

Last-Mile Delivery: From Building Infrastructure to Altering Behaviour

A Systems Approach to Last-Mile Delivery

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Executive Summary

This paper explores the trends contributing to demand for last-mile delivery, the consequent environmental impacts, the policy options available at multiple scales and, ultimately, the urgent justification for us to alter this unsustainable trajectory. Currently, the impacts of increased delivery are felt mainly at the urban scale where resources are limited. Therefore, our recommendations are focused on the benefits of national policy implementation through public messaging, online taxes, increasing consumer information and building capacities for local planning.

As part of its work to help the UK achieve Net Zero, the International Public Policy Observatory (IPPO) was tasked by its partners in government to explore issues around the decarbonisation of freight. IPPO's role is to synthesise global knowledge into realistic and potentially impactful policy recommendations. To help achieve this, we convened an exploratory roundtable with UCL academics from different disciplines, followed by a broader roundtable with representatives from across the last-mile delivery landscape, feeding into a [systems map](#). This was developed using elements of our [SEPPA Method](#) which deploys systems thinking to produce impactful, evidence-based policy options to help decarbonise last mile delivery.

The UK is [third](#) in the world for online shopping and has a fragmented logistics market; alongside a reliance on doorstep delivery spurred on by the pandemic, we are seeing more and more delivery vehicles on our roads. In addition to the environmental impacts of excess packaging, the sheer scale of the habit is increasing congestion, with more vehicles and more journeys causing immediate impacts on air pollution and road safety.

While local authorities are essential to shaping the built environment and establishing the infrastructure needed to support more sustainable delivery options - from locating lockers to building consolidation centres - national action is essential to shift the trajectory of the system itself. Beyond these tactical concerns, our systems approach suggests that improving the outlook for the UK environment and economy requires coordinated action at all levels. This should involve both influencing consumer behaviour through information and taxes, as well as changing corporate practices through local partnerships and mandated data sharing. While this is a significant challenge which requires political will – which is often resistant to impacting consumer behaviour - policies that help shift consumption to the local could have positive impacts in the long-term for social capital, economic resilience and community wealth.

‘There should be legislation to stop free returns, this would drive consumer behaviour’
- Sustainability Head, large logistics company

Introduction

An Expanding Industry

Transport is the largest contributor to UK domestic greenhouse gas emissions at [29.1%](#) - with HGV and domestic freight making up about one-third of this. With surface transport contributing the most to emissions, even when a product is shipped worldwide, the last-mile can count for up to half of the delivery emissions – a result of smaller vehicles and inefficiencies in complex routes (Higgs, 2022). The last mile is the final delivery stage, normally from a distribution centre within the region to the customer’s home or business.

The COVID-19 pandemic accelerated and embedded an existing trend towards online sales. In 2022, in retail alone, online sales accounted for around [26.5%](#) of UK sales nationally. Doorstep delivery, often meaning one parcel per house, has a failure rate of 2-10% on the first attempt; with the addition of industries like clothing, that have up to a 30% return rate, more and more delivery vehicles are needed on the road (Kardinal, 2024). With the era of ‘doorstep delivery’ not set to slow, it is predicted that increased demands will result in up to 36% more delivery vehicles in inner cities by 2030 – and up to 32% more pollution (Deloison et al., 2020). A report published in 2022 by the Clean Mobility Collective, predicted that last-mile delivery in Europe was adding 3 million tonnes of CO₂ to the atmosphere annually (Higgs, 2022).

With those living in cities globally continuing to expand, pressures of greater deliveries not only contribute to greenhouse gas emissions, but also have an immediate effect on worsening congestion, road safety and air quality (TFL, 2019).

The Hidden Impacts

While we know there are scales of efficiency that come from the densification of urban living, for many, migration to the city means transience, a disconnect from neighbourhood economies and an increase in income and consumption - with more purchased online. While rural communities are likely to use online shopping to access products they can’t find locally, or access better price points, urban dwellers are still more than twice as likely to shop, eat from restaurants and order groceries online vs accessing physically (PYMNTS, 2023). Escalated [trends](#) towards online shopping are part of a larger shift in consumerism that currently leaves most of the carbon costs in the shadows.



