Just economics

TEAM LONDON BRIDGE

Impact on Urban Health

Delivering Value

A quantitative model for estimating the true cost of freight via three transport modes

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Executive summary

Transport is the largest emitting sector of greenhouse gas emissions in the UK and rapidly needs to decarbonise if net zero targets are to be met. In addition, London is the most congested of the world's major cities, with associated air quality and quality of life impacts.

Freight makes a significant contribution to these problems, and it is set to grow in absolute and relative terms. For this growth to be sustainable, there is an urgent need to prioritise low emitting vehicles.

E-cargobikes are one such sustainable alternative, especially for last mile deliveries. Yet their growth is slow and a modal shift in freight is some way off if current trends continue.

Research with London businesses and courier companies finds that a major barrier to their adoption is that courier deliveries by e-cargobike are more expensive than diesel vans on a like-for-like basis.[1] This pricing is counter-intuitive, given that e-cargobikes have lower upfront purchase costs and per mile running costs.

There are two major drivers of this cost-differential:

- First, as the pricing system does not reflect the impacts of the goods and services, socially and environmentally damaging goods and services are sometimes cheaper than similar products with lower impacts. In the freight sector, this enables van couriers that are avoiding social and environmental costs to overturn the natural competitive advantage of much cleaner e-cargobikes.
- Second, it is common practice for van deliveries to be fulfilled by independent contractors. This means that many of the economic costs of deliveries – employee benefits, fuel, vehicle purchase – are borne by the contractor rather than the delivery company. Passing on these economic costs to drivers means that courier companies can undercut deliveries by companies that internalise such costs, including many e-cargobike operators.

This paper uses social and environmental valuation techniques to make visible these costs. Whilst freight is by no means the only sector where prices do not reflect social and environmental damage caused, it is one where better economic signaling is urgently required to promote sustainable choices.

Specifically, two costing models are constructed to compare diesel vans, electric vans and e-cargobikes. These calculate:

1. The social and environment externalities associated with each mile travelled by these modes.
2. The true economic cost of deliveries by each mode and, hence, the minimum 'fair price' of a delivery if couriers – regardless of the mode of delivery – were paid a living wage, received standard non-wage benefits and did not have to meet costs that would be expected to be borne by the delivery firm.

Hidden environmental and social costs

The findings from our model are as follows (see Table 1):

- The hidden social and environmental costs associated with diesel vans in London total **£2.46 billion** annually.
- On a per mile basis, social and environmental costs associated with diesel vans (66p/mile) are eight times higher than those associated with e-cargobikes (7.8p/mile). Hidden costs associated with electric vans are 7 times higher than for e-cargobikes.

1 These findings emerged from interviews with businesses and operators as part of the Bikes for Business evaluation.

- The difference between diesel vans and e-cargobikes is most evident around environmental cost, with these being 67 times higher on a per mile basis for diesel vans than for e-cargobikes.
- Electric and diesel vans have the same social impacts and these are around 7 times higher than for e-cargobikes.

Table 1: Social and environmental costs by delivery mode (£/mile)

Externality	Diesel van	Electric van	E-cargobike
Environmental costs per mile travelled	0.1732	0.0462	0.0026
Social costs per mile travelled	0.4929	0.4976	0.0751
Total externailties per mile travelled	0.661	0.5438	0.0777
Ratio of costs to e-cargobikes	8.58	7.00	1.00

It is important to note that these hidden costs are real and, while not incorporated into the price of a delivery, are borne by someone. Air pollution, for example, is directly responsible for many deaths and illnesses every year while climate change is arguably the greatest challenge the world faces.

The fact that these costs are not borne by delivery firms means they have no incentive to reduce them and, likewise, customers are not incentivised to opt for less damaging modes. The net result is that more damaging activities are undertaken than would be the case if both producers and consumers had to bear the true environmental and social costs.

True economic costs and fair price

Similarly, pricing does not capture the full economic cost of deliveries by vans, with courier companies often passing a substantial share of the cost of doing business (e.g. van purchase, fuel) on to drivers. E-cargobike riders, on the other hand, tend to be on payroll and have these costs met by the courier company.

This raises the question of what would constitute a minimum 'fair price' for deliveries by each mode, where this is defined as the minimum price an average delivery would need to cost if companies are bearing the full economic costs rather than passing these on to drivers/riders.

Table 2 provides a breakdown of economic costs of each mode to calculate such a 'fair price'.

It shows that an average delivery in central London by diesel van would need to cost £6.42 if full economic costs, including VAT, were covered by the courier company. This is considerably higher than the £2 per delivery that some van courier companies are charging. The corresponding figures for deliveries by electric van and e-cargobike are £5.68 and £4.98, respectively.[2]

2 These figures are based on a range of assumptions (see Annex 1) that are subject to change depending on company characteristics and parcel size, fragility, weight and time-sensitivity. They are not being suggested as universal price floors but as indicative of the kinds of costs that are being borne by drivers and preventing a level playing field.

Table 2: Economic costs by delivery mode (£/delivery)

Variable	Diesel van	Electric van	E-cargobike
Wages	1.5305	1.5305	1.5305
Non-wage employment costs	0.7002	0.7002	0.7002
Purchase	0.2343	0.2958	0.0339
Tax (VED)	0.0097	0.0000	0.0000
Insurance	0.0848	0.0751	0.0296
Fuel	0.1504	0.0659	0.0165
Parking fines	0.0128	0.0128	0.0000
Storage	0.0574	0.0574	0.0924
Repair and maintenance	0.0102	0.0102	0.0049
Congestion charge	0.3142	0.0000	0.0000
Overheads	1.5523	1.3740	1.2040
Profit margin	0.6939	0.6142	0.5382
Fair price per delivery (inc. VAT)	**£6.42**	**£5.68**	**£4.98**

It is clear that companies that are offering cut price deliveries are not bearing the full economic costs (listed in Table 2), but are passing significant costs on to drivers, who often end up having to work long hours to earn a decent income. While in the context of a cost-of-living crisis, higher delivery costs may not be desirable, it is important to note that these are not "new costs" but are currently borne by often low-wage delivery drivers.

The continued use of the independent contractor model not only places a cost and risk burden on drivers but erodes the natural cost advantage of e-cargobikes, which in turn creates a barrier to their adoption.

Recommendations

Pricing is not simply a given, but a product of how a market is regulated, subsidised and governed.

The current pricing of deliveries incentivises the wrong kinds of transport-related behaviour, and a modal shift will not be achieved without intervention at the local and national scale to level the playing field.

To this end, it is recommended that local government:

1. **Use smart road pricing** to more accurately reflect environmental and social costs of different modes and, therefore, incentivise the use of cleaner vehicles, including e-cargobikes.
2. **Invest in e-cargobike infrastructure** such as storage, consolidation hubs, battery exchanges, cycle lanes and parking bays in order to bring down the cost of doing business for e-cargobike couriers.
3. **Work with the private sector**, including developers, landlords and Business Improvement Districts (BIDs), to support the development of e-cargobike friendly infrastructure.
4. **Promote the use of e-cargobikes** by mobilising social and peer influence to encourage behavioural change.

At the national level, it is recommended that government:

1. **Introduce a smart vehicle tax** that encourages the use of cleaner vehicles, as well as a scrappage scheme targeting those on low incomes to offset any regressive distributional impacts.
2. **Strengthen employment protection laws** to ensure that contractor status is not able to be used to exploit drivers and facilitate a race to the bottom in labour practices.
3. **Ensure there is regulatory clarity on what constitutes an e-cargobike** to provide a secure investment context for courier companies that want to build up a e-cargobike fleet.

At present, the cards are stacked against clean delivery modes, such as e-cargobikes, at the very time when the twin challenges of climate change and poor air quality require a rapid shift to cleaner urban deliveries. Action must be taken to ensure that businesses are encouraged to make choices that are better for people and the planet.

