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The sustainability of the gig economy food delivery system (Deliveroo, UberEATS and Just-Eat): Histories and futures of rebound, lock-in and path dependency

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ABSTRACT

Online food delivery has transformed the last-mile of food and grocery delivery, with unnoticed yet often significant impacts upon the transport and logistics network. This new model of food delivery is not just increasing congestion in urban centers though, it is also changing the contours and qualities of those doing delivery—namely through gig economy work. This new system of food consumption and provision is rapidly gaining traction, but assessments around its current and future sustainability tend to hold separate the notions of social, environmental and economic sustainability—with few to date working to understand how these can interact, influence and be in conflict with one another. This paper seeks to work with this broader understanding of sustainability, whilst also foregrounding the perspectives of gig economy couriers who are often marginalized in such assessments of the online food delivery system. We make use of systems thinking and Campbell's conflict model of sustainability to do this. In assessing the online food delivery in this way, we seek to not only provide a counternarrative to some of these previous assessments, but to also challenge those proposing the use of gig economy couriers as an environmentally sustainable logistics intervention in other areas of last-mile logistics to consider how this might impact the broader sustainability of their system, now and in the future.

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1. Introduction

Dablanc (2019) suggests that e-commerce has influenced nearly all dimensions of urban freight and logistics: increasing the number of deliveries and collections; changing the type of vehicles (and their number) in our urban centers; altering the time and place of deliveries; fracturing labor organization and working conditions, and challenging local traffic and planning policies. The fracturing of working conditions has partly been enabled by digital platforms (e.g., *Deliveroo*, *UberEATS*, *Just Eat*), with Katta et al. (2020) noting the disruptive potential of technologies of this type to sectors of all kinds, with transport and logistics being one example of this.

Despite the fracturing of working conditions, gig work is sometimes positioned as an environmental solution to some aspects of the last-mile with little mention to how these solutions impact on the social and economic sustainability of the online food delivery system. This omission does, however, make some sense given the predominant focus on demand in transport and logistics, over how that demand comes to be serviced. But even when an assessment of the sustainability of gig economy courier work is made (see

Buldeo Rai et al., 2017; Galati et al., 2020; Li et al., 2020) these tend to separate the notions of economic, social and environmental sustainability—with little work to date having fully incorporated an understanding of how these “factors” influence, interact and are, sometimes, in conflict with one another.

Online food delivery has transformed the way that people purchase and consume food in recent years, and there is now a huge variety of companies offering on-demand take-away services. The platforms facilitating online food delivery, however, have taken on business models where those delivering the food (i.e., the couriers) are employed in what is known as the “gig economy.” Whilst some may consider these models as digitized analogues of more traditional courier work, there is more to the embedding of a digital platform. There has been a transformation of the system of food delivery, and, we argue, it is one with large and—currently—rarely measured impacts to the transport and logistics sector.

New digital services co-exist alongside more traditional couriership services and represent a significant change from more traditional takeaway and grocery services that require that individual restaurants and takeaways have the human

and vehicular resources necessitated to respond to consumers, as and when needed. The duality of these services has contributed to various forms of growth: from increased energy demand (Cass & Shove, 2017), to a growing number of delivery vehicles on the street (Allen et al., 2018b) and an increase in waste from food packaging (Song et al., 2018). Put another way, services like these represent an additional strain upon the transport and logistics' network, with more movement within cities as a "just-in-time" workforce (De Stefano, 2016) inundates, waits, and works in our urban centers, creating additional sources of waste that need to be transported, all whilst simultaneously changing the qualities and conditions of work for those couriership. The time-presures involved in just-in-time work have significant implications also for road safety (Christie & Ward, 2019).

In this paper, we apply systems thinking to what we consider to be the "dilemma" of online food delivery in the UK, specifically focusing on providing an assessment of the sustainability of online food platforms that depend on gig economy couriers. We focus in this way as a means of drawing the attention of transport and logistics researchers who position gig workers as a pro-environmental solution to some of the issues in last-mile logistics (e.g., Allen et al., 2018a; Buldeo Rai et al., 2017; McKinnon, 2016), without fully considering how these developments may come to bear on the social and economic dimensions of their sector.

Our intentions in this paper are twofold: (1.) to draw together the different aspects of sustainability of the online food delivery system in the UK, and (2.) to challenge those who position gig working couriers as a pro-environmental solution in other areas of last-mile logistics whilst failing to engage with the historical and future trajectories of this development, and the implications for sustainability more broadly. To do this, we answer the following questions: to what extent is the online food delivery system sustainable, and what can researchers who hope to integrate gig economy work into other areas of last-mile logistics learn from the developments that have taken place in online food?

1.1. An overview of online food delivery: Workers and platforms

Workers in the gig economy commonly take on work that is mediated through digital platforms matching workers and clients in the performance of short-term or individual tasks, colloquially known as "gigs" (Woodcock & Graham, 2019). This form of working has greatly expanded in recent years, with more than an estimated fifty million platform workers worldwide (Fairwork, 2020); including an estimated 4.7 million in the UK (which represents 9.6% of working-age adults)—an increase of 100% over the last three years (TUC, 2019). This figure represents gig economy workers more generally, which includes but is not exclusive to online food delivery, incorporating other fields like babysitting, graphic design and cleaning services as well. In short, there has been a sharp increase across all sectors in platform working in recent years.

Online food delivery platforms link goods' suppliers to consumers in last-mile logistics, making use of gig couriers

to do this. These platforms minimize their running costs by owning as few assets as possible, and workers, fixed capital, maintenance and training are predominantly outsourced (Srnicsek, 2017). In practice, this translates to the utilization of an independently contracted workforce, and no ownership—on the part of the platform—of vehicle fleets or physical infrastructure (e.g., warehouses) reducing the human and vehicle resources necessary, as well as middle-management costs.