Part of the Solution: the Urban Scale

Existing Solutions

Action needs to be taken at the urban scale to tackle the immediate impacts of congestion, air pollution and road safety caused by last-mile delivery. Many suggestions exist for how local governments can adapt infrastructure and collaborate with local actors to develop solutions such as curb-side management, urban consolidation centres, collection lockers and low emissions zones.

For example, smart curbside management has the potential to raise public revenue by ensuring there is space for pick-up and delivery through apps that often charge and has been piloted in UK and [Ireland](#). Meanwhile, consolidation centres bring together deliveries from different logistics companies, reducing the number of journeys needed; these often include switching to less emitting vehicles for the last leg, like electric LGVs or cargo bikes. However, such hubs in dense urban areas can cause additional noise and pollution, making planning permissions hard to obtain, not to mention the often-high costs of central sites and the challenges of coordinating multistakeholder collaborations. At the same time, Accenture (2021) suggest that increased delivery demand during the pandemic has encouraged significant increases in efficiency, and with the continued expansions of local fulfilment options like parcel shops and smaller urban distribution centres, we could see decreases in delivery traffic by 2025.

Cross-cutting Urban Planning

Solutions will require a cross-cutting approach involving greater collaboration between public officers working on transport, local economy, land use and spatial planning in new residential design, with local authorities helping to identify space for distribution centres and parcel shops. For example, in central London, businesses applying for new developments are already required to consolidate deliveries and sometimes even acquire a consolidation centre outside the centre. For new builds in the City of London, there are allocated windows for delivery and often curfews on late-night deliveries for large vehicles where noise pollution is concerned.



Emerging Innovations and Policy Demands

In a report commissioned by the Local Government Association, Paddeau (2022) consults a range of local authorities in England, developing recommendations that nearly all require regulatory intervention and national support. For many local authorities, this is an emerging issue which comes up against a lack of local capacity, ingrained consumer behaviours and funding issues. Public support is also often required to make initial changes around electrifying vehicles and creating consolidation centres (Ibid.). Suggested solutions include greater use of e-cargo bikes, micro consolidation centres and dynamic road pricing, as well as logistics data sharing to aid local transport

planning (Ibid.). Industry actors have also highlighted the lack of grants for more novel last-mile delivery modes such as cargo bikes – which, given the supporting infrastructure, can provide an effective energy and space efficient method of last-mile delivery.



REEF Technology Trailer, Bond

A report for the US National Association of Transport Officials (Kim et al., 2021) also puts forward some bold new ideas that include waterway logistics hubs and underground delivery tunnels, as well as new warehouse and supply chain models which include digital tools to support SMEs with distribution. For example, [Flowspace](#) helps SMEs to scale by taking care of distribution, selecting the best courier for companies and using decentralised fulfilment centres, reducing unnecessary inventory storage and shortening delivery distances. Likewise, [REEF Technology](#) turns underused real estate into dynamic logistics hubs through modular distribution trailers, currently being piloted in a partnership between the City of Miami, DHL, the Downtown Development Authority and the Miami Parking Authority.

Meanwhile, Milton Keynes has developed the world's largest autonomous robot fleet since starting deliveries in 2018. The operator [Starship](#) claims to have saved hundreds of tonnes of CO2 delivering through its compact electric vehicles.



Autonomous Delivery Robot, [Starship Technology](#)

The Limits of Local Influence

In an area where consumers have choices that can influence their contribution to climate change, evidence is needed to show us what can be done at all scales to alter behaviour. Whether encouraging locker collection or the acceptance of slower delivery, research shows that our demand for fast delivery over a standard wait has a disproportionate effect on the environment and urban traffic (Muñoz-Villamizar et al., 2021). While slower delivery isn't always more efficient, ensuring options are available to store in a safe space or using parcel shops ensures successful first-time delivery and more distributed vehicle schedules.

With increased urbanisation and online consumption, this problem is set to expand as traffic congestion worsens the efficiency and emissions of deliveries (Boggio-Marzet et al., 2021). As the [third biggest](#) online shoppers in the world, the UK's willingness to accept slower delivery or pay more for more sustainable products or delivery is heavily engrained, suggesting more information and proactive regulation are needed to alter this. While local authorities have more control over transport planning and the built environment, it is nevertheless likely that national intervention is required to support behaviour change, the funding of infrastructure and regulation to affect changes in corporate practices.