This research emerged from the findings of an evaluation carried out by Just Economics of the Bikes for Business programme: an initiative in Southwark, London, to help businesses switch to low-emission e-cargobike deliveries. It is being delivered by MP Smarter Travel for Team London Bridge and is funded by Impact on Urban Health. For more information see https://www.teamlondonbridge.co.uk/bikesforbusiness

1. Introduction

A modal shift to lower emission deliveries is both urgent and vital within urban centres to avoid the most damaging impacts of climate change and to reduce the deleterious health impacts of poor air quality. This is especially critical in London, which lags other European cities in the adoption of clean transport, and where air pollution and congestion problems are particularly acute.[3]

3 https://epub.wupperinst.org/frontdoor/deliver/index/docId/7033/file/7033_Living_Moving_Breathing.pdf

While the need for cleaner deliveries is generally recognised by policymakers, little has been done to ensure that there is a level playing field between different modes of delivery. Specifically, the more polluting modes, and especially diesel vans, continue to externalise many of their associated environmental and social costs.

This means that the price per delivery charged by diesel van couriers is often lower than for cleaner forms, such as e-cargobikes, and presents a significant obstacle to widespread adoption of such deliveries by businesses.[4]

There are two means by which these costs are externalised.

> First, as the pricing system does not reflect the social and environmental impacts of the goods and services we make and consume, socially and environmentally damaging goods and services are often cheaper than similar products with lower impacts. In the freight sector, this enables van couriers that are avoiding social and environmental costs to overturn the natural competitive advantage of e-cargobikes, which have lower upfront purchase costs and per mile running costs.

> Second, it is common practice for van deliveries to be fulfilled by independent contractors. This means that many of the economic costs of deliveries – employee benefits, fuel, upfront purchase – are borne by the contractor, rather than the delivery company. Passing on these economic costs to drivers means that courier companies can undercut deliveries fulfilled by other means.

Although e-cargobike riders can also be contracted independently, our research with London courier companies finds that they are more likely to be on payroll and paid at least the London Living Wage. Courier companies have also indicated that the difference in employment status between the modes of delivery is a major driver of the cost differential.

The objective of this report is to make visible the 'true cost' of deliveries by three different modes: diesel van, electric van and e-cargobike. We do this by building an economic model to capture the full environmental, social and economic costs of delivery by each of these modes.

The results of the model are used to:

1. Estimate the social and environmental costs of e-cargobikes compared with diesel and electric vans, once all externalities have been considered; and
2. Estimate the minimum cost of a single delivery in London if couriers – regardless of the mode of delivery – were paid a living wage, received standard non-wage benefits and did not have to meet costs that would be expected to be met by the delivery firm (e.g. fuel).

4 Our recent evaluation of the Bikes for Business programme, found that while satisfaction with e-cargobike couriers was extremely high, many businesses opted to discontinue their use after the trial subsidy ended due to the cost of deliveries.

This paper is structured as follows:

Section 2 sets out why e-cargobikes are key to more environmentally and socially responsible deliveries in cities;

Section 3 describes the methodology and introduces the costing models;

Section 4 estimates the true cost of social and environmental externalities;

Section 5 calculates the minimum price per delivery; and

Section 6 concludes the report with recommendations for a range of stakeholders.

A technical appendix to the models is provided in Appendix 1.

This research emerged from the findings of an evaluation carried out by Just Economics of the Bikes for Business programme: an initiative in Southwark, London, to help businesses switch to low-emission e-cargobike deliveries. It is being delivered by MP Smarter Travel for Team London Bridge and is funded by Impact on Urban Health. For more information see https://www.teamlondonbridge.co.uk/bikesforbusiness

2. Why E-cargobikes?

Although cargobikes have been in existence since the 19th century, it is only in recent years with the advent of electrically assisted, high-performance batteries that they have emerged as a potential solution to the growing problems relating to urban freight, especially last mile delivery.

There is a rapidly increasing research base that supports long-held hypotheses relating to the potential of cargobikes, both electric and non-electric.

Potential benefits (and costs) fall into four areas:

- Environmental benefits
- Health benefits
- Business benefits
- Savings or benefits to the state

2.1 Environmental benefits

Transport is the largest contributor to greenhouse gas emissions in the UK, accounting for over a third of emissions. Unlike other sectors, only small improvements have been made in recent years. In 2017, heavy goods vehicles (HGVs) were estimated to account for around 17% of UK GHG emissions from road transport and around 21% of road transport NOx emissions, while making up just 5% of vehicle miles. Last-mile fulfilment is among the most energy consuming logistics operations in the supply chain,[5] and is also a key challenge in transport planning.[6]

There are various estimates of the volume of CO2 emissions defrayed by switching to cargobikes.[7] In a simulation, for example, Browne et al., find that switching to e-cargobikes leads to a 20% decrease in total distance travelled and a 54% decrease in CO2 equivalent emissions in London.

As well as tailpipe emissions, the manufacturing of vans - including electric vans - generates substantial carbon emissions. It is estimated that around 8800kg of CO2 are emitted during the manufacture of an electric van, 7500kg for a conventional van and just 280kg for an e-cargobike.[8]

In 2020 it was reported that, despite some improvements in air quality, 99% of London exceeds the WHO recommended limits for PM2 and that deprived and Black and Minority Ethnic communities were more likely to be exposed.[9] Vans cause over 30% of NOx and particulate emissions.[10] One London-based study found that premature deaths from exposure to diesel emissions from vans could be reduced by 91.5% if local authorities were to introduce measures that lead to the replacement of the van fleet with e-cargo in the last mile.[11] Finally, road traffic is also linked to water and soil pollution.[12]

5 Halldorsson, A., & Wehner, J. (2020). Last-mile logistics fulfilment: A framework for energy efficiency. Research in Transportation Business & Management, 37, 100481.

6 Blazejewski, L., Sherriff, G., & Davies, N. (2020). Delivering the last mile: scoping the potential for E-cargo bikes.

7 Hagen, J., Lobo, Z., & Mendonça, C. (2013). The Benefits of Cargo Bikes in Rio de Janeiro: A Case Study.

8 https://pedalme.co.uk/carbon-emissions/

9 https://www.london.gov.uk/press-releases/mayoral/dramatic-improvement-in-londons-air-quality

10 Cairns, S., & Sloman, L. (2019). Potential for e-cargo bikes to reduce congestion and pollution from vans in cities. Transport for Quality of Life Ltd. https://www.bicycleassociation. org. uk/wpcontent/uploads/2019/07/Potential-for-e-cargo-bikes-to-reduce-congestion-and-pollution-from-vans-FINAL. pdf.

11 Colson, J. R. (2019). The Financial Viability and Sustainability Benefits of Using Cargo Trikes Instead of Vans for 'Last-Mile Logistics in London in the Age of Online Shopping (Doctoral dissertation, Harvard University).

12 Goonetilleke, A., Wijesiri, B., & Bandala, E. R. (2017). Water and soil pollution implications of road traffic. Environmental impacts of road vehicles: past, present and future, 44, 86-106.

2.2 Health benefits

Despite a range of alternatives and disincentives to vehicle use, congestion continues to rise in London.[13] One of the main reasons for worsening congestion is the growth in van traffic. Some 20-25% of freight vehicle kilometres is related to goods leaving urban areas, and 40-50% is related to incoming goods.[14] Since 2008, van mileage has increased by a fifth in the UK, and vans now make up about 15% of traffic.[15] The OECD projects global freight demand to triple between 2015 and 2050 based on the current demand pathway.[16]

Research also shows that only a small proportion of deliveries currently made by vans in Europe require the use of motorised vehicles, with one study in Belgium finding that 40% of deliveries are for just one box.[17] E-cargobikes can address this problem by using road and storage space more efficiently, and through shortening journey times, either through dedicated lanes or from the benefits of smaller size and greater manoeuvrability. A Department for Transport demonstration project found that 96.7% of orders could be fulfilled in a single e-cargobike drop with shorter delivery routes and time journeys.

About 1,600 people are killed in road traffic accidents in the UK each year. This figure rises to 24,470 when seriously injured casualties are included and 131,220 casualties of all severities.[18] It is estimated that a third of road deaths are incidents relating to people driving for work, more than the number of people killed in workplace accidents.[19] According to a report by UCL, despite a rapid increase in vans, this sector falls outside the strict regulations governing other occupational drivers such as HGVs.[20] Although there are some issues with road safety in relation to e-cargobikes, these predominantly come from motorised vehicles and could be addressed through better infrastructure (e.g. separate lanes) and training for both van drivers and e-cargo bike-riders.