The platforms typically take a percentage commission from both the delivery fees and the costs of meals and takeaways sold through them. For instance, Deliveroo takes a 35% commission of the meal and rider costs (Shead, 2020a), and even when restaurants and/or takeaways sell their produce via the platform but have their own in-house delivery, there is still a 5% commission taken from the cost of the meal (Marston, 2020). These commissions make the task of the intermediary lucrative in the short-term. Platforms can facilitate food delivery gigs to those who are signed up to receive them, if potential couriers have access to a vehicle (i.e., bicycle, motorbike, car) and smartphone capable of downloading an app that provides access to the platform (Hill, 2020).

Food delivery gig work is predominantly conducted by younger men, many of whom are migrant workers (Cant, 2019). It is challenging to say the exact characteristics of those working for online food delivery platforms, or how many people work in this context due to the dynamic and informal nature of the work. However, Deliveroo announced in 2020 that they were increasing their UK-based courier numbers to 50,000 couriers by the end of the year (Armitage, 2020)—a 286% year-on-year increase in their reported courier numbers.

A direct effect of working for such platforms is an increase in piecemeal work and paid piece-rates, requiring that workers string together enough gigs (Woodcock, 2020) to make adequate earnings. Data are core to the platforms' operating model (Doorn & Badger, 2020): they are required to match nearby workers to jobs; to monitor job progress; to measure performance; and to ensure a good consumer (i.e., restaurant/takeaway and customers) experience. Though data are required for the decision-making processes embedded within the algorithm, these processes do not provide a sense of how much a worker should expect to earn during a shift—with many reports suggesting it is inadequate (Barker, 2020; McClenahan, 2017)—nor whether work is fairly distributed among available workers—with workers suggesting that motorized vehicles are prioritized over more sustainable modes of transport such as bicycles (Farrell, 2019).

2. The sustainability of gig-economy food delivery platforms

The on-demand economy has led to consumer expectations for ever faster deliveries at low or zero cost. The true cost of delivery is often obscured (Bates & Friday, 2018; Dablan, 2019) by the elasticity of purchase costs, a measure of how

sensitive the quantity demanded of a good is to its price (Ellison & Ellison, 2009). This has led to the fragmentation of deliveries, with more A2B (pickup and delivery) jobs and fewer coordinated multi-drop delivery rounds (Reyes et al., 2018). This is especially so for takeaway meal deliveries, which are special case of optimal routing due to their very tight time window, though the algorithmic problem has been studied theoretically (i.e., the “Meal Delivery Routing Problem” (MDRP)). Combining two or more deliveries of hot food to reduce the number of journeys is difficult, particularly when trying to minimize deterioration in the quality of the product and avoid confusion or cross-contamination—though some solutions have been developed to better coordinate these deliveries (Reyes et al., 2018; Yildiz & Savelsbergh, 2019). Coordination challenges are further compounded when couriers work for multiple platforms (i.e., known as multi-apping) or suppliers (Wang, 2018). Whilst new digital technology and applications such as MDRP solutions provide better estimation of on-demand order fulfillment time (e.g., Zhu et al., 2020) these solutions also lead to higher expectations from customers, further driving growth in small vehicle movements in cities, and placing additional pressures on couriers (Dablanc et al., 2017).

Prior work has highlighted the increasing environmental impacts related to growing same-day delivery and pressures in the sector to provide faster A2B logistics (Allen et al., 2018b; Dablanc et al., 2017). But the time pressures on gig couriers are also prompting them to work faster and for longer. This, in turn, is leading to gig couriers upgrading from bicycles to scooters (Barratt et al., 2020) with likely implications on the carbon intensity of deliveries. Allen et al. (2018d), for instance, highlight that the increasing pressure for faster A2B deliveries reduces the scope of, and opportunities for, schemes such as parcel consolidation—considered key in reducing the environmental implications of last-mile logistics. The rise of on-demand deliveries in European cities is leading to a significant growth in small vehicle movements in already busy cities, whilst further reducing space on the streets and at the curbside (Dablanc et al., 2017).

Despite these pressures, self-employed, gig economy and casual piecemeal work has been seen as part of the solution, to some, of the environmental sustainability concerns of last-mile logistics. Proposals include “crowd logistics,” where groups of ad-hoc and informal workers are used for deliveries/collections rather than employing professional couriers (Buldeo Rai et al., 2017), crowdshipping (McKinnon, 2016) and pavement porters (Allen et al., 2018a) which also encourage the use of casual laborers and crowd workers. These modes of work have been suggested to help respond to consumer demand, utilizing flexible workforces and providing more environmentally sustainable options for logistics in hard-to-reach areas where delivery can be expensive (cf. crowdshipping). But are these forms of informal and flexible work actually sustainable?

To date, transport and logistics research has focused little on aspects of social sustainability in this context. Christie and Ward (2019) interviewed 48 and surveyed 231 respondents exploring the health and safety of gig workers and found that

the conditions were challenging: workers are fatigued, feel a pressure to violate traffic regulations to complete work on time, and also find themselves distracted when driving or riding by the apps that mediate their work. Due to the lack of regulation underpinning platforms and gig economy employers, drivers are provided with little training, and there is a high likelihood of collisions, particularly amongst those who are young and using two-wheeled vehicles (i.e., bicycles and motorbikes), putting both the worker as well other road users at risk. Building on this, Allen et al. (2021) outline, through a review of international case studies of on-demand meal delivery work, how the increasing pressures on couriers are leading to a rising usage of privately owned vehicles doing short A2B journeys—noting the environmental and logistic imprints of this on our urban centers.

In an approach closer to our own, Buldeo Rai et al. (2017) consider the sustainability (economic, environmental and social) of crowd logistics (as a form of gig economy delivery work). Whilst this analysis (Buldeo Rai et al., 2017) works across relevant stakeholder groups (including the “crowd”), it does not engage with the quality of work (or compensation) being offered, concentrating also on one moment in time. The authors do demonstrate, however, that it is relatively uncommon for research focusing on gig economy logistics to consider sustainability across its three primary dimensions.

