to be much more reliable than their motorised counterparts. In the case study, the service performed by the Pedal Me freight cycles was by an average of 1.61 times faster than the one performed by the van. An expansion of this type of service to replace 10% of the van-km currently driven in London would mean helping to save as much as 133.3 million kg of CO_2 and 190.4 thousand kg of NOx per year.

At the same time, thanks to their flexibility, cargo bike adoption can help us to rethink traditional problems in urban logistics and readapt them to new needs. For example bringing together freight and passenger transport, whilst indirectly contributing to creating a genuine culture around the use of the bike in our cities, with cargo bikes carrying people and objects and replacing services with more agile and friendly options, from school buses to 'ambulances' to 'urban infrastructure' components to media units or covid-proof taxis.

Cargo bikes cannot provide a solution to all logistic and urban issues, especially when looking at a broader scale and considering the total distance each of the items that we buy every day has to travel to arrive in our homes. Especially when looking at the potential for greenhouse gas reduction, issues start further away than the urban scale we approached in this report and can only be fully addressed considering the entire production to consumption chain. The world of sustainable freight is very much at its beginning, with only isolated examples of long-distance sustainable freight systems (with inspiring emerging models using sailboats to transport goods in an increasing number of countries[96]). For instance, Possible is currently working with the Centre for Sustainable Road Freight on an electric road system trial in the UK, allowing battery HGVs to run on power from overhead lines in dedicated motorway lanes[97]. However, with examples like Pedal Me, or many other similar initiatives across Europe and beyond, the use of cargo bikes in combination with local services (including local organic food production) can inspire customers to buy overall more sustainable and affordable goods. Having recognised such potential for this sector, there is still much to be done both at a regulatory and provision level to ensure that those options are used at the best potential.

[96] See for example: Sail Boat Project - Sail Boat Project

[97] See Department for Transport announcement here: https://www.gov.uk/government/news/road-freight-goes-green-with-20-million-funding-boost

9. Recommendations

There are many actions that can be taken in support of wider adoption of cargo bikes and which involve actors at various levels of transport governance. Amongst these, we believe that some steps will be crucial in the near future:

- National government should create a consistent and clear strategy in support of urban non-motorised freight distribution. They should support cargo-bikes uptake with adequate and long-term investments in cycling provision. The presence of segregated and wide bike lanes is essential to cargo bikes services and will in turn benefit wider adoption of cycling and access to cycling infrastructures for many others, including disabled cyclists and others who use different types of non-motorised wheeled vehicles.

- Charges and taxes should be levied to discourage unnecessary use of motor based logistics. User charging mechanisms, such as fuel duty, road pricing, or Clean Air Zones (CAZ) and Low Emission Zones (LEZ), should be widely adopted to discourage unsustainable motorised freight where this is unnecessary. Pricing should instead encourage sustainable freight, for example by introducing a flat subsidy for cargo bike logistics or reducing taxation on their operations. For example, there is a strong case for reduced (e.g. 5%) or even 0% - rating for VAT on cycle logistics to stimulate demand.

- National Government should increase the current 250w power output limit on e-bike assists to 1000w for unlicensed commercial delivery bikes with a top motor speed of 15.5mph to enable them to compete effectively with LCVs in all UK urban topographies. Commercial e-assist bikes with power output up to 1000w but retaining the standard speed limit of 15.5mph should not be subject to DVLA registration and licensing.

- National government should introduce clear regulations and procedures for cargo bikes to apply for an operator license to carry fare-paying customers, filling up the current regulatory void and increasing the potential for others to introduce similar services safely and fairly. Moves in this direction might also highlight how cargo bikes are not aiming at out-competing taxi services as feared in the sector.

- Similarly, the government should standardise insurance procedures and safety regulations, for example by accrediting the safety training courses already provided by some companies like Pedal Me.
- National government should regulate and monitor working conditions of cargo bike workers and drivers in the gig economy as well as tackle fraudulent gig economy working which creates unfair competition against companies which offer fairer working conditions.
- Cities should introduce further restrictions for freight motorised vehicles to access urban centres. For example by delivering widespread Ultra Low Emission Zones, as well as Low Emission Neighbourhoods, local ultra-low emissions zones (ULEZs) and zero emissions zones (ZEZs).
- Cities should show support towards a variety of cargo-bikes trials. As much as accurate models can be helpful, we are unlikely to fully understand the behavioural side and the potential that a widespread presence of cargo bikes could have on consumers and travellers behaviours without real world trial schemes.
- Cities should introduce shared cargo bikes schemes and facilitate the installation of micro-consolidation centres. For London specifically, it will be important to set up a clear road map for implementing the consolidation centres promised in the Freight and Servicing Action Plan.
- Cities and businesses should provide adequate parking facilities for (e-)cargo bikes and shared (e-) cargo bike schemes and adequate charging solutions for e-bikes.
- Public bodies should show public support to cargo bikes uptake by adopting them within the public sector. For example by replacing the costly transport of ministerial briefcases and papers.

Appendices

The appendices for the report contain the raw data arising from the modelling exercise.

Appendix one contains details of the time taken to complete all deliveries, and the distance travelled to complete all deliveries per day for both cargo bike deliveries and van deliveries.

Appendix two contains details of the time taken to complete all deliveries, parcels delivered per hour, number of clients that parcels were delivered for, and average vehicle speed, per day for both cargo bike deliveries and van deliveries.

Time calculations include the time that the rider took to park the cargo bike or van, unload the package and hand it over to the receiver, as well as time spent in traffic congestion for van deliveries. Distance calculations include the distance travelled by vans in search of a parking space.