Switching to e-cargobikes also has the potential to improve the health of drivers. Research has found poor health outcomes amongst truck drivers as a result of unfavourable working conditions including long work hours, sleep deprivation, sedentary lifestyle and unhealthy diet.[21] This in turn has resulted in below average life expectancy for male truck drivers.[22] Cargo bikes by contrast are an active form of transport that promotes health. Van drivers are also highly exposed to air pollution, due to long periods sitting in traffic,[23] and studies show that exposure of motorists is higher than that of cyclists.[24]

Finally, displacing vans with cargobikes can lead to improved quality of life. Noise pollution is of particular importance here due to its physical and psychological effects. Noise pollution has been linked to a range of mental and physical health problems, such as cardiac disease, birth defects and immune system problems.[25] Health risks from noise are

13 Cairns, S., & Sloman, L. (2019). Potential for e-cargo bikes to reduce congestion and pollution from vans in cities. Transport for Quality of Life Ltd. https://www.bicycleassociation. org. uk/wpcontent/uploads/2019/07/Potential-for-e-cargo-bikes-to-reduce-congestion-and-pollution-from-vans-FINAL. pdf.

14 Wiki, C. (2015). Smart Choices for Cities. Making Urban Freight Logistics More Sustainable.https://civitas.eu/sites/default/files/civ_pol-an5_urban_web.pdf

15 Cairns, S., & Sloman, L. (2019). Potential for e-cargo bikes to reduce congestion and pollution from vans in cities. Transport for Quality of Life Ltd. https://www.bicycleassociation. org. uk/wpcontent/uploads/2019/07/Potential-for-e-cargo-bikes-to-reduce-congestion-and-pollution-from-vans-FINAL. pdf.

16 OECD (2019) ITF Transport Outlook 2019 https://www.oecd-ilibrary.org/sites/c013afc7-en/index.html?itemId=/content/component/c013afc7-en

17 Government Office for Science (2019) Last mile urban freight in the UK: how and why is it changing? https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/777682/fom_last_mile_road_freight.pdf

18 Department for Transport (2021) Reported road casualties in Great Britain: provisional estimates year ending June 2020 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/956524/road-casualties-year-ending-june-2020.pdf

19 Ward, H., Christie, N., & Walton, B. (2020). Driving for work: A strategic review of risks associated with cars and light vans and implications for policy and practice.

20 Ward, H., Christie, N., & Walton, B. (2020). Driving for work: A strategic review of risks associated with cars and light vans and implications for policy and practice.

21 Taylor, A. H., & Dorn, L. (2006). Stress, Fatigue, Health and Risk of Road Traffic Accidents Among Professional Drivers: The Contribution of Physical Inactivity.

22 Ng, M. K., Yousuf, B., Bigelow, P. L., & Van Eerd, D. (2015). Effectiveness of health promotion programmes for truck drivers: a systematic review. Health Education Journal, 74(3), 270-286.

23 Lim, S., Barratt, B., Holliday, L., Griffiths, C. J., & Mudway, I. S. (2021). Characterising professional drivers' exposure to traffic-related air pollution: Evidence for reduction strategies from in-vehicle personal exposure monitoring. Environment International, 153, 106532.

24 Rank, J., Folke, J., & Jespersen, P. H. (2001). Differences in cyclists and car drivers exposure to air pollution from traffic in the city of Copenhagen. Science of the Total Environment, 279(1-3), 131-136.

25 Geravandi, S., Takdastan, A., Zallaghi, E., Vousoghi Niri, M., Mohammadi, M. J., Saki, H., & Naiemabadi, A. (2015). Noise pollution and health effects. Jundishapur Journal of Health Sciences, 7(1).

correlated with road traffic, suggesting that they are the consequences of elevated sound levels.[26] In 2008, the social costs of traffic noise in the EU22 was estimated at more than €40 billion per year; with passenger cars and lorries responsible for the bulk of costs.[27] In addition, to noise impacts, people report lower overall quality of life when they live near road traffic.[28] This is certainly partly mediated by noise but may also be linked to vibration and visual pollution,[29] or reduced social capital.

2.3 Business benefits

In a review of the literature, Hagen and Mendonça (2013) identify a number of potential benefits to businesses from e-cargobikes.[30] These are i) lower purchase, maintenance and running costs; ii) greater ease of access and thus shorter delivery times (during business hours London traffic speed is about 9 mph compared with 12 mph for cargo bikes);[31] and iii) reputational benefits from green branding.

Although there is much anecdotal evidence to support the argument that e-cargobikes should be cheaper and more productive than diesel vans – and therefore able to outcompete them on cost grounds – there are currently no robust examples where monetary benefits have been quantified. Indeed, as will be discussed in more detail, our own research has found that – with the exception of the purchase of bikes by businesses themselves – the cost of courier deliveries by e-cargobike is often more expensive with employee wages and benefits being the main source of this cost differential, hence the impetus for this research.

2.4 Benefits to the state

Most state benefits derive indirectly from the other benefits set out above – e.g. reduced air and noise pollution, accidents and improved driver health should reduce demands on the health service, while benefits to business should boost tax revenues.

One direct benefit to the state is lower infrastructure costs. Motor vehicles, and particularly heavy trucks, cause substantial damage to roads and bridges, requiring expensive maintenance regimes.[32]

Governments will, however, also incur a cost from cleaner transport as a result of reduced fuel duty and other costs. These are largely neutralised in a holistic economic analysis as they are mainly transfers from businesses that would have to meet these costs.

Transitioning to robust cycling infrastructure will also require investment. E-cargobikes are more economically feasible where there are cycle lanes and local depots close to, or within, the delivery areas.[33] Studies that consider costs and benefits at the national level tend to find a positive net present value from these investments due to the size and value of the positive externalities from cycling.[34]

26 Geravandi, S., Takdastan, A., Zallaghi, E., Vousoghi Niri, M., Mohammadi, M. J., Saki, H., & Naiemabadi, A. (2015). Noise pollution and health effects. Jundishapur Journal of Health Sciences, 7(1).

27 Biddulph, M. (2012). Radical streets? The impact of innovative street designs on liveability and activity in residential areas. Urban Design International, 17(3), 178-205.den Boer LC, Schroten A. Traffic noise reduction in Europe. 2008;

28 Foley, L., Prins, R., Crawford, F., Humphreys, D., Mitchell, R., Sahlqvist, S., ... & M74 Study Team. (2017). Effects of living near an urban motorway on the wellbeing of local residents in deprived areas: Natural experimental study. Plos one, 12(4), e0174882.

29 Slabinac, M. (2015). Innovative solutions for a "Last-Mile" delivery–a European experience. Business Logistics in Modern Management.

30 Hagen, J., Lobo, Z., & Mendonça, C. (2013). The benefits of cargo bikes in Rio De Janeiro: a case study.

31 Conway, A., Fatisson, P. E., Eickemeyer, P., Cheng, J., & Peters, D. (2012, January). Urban micro-consolidation and last mile goods delivery by freight-tricycle in Manhattan: Opportunities and challenges. In Conference proceedings, Transportation Research Board 91st Annual Meeting.

32 Hagen, J., Lobo, Z., & Mendonça, C. (2013). The Benefits of Cargo Bikes in Rio de Janeiro: A Case Study.

33 Choubassi, C., Seedah, D. P., Jiang, N., & Walton, C. M. (2016). Economic analysis of cargo cycles for urban mail delivery. Transportation Research Record, 2547(1), 102-110.

34 Rajé, F., & Saffrey, A. (2016). The value of cycling. Cycling Embassy.

Finally, the total benefits of e-cargobikes should increase relative to the costs over time. As with other transport systems, cycling exhibits some network effects (i.e. their value increases as more people participate).[35] However, it is not until we see a 'modal shift' (i.e. where cargo bikes are mainstream, displacing large numbers of cars and vans) that we will start to see material changes in air quality and quality of life outcomes. There are many estimates of the potential for e-cargobikes to replace vans ranging from as low as 15% to as high as 51%.[36][37] The potential benefits discussed above, therefore, should be viewed as having a similar range, suggesting that the greater the transition to e-cargobikes the greater the benefits.

35 Schoner, J. E., & Levinson, D. M. (2014). The missing link: Bicycle infrastructure networks and ridership in 74 US cities. Transportation, 41(6), 1187-1204.

36 Gruber, J., Ehrler, V., & Lenz, B. (2013). Technical potential and user requirements for the implementation of electric cargo bikes in courier logistics services. In 13th World Conference on Transport Research (WCTR).