Others have assessed the sustainability of online food delivery specifically. Galati et al. (2020), for instance, take on Deliveroo as a case study, investigating the main enabling factors that affect the adoption of sustainable strategies (e.g., electric vehicles). Having interviewed the managers of Deliveroo Italy, they foreground the perspectives of the platform highlighting how their results show that “[...] numerous initiatives and choices are a result of a corporate culture of sustainability which integrates social, environmental and economic concerns into [...] decision-making strategies and operations.” Pay and working conditions of Deliveroo workers, however, do not feature. Li et al. (2020) on the other hand, are more sensitive to the perspectives of those delivering for online food platforms, but they take on a pillar-by-pillar analysis, and do not consider how these pillars interact or might be in conflict.

In what follows we bring together these pillars in considering the online food delivery system in the UK, demonstrating how they interact and are in conflict. In doing so, we aim to challenge those that consider the dominant voice of the platform, over the perspectives of the worker, as well as those who consider gig workers as the idealized environmental solution (e.g., in the form of crowd logistics, crowdshipping and pavement porters) to some of the issues present in last-mile logistics.

3. Methodology: Applying systems thinking to the dilemma of online food delivery platforms’ sustainability

We now draw on a wider and interdisciplinary body of research to consider the system of online food delivery

platforms from multiple perspectives of sustainability. We follow Easterbrook (2014) in viewing a system as not purely technological, but instead as emerging as the result of the tight relationship that technologies have with human activity. A system here is any group of interacting components that has a specific purpose (Kim, 1999). The purpose of the system (in this case, online food delivery) is a property of the whole, and it is this purpose that defines a system as a discrete entity. By understanding our context in this way, we approach the dilemma of online food delivery differently than the work considered above.

The sustainability of gig economy food delivery platforms has previously been assessed through a pillar-by-pillar approach (Galati et al., 2020; Li et al., 2020), as popularized through the three circles diagram (Barbier, 1987). However, and in brief, these interpretations are intended to capture the intersecting relationship that exists between society, the economy and the environment, with sustainability emerging out of this intersection (Purvis et al., 2019). Despite the acknowledgement that these are not mutually exclusive, and that they form an intersecting relationship, exploring the phenomenon of online food delivery platforms in this way brings limitations. By separating “the system” in this way, it positions facets of that system as problems to be solved (i.e., through technological solutionism), or it implies that the individual properties of pillars are comparable or equitable, rather than the result of the interactions of the whole system.

There is, of course, purpose in this separation, in that it is needed when breaking that sustainability down in terms of its constitutive components (i.e., economic, social and environmental) to contribute to the distinct bodies of knowledge that exist around each. We too will analytically separate out the components in this way, but we attempt to overcome the conceptual separation of what is a holistic entity with the use of systems thinking in the analysis, and Campbell’s (1996) conflict model in the discussion.

Campbell (1996) introduced the “triangle” model of sustainable development as a means of explaining with conceptual simplicity how the three points of the model (economic, environmental and social) are generally in conflict with one another, with three defined conflicts existing across the axes. He explains:

[... T]he property conflict [economic vs. social] is characterized by the economy’s ambivalent interest in providing at least a subsistence existence for working people, and the resource conflict [economic vs. environmental] by the economy’s ambivalent interest in providing sustainable conditions for the natural environment, the development conflict [social vs. environmental] stems from the difficulty of doing both at once. (Campbell, 1996, p.299).

Using these concepts, alongside systems thinking, we work to acknowledge the recursive relationship of constituent elements of the system by emphasizing the relationship of the whole. Systems thinking (Córdoba-Pachón & Ochoa-Arias, 2010; Easterbrook, 2014) provides a set of concepts for understanding and reasoning about the behavior of a whole system. It works to counteract technological solutionism which treats complex problems too simplistically, by

applying a toolbox of standardized methods to problem situations—this being a critique of our prior work (Bates et al., 2018), as well as that of others. In a sense, we apply systems thinking to online food delivery platforms where prior work has largely treated the delivery of hot meals and groceries as a computational problem that can be solved with gig couriers as the moving resources necessary to match moments of demand with businesses capable of its supply. For example, by identifying, analyzing and implementing possible solutions computationally with the goal of achieving the most efficient and effective combination of steps and resources. We now explain the most pertinent tools from systems thinking, for our purposes, in brief.

Emergent behavior is the observation that systems tend to have characteristics that cannot be traced to individual components, but rather arise from the interaction of these components as a system—rebound effects are one prominent example of this. Jevons (1865) initially pointed out what we now term as the “rebound effect” when technological improvements that increased the efficiency of coal-use, led to its increased consumption in a wide range of industries. The rebound effect is now applied to the wide number of so-called efficiency technologies who tend to produce growth in their uptake and use, counteracting any environmental gains garnered through their new efficiency (Hilty & Aebischer, 2014).

A focus on change too, is necessary in a systems thinking approach. We do this by presenting a historical analysis of the development of online food platforms, showing how histories come to matter in the development of a system. We mobilize the concepts of path dependence and lock-in, to highlight how change in any system is rarely random but is instead the result of the system’s structure. David’s (1985) detailed history of the QWERTY keyboard popularized these concepts, and they are helpful in highlighting how past actions can commit us into specific (and at times unsustainable) tracks of development (David, 1985; De Wit et al., 2002). We build on the historical analysis by making use of public presentations and communications from these platforms to point to the future trajectories of development embedded in the platforms’ planning and promotions.

Finally, the role of critical analysis within systems thinking forces us to consider the disempowering effect of some systems, foregrounding the perspectives and experiences of couriers we have worked with, and placing more importance on these over more dominant voices like customers and restaurants/takeaways (as the consumers of the service) and the platforms (as the producers of the service) that are usually at the forefront in this debate. In doing so, we hope to address the imbalance, as even when gig couriers are considered in analyses of online food delivery’s sustainability, their perspectives are often backgrounded or not fully engaged with (e.g., Galati et al., 2020; Li et al., 2020).