Joining the Actors: the National Scale

Multi-Level Collaboration

Much like greenhouse gas emissions, the movement of goods transcends geographical boundaries and hence requires coordination amongst a broad range of actors. While cities have the authority to regulate, manage and plan for where and how freight activities take place - through highways, the public realm, built form and land use - they can move faster when they work with businesses and other levels of government.



Cross-sector Information Sharing

Some of the inefficiencies in routing last-mile vehicles through the city are a result of a fragmented market, with many logistics companies operating separately and often subcontracting deliveries to individuals. While logistics companies argue they already operate high-load vehicles, academics and policymakers suggest that research on supply optimisation is inhibited by a reluctance of companies to share what is considered competitive information. National intervention is needed to mandate cooperation, whether through supporting consolidation centres or data sharing for collaborative planning. Especially as industry

actors have suggested, when it comes to parcel shops, consumers don't care which brand delivers - removing some of the competitive concerns about lost visibility and service.

A report published by the World Economic Forum, 'The Future of the Last-mile Ecosystem', takes a systems view, highlighting the importance of multi-actor collaboration, but also of data and advanced analytics in efficient delivery and effective traffic management (Deloison et al., 2020). Optimising delivery schedules using AI also has the potential to significantly reduce the environmental impacts of last-mile delivery (Ramírez-Villamil et al., 2023). Likewise, developing data standards for effective sharing of information could also bring benefits to ecosystem players - including the logistics companies themselves - who can reduce time on the roads.

Labelling

In one IPPO roundtable, the sustainability lead of a large logistics company suggested 'there should be legislation to stop free returns, this would drive consumer behaviour'. While even corporations understand the requirements for legislation, there is also a need for information earlier in the journey, encouraging consumers to change their habits. While we know logistics companies currently calculate their emissions via different modes, an estimate at the point of purchase of the emissions produced by different delivery modes



Numi Organic Tea

(e.g. locker, standard, next day delivery) has the potential to affect consumer choices (Nogueira, Rangel, and Shimoda, 2021). This type of measure benefits the road users and the logistics companies, who can better optimise their deliveries with more flexible timeframes. A survey by Doddle supports the potential for behaviour to be shifted by information, suggesting that 43% of consumers are more likely to shop with a retailer offering sustainable delivery options (Barrett, 2019).

Taxes

As well as mandated labelling on emissions and restrictions on advertising, France has gone further with the ‘fast fashion tax’ (Agence France-Presse, 2024). Backed by France’s lower parliament, the ‘fast fashion tax’ is a bill that calls for penalties of up to 10 euros per item by 2030 on super-fast fashion shipped across the world to customers doorsteps (Ibid.) At the same time, the French Environment minister discussed proposing a European Union ban on the export of used clothes, to stunt worsening textile waste (Reuters, 2024). These combined efforts to affect consumer and corporate behaviours would likely influence textile producers’ practices and the costs of their goods.

The UK started to consider an [online sales tax](#) in 2022, addressing the fact that in-store retail is disproportionately affected by business rates. An attempt to level the retail playing, using revenues to relieve business rates, if enacted this shift of the tax burden could help revive economic centres and support more independent businesses.

While there are some concerns by policymakers of the equity implications of passing the costs onto consumers, Benzarti and Tazhitdinova (2021) found there to be low elasticity of changes in VAT compared to the implications of tariffs – implying

taxes would be more effective imposed on businesses, even when a percentage is passed on. While making imports more expensive in a heavily globalised market could have widespread economic implications, it does offer the opportunity to shift the focus to more local consumption.

The Challenge: Political Will

A Growing Industry and Growth Aspirations

The freight industry now contributes approximately £127 billion to the UK economy and supports £400 million in manufacturing sales, making up to 10% of the UK non-financial business economy and employing around 2 million people within the logistics sector (Department for Transport, 2022). Hence, the number of freight and logistics jobs have grown at twice the rate of the wider economy since 2010 – [some 26%](#). However, with Amazon being the largest actor in the UK, questions exist as to how much this growth benefits the broader population. The company - also in receipt of significant [public money](#) - is notorious for [irresponsible selling](#) tactics, [tax avoidance](#) and its provision of [low-quality jobs](#) – not to mention the 28% of deliveries that are subcontracted out to further limit employment benefits (Higgs, 2022).