37 www.cyclelogistics.eu

3. Methodology

This section sets out the methodology for the quantitative model comparing diesel vans, electric vans and e-cargobikes.

The impetus for this paper were the findings of the *Bikes for Business* evaluation.

Bikes for Business was developed by Team London Bridge, a business improvement district, to promote e-cargo-bikes as a mainstream solution for business deliveries and freight.[38] The evaluation found that, whilst user satisfaction with e-cargobikes was very high, like-for-like cost of deliveries was significantly higher by e-cargobike courier than van courier (up to a third more expensive in some cases). A significant proportion of businesses were not in a position to absorb these costs and returned to van couriers after the e-cargobike trial period and subsidy ended.

The price differential between van and e-cargobike couriers is the opposite to what might be expected, and hypothesised, in the literature. Given their lower purchase and running costs, and greater potential for efficiency, we would expect e-cargobikes to be cheaper than vans.

There are two possible explanations for the higher price of e-cargobike courier deliveries, which this study sets out to test:

- First, it may be that many of the environmental and social costs of diesel van deliveries are not reflected in the prices charged for these kinds of deliveries (e.g. costs related to climate change, air pollution, congestion and noise.)
- Second, it may be that the employment status of van drivers means that many economic costs, such as van purchase, fuel, maintenance, and employee benefits are not borne by delivery companies, enabling them to charge less for deliveries and undercut companies that are bearing these costs.

To test these explanations, we constructed quantitative models to compare the full environmental, social and economic costs of delivery by diesel vans, electric vans, and e-cargobikes.

Petrol vans are not included in the analysis as a) the differences with diesel vans are minimal on most variables and b) most vans on the road are diesel (96% in the UK),[39] meaning that data are more limited and impacts not material.

Although electric vans also only make up a fraction of the fleet, they are a significant growth area and advocated as a greener alternative to diesel vans and, hence, are included in this analysis.

3.1 Cost Models

This research is based on two cost models. In this section, we provide an overview of each. A Technical Appendix with all assumptions in the model is contained in Annex 1.

3.1.1 Environmental and social costs

We calculated the environmental and social costs of making deliveries in London, comparing diesel vans, electric vans and e-cargobikes.

38 Commissioned by the Institute on Urban Health (IOUH), the evaluation is ongoing and a final report will be published in 2023

39 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1065072/van-statistics-2019-to-2020.pdf

The following environmental externalities were included in the model:

- Climate change
- Air pollution
- Noise
- Water pollution

For social externalities, the following variables were included:

- Accidents
- Infrastructure costs
- Congestion
- Health of drivers

Each of these was calculated on a per mile basis.

3.1.2 Economic cost

The second application of the model focused on the true economic costs of a delivery.

As noted above, many van courier companies operate an independent contractor model where significant costs are borne by drivers rather than the firm, allowing the company to provide low-cost services. This can result in net incomes for drivers that are effectively below the minimum wage.

To capture this, we estimate the full economic cost of a delivery. The economic variables included in the model are:

- Employment costs, including standard non-wage costs
- Purchase costs
- Fuel costs
- Tax and insurance
- Parking and storage
- Servicing and MOT
- Congestion charge costs

To enable direct comparability for a single delivery we assume that van drivers make an average of 70 individual drops each day. Given their greater manoeuvrability and smaller size, e-cargobikes are able to go where van drivers cannot and are potentially able to make more drops in the same period of time, with some evidence suggesting this is up to 3 times as many. However, because it is difficult to compare deliveries on a like-for-like basis, we are assuming the same number of drops across all modes, while recognising that this may underestimate the efficiency potential of e-cargobikes. Greater efficiency would be reflected in lower cost per delivery, so we would expect the cost advantage of e-cargobikes to increase in proportion to their greater efficiency.[40]

40 https://www.forbes.com/sites/carltonreid/2019/05/31/e-cargobikes-do-30-daily-drops-compared-to-12-by-van-finds-154-year-old-london-courier-company/

4. The environmental and social cost of deliveries

All forms of deliveries create environmental and social costs that are not currently reflected in prices – i.e. externalities. The fact that these costs are not borne by delivery firms means they have no incentive to reduce them. The fact that these costs are not paid by clients of these firms, has the same effect. As with all negative externalities, the net result is that more damaging activities are undertaken than would be the case if both producers and consumers had to bear the costs.

Yet just because these costs are not reflected in prices does not mean that they are not real. As we saw earlier, air pollution is directly responsible for many deaths and illnesses every year while climate change is arguably the greatest challenge the world faces.

Externalities are also not simply a given but a product of the economic rules governing a market. As such, they are not immutable but change depending on priorities and objectives. For example, alcohol, fuel and tobacco duties are all examples of attempts to 'price in' negative externalities and influence behaviour.

Faced with the need to reduce emissions drastically, it could be argued that similar mechanisms for 'pricing in' social and environmental costs to deliveries should be considered.

The research in this report seeks to contribute to this debate by making visible the externalities associated with different modes of delivery.

4.1 Environmental costs

Table 3 estimates environmental costs per mile, for diesel vans, electric vans and by e-cargobike.

Table 3: Environmental externalities (£/mile)

Variable	Diesel van	Electric van	E-cargobike
Climate change	0.0312	0.0120	0.0026
Air pollution	0.0852	0.0043	0.0000
Noise	0.0288	0.0089	0.0000
Water pollution	0.0280	0.0210	0.0000
Total environmental (per mile)	**0.1732**	**0.0462**	**0.0026**
Total environmental (annual, London)	**640,663,482**	**170,773,691**	**9,535,212**

There are two key points to note. Firstly, while the costs per journey may seem small this must be placed in the context of the number of daily miles travelled. If we translate the per mile figures to the total environmental externalities for a year, the figure for diesel vans in London is **£640 million**.

Secondly, there is a substantial difference in relative costs. The environmental externalities of an electric van (£170 million) are nearly 18 times higher than an e-cargobike (£9.5 million) and the externalities of a diesel van are more than **67 times higher** than for an e-cargobike.

4.2 Social costs

Social costs are also real. Every year road accidents cause many deaths and injuries. While the impacts of congestion are far less severe, there is an important and measurable cost, both to individuals and to the economy as a whole. Time spent in traffic jams is time that cannot be spent doing other things. This is a significant drag on economic productivity, as well as on people's quality of life.

Table 4 gives estimates for these social externalities by vehicle type. Again, this is expressed on a per mile basis.

Table 4: Social externalities (£/mile)

Variable	Diesel van	Electric van	E-cargobike
Accidents	0.0465	0.0465	0.0234
Infrastructure costs	0.0316	0.0363	0.000001
Congestion	0.2757	0.2757	0.0517
Health (riders vs drivers)	0.1391	0.1391	0.0000
Total social costs (per mile)	**0.4929**	**0.4976**	**0.0751**

When looking at social costs, the table shows that diesel and electric vans are largely indistinguishable as the fuel type does not impact on these costs in a material way. These modes both incur more than six times the social costs of e-cargobikes. If we translate these per mile costs to an annual figure based on total miles travelled, the annual cost to London of social externalities resulting from diesel van travel is **£1.8 billion.**

4.3 Combined social and environmental costs

Table 5 Combines the environmental and social factors to estimate total externalities associated with delivery by diesel van, electric van, and cargo bike.

Table 5: Total externalities (£/mile)

Externality	Diesel van	Electric van	E-cargobike
Environmental costs per mile travelled	0.1732	0.0462	0.0026
Social costs per mile travelled	0.4929	0.4976	0.0751
Total externailties per mile travelled	0.661	0.5438	0.0777
Ratio of costs to e-cargobikes	8.58	7.00	1.00

This shows that the combined social and environmental costs of diesel vans are over 8 times higher than the combined social and environmental costs of an e-cargobike delivery. Even when compared to electric vans, e-cargobikes perform significantly better. Due to the high social costs of electric vans, the total environment and social cost of a 1-mile electric van journey is 7 times that of an e-cargobike.

5. Estimates of a fair price for delivery costs

In the previous section, we estimated the hidden social and environmental costs of deliveries. Cut price deliveries also often mask hidden economic costs. These are not shadow prices but actual pounds and pence that come from the pockets of drivers.

At present many van deliveries are made on an independent contractor model, where firms pass on costs of doing business to drivers. This enables companies to offer deliveries at prices that firms with employees on the payroll cannot compete with.