This combination of concepts is particularly useful for answering our research questions (see p. 4) as it forces us to work with a broader sense of sustainability, emphasize the interrelation of the system of online food delivery (and its relation to last-mile logistics) and highlight how the

structural properties of systems are crucial to their later development.

Having presented these concepts here, it is crucial to note that social, economic, and environmental analyses of different transport modes and means is not entirely new. Of course, transport and logistics researchers have sought to combine understandings of sustainability in different ways, understanding them as factors, impacts and pillars and also in different combinations: social-economic (e.g., Zhang & Levinson, 2009), economic-environmental (e.g., Cochrane et al., 2017; Siragusa et al., 2022), social-environmental (e.g., Romanillos & Gutiérrez, 2020), and even social-environmental-economic (e.g., Alpkokin et al., 2016; Nuzzolo et al., 2016; Song et al., 2018). Despite this, we have found that—in some cases—research putting forth suggestions that impact upon work and workers (e.g., exploring models for different forms of Freight on Transit (FOT) as one solution to urban freight) appears to engage little with those whose work and its quality (e.g., pay, workers' protections) will be impacted.

Couriers are research objects instead, understood in relation to their cycling speeds (Romanillos & Gutiérrez, 2020), vehicle types (Siragusa et al., 2022) and as contributing strategies to potential innovations in freight modes (e.g., on foot or bicycle couriers moving freight from trains to consumer homes (Cochrane, 2017)). Whilst we are critical of this in this paper, we too have fallen into this same trap previously (e.g., Bates et al., 2018)—seeking to attend to driver effectiveness and efficiency to better support more sustainable forms of urban deliveries without considering the extra pressures that this has on couriers. We argue that transport and logistics could learn about the potential impact of some of their proposed interventions by looking at the sustainability of the system of online food delivery.

We, therefore, combine these foci and the tools of systems thinking across our case study of the three primary online food delivery platforms in the UK: Deliveroo, Just Eat and UberEATS. Given that these platforms differ, we focus mostly on Deliveroo due to the prominence of promotional and organizational materials online—when compared to the other two platforms. We concentrate on the UK as our work—to date—has been specific to this context. This work involves experience with couriers (gig economy and otherwise) gained over the course of three research projects (FTC2050, Switch Gig, and FlipGig)¹ conducted by a team of multidisciplinary researchers including a blend of technological and logistics research. Our most recent project, FlipGig, is interested in fairness for gig couriers—one aspect of social sustainability. We recognize that the latter projects have produced a particular bias for us as researchers, yet we believe that the voice of couriers has not been fully engaged with by those proposing environmental solutions, nor by those who have sought to assess the sustainability of the system (e.g., Galati et al., 2020; Li et al., 2020). In what follows, we hope to address this lack of engagement.

The remainder of the paper is structured as follows, first we provide a history of the online food delivery system, before then engaging with the different perspectives of the stakeholders of this system. We then provide an assessment of the sustainability of this system, employing Campbell's (1996) conflict model of sustainability to do this. Finally, we discuss the implications of this analysis for those seeking to integrate gig style working into other areas of last-mile logistics.

4. Systems thinking: Histories, perspectives and futures of online food delivery (rebounds, path dependence and lock-in)

4.1. The evolution of the online food delivery system

Recognizing that history matters for how systems come to develop (David, 1985; De Wit et al., 2002), we begin with a history of online food delivery to demonstrate some of the structural properties of its development. We make use of some of the threads highlighted by Hishamuddin (2019), before building on these to extend this history to the present (i.e., and the COVID-19 pandemic).

Whilst fish and chips dominated takeaway services in the UK until the 1970s, the rising trends of working women led to both an increase in household earnings as well as a reduction in the time available for domestic work like the preparation of meals (Ball, 1996). This coincided with a diversification of type of foods offered, as American chain food branches were popularized, leading to a steady growth of businesses offering takeaway services between 1980 and 1992 (Ball, 1996). This shift in lifestyles and foods led to increases in takeaway and home deliveries as consumers sought foods that were more convenient (Cullen, 1994).

With the advent and increasing popularity of the Internet, restaurants and takeaways soon had a new means of advertising their meals online. Just Eat (founded in 2001 in Denmark) moved to the UK in 2006 and offered a marketplace service which brought together a range of restaurant and takeaway options on one website (Competition and Markets Authority (CMA), 2017). Participating restaurants paid a registration fee to be listed on the site and paid a commission on every purchase by consumers (Competition and Markets Authority (CMA), 2017), however at this point, businesses still had to deliver their own foods.

Deliveroo expanded this model in 2013 by offering delivery (Deliveroo, 2016). Born of the technological solutionism described earlier, Will Shu (Deliveroo's founder) sought to algorithmically solve London's problem of slow and poor food delivery options (Deliveroo, n.d.-D). UberEATS opened their London operations in 2016 using a similar model (Toor, 2016). Just Eat followed in what it terms its "hybrid" model, allowing restaurants to make their own deliveries where possible, and offering deliveries through its partnership with French logistics company Stuart when needed (Just Eat, n.d.). These companies now operate across the UK, and the market is used by over 11 million people in the UK and has an estimated value of £8.5bn (Statistica, 2020).

¹www.FTC2050.com; <http://switchgig.wordpress.com>; www.FlipGig.org

Compared to the historically limited selection of take-aways, food delivery platforms now offer a wide range of foods including breakfast, coffees and desserts. Whilst this is partly due to the changing food landscape in the UK during this time, many of these products were not available for home delivery prior to online food delivery platforms. Grocery delivery services have also been added to the mix, with—for instance—Aldi partnering with Deliveroo (Deliveroo, 2020). Though groceries have long been available for home delivery, these platforms allow for same-day delivery instead of requiring that consumer book timeslots for later in the week.