Re-routing Retail

Logistics companies often argue that online stores are less carbon intensive than traditional bricks and mortar shopping. However, this framing does not take account of the advantages of local economic development, not the mention packaging; the hidden distribution emissions and the ease of online marketing tactics used by large

retailers to spur demand further for inessential goods.

While brick-and-mortar retail may look on one level to be more carbon intensive due to its physical presence, home delivery has been shown to significantly higher demand for distribution and warehousing space – 3 times traditional retail (Knight Frank, 2024). Significantly, the UK generates around [11billion](#) items of packaging waste a year, and with the average British householders ordering on average [200](#) parcels a year – with large [amounts](#) not being recycled – there is clearly an incentive to lessen the burden of this industry on the environment.

That these hidden costs are not addressed demonstrates a lack of visibility or debate on the topic at the national level, suggesting that political will is needed to the collect data and address the issues. Nevertheless, the gap between long-term decarbonisation strategies and political short-termism of means there remains a potential

reluctance to sign-off on regulation that could impact consumers.



Reframing the Problem

While it may seem that there are trade-offs between economic growth ambitions and regulation that seeks to reduce the consumption of goods and delivery services, we suggest a shifting in outlook onto what type of growth society wants. This may involve reframing ambitions to think more systematically about the unsustainability of the current consumption trends and how national action could lead the way for future economic benefits by supporting local economies. While logistics may seem like a blossoming industry when looking at national-level data, it is one with hidden costs and legitimate concerns around its ability to provide sustainable economic, social or environmental benefits.

Promoting Local Shopping

Encouraging less online consumption may mean fewer absolute products purchased, but it likely also may means more products sold locally, more by SMEs, more active travel and the support of more locally sourced and produced items. **Our first recommendation is therefore that national and local governments deploy public messaging to promote local shopping.** There is the opportunity for the government to back existing [grassroots campaigns](#) such as [Totally Locally](#), which provide communications tools for towns across the UK. When consumers shop locally, more money stays within the community and is recirculated locally, and local businesses are more likely to reinvest profits locally – supporting job creation and economic stability (AMIBA, 2014). Local economic development

is more sustainable socially and environmentally, providing job creation, better quality jobs and support for businesses embedded in communities (Brett and Alakeson, 2019). Public messaging that encourages citizens to shop locally over ordering individual items delivered to their doorstep could also help in reviving local economic centres and high streets.

An online sales tax?

Our second recommendation is to explore further options for an online sales tax. To create a more progressive tax system, government should seek to capture greater profits from large online retailers and use this revenue to support independent stores through business rates relief. Charges for home delivery could also encourage the substitution of small independent retailers often situated on high streets. While usually privately owned, these independent and locally rooted businesses also encourage economic pluralism and the pursuit of the common good through fairer labour practices, greater informal support and community initiatives (We Made That & LSE Cities, 2017).

Clarity about emissions

However, research has shown that switching methods to lockers or parcel shops, avoiding fast delivery and building more local fulfilment centres, combined with routing optimisation, already have the potential to dramatically reduce the number of delivery vehicles on the road. **So, our third recommendation would be to mandate online retailers, couriers and food delivery providers to inform shoppers of the emissions produced from their deliveries, encouraging them to combine orders and use more eco-friendly methods.**

Convening working groups and issuing guidance

As the immediate effects are felt locally, where there are limited resources and knowledge on how to support such urban infrastructure, **our fourth recommendation is for national government to focus on building capabilities by convening working groups and distributing design and funding guidance to local authorities.** Sharing best practice and case studies of private-public partnerships, as well as schemas for travel and logistics data sharing could also utilise soft power to support logistics infrastructure across the UK.

Putting in local infrastructure to make home delivery more efficient and less polluting is not enough to ensure environmental or social justice. Bold action and regulation are needed which can shift the dial on patterns of consumption. By moving towards greater local purchasing, consumers can make a substantial contribution to a more sustainable and prosperous future economy.

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