Many e-cargobike riders, on the other hand, are on payroll pushing up the cost of e-cargobike deliveries. Interestingly, even within larger courier companies that provide deliveries by a range of vehicle types (van, motorcycle, e-cargobike), it is usually only the e-cargobike riders that are on payroll.

This section sets out to calculate a minimum 'fair price' for deliveries by different modes. This is defined as the minimum price an average delivery would need to cost if companies were bearing full economic costs rather than passing these on to drivers/riders.

Table 6 provides the economic cost of diesel van, electric van and e-cargobike deliveries if all relevant costs of doing business are met by the companies. Note that, for labour costs, we assume that wages are set at the level of the London Living Wage.[41]

Table 6: Economic costs of delivery by vehicle type (£/delivery)[42]

Variable	Diesel van	Electric van	E-cargobike
Wages	1.5305	1.5305	1.5305
Non-wage employment costs	0.7002	0.7002	0.7002
Purchase	0.2343	0.2958	0.0339
Tax (VED)	0.0097	0.0000	0.0000
Insurance	0.0848	0.0751	0.0296
Fuel	0.1504	0.0659	0.0165
Parking fines	0.0128	0.0128	0.0000
Storage	0.0574	0.0574	0.0924
Servicing and MOT	0.0102	0.0102	0.0049
Congestion charge	0.3142	0.0000	0.0000
Overheads	1.5523	1.3740	1.2040
Profit margin	0.6939	0.6142	0.5382
Fair price per delivery (inc. VAT)	**£6.42**	**£5.68**	**£4.98**

It is clear that companies that are offering cut price deliveries cannot be bearing the full economic costs, but are passing significant costs on to drivers, who often end up having to work long hours to earn a decent income. On the other hand, the price of e-cargobike courier deliveries, which can be up to twice the cost of van deliveries, are commensurate with the 'fair price' calculated.

Examining the table above, when costs that are often externalised to van drivers are removed (e.g. wage costs, fuel, vehicle purchase, parking finance etc.), the remaining economic costs for a van delivery come to £2.06, thereby showing how it could be possible to provide a single delivery for somewhere in the region of £2.

41 It should be noted, however, that at just £11.95 per hour, this is still quite low. If this is all that is paid to a delivery driver, employers are avoiding significant non-wage costs in areas such as holiday and sick pay, NI and pension contributions. These amount to around half of wage costs

42 Not all vehicles incur a cost in each category. Electric vans and e-cargobikes, for example, are exempt from road tax (Vehicle Excise Duty, VED) and the congestion charge. Conversely, while diesel vans are likely to be stored at their drivers' property, e-cargobikes have to be stored in central London. This is a significant cost to e-cargobike firms.

It is important to note that these figures are based on a range of assumptions that are subject to change depending on company characteristics and parcel size, fragility, weight and time-sensitivity. They are not suggested as universal price floors but as indicative of the kinds of costs that are being borne by drivers and prevent a level playing field between different modes.

The difference in the way drivers and riders are engaged goes a long way to explaining why e-cargobikes cannot compete on price with diesel delivery vans. The continued use of the independent contractor model, therefore, not only places a cost and risk burden on drivers but presents a significant barrier to encouraging deliveries by cleaner modes and the achievement of a modal switch.

6. Recommendations

It is vital that a modal shift to cleaner freight and deliveries occurs in major cities, such as London. But at the moment the cards are stacked against one of the most promising modalities, e-cargobikes.

This research has demonstrated that the most harmful delivery modes externalise social, environmental and economic costs and, in so doing, overturn the natural cost advantage of e-cargobikes.

Without intervention, a modal shift will not occur at the pace that is required to address the twin challenges of climate change and air pollution.

To this end, the final section of this report sets out a suite of interventions to address the "push" and "pull" factors for switching to cleaner modes, with the recommendations organised by stakeholder.

Local: GLA, Transport for London, and Local Authorities

At the local scale, we recommend the following interventions to encourage modal shift to e-cargobikes for freight and deliveries:

1. **Using smart road pricing to more accurately reflect environmental and social costs:** The London congestion charge and ULEZ are very blunt tools as currently deployed. More could be done with variable road pricing to discourage driving at certain times and places. For example, electric vans don't currently pay a congestion charge despite their equivalent contribution to congestion as fossil fuel vehicles. Pricing could also vary more significantly by type of vehicle. If done well, this has the potential to reduce environmental damage from emissions and noise, and to also address social costs such as congestion.
2. **Investing in e-cargobikes and cycling infrastructure:** E-cargobike courier companies require a different infrastructure to vans. Most immediately, they require storage facilities as well as consolidation hubs. With land values at a premium in central London, local authorities and other public bodies can play a role in driving down the cost of e-cargobike operations by:
   - Repurposing land and facilities for e-cargobike storage and consolidation hubs;
   - Ensuring that the planning framework supports the repurposing of buildings and facilities in this way;
   - Further investment in the creation and upkeep of e-cargobike and cycle lanes and dedicated e-cargobike parking bays;
   - The creation of battery exchanges and expansion of charging facilities;
   - Extension of Community Infrastructure Levy (CIL) to target e-cargobike infrastructure specifically;
   - Further restrictions on van use, to encourage more e-cargobike-friendly infrastructure: such as extending Low Traffic Neighbourhoods and Low Emissions Zones.
3. **Working with the private sector:**
   - Business Improvement Districts, major landlords and other place-based organisations can support the development of storage and consolidation solutions, and promote the concept of fair pricing in freight deliveries.
   - Freight operators and their business customers are also key stakeholders and will require additional targeted supports to move away from polluting vehicles. Direct financial support with e-cargobike purchase through subsidies will help smaller operators and businesses, while tighter regulation and codes of conduct will close loopholes, raise standards and ensure a level playing field for larger businesses.

4. **Promoting the use of e-cargobikes:** The findings from behavioural economics show us that interventions that promote economic rationality, such as pricing externalities, sometimes fail because of the role of seemingly irrational factors, such as habit-formation and loss aversion in decision-making.[43] E-cargobike promotion activities can play a role in countering some of these factors. Campaigns can support e-cargobike use by:
    - Providing real-life case studies of diverse businesses using e-cargobike deliveries and the benefits of doing so.
    - Highlighting the social and environmental benefits of switching to e-cargobikes.
    - Mobilising social and peer influence to encourage behavioural change.

National: Department for Transport, BEIS, and others

Some of the changes required to influence a modal shift are beyond the devolved powers available to public bodies in London. At the national scale, we recommend that the following interventions are considered:

1. **Introduction of a smart vehicle tax:** Road tax (VED) is also currently a very blunt tool, with significant potential for much greater variability around vehicle type. If set at a high enough level in the worst cases, this would go some way to correcting the cost differentials described above and create an incentive to switch vehicle type. Evidence shows taxes steeply graduated by CO2 emissions, are very effective at lowering fleet average emissions and tackling rising transport CO2 emissions.[44] Funds raised could be used to subsidise e-cargobike purchase schemes and other economic incentives.
2. **Introduction of a scrappage scheme:** Pricing mechanisms, such as road pricing and smart vehicle tax, can have unintended regressive distributional impacts. To offset the cost of switching, a scrappage scheme targeting those on low incomes should be introduced. This should include the option of replacing a polluting vehicle with an e-cargobike.
3. **Strengthen employment protection laws:** Laws should be strengthened so that independent contractor status cannot be used disingenuously to pass costs on to drivers. This would eliminate the unfair cost advantage of vans, and enable e-cargobikes to exploit their natural competitive advantages. Our previous research for Bikes for Business found that many courier companies would favour higher regulation as it levels the playing field and prevents a 'race to the bottom' in labour practices.
4. **Ensure there is regulatory clarity on what constitutes an e-cargobike:** For courier companies to feel confident in investing in an e-cargobike fleet, they need to have certainty around the definition of e-cargobikes and EAVs and how these will be treated in terms of licensing, road use, and other regulatory matters. Improved regulation of e-cargobikes should extend to better insurance availability, as well as training and licencing of riders to reduce the burdens these place on businesses.