Self-employed couriership itself did not, however, emerge from the above developments. Allen et al. (2018c) suggests that most same-day non-food parcel carriers in 1970s London were using self-employed couriers, and it was only when typesetters and printers required in-house same-day couriers that employed couriers emerged (Scott, 2016). By 2007, 80% of carriers were using independently contracted couriers, with only 29% having employed couriers (Synovate, 2007). Meanwhile and for meal delivery, 50% of responding companies made use of independent contractors, while 60% used employed couriers. As noted by Allen et al. (2018c), this situation has likely changed in the decade between the report and current day, due to the proliferation of food delivery platforms who use no employed couriers at all.

There are obvious differences between independent and employed couriers, as many legal protections only become accessible through employment (e.g., minimum wage, discrimination protections, sickness pay, parental leave, pensions etc.) (Prassl, 2018). The tightly defined and controlled nature of platform work has caused much debate—with the UK Supreme Court recently ruling that Uber (car sharing) drivers are entitled to employment rights (Russon, 2021). This decision was not, however, translated across to the meal delivery arm (i.e., UberEATS) of the company.

Arriving to present day, the impact of COVID-19 has turned what the Department for Business, Energy and Industrial Strategy (BEIS) noted as the “philosophical” (Department for Business and Energy and Industrial Strategy (BEIS), 2018, 70) work protection worries of gig economy workers into a very practical concern. The implications of this extend beyond the individual worker, to the collective public too. Making use of such a precarious workforce to deliver food during lockdown likely led to some workers working, despite illness, facing the stark choice of feeding themselves or self-isolating (Lord et al., 2020; Riordan et al., 2020).

Despite the practical consequences this could have had to the spread of COVID-19, the pandemic has accelerated the adoption of takeaway apps, according to Deliveroo’s founder Will Shu, by about two to three years (Shead, 2020b). More takeaways and restaurants have signed up to digitize their services overnight, demand also increased, and more couriers had to be recruited satiate this appetite. This has further deteriorated pay and work opportunities for existing

couriers by spreading available work more thinly (De Stefano, 2016).

Having traced the history of online food delivery, next we critically engage with the perspectives of pertinent stakeholders, before mobilizing the language of rebound effects, path dependence and lock-in in relation to the themes of social, economic, and environmental sustainability.

4.2. Engaging with perspectives of the stakeholders

4.2.1. Gig economy couriers

The online food delivery system depends on gig economy workers. This status impacts upon pay, health and safety, contract, benefits, pensions, as well as training and development, but it also goes further, causing issues in how other city users interact and react to riders (as termed by Deliveroo (n.d.-A)).

Costs associated with delivering meals (like vehicles and their associated costs etc.) are offset to the worker (De Stefano, 2016)—rationalized, again, due to their status as independent contractors. Though the term “independent” suggests that workers have free reign over the jobs and days they work, and companies often highlight the “flexible” nature of gig work (Deliveroo, n.d.-A), job allocation and resulting pay is determined by the design of the platform’s algorithm. Prassl (2018) suggests that “*tight control over all aspects of service delivery [is] the hallmark of algorithmic management*” (p. 96). Algorithmic management is deliberately obscure, and workers know little of the expectations around their work, how to attract more gigs or how to generate more income.²

Deliveroo (n.d.-A) suggest that the following factors are used to determine job allocation: How far it is from their current location to the restaurant; How long it should take them to park their vehicle; and the time they expect it will take the courier to travel from the restaurant to the customer. However, it is not clear how decisions are made between several couriers with the same characteristics.

Workers are aware too that those in motorized vehicles (e.g., cars or motorbikes) are usually given precedence over cycle riders (Farrell, 2019). They can complete jobs more quickly, travel further, work for longer as they get less fatigued and carry more food—suggesting that they might be viewed as “more productive” by the algorithm. Deliveroo (n.d.-C) deny this is the case, saying that it is area specific. Citing the examples of Chingford (Essex) and Solihull (Birmingham), they suggest that in areas with characteristics like one-way systems, parks or roundabouts and heavy traffic, bicycles can bypass traffic in ways other vehicles cannot. Whilst there is variation across the UK, many cities are designed around the car (Urry et al., 2017) meaning that, for the most part, bicycles are not prioritized.

Beyond their deprioritisation by online food platforms, policymakers and other important city stakeholders (e.g.,

²Deliveroo’s management algorithm, Frank, is said to be so complex that engineers at Deliveroo have created a visualisation tool termed ‘Frank’s Brain’ to better understand “what Frank is thinking” (Pudwell, 2017).

police, local councils) do not consider cycle couriers in their city decision-making. The city of York, for example, has one of the largest pedestrian zones in Europe, meaning that it should be easier for cyclists to deliver there. But where postal workers are allowed unrestricted access to these areas, riders are not—even when pedestrian zone restrictions were lifted during lockdown (MacMichael, 2020). Multiple incidents of rider conflict have ensued, as police officers did not always appreciate the “essential worker” classification accorded to food delivery workers—resulting in fines for working rather than staying at home (MacMichael, 2020). Where complaints are made about a rider, or if their performance falls below expected (and unknown) standards, they can be terminated (Andersson, 2020) finding themselves unable to log in, usually with little to no notice about why.

4.2.2. Consumers of the platforms: Businesses and customers

We now consider the consumers of this system. Normally, this would refer only to customers, but with the online food delivery system, restaurants and takeaways are also implicated as consumers of the platform.

Initially, signing up to online food platforms was optional, as other means of delivery existed. However, their level of saturation now means that businesses must sign up to attract customers, leading to one manager describing Deliveroo as a “double edged sword” which restaurants cannot afford to not buy into (Heward, 2019).

Both sets of consumers, however, do have the advantage of convenience by making use of such services—even if it comes at a premium. For customers, these platforms represent an amalgamation of all food delivery services in their local area, whilst for restaurants and takeaways, these platforms offer a quick and easy means of finding an established customer base.

Online food delivery platforms have not just diversified the foodstuffs available for home delivery—as described earlier—they have allowed for businesses to diversify themselves. Virtual brands allow businesses to operate multiple brands from one kitchen. Sold to trial new ideas and cuisines whilst lowering the risk of damaging established reputations, brands reduce the running costs associated with running multiple businesses. Different brands can, for instance, target specific audiences (e.g., vegan) and broaden their appeal. However, in certain cases, businesses simply offer similar or the same menu under different names (Eccles, 2021) and one business in Reading operated under 40 different virtual brands (Markson, 2021). Strategies like this allow for a business to increase their presence on a platform and boost their sales. Whilst there are clear advantages for restaurants to do this, customers may be misled—particularly as it is not clear that brands are not always individual businesses.

4.2.3. The platforms: Models of continual growth

From the perspective of the platform, offsetting costs allows for platforms to extend their services to increasing numbers

of areas (and countries) for little to no costs (Graham, 2020). The active efforts involved are also lessened due to their algorithmic rather than a human operator (Lee et al., 2015).³ After the initial design of the system, large numbers of commission-based meals can be sold with relative ease. This creates a lean service, increasing the economic competitiveness of the operator in relation to those using employed couriers who have increased costs like management, and staff pay and protections.

Operations depend on control over data as their accumulation and aggregation are crucial. Outside of their use to manage and allocate gigs, they allow platforms to understand consumers and improve the targeting of their services at them. As Deliveroo (2016) explains it, data allow restaurants and takeaways to secure new customers, drive demand during less busy periods (e.g., Sundays) and market themselves.

There are other ways in which a data-led understanding of the consumer is used. Because platforms can predict when more workers are needed, areas can be flooded with more workers than there is work available (through fee “boosts”), making deliveries more efficient. With a bank of workers waiting, consumers do not have to wait. Casual labor contracts can be leveraged to onboard more workers too, meaning that less profits are passed to individual workers as work and pay is spread more thinly. Riders have reported waiting for long periods of time for jobs to be allocated; a form of unpaid labor, even though waiting produces the value of efficiency for the platform.

Following a Silicon Valley approach (Hambrecht, 1984; Zhang, 2007), this business model depends on continual growth and, therefore, venture capitalist funding (Deliveroo, 2016). Estimates from 2019 suggest that the amount of capital invested into Deliveroo since 2013 totals more than \$1.5 billion (BBC, 2019). Funding is attracted by leaning on the idea that if market domination is achieved, there will be profitability in the future.

4.3. Assessing the sustainability of the system

Having considered the perspectives of the relevant stakeholders of the online food delivery system, we now turn to an assessment of the sustainability of it. We separate the pillars, then bring them back together through the concepts introduced earlier—a conceptual shift that is subtle but produces particular insights around our current paths of developments and their future sustainability.

4.3.1. Environmental sustainability: Convenience and rebound

The dependence on the system on data, means that—currently—little is known of the energy intensity of these services, but the global impact of data centers is growing (Morley et al., 2018).

³It is also less reputationally damaging to be able to blame an algorithm, when compared to a human operator.

The convenience of the system for its consumers is crucial, even if it does have a price, as this produces rebounds. When services are made more convenient, they tend to be used more often (Shove, 2003). Statistica (2021) suggests that there has been a £1.5bn growth in the UK market in the last two years. This growth is also reflected in the transport network, with an increase in traffic, road traffic incidents (e.g., crashes) and parking/loading bay usage, and more densely populated, congested and polluted urban areas. More deliveries also mean increased packaging (Song et al., 2018) and the increased use of motorized personal vehicles (i.e., cars and motorcycles) by delivery drivers (cf. Allen et al., 2021).

Because gig workers use private vehicles, some of these impacts are challenging to measure. But they are growing in line with the increasing number of couriers and driven mileage (Allen et al., 2021). Platforms are quick, however, to highlight their use of cycle couriers, or the possibility of using e-vehicles for the work. For instance, the Managing Director of Deliveroo for the UK and Ireland said:

“[...] we are working hard to make sure we are a green company too. Electric vehicles and bikes represent an environmentally friendly, neighborhood conscious solution to cut emissions which save riders money in the long run” (Deliveroo, 2019).

Researchers too have made this suggestion when recommending this style of work as an environmental solution (e.g., Allen et al., 2018a; McKinnon, 2016).

Whilst electric vehicles may be suggested as an option, the onus of purchasing is currently on couriers. They are, however, currently expensive. Siragusa et al. (2022) suggests that EVs only prove to be economically beneficial when an 8-year time frame is considered, which is in tension with the casual and part-time nature of many workers (Dupont et al., 2018). Whilst Deliveroo offers rental services for hiring an e-scooter, these range between £79–94 a week (Deliveroo, n.d.-B), a fee that can take a courier over 12 hours to make (Bernal, 2020).

The prioritization of motorized vehicles over cycles in job allocation (Farrell, 2019) too means that as cycle couriers take increasing note of their disadvantage, they are likely to defect from their cycles or from this work, recognizing the difficulties of making adequate earnings through the only cheap sustainable option.

4.3.2. Social sustainability: (dis)empowerment

Convenience, again, is key in understanding the social sustainability of the system—as this has changed the relationship that consumers have with food delivery (Li et al., 2020). For restaurants and takeaways, it splits the work of delivery from making food. For customers, it requires that they insert their information (name, address, payment information) once, to be allowed to order from several businesses at any time.

The attraction of more customers and orders increases the market share of platforms—ever working toward market dominance. A part of this growth strategy, however, is that the platforms hire an increasing number of workers, giving further rise to the “just-in-time workforce” (De Stefano,

2016). This is required to maintain an efficient service as the platforms have workers waiting to receive orders, rather than consumers waiting for collection and deliveries. The protections and pay around this type of work are not clear, with reports suggesting that workers make inadequate earnings both to satisfy the demands of daily life, but also for the level of work conducted (Bernal, 2020).