43 Kroesen, M., & Chorus, C. (2018). The role of general and specific attitudes in predicting travel behavior–A fatal dilemma?. Travel behaviour and society, 10, 33-41.
44 https://www.transportenvironment.org/wp-content/uploads/2021/07/2019_02_How_vehicle_taxes_can_accelerate_electric_car_final.pdf

Appendix 1: Model assumptions by cost area

Environmental

a. Climate change

For the climate change analysis, we consider just one greenhouse gas: carbon. However, there are two means by which GHGs are created in transport: tailpipe and non-tailpipe emissions. Tailpipe emissions derive from the burning of fossil fuels to drive the vehicles– diesel, petrol and those used in electricity generation – and non-tailpipe are those that are emitted in the production of the vehicles. We include both forms of emissions in this analysis.

Data on the differential carbon emissions from e-cargo bikes, diesel, vans and electric vans are drawn from research by Pedal Me.[45] The carbon emissions from e-vans and e-cargo bikes depends on the energy mix used to generate electricity. As this becomes more renewable over time, the tailpipe emissions from e-vehicles is likely to fall. Table 7 sets out the tailpipe and non-tailpipe CO2 emissions of the three modes of transport in grams.

Table 7: Tailpipe and non-tailpipe CO2 emissions form the three modes

Type of vehicle	Type of emissions	Value	Unit
Diesel van	Tailpipe	246.2g	Per km
	Non-tailpipe	7500kg	Lifetime
Electric van	Tailpipe	49g	Per km
	Non-tailpipe	8800kg	Lifetime
E-cargobike	Tailpipe	4.5g	Per km
	Non-tailpipe	280kg	Lifetime

To include non-tailpipe emissions in our analysis, we need to convert them into a value per km travelled. We do this by dividing the grams of carbon by the average km travelled in a lifetime by the different vehicles. Data on lifetime mileage is taken from research by Fraselle et. Al (2021).[46] The assumptions on mileage and associated emissions are set out in Table 8.

Table 8: Assumptions on lifetime mileage and associated carbon emissions from non-tailpipe

Mode	Mileage (km)	Grams of carbon per km
Diesel van	218,000	34
Electric van	150,000	58
E-cargobike	15,000	18

It is possible then to value the total carbon produced per km by multiplying it by the cost of carbon per gram. There are many methodologies for valuing carbon. Our base case uses the cost of carbon recommended by the UK government for policy appraisal (DBEIS, 2019b) for non-ETS sectors of which transport is one. The 2020 recommended value is £69 and is based on the UK Emissions Trading Scheme permits plus a premium. This is a relatively low value, however. For example, the EU Emissions Trading Scheme reached almost €100 in August 2022. It has fallen back somewhat since then due to rising fuel costs. This points to problems with market-derived values of carbon, which will fluctuate with market conditions, rather than climate science. Other methods of valuation are advocated such as estimating the marginal social cost of carbon SCC (i.e. the cost additional unit of carbon, into the atmosphere will cause the society as a whole). These

45 https://pedalme.co.uk/carbon-emissions/

46 Fraselle, J.; Limbourg, S.L.; Vidal, L. Cost and Environmental Impacts of a Mixed Fleet of Vehicles. Sustainability 2021, 13, 9413. https:// doi.org/10.3390/su13169413

can be as high as $312 per ton. However, to ensure our analysis is conservative, we have used the Treasury recommendation. Arguably, given the scale and urgency of the climate challenge, the relative value of carbon emissions in this model should be significantly higher. Whilst, it is appropriate to follow Treasury guidance on economic appraisal, we can highlight the inadequacy of this figure to capture climate impacts.

All per km figures were then converted into a cost per mile.

b. Air pollution

Overall human exposure to both PM2.5 and NOX is linked to around 40,000 early deaths and hundreds of thousands of life years lost in the UK each year, with an average loss in life expectancy per person of approximately six months.[47] The costs of air pollution were derived from a study carried out by economists on behalf of Global Action Plan.[48] Brand and Hunt (2018) use two methods to value these deaths. The first of these is the bottom up approach, which values all costs incurred from illness and hospitalisation and the second is to use the Value of a Statistical Life approach (VSL).

They estimate that the lifetime economic costs for air pollution per van using both methods. These are significantly different from each other: £5,107 for the bottom-up approach and £15,130 for the VSL approach. We have taken an average of these two approaches (£10,118) and divided it by the average lifetime mileage: 190,080 per year. The mileage was calculated by multiplying the life of the van (9 years)[49] by the average annual mileage 21,180.[50] This gives a cost per mile of £0.0852.

The main pollutants that are of concern in London are PM and NOx. However, these vary by vehicle age. A further caveat therefore is that vans are regulated by the Euro standards 1-6 and the newest standard (6) is designed to much stricter environmental limits. Our calculations are based on the fleet mix from 2018 but it is likely to have improved since then as more polluting vehicles come off the road and/or as low emissions zones are extended. It should be noted that even as pollutants from tailpipe emissions fall, particulate matter from tyre, brake wear and road abrasion, are still present, including for heavier electric vehicles.[51] These emissions have been on the rise and remain a concern for air pollution.

There is limited real-world data on E-vans and air pollution, as they make up such a small proportion of the fleet mix. However, Brand and Hunt estimate that they produce 20 times less pollution than diesel vans.[52] Using this figure, we can derive the air pollution from e-vans from the diesel vans estimate. This gives us an economic cost of £0.004 per vehicle mile.

There is no data available on air pollution impacts of e-cargobikes. However, the research literature suggests that these are negligible (zero tailpipe emissions and very small non-tailpipe emissions due to light weight of vehicle).

Table 9 summarises the air pollution costs for each mode. As we can see the cost per mile is £0.0852 for a diesel van and £0.0043 for an electric van.

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47 https://www.cleanairday.org.uk/files/the_health_costs_of_air_pollution_from_cars_and_vans_20180518.pdf

48 https://www.cleanairday.org.uk/files/the_health_costs_of_air_pollution_from_cars_and_vans_20180518.pdf

49 https://www.cleanairday.org.uk/files/the_health_costs_of_air_pollution_from_cars_and_vans_20180518.pdf

50 Estimated from van statistics https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1065072/van-statistics-2019-to-2020.pdf

51 https://www.emissionsanalytics.com/news/pollution-tyre-wear-worse-exhaust-emissions

52 https://www.cleanairday.org.uk/files/the_health_costs_of_air_pollution_from_cars_and_vans_20180518.pdf

Table 9: Air pollution costs (£/mile)

	Diesel van	Electric van	E-cargobike
Per mile	0.0852	0.0043	0.0000

c. Noise pollution

Noise pollution has been linked to a range of mental and physical health problems.[53] The UK Treasury (2014) estimates that noise pollution costs the UK between £7 and £10 billion annually[54] with much of that coming from road use.

Most studies place average automobile noise costs at 0.8p-1.7p per vehicle mile. In a review of studies, the Victoria Transport Policy Institute (VTPI) argues that noise costs vary between rural and urban areas.[55] It's estimate for road noise is 1.3¢ per mile on urban roads with electric vehicles at producing 30% of the noise cost of an automobile under urban conditions ($0.004). We have converted these figures to Sterling and uprated to 2022 prices. In the VTPI analysis, noise pollution from bikes is valued at zero but no values are provided for e-cargobikes. We assume no noise from cargo bikes but further research is required to assess whether ecargo bikes contribute towards noise pollution.[56] Table 10 provides a summary of all of the values for noise pollution.

Table 10: Noise pollution costs (£/mile)

	Diesel van	Electric van	Cargo bike
Noise costs per mile	0.0288	0.0089	0.0000

d. Water pollution

While air pollution is the most well-known environmental consequence of transport and freight, fuel, particle, and salt-laden runoff from streets, can also result in damage to public water supplies, soil and vegetation.[57] The methodology used in this section, closely followed that of noise pollution. Our estimates are again taken from the VTPI that has reviewed international studies to arrive at an estimate of the costs of water pollution from different modes of transport.[58] It's estimate for diesel vans is 1.4¢ per vehicle mile and 0.7¢ for an electric vehicle. Although non-e-assist bikes are used, rather thane-cargobikes in the analysis (value of 0), the water pollution impacts of electric cargo bikes are again likely to be minimal. As with noise pollution, these values have been converted to Sterling and uprated to 2022 prices (see Table 11).

53 Geravandi, S., Takdastan, A., Zallaghi, E., Vousoghi Niri, M., Mohammadi, M. J., Saki, H., & Naiemabadi, A. (2015). Noise pollution and health effects. Jundishapur Journal of Health Sciences, 7(1).