This unpredictability, coupled with distraction from interacting with the mobile app while moving, has been associated with risky behaviors. Riders are under pressure to violate traffic regulations, experiencing occasional collisions or near misses that impact their safety and other users of transportation networks (Christie & Ward, 2019; Gregory, 2021).

These working conditions are not possible to maintain over time. Those with families or who hope to achieve a certain and relatively basic standard of living may struggle to do so. This results in a high turnover of workers, as the work being offered is better suited to those looking to supplement other earnings (e.g., students, part-time workers). It is not clear how many students work for Deliveroo. 21% of those surveyed were full-time students, but the remaining 79% did include any part-time students (Dupont et al., 2018).

Depending on a high turnover is contentious, as our work has shown that those with more experience are better able to negotiate which gigs they should reject, and which routes they should take, making use of their expert knowledge to increase possible earnings (Bates et al., 2018; Bates et al., 2020). Depending on a fast-changing and inexperienced workforce allows for platforms to maintain power, ensuring all gigs are fulfilled whether the earnings made from it are worth the effort or not. With no earning guarantees for workers, it is of no surprise that many workers choose to move onto other domains when possible.

To make a living wage without this knowledge, riders must be logged in for 10+ hours a day waiting for work. Online food delivery has a particular rhythm, as meals are generally bought at mealtimes. This rhythm is not conducive to 10-hour shifts, requiring that workers go out for short bursts of time, multiple times a day.

In combination, this suggests that the current system is following a path dependence (David, 1985) whereby consumers are increasingly dependent on a system that its workers cannot depend upon. This is only more challenging in the context of COVID-19 as more couriers are onboarded, and more deliveries are being ordered. Whilst future work is required to see whether these effects are long-lasting, the concepts of path dependence and lock-in suggest that systems are developed on top of past actions, and these may commit us to certain tracks of development.

4.3.3. Economic sustainability: Future visions of market domination and automation

The leanness of the business model we argue depends on a leveraging of economic competitiveness to attempt to reach market domination but effectively the economic sustainability of the sector itself is also depressed. By decoupling the

cost of delivery from the delivery itself, leveraging elastic pricing (Ellison & Ellison, 2009), and offering these services at a cut price, the service being sold is devalued.

Consistent with other venture capitalist supported digital business growth, Deliveroo has yet to make any profit, losing money on every delivery made during the seven years of its operation (Ball, 2020). But if control of the system is achieved, online food delivery platforms could make use of their data collection to further redesign the system.

Deliveroo have presented their future visions to their funders and in doing so, hinted toward some threads of path dependence that we may see in the future. Deliveroo's plans suggest that the company would like to: 1) Create its own food offerings, personalized for customers; 2) Halve the cost of food for customers; 3) Automate delivery, and 4) Double its profit margins (Panja, 2018).

To do this, Deliveroo must, first, expand its services from food delivery mediation to food production too. The accumulation and aggregation of customer data (i.e., what customers purchase and when) means that Deliveroo not only understands the consumer base of most takeaway and restaurant services in the UK but could mobilize this knowledge to compete with the businesses currently on their platform. Secondly, the cost of delivery and production will be reduced by making use of new delivery technologies such as drones as a form of delivery automation instead of utilizing human riders. Though the short-term costs are much higher, in the long-term, drones do not require payment. Of course, depending on automation over human labor means that these services will no longer provide work opportunities in the communities that they profit from.

By leveraging a weak labor market and extracting data, Deliveroo and similar models are to set to further disrupt the restaurant/takeaway industry, as well as last-mile logistics. Whilst it is relatively easy to wave away the implications of such transformations, they are latent and already becoming. Elements of this new system are already in production, with Deliveroo setting up its own "ghost kitchens" (known as Deliveroo Editions) where established or new businesses can hire small kitchen spaces from Deliveroo (Heward, 2019).

This is not, however, the first time that the goal of profit-maximization, the existence of monopolies and severe competition (common qualities in different components of the transport and logistics sector) has been understood to influence economic profitability, whilst deteriorating social optimality (e.g., in the context of private roads (see, Zhang & Levinson, 2009)).

4.3.4. Conflicts across the model

Having provided an assessment of the system across the three dimensions of sustainability, we now work to consider how these are in conflict (i.e., are incompatible) with one another.

Campbell's (1996) conflict model of sustainability suggests that planners (or in our context, developers of systems) must reconcile three conflicting interests: "to "grow" the economy, distribute this growth fairly, and in the process

not degrade the ecosystem" (Campbell, 1996, p.297). In short, interests are often in conflict. However, what is particularly fascinating in the case of online food delivery as it has been implemented through platforms like Deliveroo, UberEATS and Just Eat, is that—it would appear—that all three conflicts (i.e., property, development and resource) exist at once. There is no prioritization of any of the goals of sustainable development, only that of market domination.

Online food delivery contributes to evolving expectations around convenience in food delivery, produces rebound effects which counteract any environmental savings made in reducing the number of trips consumers make in relation to food provision and consumption (with these simply being replaced by couriers making these trips instead).

Socially, these platforms disrupt working conditions for couriers, exploiting legal loopholes around categorizations of their workers as "independent contractors." Economically, customers and businesses find themselves paying more for a service through the fees paid for platforms to act as mediators. Yet, despite the leanness of the model, these platforms are not economically sustainable either. Instead, market domination is the goal, devaluing the very service that they provide in the attempt to attract a larger market share. Looking to the future, profits are only expected once platforms can begin to make use of further automation in the form of drones etc., working to attract profits without providing opportunities for labor and capitalizing on the data accumulation and aggregation they have conducted as a means of pushing out restaurants and takeaways.

This system involves all three conflicts described by Campbell (1996). The economy is not being grown, outside of the gig economy itself, and its wealth is not distributed fairly. And whilst there has been much discussion around the use of bicycles and electric vehicles for this work—costs and job allocation priorities suggest that these modes of transport may not be economical to couriers.

5. Discussion: Transport and logistics must think more broadly about sustainability

In this paper, we have used two sets of concepts to seek to understand the sustainability of the online food delivery system: systems thinking and Campbell's (1996) conflict model of sustainability. Approaching the topic of online food delivery in this way has allowed us to provide a historically situated assessment of different stakeholder perspectives, whilst considering the rebound and path dependence that has been built into the current system of online food delivery.

The intention in doing this has been two-fold: (1) to push back on those who call for a gig economy style of work to be integrated into other aspects of last-mile logistics, and; (2) to provide a counternarrative to those who have assessed this system across the pillars of sustainability whilst failing to bring these pillars together.

Pillar-styled analyses, often, take the phenomena at one point in time, as opposed to considering the trajectories of development in which systems are entangled, and they often foreground the dominant voice of platforms over the

consumers and workers of these platforms (e.g., Li et al., 2020; Galati et al., 2020). Though we too have worked to understand the constitutive elements of sustainability (i.e., environmental, social, and economic) by analytically separating them, we have done this using a vocabulary and a set of tools that allow us to draw attention to the interacting, influencing and conflicting factors of the system itself.

The insights that have been produced suggest that such platforms are not (environmentally, socially and/or economically) sustainable. Further to this, all three of Campbell's (1996) defined conflicts are present in the current system, and there appears to be no apparent prioritization of economic, social or environmental sustainability. Instead, these platforms are working toward domination in a saturated marketplace, in the hope that profits will follow.

It is not our suggestion, however, that this is the intention with transport and logistics researchers who have proposed the use of gig style workers (e.g., crowd logistics) in other facets of last-mile logistics as an environmental solution. We have no doubt that such suggestions are intended to work against the growing pollution and congestion of last-mile logistics. However, and as we have shown, online food delivery is itself tightly intertwined as a system, and this is connected to the broader system of transport and logistics. Our history demonstrated how online food platforms have borrowed, lifted, and then extended parts of the transport and logistics sector with important implications. In this moment, transport and logistics appears to be seeking to borrow from online food delivery. The interconnected nature to the trajectories of development across both suggests that we must be cautious in doing so.

This caution stems from the fact that certain solutions that are intended to increase the environmental sustainability of systems may have rebound effects which could not only lead to a reduction in expected (environmental) gains from a solution but might also further deteriorate the conditions of work for those working within them (Bates et al., 2018). As Easterbrook (2014) suggests, innovations in digital models (or ICTs more generally) may be counterproductive if they contribute to underlying unsustainable trends in consumption and provision. We extend this by arguing that borrowing from these models without seeking to first fully understand their impacts and conflicts is likely to lead to new problems within transport and logistics.

Prassl (2018) suggests that whilst all the issues of gig economy work (e.g., unpredictability of earnings and of work; health and safety; fairness in work allocation) cannot be solved by a recategorization of gig workers as independent contractors, it is a crucial first step. Many employment law systems limit employers' powers in important ways. Platforms miscategorize their workers as a means of retaining a competitive advantage over others in the sector, with Prassl (2018) terming this as an attempt to have "the best of both worlds" with platforms combining "the full control and financial rewards enjoyed by employers with the lack of responsibility inherent in contracting independent service providers." This has implications on other operators in the sector, putting pressure on them to adopt similar models,

lowering their prices and casualizing their workforces to stay afloat.

Prassl (2018) is not alone in these suggestions, and the review on modern working practices (Taylor et al., 2017) also suggests that there should be new legislation to protect what they term as "dependent contractors" whose work is tightly controlled by platforms, moving them toward employee status or drafting new regulations that protects platform workers. Whilst that legislation is yet to be developed, we caution others against attempting to exploit those same loopholes, suggesting that this move is something of a "lock-in" in terms of a system's development. It is difficult to reverse and sets a system off down a specific and, arguably, unsustainable route. Though transport and logistics researchers may be interested in how they might increase the competitive advantage of their own systems, recognizing the economic benefits (but not sustainability) of doing so, we suggest that they should take heed of current design of online food delivery and its future ambitions, recognizing the unsustainability of making use of these designs in their own systems as a quick environmental fix.

Campbell (1996) introduced his conflict model in reference to attempts to "get to the center of the triangle" (i.e., sustainable development) through the elusive balancing of conflicting goals. Despite the challenges of balancing, transport and logistics should attempt and ensure that it does not borrow too much from a system plagued by conflict and with no interest in resolving it. Integrating the goal of overall sustainability into interventions of different types, no matter the difficulty, will increase the likelihood of a green, growing and just last-mile logistics.

Practically speaking, we call for other researchers interested in the environmental sustainability of their logistics systems to consider working with a broader sense of what sustainability is, which partly involves speaking more with those whom their proposed innovations may impact upon. Whilst work that incorporates the perspectives of different stakeholders exists, so-called expert panels often do not include workers or consumers (e.g., Perveen et al., 2019). Working with couriers has uncovered a range of issues, further contextualized by understanding the historical and future development of the systems they work in. Rather than innovating *at* couriers, transport and logistics should seek to innovate *with* them—better incorporating their knowledge and interests. Whilst we commend the interventions developed by researchers with the environment in mind, it is time to consider sustainability more holistically, avoiding the technological solutionism and pillared approach that ignores the broader dimensions of sustainability and its rebounds.

Rebound effects are already impacting the system of online food delivery, deteriorating that system in terms of its future sustainability. We recommend that researchers take seriously this idea when designing new models and think carefully about how their proposals may impact workers now, and in the future. As Kim (1999) suggests, a systemic perspective allows for us to engage with the role that we play in how systems work and let us function more

effectively and proactively within them: “The more we understand systemic behavior, the more we can anticipate that behavior and work with systems (rather than being controlled by them) to shape the quality of our lives” (Kim, 1999, 1). Ultimately, disruptive technologies are already transforming working lives, opportunities, and the environment, promising convenience whilst hiding a triumvirate of sustainability impacts and conflicts. As a society we need to be recognizing this digital revolution and act now to lock-in a more holistically sustainable future.

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