54 https://www.gov.uk/guidance/noise-pollution-economic-analysis#overview

55 https://www.vtpi.org/tca/tca0511.pdf

56 This approach was corroborated by the study author in email correspondance

57 Ortolani, C., Persona, A., & Sgarbossa, F. (2011). External cost effects and freight modal choice: research and application. International Journal of Logistics Research and Applications, 14(3), 199-220.

58 https://www.vtpi.org/tca/tca0515.pdf

Table 11: Water pollution costs (£/mile)

	Diesel van	Electric van	Cargo bike
Water pollution costs per mile	0.028	0.021	0

Social

a. Accidents

There are three types of costs borne by individuals involved in accidents: costs relating to the crash, an injury or a fatality. In London, there are 23,131 collisions each year. 23,096 result in a minor injury with 3,505 serious injuries and 75 fatalities.

We can disaggregate these by goods vehicles and bikes (Table 6). No data are available on cargo bikes. Because they are heavier than bikes, we can assume that accident data are more severe but we do not have any basis for an alternative estimate and have used the bikes data instead. Although this is likely to underestimate the accident risk associated with e-cargobikes, it is still the case that due to the lower speed limit (15 kph)[59] and significantly smaller weight than a van, that they are still likely to be much less like to causes serious or fatal injuries (see Table 12).

Table 12: Incidence and share of accidents for goods vehicles and bikes

Goods vehicles	Number of incidents	%
Fatal	17	0.23
Serious	410	0.12
Minor	3012	0.13
Total		**0.16**
Bikes	**Number of incidents**	**%**
Fatal	0	0
Serious	71	0.02
Minor	347	0.02
Total	**418**	**0.04**

Cost data for Britain on accidents have been accessed from Statistica. These are £1.9 million per fatality, £216,815 per serious injury and £16,722 per slight injury.[60] These include all costs such as police time, courts and costs borne by individuals. These costs are multiplied by incidence of accidents for London and the share for goods and pedals (Table 12). We assume the risk of e-vans are the same as for diesel. These are then divided by the number of LCV miles for London (3.7 billion), which gives us a cost per vehicle mile (see Table 13).

Table 13: Accident cost for each mode (£/mile)

	Diesel van	Electric van	Cargo bike
Cost per mile	0.0465	0.0465	0.0234

59 Being hit by a car at 30 mph carries a 20% chance of a fatality, which rises to 33% at 35 mph. https://www.brake.org.uk/get-involved/take-action/mybrake/knowledge-centre/speed/speed-and-injury#:~:text=The%20greater%20the%20impact%20speed,they%20are%20hit%20at%2035mph.

60 https://www.statista.com/statistics/322862/average-cost-of-road-accidents-and-casualties-in-great-britain-uk/

b. Infrastructure

The infrastructure component focused on the costs of maintaining London's road network, and the impact on these costs of different vehicle use. The core assumption, supported by standard practice in the engineering industry, is that impact is a direct function of weight, and this will increase by the 4th power of the ratio of difference in vehicle axle weight.

London's road network contains 14,842 km of carriageway. 60 km is comprised of motorways, which is managed by Highways England. There are 580 km of major arterial roads (A roads), which are managed by Transport for London (TfL). The remaining 14,202 km of smaller roads are managed by the London Boroughs.

Excluding motorways (where cargo bikes are not allowed) the total annual maintenance cost of the network is a little over £1 billion, with roughly two thirds of this being spent on the TfL network and a third by the London Boroughs. A significant proportion of this total (43%) is spent on factors such as traffic lights that are not influenced by vehicle type. We therefore exclude this and focus on carriageway maintenance only. At 57% of the total, this equates to £584 million per year, or £39,549 per km of road.

Vans account for 20% of traffic in London so we assume the same proportion of responsibility for maintenance costs. As discussed above, impact is a function of weight, so we would expect vans to create more impact than cars, but significantly less impact than lorries. We therefore assume this balances out with the 20% figure being a reasonable estimate. This results in an annual cost of £117 million of carriageway maintenance resulting from van, which equates to 3.16p per mile driven by a diesel van. Given electric vans are 16% heavier than diesel vans on average, we increase their cost estimate by this proportion relative to diesel vans[61].

Here and elsewhere, we assume vans to be standard Ford Transit, cargo bikes to be a mid range/size model, and EAVs to be the shorter wheelbase model that is most commonly used. The respective loaded weights of each are 3,500 kg, 225 kg, and 320 kg. This results in a weight ratio difference of 15.5[62] between vans and cargo bikes and 10.9 between vans and EAVs. Taking an average of cargo bikes and EAVs, and applying the 4th power formula, result in the impact cost of a 1-mile cargo bike/EAV journey.

c. Congestion

Congestion cost estimates are driven by hours lost as a result of congestion, drawn from an international study (INRIX) that uses GPS data to compute time lost statistics for major cities in Europe and the US. In the most recent study (2021), London topped the table, with an average of 148 hours lost each year per driver. This is similar to the level for 2019 (149), and more than double that for 2020 (69). The sharp reduction in congestion in 2020 reflects the impact of covid lockdowns on traffic.

The INRIX study estimated the value of lost time, using an estimate of £8.14 per hour for London.[63] Given the number of drivers in London each year, this results in an annual cost per driver of £1,200 as a result of congestion.

61

62 i.e. vans are 15.5 times heavier than cargo bikes.

63 Hourly values of time in the INRIX study were based on U.S. Federal Highway Administration's Revised Departmental Guidance on Valuation of Travel Time for Economic Analysis, 2016, adjusted for inflation: $15.60 per hour in the U.S., £8.14 per hour in the U.K. and 9.37 € per hour in Germany.

The smaller size and maneuverability of cargo bikes means they are more able to avoid congestion and at scale reduce it overall. In terms of area, e-cargobikes are roughly three times smaller than vans. We therefore assume that congestion resulting from e-cargobikes would be reduced by the same order of magnitude.

d. Health (riders vs. drivers)

Commercial drivers have been found to be at risk of a range of health problems including sleep disorders, diabetes, hypertension, and obesity,[64] and lower back pain.[65] Factors related to the work environment affect drivers' lifestyle, which often consists of long sitting periods at work and low leisure-time physical activity.[66] This contrasts with the active lifestyle of e-cargobike riders. Research has shown that using an e-cargobike ensures that riders meet physical health guidelines of 150 minutes of moderate-to-vigorous physical activity.[67]

Data was not available on the physical activity of van drivers in London. Instead we used a study based on lorry drivers in the East Midlands. This study found that on average, drivers accrued 12 min/day on workdays and 6 min/day on non-workdays of moderate-to-vigorous PA (MVPA). This equates to 72 minutes per week: 78 minutes or 52% of the recommended minimum.

People who are insufficiently active have a 20% to 30% increased risk of death compared to people who are sufficiently active.[68] We also know that the average number of life years lost from physical inactivity is between 1.4 and 2 years, or an average of 1.7 years[69] We can use these data to value the health benefits to riders compared with drivers.

The 2022 UK Treasury Green Book recommends using £70,000 as the value of a Quality-of-Life-adjusted-Year (QUALY).[70] This means that each sedentary lifestyle has a loss of life equivalent to £119,000 (£70,000x1.7). This means that each sedentary lifestyle has a loss of life equivalent to £119,000 (£70,000x1.7). As drivers meet 58% of the recommended amount, we assume that 52% of that amount is what each driver loses from physical inactivity. Although the minimum recommendations may not be entirely linear, this approach enables us to link the lack of physical activity with mortality in a plausible way. If we assume that each driver works in line with the average EU working week (33.7 hours),[71] this equates with 1836.2 hours per year. We know that the average kms driven per year is 21,120, which enables us to calculate the health loss per km (£0.09). These per km figures were then converted into a cost per mile. These data only consider mortality and do not include the costs of other chronic conditions and mental health associated with commercial driving.

64 https://bmjopen.bmj.com/content/4/3/e003434.short

65 https://www.sciencedirect.com/science/article/abs/pii/S0169814105001757

66 https://www.sciencedirect.com/science/article/pii/S2211335516301012

67 https://pubmed.ncbi.nlm.nih.gov/22005715/

68 https://www.who.int/news-room/fact-sheets/detail/physical-activity#:~:text=Physical%20inactivity%20is%20one%20of,people%20who%20are%20sufficiently%20active.

69 https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3400064/

70 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1063330/Green_Book_2022.pdf

71 https://ec.europa.eu/eurostat/web/products-eurostat-news/-/ddn-20220706-1#:~:text=For%20women%2C%20the%20average%20duration,and%20Romania%20(27.4%20years).

Economic

The variables examined in this section reflect the relative economic costs of different modes of delivery: diesel van; electric van; and e-cargobike. As well as the direct and indirect costs of employment, these include the costs of purchasing, taxing, insuring, servicing and running (i.e. fuel) the vehicle, as well as factors such as the London congestion charge, parking fines and storage. We also take account of overhead costs (to cover fixed costs such as rental, utilities and non-delivery staff) costs, and a reasonable profit margin.

In all cases, annual costs are converted into estimates per delivery. As described in the main body of the report, this is based upon an estimate of 70 deliveries per day extended over a year, with an assumed 4 weeks of holiday/time off.

a. Employment

The employment cost estimates aim to capture the real costs of reasonable quality employment. Many van delivery drivers in London operate on an independent contractor model, where they are paid an hourly rate for deliveries, but do not receive any other standard employment benefits.[72]

The true cost of employment is therefore being hidden, or more accurately borne by drivers themselves, depressing real, disposable incomes. To capture this, we estimate the full cost that should be borne to cover the following:

- Wages
- National insurance
- Holiday pay
- Sick pay
- Pension contribution
- Life insurance
- HR costs and training
- Equipment

In each case, standard industry estimates are used. The results show that the weekly cost of employing a driver is £478, based on a 40-hour week. Extending to a year gives a figure of £24,856. The additional costs detailed above, however, increase this by £11,371, with a total cost per driver employed of £36,227.

a. Purchase

As elsewhere, we take the Ford Transit as the baseline model for diesel, and the E-Transit as the equivalent for electric vehicles. For cargo bikes, the baseline is an average of costs of the e-cargobikes for business models produced by Urban Arrow[73]. and the EAV is the most popular model as made by EAV solutions. In all cases, prices are based on the standard model without additional features.

72 Independent contractor drivers also tend to use their own vans for deliveries that are therefore liable for the costs of taxing, insuring, and maintaining these vehicles.

73 https://app.hubspot.com/documents/19535859/view/447654978?accessId=218f68

2022 purchase prices are £38,055 for diesel van, £48,045 for the E-Transit, £10,995 for the EAV, and £5,500 for a cargo bike. Vans are assumed to last for 10-15 years depending on use, so we assume a ten-year lifespan and apply this to all vehicles.

b. Tax (VED)

Road tax, or more accurately Vehicle Excise Duty (VED) does not apply to electric vehicles, including cargo bikes and EAVs. There are two VED rates applied to diesel vans. Old vans registered before 2002 (tax class 39 vans) pay £290, while more recent models (Euro 4 and 5 regulation standards, or tax class 36) pay a lower rate of £140. Vans registered after 2016 are taxed at the same rate and are generally compliant with Euro 6 regulatory standards.

To estimate the average VED cost of London' van fleet, UK government data on the age of registered vans on the UK roads in 2021 was used. This shows that 23% of vans fall into the older category where the higher VED rate applies. Applying these proportions produces a weighted average annual VED cost per van of £157.80.

c. Insurance

Both cargo bikes and EAVs are classed as bicycles and therefore do not need to pay road insurance. They are, however, susceptible to theft and drivers may also face liability in the event of an accident. To capture this, we take a monthly insurance estimate for a cargo bike provided by the main insurer of bikes and E-bikes, Laka Insurance. This is likely to be an overestimate as the quote is for personal rather than corporate insurance. Laka also offer commercial rates, which are no doubt somewhat lower, but are not publicly available. The personal insurance cost average is £40 per month, or £480 per year.

The cost of insuring diesel and electric vans depends on the age of the vehicle and its value. It also depends on the type of insurance, and we assume third party, fire and theft cover in all cases. Using the same data on the age of vehicles discussed above, annual cost are produced as a weighted average of actual quotes provided by an online insurance comparator. [74]

d. Fuel

Fuel costs for diesel vans are based on average fuel economies of vans of different ages. Again, the same underlying data on the age profile of the van fleet is used. So, for example, a new Ford Transit can travel 72km per gallon of diesel, whereas an older model would run for an average of around 50 km. A weighted average of fuel costs is produced based on current retail diesel costs.

Electric vans also need fuel. In this case electricity. While less dramatic than with petrol and diesel, the cost of electricity has also increased significantly, with increases of around 50% in fast charging stations, as well as home charging. The cost also varies significantly between home charging and fast charging from commercial sites, as well as between commercial providers themselves. In the service of simplicity, we assume that vans are charged at home, at an average rate of on- and off-peak, and based on the standard battery size of Ford E-Transits.

74 Moneysupermarket.com

e. Parking fines

Estimates for parking fines are drawn from data provided by London Councils, an umbrella group of London boroughs. This distinguishes between different levels of Penalty Charge Notice (PCN) in terms of severity as well as the location of the offence – i.e. higher charges in Band A than Band B areas. PCNs are issued at a particular rate, with the option to reduce this by half if paid within 14 days. In the absence of data on actual practice, we assume that all PCNs are paid early. The resultant estimates will therefore underestimate the real costs somewhat.

We also assume that vans receive PCNs in proportion to their road use in London – i.e. 20% of the total – and do not distinguish between diesel and electric vans.

f. Storage

An issue raised by e-cargobike providers is the high cost of storage in central London, as E-cargobikes need to be stored securely in the centre of the capital. The cost of storage (including charging[75]) is estimated at £50 per square foot per year. The average size of a standard cargo bike is 7 square metres, or 30 square feet, resulting in an annual storage cost of £1500.

The situation with vans is a little different. Where vans are owned by firms, there will be a need to store them in London, though this is unlikely to be in central London due to cost. To estimate this, we therefore take average annual rental cost per parking space for outer London from JustPark. Independent contractors will be parking their vehicles at home overnight. For this take the annual cost of a parking permit, again for outer London.[76] The resulting storage costs are therefore a weighted average of the two figures, based on the estimated discussed previously that 58% of van delivery drivers in London are independent contractors.

g. Servicing and MOT

According to industry publications, the average cost of servicing a diesel van is £125. Electric vans are cheaper to service, while hybrid models cost more. As a result, we again assume these factors balance out and give the same annual service cost of £125. The average cost of quotes to service a cargo bike is £40, but industry sources suggest £80 is more realistic figure. In all cases, we assume one basic service per year, which is the annual cost. For diesel vans, we add $40 per year for MOT costs.

h. Congestion charge

There are two forms of congestion charge. The basic charge is £15 per day and applies to all diesel vans. Electric vans are able to claim an exemption and e-cargobikes are also exempt.

In addition, the Ultra Low Emission Zone (ULEZ) in the centre of London attracts an additional charge. Again, Electric vans, cargo bikes and EAVs are exempt from the ULEZ. This is also the case for modern diesel vans – i.e. those from after 2016 that meet Euro 6 regulations. Using the same fleet age data as above, this equates to an average daily ULEZ charge of £6.99 for the existing fleet. Combined with the general CC, this gives a daily charge for diesel vans of just over £20.

75 To reflect this, fuel costs for cargobikes have been removed from the economic costs estimates as they are included in the estimates for storage costs.

76 Figures cited in the 2020 Centre for London publication: 'Reclaim the kerb: The future of parking and kerbside management in London'. https://www.centreforlondon.org/publication/parking-kerbside-management/

i. Overheads and profit margin

All companies face overhead costs, which cover office rental, utilities, non-income generating staff salary costs, as well as the cost of marketing and financial costs such as insurance and the servicing of debt. Overhead rates vary widely, both by industry and location – e.g. prime office space in St. James's is £115 per square metre, but less than half of this in Hackney. Overheads for manufacturing firms are higher than for service firms, and other industries also vary widely. Reported rates range from 23-70%, so we assume an average figure of 50% overheads.

For profit margin, the UK Office for National Statistics, reports average profit margins by industry for 2019, differentiating between manufacturing, financial firms, non-financial private companies, and service providers. We take the last of these as the benchmark, assuming a profit margin of 14.9%.

Finally, we apply VAT at 20% to all the preceding costs to arrive a fair delivery estimate.

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